RICHARD T. BISSEN, JR.
Mayor

JOSIAH K. NISHITA
Managing Director

JORDAN MOLINA
Director

PAUL M. BARANY, P.E.
Deputy Director

WADE SHIMABUKURO, P.E.
Development Services Administration

RODRIGO "CHICO" R. RABARA, P.E.
Engineering Division

JOHN R. SMITH, P.E.
Highways Division

Telephone: (808) 270-7845
Fax: (808) 270-7955

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
200 SOUTH HIGH STREET, ROOM NO. 434
WAILUKU, MAUI, HAWAI`I 96793
www.mauicounty.gov/publicworks

October 4, 2024

Ms. Mary Alice Evans
State of Hawai'i
Office of Planning and Sustainable Development
Environmental Review Program
235 South Beretania Street, Suite 702
Honolulu, Hawai'i 96813

SUBJECT: DRAFT ENVIRONMENTAL ASSESSMENT AND ANTICIPATED FINDING OF NO SIGNIFICANT IMPACT FOR THE PROPOSED WAIALE ROAD EXTENSION PROJECT AT WAIKAPU, MAUI, HAWAI'I

Aloha Ms. Evans:

The County of Maui, Department of Public Works hereby transmits the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFNSI) for the Waiale Road Extension project for publication in the next available edition of the Environmental Notice. The proposed project will affect portions of Tax Map Keys (TMKs) (2)3-6-002:003 and 004; (2)3-6-004:003; (2)3-5-002:001, 009, 014, and 888; and (2)3-5-036:035.

In addition to this letter, we have also submitted the electronic version of the Environmental Review Program Publication Form and a searchable PDF-formatted copy of the DEA-AFNSI through the online submission platform.

If you have any questions, please contact our Planning consultant, at (808) 244-2015 or via email at planning@munekiyohiraga.com.

Sincerely,

JORDAN MOLINA
Director of Public Works

JM/RR/NY (ED24-0784)
S:\ENG\PROJECTS\02 CIP\2021\21-33 Waiale Road Extension\C Environmental\HRS 343\2024-10 21-33 Waiale Road Ext Agency Determination Letter.doc

cc: Nolly Yagin, Department of Public Works
Kathleen Chu, Bowers + Kubota
Jared Chang, Bowers + Kubota
Hoku Krueger, Munekiyo Hiraga

From: webmaster@hawaii.gov
To: DBEDT OPSD Environmental Review Program
Subject: New online submission for The Environmental Notice
Date: Wednesday, October 30, 2024 1:17:12 PM

Action Name

Waiale Road Extension 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

Wailuku, Maui

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

Portions of (2) 3-6-002:003; (2) 3-6-002:004; (2) 3-6-004:003; (2) 3-5-002:001; (2) 3-5-002:009, (2) 3-5-002:014; (2) 3-5-002:888; (2) 3-5-036:035

Action type

Agency

Other required permits and approvals

See Chapter IX of Draft EA

Proposing/determining agency

County of Maui Department of Public Works

Agency jurisdiction

County of Maui

Agency contact name

Nolly Yagin

Agency contact email (for info about the action)

Nolly.Yagin@co.maui.hi.us

Email address for receiving comments

waialeroad@munekiyohiraga.com

Agency contact phone

(808) 270-7845

Agency address

200 S. High Street
Kalana O Maui Bldg. 4th Floor
Wailuku, Hawai'i 96793
United States

Map It

Is there a consultant for this action?

Yes

Consultant

Munekiyo Hiraga

Consultant contact name

Cathleen Krueger

Consultant contact email

planning@munekiyohiraga.com

Consultant contact phone

(808) 244-2015

Consultant address

305 High Street
Suite 104
Wailuku, Hawai'i 96793
United States
Map It

Action summary

The County of Maui Department of Public Works proposes the extension of Waiale Road from its current terminus at East Waiko Road southward to Honoapiilani Highway at the intersection of Old Quarry Road, to support regional transportation needs and future land uses in the Waikapu region. The Waiale Road Extension is currently proposed to be approximately 8,600 lineal feet (lft.) in length generally within an existing 80-ft. access and utility easement that traverses over former sugar cane fields. It includes two (2) vehicle lanes, shoulder bikeways, pedestrian sidewalks, a shared use path, drainage improvements, underground utilities, and grassy swales to lessen the impact of stormwater pollution. The proposed project also contemplates four (4) intersections, which will each be evaluated for various treatments including single-lane roundabouts, signalization or other traffic controls. Additionally, a bridge will be constructed to cross Waikapu Stream.

Reasons supporting determination

See Chapter VIII of Draft EA.

Attached documents (signed agency letter & EA/EIS)

- Waiale_Road_Draft_EA_Volume_II_of_II_October_2024.pdf
- Waiale_Road_Draft-EA_Volume_-I_-of_-II_October_2024.pdf
- Waiale_Road_Extension_DPW_AFNSI_10.04.24.pdf

Action location map

- Waiale_Road_Extension_Shapefile.zip

Authorized individual

Cathleen Kruger

Authorization

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

VOLUME I OF II
(Including Appendices A to D)

Draft Environmental Assessment

WAIALE ROAD EXTENSION PROJECT WAIKAPU, MAUI, HAWAII (TMK NOS. (2)3-6-002:003(POR.), 004(POR.); (2)3-6-004:003(POR.); (2)3-5-002:001(POR.), 009, 014(POR.), 888(POR.); AND (2)3-5-036:035(POR.))

Federal Project No: STP-3180 (001) Federal Highway Administration

Prepared for:

U.S. Department of Transportation
Federal Highway Administration,
State of Hawaii
Department of Transportation, and
County of Maui
Department of Public Works

November 2024

VOLUME I OF II
(Including Appendices A to D)

Draft Environmental Assessment

WAIALE ROAD EXTENSION PROJECT WAIKAPU, MAUI, HAWAII (TMK NOS. (2)3-6-002:003(POR.), 004(POR.); (2)3-6-004-003(POR); (2)3-5-002:001(POR.), 009, 014(POR.), 888(POR.); AND (2)3-5-036:035(POR.))

Submitted Pursuant to
42 U.S.C. 4332 (2) (c), 49 U.S.C. 303, by the
U.S. Department of Transportation
Federal Highway Administration
and
County of Maui
Department of Public Works

November 2024

CONTENTS

K:\DATA\BOWERS\WAIALE ROAD EXTENSION\APPLICATIONS\DRAFT EA\(DRAFT) NEPA DEA.DOCX

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES (VOLUME I OF II)

LIST OF APPENDICES (VOLUME II OF II)

Executive Summary

Project Name:	Proposed Waiale Road Extension Project
Type of Document:	Draft Environmental Assessment
Legal Authority:	Chapter 343, Hawaii Revised Statutes (HRS) 42 United States Code, subsection 4321 et seq.
Anticipated Determination for Chapter 343, HRS Environmental Assessment:	Anticipated Finding of No Significant Impact (AFNSI)
Applicable Environmental Assessment review "Trigger":	Use of State and County Lands and Funds Use of Federal Funds
Location:	Maui Island Waikapu TMK Nos. (2)3-6-002:003(por.), 004(por.); (2)3-6-004:003(por.); (2)3-5-002:001(por.), 009, 014(por.), 888(por.); and (2)3-5-036:035(por.)
Landowners:	County of Maui 200 South High Street Wailuku, Hawaii 96793 Waiale 905 Partners LLC P.O. Box 1870 Manteca, California 95336 Waiko Baseyard LLC P.O. Box 5 Kula, Hawaii 96790
Applicant:	County of Maui Department of Public Works 200 South High Street Kalana O Maui Building, 4th Floor Wailuku, Hawaii 96793 Contact: Jordan Molina, Director Phone No.: (808) 270-7745

Approving Agency for Chapter 343, HRS Environmental Assessment:	County of Maui Department of Public Works 200 South High Street Kalana O Maui Building, 4th Floor Wailuku, Hawaii 96793 Contact: Jordan Molina, Director Phone No.: (808) 270-7745
Consultant:	Munekiyo Hiraga, Inc. 305 High Street, Suite 104 Wailuku, Hawaii 96793 Contact: Hoku Krueger, Associate Phone: (808) 244-2015

Project Summary:

The County of Maui, Department of Public Works proposes the extension of Waiale Road from its current terminus at East Waiko Road southward to Honoapiilani Highway at the intersection of Old Quarry Road, to support regional transportation needs and future land uses in the Waikapu region of the island of Maui. The project is largely located on portions of Tax Map Key (TMK) (2)3-6-002:003 (Parcel 003), owned by Waiale 905 Partners, LLC, and TMK (2)3-6-002:004 (Parcel 004), owned by the County of Maui. The northern end of the project is located on, and adjacent to, portions of five (5) other parcels: TMK (2)3-5-002:001 (Heona Investments, LLC), (2)3-5-002:009 and 014 (Waiko Baseyard, LLC), (2)3-5-002:888 (Waikapu Stream), and (2)3-5-036:035 (Geste L. & Chaminade Ornellas). A small portion of the project near Old Quarry Road to the southwest is owned by Waikapu Properties, LLC (TMK (2)3-6-004:003(por.)). Waikapu Gardens and industrial businesses are located to the north, Maui Tropical Plantation is to the west, Kuihelani Highway is to the east, and vacant agricultural lands are to the south. The Waiale Road Extension is currently proposed to be approximately 8,600 lineal feet (ft.) in length generally within an existing 80-ft. access and utility easement, which will be subdivided and dedicated to the County, and traverses over former sugar cane fields. It includes two (2) vehicle lanes, shoulder bikeways, pedestrian sidewalks, a shared use path on the west (mauka) side of the roadway extension, drainage improvements, installation of underground utilities (e.g., potable water mainlines, gravity and forcemain sewerlines, reclaimed (R1) waterlines, drainlines, electrical ducts, and associated appurtenances), and grassy swales to lessen the impact of stormwater pollution. The proposed project also contemplates four (4) intersections, which will each be evaluated for various treatments including single-lane roundabouts, signalization or other traffic controls. Additionally, a bridge will be constructed to cross Waikapu Stream.

The subject properties are designated "Urban", "Rural" and "Agricultural" by the State Land Use Commission, and "Light Industrial" and "Agriculture" district by the Wailuku-Kahului Community Plan. The project site is designated "Waikapu Country Town District" and Parcel 004 is designated "Agricultural" by Maui County Zoning. The project site is situated within the County of Maui's Urban Growth Boundary and Small Town Boundary as set forth by the Maui Island Plan (MIP). The subject properties are not located in the Special Management Area (SMA) of the island of Maui. Portions of the proposed project site are located within MIP Protected Areas (Park and Preservation).

The proposed project will utilize State and County funding and will also involve installation of infrastructure improvements along Waiale Road and East Waiko Road (County right-of-way), as well as Honoapiilani Highway (State right-of-way). Use of State/County funds and State/County lands are triggers for preparation of an Environmental Assessment (EA) pursuant to Chapter 343, Hawaii Revised Statutes (HRS). The County of Maui, Department of Public Works will serve as the approving agency for the EA. Furthermore, the County of Maui was awarded funding support from the Federal Highway Administration (FHWA) through the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) program, thereby triggering requirements of the Federal National Environmental Policy Act (NEPA) of 1969.

Based on the foregoing, this Draft EA document has been prepared to jointly satisfy HRS and NEPA requirements. It is noted that a HRS Chapter 343, Final EA was published in 2011 for the Waiale Road Extension, with a number of technical studies including traffic, archaeological, cultural, and drainage impacts. New studies have been prepared and conducted for the preparation of this document and proposed project.

List of Acronyms

ADA	Americans with Disabilities Act
AIS	Archaeological Inventory Survey
ALISH	Agricultural Lands of Importance to the State of Hawaii
CIA	Cultural Impact Assessment
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO2 EQ	Carbon Dioxide Equivalent
CWB	Clean Water Branch
CWRM	Commission on Water Resource Management
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DA	Department of Army
DOE	Department of Education
DOH	Department of Health
DPW	Department of Public Works
DWS	Department of Water Supply
EA	Envrionmental Assessment
EO	Executive Order
EPA	Envrionmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highways Administration
FIRM	Flood Insurance Rate Map
GHG	Greenhouse Gases
gpm	gallons per minute
GPS	Global Positioning System
HAR	Hawaii Administrative Rules
HCZMP	Hawaii Coastal Zone Management Program
HDOT	Hawaii Department of Transportation
HICRIS	Hawaii Cultural Resource Information System
HOA	Homeowner Association
HRS	Hawaii Revised Statutes
IcB	Iao Clay
IPaC	Information for Planning and Consultation
JAC	Jaucas Sand
JD	Jursidictional Determination
kV	kilovolt
Leq(h)	Hourly Equivalent Sound Levels
LOMR	Letter of Map Revision
LOS	level of service
LRFI	Literature Review and Field Inspection
LSB	Land Study Bureau
LWCF	Land and Water Conservation Fund
MG	Million Gallons

MGD	Million Gallons Per Day
MIP	Maui Island Plan
MPD	Maui Police Department
MPH	miles per hour
MRTDM	Maui Regional Travel Demand Model
NEPA	National Envrionmental Policy Act
NHPA	National Historic Preservation Act
NHO	Native Hawaiian Organization
NPS	National Park Service
NWI	National Wetlands Inventory
PpA	Pulehu Silt Loam
PrB	Pulehu Cobbly Silt Loam
PtA	Pulehu Cobbly Clay Loam, 0 to 3 percent slopes
PtB	Pulehu Cobbly Clay Loam, 3 to 7 percent slopes
PUC	Public Utilities Commission
PZUE	Puuone Sand
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
ROE	Right-of-Entry
ROW	Right-of-Way
SCAP	Stream Channel Alteration Permit
SCS	Scientific Consultant Services
SHPD	State Historic Preservation Division
SHPO	State Historic Preservation Officer
SIHP	Statewide Inventory of Historic Places
SMA	Special Management Area
TDM	Travel Demand Management
UGB	Urban Growth Boundary
UHMC	University of Hawaii Maui College
USACE	U.S. Army Corps of Engineers
U.S. DOT	U.S. Department of Transportation
W-K WWRF	Wailuku-Kahului Wastewater Reclamation Facility
WCA	Waikapu Community Association
WCT	Waikapu Country Town
WQC	Water Quality Certification
WRD	Wastewater Reclamation Division
WRE	Waiale Road Extension
WWPS	Wastewater Pump Station
WWRF	Wastewater Reclamation Facility

PROJECT OVERVIEW

I. PROJECT OVERVIEW

A. PROJECT LOCATION

The County of Maui, Department of Public Works (DPW) is proposing to extend Waiale Road from its current terminus at East Waiko Road southward to Honoapiilani Highway at the intersection of Old Quarry Road, to support regional transportation needs and future land uses in the Waikapu region of the island of Maui. See **Figure 1**. The project is largely located on portions of Tax Map Key (TMK) (2)3-6-002:003 (Parcel 003), owned by Waiale 905 Partners, LLC, and TMK (2)3-6-002:004 (Parcel 004), owned by the County of Maui. The northern end of the project is located on, and adjacent to, portions of five (5) other parcels: TMK (2)3-5-002:001 (Heona Investments, LLC), (2)3-5-002:009 and 014 (Waiko Baseyard, LLC), (2)3-5-002:888 (Waikapu Stream), and (2)3-5-036:035 (Geste L. and Chaminade Ornellas). A small portion of the project near Old Quarry Road to the southwest is owned by Waikapu Properties, LLC (TMK (2)3-6-004:003(por.)). Waikapu Gardens and industrial businesses are located to the north, Maui Tropical Plantation is to the west, Kuihelani Highway is to the east, and vacant agricultural lands are to the south. See **Figure 2**.

B. PURPOSE AND NEED

The proposed Waiale Road Extension project will provide roadway redundancy, reducing traffic congestion. If the Waiale Road Extension is not built, the levels of service in the region will continue to decrease. According to the Traffic Impact Analysis Report (TIAR) prepared for the proposed project, one (1) of the 12 intersections near the project area studied currently operates at Level of Service (LOS) F. See **Appendix "A"**. Without the proposed project, seven (7) of those intersections will be operating at LOS E or F by the year 2045.

In December 2019, the Maui Metropolitan Planning Organization prepared the Hele Mai Maui 2040 Long-Range Transportation Plan (Hele Mai). According to the plan, there will be an additional 47,000 more residents and visitors on the island by 2040, resulting in demand for additional residential units. The Hawaii Housing Planning Study, 2019 lists four (4) items as impediment to increasing the housing supply, including the "Lack of Major Offsite Infrastructure".

Through a public-private partnership with the developers of the approved Waikapu Country Town community, the proposed project will help to provide more affordable housing on Maui. DPW agreed to waive the developers' roadway fees in exchange for the development of 500 affordable units. Additionally, the Waiale Road Extension will provide

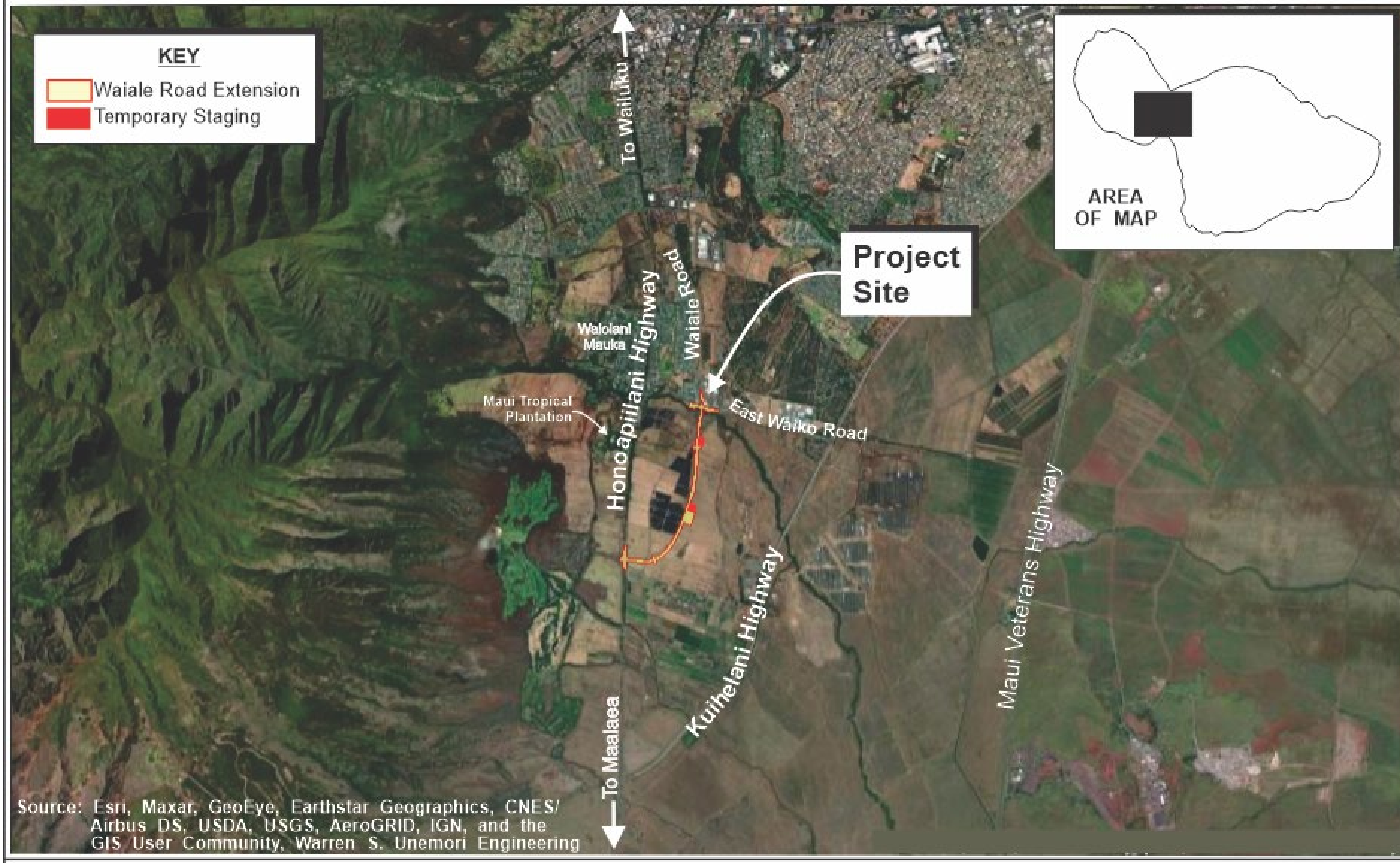


Figure 1

Waiale Road Extension Project

Regional Location Map

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\Regional

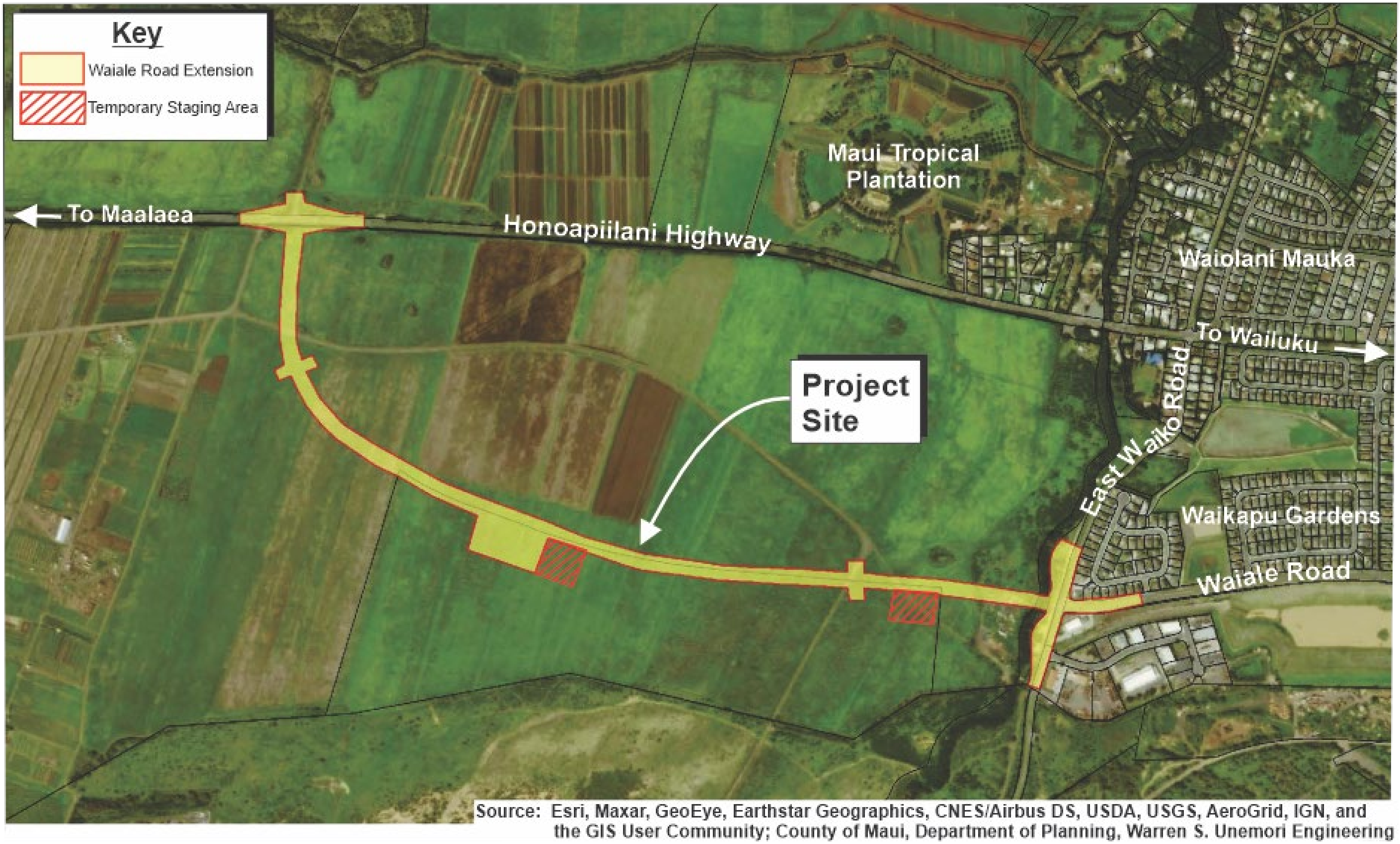


Figure 2

Waiale Road Extension Project

Property Location Map

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\ProjLoca access to the future Waikapu Country Town development, a complete, mixed-use community with commercial and residential uses, walkable neighborhoods, parks, and a new public school.

In the Hele Mai Maui 2040 Long-Range Transportation Plan, the Central Maui district was identified as an area of growth with many activity centers due to multiple services, jobs, shopping centers, communities, and the location of the County government. Central Maui also includes the Kahului Harbor and the island's only hospital. The Waiale Road Extension project was identified as a priority project. The Wailuku-Kahului Community Plan (2002) also identified and supported the proposed extension of Waiale Road as part of the plan's Transportation Objectives and Policies.

To help guide the planning and design of the Waiale Road Extension project, the following objectives (or goals) were identified:

- Improve safety and mobility for non-motorized users, such as bicyclists and pedestrians, by including shoulder bikeways, pedestrian sidewalks and a shared-use path

- Provide transportation redundancy with an alternate route in and around the urban areas of Kahului and Wailuku, as well as connections to South and West Maui, which would further assist in enhancing safety and emergency response.

- Reduce traffic-related impacts such as work commute times and localized air/noise pollution for neighboring properties.

- Improve local access to areas planned for affordable housing.

- Provide infrastructure to facilitate regional critical utility services to planned neighboring residential, commercial, and industrial users.

- Fulfills objectives and policies related to transportation improvement and connectivity included within various State and County plans (Hawaii State Plan, State Functional Plans, Maui Island Plan, Countywide Policy Plan, and Wailuku-Kahului Community Plan).

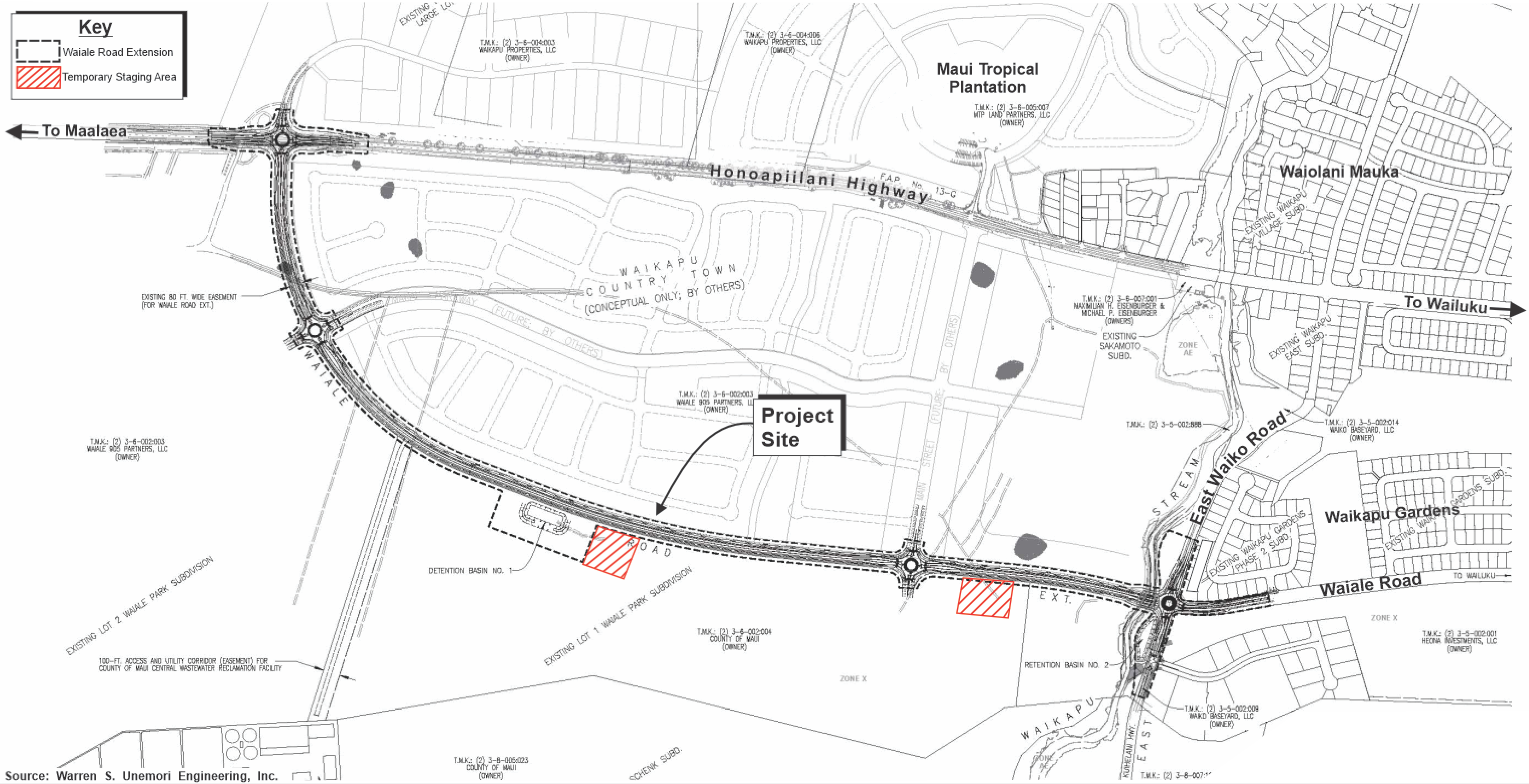
    - Support the extension of Waiale Drive to a new intersection with Honoapiilani Highway south of Waikapu Village. (Wailuku-Kahului Community Plan, Transportation Objectives and Policies (9))

    - Encourage transportation systems that serve to accommodate present and future development needs of communities. (Hawaii State Plan, Sec. 226-17 (b)(6))

- Safe, interconnected transit, roadway, bicycle, equestrian, and pedestrian network. (Maui Island Plan, Objective 6.4.2)
- Execute planning strategies to reduce traffic congestion. (Countywide Policy Plan, (H)(1)(a))
- Increase route and mode options in the ground-transportation network. (Countywide Policy Plan, (H)(1)(d))
- Design new roads and roadway improvements to retain and enhance the existing character and scenic resources of the communities through which they pass. (Countywide Policy Plan, (H)(1)(g))
- Provide bikeway and walkway systems in the Wailuku-Kahului area which offer safe and pleasant means of access, particularly along routes accessing residential districts, major community facilities and activity centers, school sites, and the shoreline between Kahului Harbor and Paia. (Wailuku-Kahului Community Plan, Transportation Objectives and Policies (2))
- Accommodate bicycle and pedestrian transportation within planned roadway improvements. (Wailuku-Kahului Community Plan, Transportation Objectives and Policies (6))

C. PROPOSED ACTION

The Waiale Road Extension is currently proposed to be approximately 8,600 lineal feet (ft.) in length generally within an existing 80-ft. access and utility easement, which will be subdivided and dedicated to the County, and traverses over former sugar cane fields. It includes two (2) through lanes, shoulder bikeways, pedestrian sidewalks, a shared use path on the west (mauka) side of the roadway extension, drainage improvements, installation of underground utilities (e.g. potable water mainlines, gravity and forcemain sewerlines, reclaimed (R1) waterlines, drainlines, electrical ducts, and associated appurtenances), and grassy swales to lessen the impact of stormwater pollution. The proposed project also contemplates four (4) intersections, which will each be evaluated for various treatments including potential roundabouts, signalization or other traffic controls. See **Figure 3** and **Figure 4**. A Traffic Impact Analysis Report (TIAR) was prepared for the proposed project and will be discussed in further detail in Chapter III of this EA document. See **Appendix "A"**. Additionally, a bridge will be constructed to cross Waikapu Stream. See **Figure 5** and **Figure 6**.



Source: Warren S. Unemori Engineering, Inc.

Figure 3

Waiale Road Extension Project

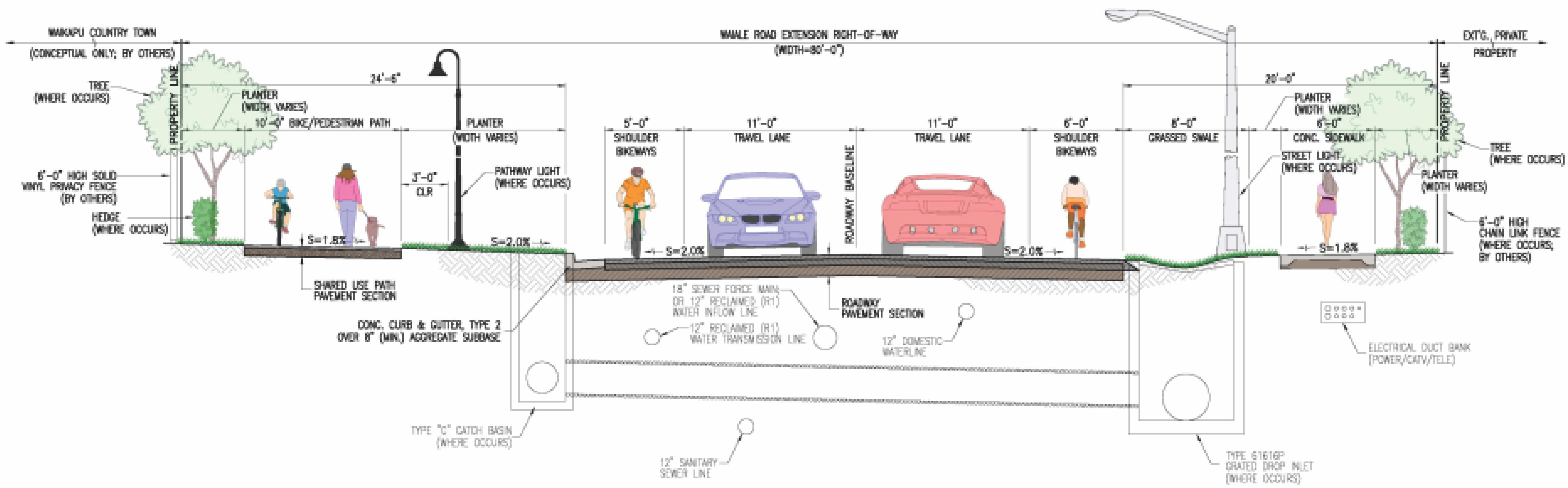
Site Plan Map

NOT TO SCALE

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\Site Plan



Source: Warren S. Unemori Engineering, Inc.

Figure 4

Waiale Road Extension Project

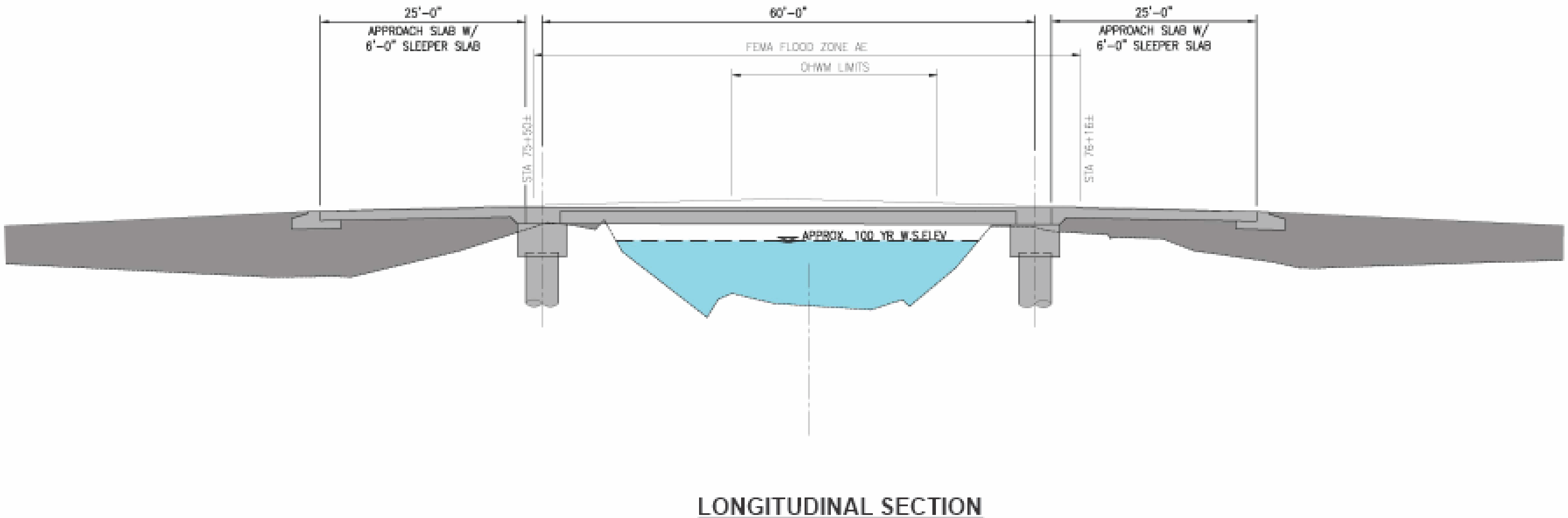
Typical Roadway Section

NOT TO SCALE

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\TypRdwySec



Source: Bowers + Kubota Consulting/KSF, Inc.

Figure 5

Waiale Road Extension Project

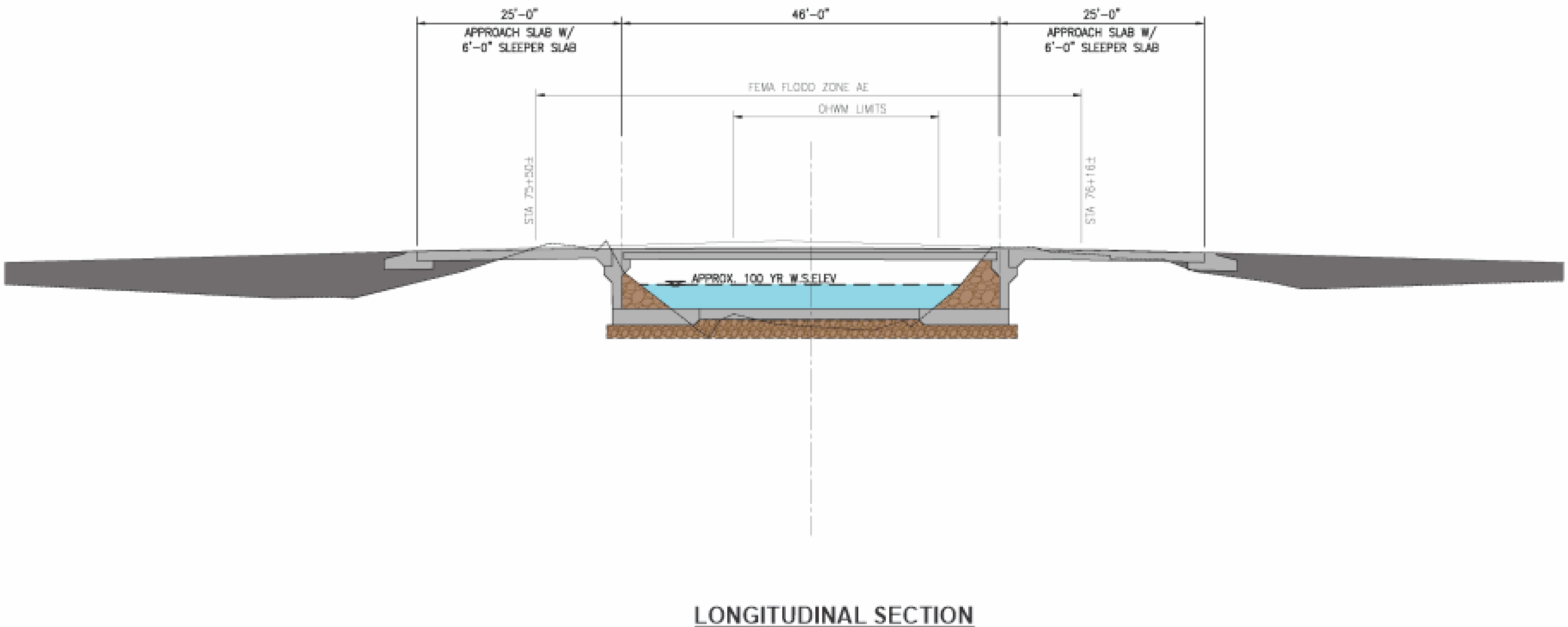
Preliminary Design for Single Span Bridge with No Stream Bed or Bank Alteration

NOT TO SCALE

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\SS Bridge



Source: Bowers + Kubota Consulting/KSF, Inc.

Figure 6

Waiale Road Extension Project
Preliminary Design for Single Span Bridge with Stream Bed and Bank Alterations
(Reinforced Concrete Invert, Grouted Rubble Pavement Bank Protection, etc.)

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

FE\Bowers\Waiale Road\Apps\Figs\RevSingle Span Bridge w-Grouted Rock

1. Project Limits

The proposed project extends Waiale Road from its current southern terminus at its intersection with East Waiko Road southward along an existing 80-ft. wide easement and terminates in the vicinity of Honoapiilani Highway's intersection with Old Quarry Road, an old agricultural road. Roadway improvements (with associated infrastructure) at both the northern (East Waiko Road) and Southern (Honoapiilani Highway) termini will provide smooth transitions to the existing roadway connections, and all intersections will be master-planned to facilitate cross street connections for known future developments. See **Appendix "B"**.

Additionally, the one (1) bridge crossing at Waikapu Stream will involve work upstream and downstream of the bridge to provide the requisite hydraulic transition measures. Two (2) alternatives for the bridge crossing are being studied in the EA.

Temporary construction easements, permanent drainage easements, sight distance easements, drainage lot acquistions, and roadway/pathway dedication requirements are anticipated to be needed from select adjoining properties. The securing of easements and acquisition requirements will be coordinated by the DPW with the respective property owners at an old agricultural road.

2. Roadway

The Waiale Road Extension Project will primarily fall within the existing 80 ft. wide easement between the County of Maui and Waiale 905 Partners, LLC properties. As discussed above, as needed, easements or land acquisition will be coordinated with individual property owners to ensure that dimensional criteria for typical sections are met. Landscaping will be provided to ensure a context-appropriate visual experience. Refer to **Figure 4** for an illustration of a typical section. See **Appendix "B"** for additional project plans.

3. Roundabouts and Intersections

The Waiale Road Extension will intersect with four (4) roadways: Honoapiilani Highway, the future Main Street, the future Makai Parkway, and East Waiko Road. A roundabout is preferred at the middle intersections to tie into the planned Waikapu Country Town development to the west, which is consistent with plans that have already been approved by the County and State. Signalized traffic controls and roundabouts are being considered for installation at the Waiale Road-Honoapiilani Highway and Waiale Road-East Waiko Road intersections.

4. Utilities

The scope of the proposed improvements will include the installation of underground utilities, drainage facilities to include new storm drainlines along the roadway (from 18-inch to 36-inch diameter) with larger diameter culverts crossing the roadway to address regional drainage master plans (e.g. Waikapu Country Town), manholes and catch basins, aboveground detention and retention basins, and associated appurtenances. Additionally, work will include the installation of a combination of gravity sewer main lines (8-inch to 24-inch diameter) with manholes, an 18-inch sewer force main line, and associated appurtenances. Water system utilities include installation of new 12-inch potable and 12-inch and 18-inch reclaimed (R1) waterlines, fire hydrants, and associated appurtenances.

5. Bridge Crossing

The limits of the proposed action encompass the Waikapu Stream. As such, DPW proposes to construct a modern, concrete free-span bridge crossing, accommodating the proposed electric, water, sewer force main, drain, and reclaimed waterlines to be mounted to the exterior on both upstream and downstream sides, as required. DPW is currently considering options for the bridge crossing and will be evaluating the options on a variety of criteria including Federal and State requirements, permitting, and input from the community. These alternatives consist of a free-span bridge with no stream bed or bank protection or a free-span bridge with stream bed and bank alterations. Excavation of the bridge is preliminarily anticipated to include a minimum of 12 4-ft. diameter drilled shafts at estimated depths of 45 ft. It is anticipated that the major utilities (e.g., waterlines, sewer force main, reclaimed (R1) waterlines, etc.) will be mounted on the upstream and/or downstream edge of the proposed bridge, as necessary. Electrical ducts will be installed in the bridge railings on both the upstream and downstream sides, as necessary. It should be noted that any bridge built will be designed for a 100-year life instead of a 75-year life to reduce future life-cycle costs. Preliminary concepts for the bridge crossings are included in **Figure 5** and **Figure 6**.

6. Related Improvements

Among the other related improvements associated with the proposed action are the installation of street lights, pathway lights, underground electrical conduits, hand holes, and associated appurtenances to provide electrical service. As needed, the existing 69 kilovolt (kV) power poles along East Waiko Road and Honoapiilani Highway will be relocated to accommodate the proposed new improvements. Retaining walls, railing, guard rail treatments, landscaping and traffic signage will also be provided in accordance with applicable roadway design standards.

D. WAIKAPU COUNTRY TOWN

It is noted that the proposed project provides critical infrastructure to support the separate, but adjacent, Waikapu Country Town development to the west, which plans for 1,433 residential units, including 500 affordable units. The master-planned development also includes areas for neighborhood retail, commercial, employment uses, a school, parks, and open space. The County of Maui and the Waikapu Country Town developers have agreed to a public/private partnership to support the Waiale Road Extension, and provide for more affordable homes for the Maui community. The Waiale Road Extension project will support all transportation modes, protect non-motorized travelers, and provide an alternate route between the urban areas of Kahului and Wailuku. It is recognized as a long-range strategy to improve traffic flow within and around the Waikapu area.

E. CHAPTER 343, HAWAII REVISED STATUTES AND NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE

As previously noted, the proposed project includes the use of State of Hawaii lands and funds as well as the use of County of Maui lands and funds. The use of State and County lands and funds are "triggers" for HRS, Chapter 343 environmental review. Additionally, the DPW was awarded a Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant for the project through the FHWA. The use of Federal funds is a "trigger" for NEPA review. As such, this joint HEPA and NEPA EA document is being prepared to address both the State and Federal environmental review regulations. The DPW is the proposing agency for the HEPA document, while the FHWA is the approving body for the NEPA requirements.

F. PROJECT COST AND TIME SCHEDULE

The DPW anticipates construction to be initiated upon receipt of all regulatory permits and approvals. It is anticipated that the project will begin construction in late 2025 to early 2026 and take 18 to 24 months to construct. The construction of the proposed Waiale Road Extension Project is estimated at $73,000,000.00.

ALTERNATIVES TO THE PROPOSED ACTION

II

II. ALTERNATIVES TO THE PROPOSED ACTION

As noted previously, the proposed Waiale Road Extension project provides critical infrastructure to support the separate, but adjacent, Waikapu Country Town development to the west, which published its Final Environmental Impact Statement in 2016. The master-planned development includes 1,433 residential units (500 of which will be affordable units), areas for neighborhood retail, commercial, employment uses, a school, parks, and open space. The County of Maui and the Waikapu Country Town developers have agreed to a public/private partnership to support the Waiale Road Extension, and provide for more affordable homes for the Maui community. The Waiale Road Extension project will support all transportation modes, protect non-motorized travelers, and provide an alternate route between the urban areas of Kahului and Wailuku. It is recognized as a long-range strategy to improve traffic flow within and around the Waikapu area. This is noted in the Wailuku-Kahului Community Plan (2002) and the Hele Mai Maui 2040 Long Range Transportation Plan (2019).

The general parameters for roadway location, design and implementation, therefore, have been previously determined. For the proposed action, the extension will primarily utilize existing County right-of-way (ROW) and a roadway easement that will be dedicated to the County. From an alternatives analysis standpoint, the proposed project is presented as several alternatives.

A. THE PROPOSED ALTERNATIVE

The Proposed Alternative is that presented in Chapter I of this document. The proposed action represents the extension of Waiale Road from its current terminus at East Waiko Road southward to Honoapiilani Highway at the intersection of Old Quarry Road. The two-lane, two-way roadway with shoulder bikeways, pedestrian sidewalks, and a shared-use path is intended to provide needed infrastructure that supports the existing and planned neighboring residential, commercial, and industrial users in the surrounding area through funding support from the FHWA RAISE program. In this regard, the preferred alternative will reduce the amount of industrial and other traffic utilizing East Waiko Road through the existing residential area and allow for economic growth in the surrounding area.

B. NO ACTION ALTERNATIVE

The Wailuku region, within which the project area is located, had a population of 61,346 in 2000, according to the U.S. Census Bureau. By 2020, the population had risen to 83,777, a near 37 percent increase (Maui County Data Book, 2022).

According to U.S. Census Bureau data, the Waikapu area had an estimated population of 3,437 in 2020 (2020 Decennial Census). Buildout of the Waikapu County Town project will add approximately 4,085 persons (Waikapu Country Town FEIS, 2016). The Proposed Alternative is deemed appropriate to accommodate this planned increase in population and traffic, providing an additional road to access Waikapu Country Town from East Waiko Road. Failure to extend Waiale Road will result in only one (1) access to the development off of Honoapiilani Highway and increased traffic congestion in the surrounding area.

In light of the master-planned development of the Waikapu Country Town project, as well as other existing and planned neighboring residential, commercial and industrial users, the No Action Alternative is not deemed a viable alternative for meeting continuing demands placed on the local transportation network. It does not meet the purpose and need for this project and will not be considered going forward.

C. DEFERRAL OF ACTION ALTERNATIVE

In the context of conditions and circumstances described for the No Action Alternative, the Deferred Action Alternative was also not deemed an appropriate consideration. When accounting for funding acquisition, as well as design and permitting requirements for project implementation, any delay in proceeding with a project of this nature will likely translate to years of additional delay in addressing transportation capacity issues for the Wailuku-Kahului region. Inasmuch as opportunity for project development is in motion, proceeding with the preferred option is deemed to be the optimum solution.

D. INTERSECTION DESIGN ALTERNATIVES

1. Four (4) Roundabout Intersections Alternative

This scenario requires an 8,600 ft. roadway corridor, the dedication of the existing 80-ft. access easement to the County, and additional ROW to accommodate four (4) proposed roundabouts along the Waiale Road Extension at its intersections with East Waiko Road, Main Street, Makai Parkway, and Honoapiilani Highway. A Traffic Impact Analysis Report (TIAR) was prepared by Fehr & Peers. Refer to **Appendix "A"**. Based on their findings, Fehr & Peers recommended constructing roundabout configurations along the Waiale Road Extension at its intersections with East Waiko Road, Main Street, Makai Parkway, and Honoapiilani Highway. Not only are single-lane roundabouts projected to operate acceptably with single-lane approaches in 2045, but, when compared to traditional intersection design, roundabouts have the potential to reduce both the number and severity of vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure. As such, the TIAR recommends constructing four (4) roundabouts. The TIAR suggests considering multi-lane approaches to the roundabouts at Waiale Road-Honoapiilani Highway and Waiale Road-Waiko Road if additional land use is anticipated beyond what was assumed in the study or to accommodate future roadway widening to further improve projected traffic operations.

2. Two (2) Signalized Intersections and Two (2) Roundabout Intersections Alternative

This scenario involves the same 8,600 ft. roadway corridor and dedication of the existing 80-ft. access easement to the County, with two (2) proposed signalized intersections at Waiale Road-East Waiko Road and Honoapiilani Highway-Waiale Road, and two (2) single-lane roundabouts at Waiale Road-Main Street and Waiale Road-Makai Parkway, with additional ROW, as required for the roundabout transitions. According to the TIAR, a signalized intersection would provide a better level of service (LOS) for vehicle movements than a roundabout at Honoapiilani Highway-Waiale Road, with the installation of single-lane approaches on Waiale Road, a dedicated left-turn lane, and a shared through-right-turn lane on the north and south approaches. However, as previously noted, not only are single-lane roundabouts projected to operate acceptably with single-lane approaches in 2045, but, when compared to traditional intersection design, roundabouts have the potential to reduce both the number and severity of vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure. As such, the TIAR recommends constructing four (4) roundabouts.

E. BRIDGE DESIGN ALTERNATIVES

1. Bridge Crossing with No Stream Bed or Bank Alteration Alternative

One (1) alternative considered for the bridge crossing is a single-span bridge with no stream bed or bank alteration. This option is not anticipated to involve work within the stream. Refer to **Figure 5**.

Under this alternative, drilled shafts would be located outside of the Ordinary High Water Mark (OHWM) as designated by the project biologist, allowing the existing stream to remain as-is. For this bridge, it is preliminarily anticipated to include 12 4-ft. diameter drilled shafts at estimated depths of 45 ft. It is anticipated that the major utilities (including waterlines, the sewer force main, reclaimed (R1) waterlines, etc.) will be mounted on the upstream and/or downstream edge of the proposed bridge, as necessary. Electrical ducts are anticipated to be installed within the bridge railings (both the upstream and downstream sides) and the cast-in-place portion of the bridge deck, as necessary.

2. Bridge Crossing with Stream Bed and Bank Alterations Alternative

The second alternative presented for the bridge crossing at Waikapu Stream is a single-span bridge with stream bed and bank alteration (reinforced concrete invert lining, grouted rubble pavement bank protection, etc.). This option would involve work within the stream (including excavation (estimated depths of 3-ft.)), potential horizontal and vertical realignment of the stream channel, and modifications to the stream channel characteristics. Under this alternative, stream bed and bank alterations are anticipated to extend approximately 300-ft. upstream and 450-ft downstream of the bridge crossing. Refer to **Figure 6**.

Based on the anticipated improvements, roughly one (1) acre of stream channel would be altered during reconstruction. In addition, the construction of a temporary stream diversion channel (to allow the by-pass of the existing, active stream flows during the reconstruction process) may be required, and it is anticipated to be routed through the adjacent, privately-owned properties.

F. ALTERNATIVES FOR IMPROVING HONOAPIILANI HIGHWAY CAPACITY

1. Widening of Honoapiilani Highway

To address the anticipated population growth, the widening of Honoapiilani Highway through Central Maui was considered. However, doing so would not align with the purpose and need of the project, which are to accommodate future development and access in the area, including Waikapu Country Town.

2. Travel Demand Management

A Travel Demand Management (TDM) alternative was also considered but not studied further, because it would involve access management through roadway pricing. This would provide preferential treatment to high-occupancy vehicles or buses, which would require widening at intersections or additional lanes on the highway.

DESCRIPTION OF EXISTING CONDITIONS, POTENTIAL IMPACTS, AND PROPOSED MITIGATION MEASURES

III

III. DESCRIPTION OF EXISTING CONDITIONS, POTENTIAL IMPACTS, AND PROPOSED MITIGATION MEASURES

A. PHYSICAL ENVIRONMENT

1. Surrounding Land Uses

a. Existing Conditions

The project site is located in the Waikapu region of the island of Maui. Refer to **Figure 2**. Waikapu Gardens and industrial businesses are located to the north, Maui Tropical Plantation is to the west, Kuihelani Highway is to the east, and vacant agricultural lands are to the south. The Waiale Road Extension traverses over former sugar cane fields and proposes to cross Waikapu Stream near the existing Waiale Road and East Waiko Road intersection to the north. Refer to **Figure 3**.

b. Potential Impacts and Proposed Mitigation Measures

The proposed project is a long-planned roadway improvement project that is not anticipated to have an adverse impact on surrounding land uses. Rather, in providing an extension of Waiale Road within an existing access and utility easement, the proposed project provides needed infrastructure that supports the existing and planned neighboring residential, commercial and industrial uses along Waiale Road and East Waiko Road. The project would additionally reduce the amount of industrial and other traffic utilizing East Waiko Road through the existing residential area and allow for economic growth in the surrounding area. Best Management Practices (BMPs) will be implemented during construction to mitigate impacts to surrounding properties. See **Table 1** below for an assessment of each of the design alternatives identified in Chapter II.

Table 1. Impact Assessment of Design Alternatives on Surrounding Land Uses

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The proposed project would provide needed infrastructure to the surrounding land uses. In that regard, it is anticipated to have a beneficial impact. In the Traffic Impact Analysis Report (TIAR) prepared for the proposed project, Fehr & Peers writes that roundabouts tend to reduce both the number and severity of vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure. Refer to **Appendix "A"**. As such, the four (4) roundabout intersection alternative may be the safer alternative for surrounding land uses than the alternative that would install two (2) signalized intersections.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As described above, it is anticipated that both intersection alternatives would have an overall positive impact on surrounding land uses. While a signalized intersection at Waiale Road-Honoapiilani Highway might result in a better LOS for vehicle movements than a roundabout, as reported in the project's TIAR and discussed further in **Section III.D.1** of this document, roundabouts encourage slower speeds and provide fewer points of conflict, reducing the number and severity of vehicle crashes. As such, the TIAR recommended the construction of four (4) roundabout configurations.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	For this alternative, the existing stream would maintain its current alignment and cross section. The runoff generated by the project improvements would be collected in catch basins and then conveyed to the new retention basin. The retention basin will be sized to mitigate the increase in runoff, such that no more than pre-existing rates will be allowed to discharge downstream, into Waikapu Stream, as it is presently doing. In addition, the property to the west (mauka) side of the bridge crossing would be graded to drain towards the roadway, and the property to the east (makai) side of the bridge crossing would contain the retention basin. While bridge railings and utility mainlines (mounted to the bridge sides) will be visible to users, the existing stream will continue to retain its existing natural aesthetics. Though this alternative will require the raising of the intersection at Waiale Road and East Waiko Road, the surrounding land uses associated with the adjacent properties are not anticipated to be impacted (with the exception of the property to the east (makai) side where the retention basin is to be located). This alternative is anticipated to have a beneficial impact to the surrounding land

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
	uses as it will provide continuity and connectivity for all modes of transportation (e.g., vehicles, cyclists, pedestrians, etc.) over Waikapu Stream.
Bridge Crossing with Stream Bed and Bank Alterations	For this alternative, the existing stream will be altered to reduce the general profile of the roadway, modifying its current alignment and cross section. The conveyance and collection (including the retention basin) will be similar to that of the above alternative. The property to the west (mauka) side of the bridge crossing will be graded to drain toward the roadway, and the property to the east (makai) side of the bridge crossing will contain the retention basin. The bridge railings, as well as the proposed man-made channel both upstream and downstream of the bridge, will be visible to users. It is anticipated that approximately one (1) acre of stream channel will be disturbed for the reconstruction. In addition, a temporary diversion channel is anticipated (to be located within adjacent privately-owned properties) to allow the by-pass of the existing, active stream flows during construction. The surrounding land uses (specifically for the property containing the diversion channel) are anticipated to be negatively impacted during construction, but restored to current conditions once construction is completed (with the exception of the property to the east (makai) side where the retention basin is to be located). Similar to the above alternative, it will also have a beneficial impact to surrounding land uses as it will provide continuity and connectivity for all modes of transportation (e.g., vehicles, cyclists, pedestrians, etc.) over Waikapu Stream.

2. Climate

a. Existing Conditions

Maui is characterized by a semi-tropical climate containing a multitude of individual microclimates. A high proportion of the rainfall that Maui receives each year falls on the northeast facing shores leaving the south and southwest coastal areas relatively dry. The project site is located within one of these drier areas of the southwest coast.

The climate in Waikapu is relatively uniform year-round. The project site experiences mild and uniform temperatures, moderate humidity and relatively consistent northeasterly tradewinds. Average temperatures typically range between 68.1 degrees and 86.1 degrees Fahrenheit (measured at Kahului Airport). August is historically the warmest month, while January is the coolest. Rainfall in Waikapu can vary from month to month. In 2022, December was the wettest month, with 3.59 inches of rain, May was the driest, with 0.03 inches (Maui County Data Book, 2022).

b. Potential Impacts and Proposed Mitigation Measures

The proposed project will consist of an approximately 8,600 lineal ft. extension of Waiale Road from East Waiko Road to Honoapiilani Highway. In light of the proposed action's limited geographic footprint within an existing County ROW easement, adverse impacts to the microclimate of the surrounding area is not anticipated. See **Table 2** below for an assessment of each of the design alternatives identified in Chapter II.

Table 2. Impact Assessment of Design Alternatives on Climate

Intersection Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Four (4) Single-Lane Roundabouts	The proposed project is limited to the extension of Waiale Road, including related improvements such as the construction of a shared-use path and the installation of utilities. Impacts to climate in the region are not anticipated. As such, the four (4) roundabout design alternative is not anticipated to have any additional climate impacts when compared to the alternative involving two (2) signalized intersections.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	There is no difference between the two (2) intersection alternatives when assessing their potential impacts to climate in the project area.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The proposed bridge alternative is not anticipated to have potential impacts to climate in the project area.
Bridge Crossing with Stream Bed and Bank Alterations	The proposed bridge alternative is not anticipated to have potential impacts to climate in the project area.

3. Greenhouse Gas and Air Quality

a. Existing Conditions

Greenhouse gases (GHG) (carbon dioxide, methane, nitrous oxide, and fluorinated gases) trap heat in the earth's atmosphere. In the context of climate and ocean warming, increases in levels of atmospheric GHG have been attributed to human activity (IPCC, 2007). Within the State of Hawaii, the energy sector (including fossil fuel burning to produce electricity, transportation, waste incineration, and natural gas systems) is identified as the source of 89.7 percent of GHG emissions (Hawaii Department of Health, 2019). Other sources of GHG emissions include industrial facilities, agriculture and forestry, and waste treatment such as landfills, composting, and wastewater treatment.

The Federal Greenhouse Gas Reporting Program (40 CFR Part 98) requires mandatory reporting of GHG emissions from sources that emit 25,000 metric tons or more of carbon dioxide equivalent (CO2 EQ) per year in the United States. Categories of use which are generally associated with this level of reporting include power plants, petroleum and natural gas systems, refineries, and other heavy manufacturing processes. On Maui, the facilities operating at or above the 25,000 metric ton level include Maui Electric Company's Kahului Power Plant, its Maalaea Power Plant, and the Central Maui Landfill (U.S. Environmental Protection Agency (EPA), 2017).

To evaluate the impacts on air quality and GHG emissions, a study was undertaken by B.D. Neal & Associates in December 2023 to specifically consider the proposed Waiale Road Extension project. See **Appendix "C"**. The purpose of the study was to evaluate the potential short- and long-term air quality and GHG emission effects associated with implementation of the proposed project and suggest mitigative measures to reduce any potential air quality impacts where possible and appropriate. In part, the study addresses pertinent air pollutant parameters and characteristics, GHG emissions, and the regulatory framework for climate change. The study used a computerized air quality analysis to assess the potential long-term effects of project-related motor vehicle traffic operating on roadways in the project area during the operational phase of the project on air quality and GHG emissions.

B.D. Neal & Associates noted that regional and local climate together with the amount and type of human activity dictate the air quality in an area. The climate in the project area is very much impacted by its elevation near sea level and the nearby mountains. The predominant trade winds tend to be channeled through the area by the mountains to the east and west. Average temperatures range between 68.1 and 86.1 degrees Fahrenheit (measured at the Kahului Airport) (Maui County Data Book, 2022). Rainfall in the project area is minimal with an average of about 16 inches per year.

Except for periodic impacts from volcanic emissions (vog), occasional wildfires and occasional localized impacts from traffic congestion and agricultural activity, the existing air quality in the project area is believed to be relatively good. According to B.D. Neal & Associates, there is very little air quality monitoring data from the Department of Health for the project area, but the limited data that are available suggest that concentrations are generally within the State and National air quality standards, as defined in

Chapter 11-59, HRS and Section 40, Part 50, Code of Federal Regulations (CFR). Moreover, the recent cessation of sugar cane cultivation in the project area has likely resulted in improved air quality.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The proposed project area involves the extension of Waiale Road, including two (2) vehicle travel lanes, shoulder bikeways, pedestrian sidewalks, a shared-use path on the west (mauka) side of the roadway extension, drainage improvements and grassy swales to lessen the impact of stormwater pollution.

The air quality and GHG emissions study prepared by B.D. Neal & Associates (**Appendix "C "**), advanced the following findings.

- Short-term and long-term impacts may occur either directly or indirectly as a consequence of project construction and use.
- The primary short-term air quality concern regarding the construction phase of the project is fugitive dust caused by grading and dirt-moving activities associated with site clearing and preparation work. As such, a dust control plan will be implemented in compliance with State air pollution control regulations. The following BMPs suggested by the study will be included in the plan, as applicable: watering of active work areas, using wind screens, keeping adjacent paved roads clean, and covering open-bodied trucks. Other dust control measures that will be considered include limiting the area that is disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked, and paving and landscaping project areas early in the construction schedule.
- To a lesser extent, exhaust emissions from stationary and mobile construction equipment, minor disruptions to traffic, and workers' vehicles may also impact air quality during the construction phase. The study also recommended mitigating exhaust emissions by moving construction equipment and workers to and from the project site during off-peak traffic hours.
- The study compared projected carbon monoxide emissions in the year 2045 with and without the Waiale Road Extension and found that any increase to overall GHG caused by the proposed project would be negligible. It was noted that due to the negligible impact the project is expected to have, implementing mitigation measures for long-term traffic-related air quality impacts is likely unnecessary and unwarranted.
- The project is expected to result in improved traffic flow and reduced intersection delay in the project area, thereby providing for a reduction in GHG.

See **Table 3** below for an assessment of each of the design alternatives identified in Chapter II.

Table 3. Impact Assessment of Design Alternatives on Greenhouse Gas and Air Quality

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The TIAR prepared on behalf of the proposed project found that, while a signalized intersection may provide a better LOS for vehicle movements at peak traffic hours than a roundabout at the Honoapiilani Highway-Waiale Road intersection, a roundabout could potentially reduce the number and severity of vehicle crashes that would cause delays due to road closures. As such, it is anticipated that the two (2) intersection alternatives would have similar impacts to GHG levels in the project area. In the short term, BMPs implemented to control fugitive dust would be sufficient to mitigate any potential dust pollution that would occur during the constructon of either intersection alternative. Therefore, the four (4) roundabout design alternative and the alternative involving two (2) signalized intersections would likely have similar impacts to air quality and GHG levels in the project area. It is noted that the TIAR recommended construction of four (4) single-lane roundabouts.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As described above, the short- and long-term impacts of the alternative involving two (2) signalized intersections and two (2) roundabouts are not anticipated to significantly differ from those anticipated to result from the implementation of the alternative involving four (4) roundabouts.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The associated construction activity relative to the bridge alternative may involve additional work to raise the Waiale Road and East Waiko Road intersection. However, upon completion of construction, the potential impact for air quality and GHG would remain the same between the two (2) bridge alternatives.
Bridge Crossing with Stream Bed and Bank Alterations	The proposed bridge alternative is not anticipated to have greater impacts to air quality and GHG levels than other alternatives. Short-term impacts to air quality are anticipated during construction, however, following completion of construction, no greater impacts are anticipated.

4. Topography and Soils

a. Existing Conditions

The Waiale Road Extension project traverses over former sugar cane fields in an area surrounded by vacant agricultural lands, industrial businesses, residential subdivisions and the Maui Tropical Plantation. The topography in this area reflects general topographical patterns of the Central Maui isthmus, characterized by generally flat land and slightly sloping easterly and towards the ocean. The existing grades within the project corridor vary in elevation from approximately 250 ft. to approximately 355 ft. above mean sea level (AMSL).

The existing ground is characterized by gentle, longitudinal slopes that generally range from 2 to 7 percent in a westerly to easterly direction, with cross slopes of approximately 0 to 5 percent along existing roadways. There are several rock piles scattered throughout the project area, and Waikapu Stream is contoured by earthen berms and large boulders lining the top banks of the stream to protect the fields from flooding.

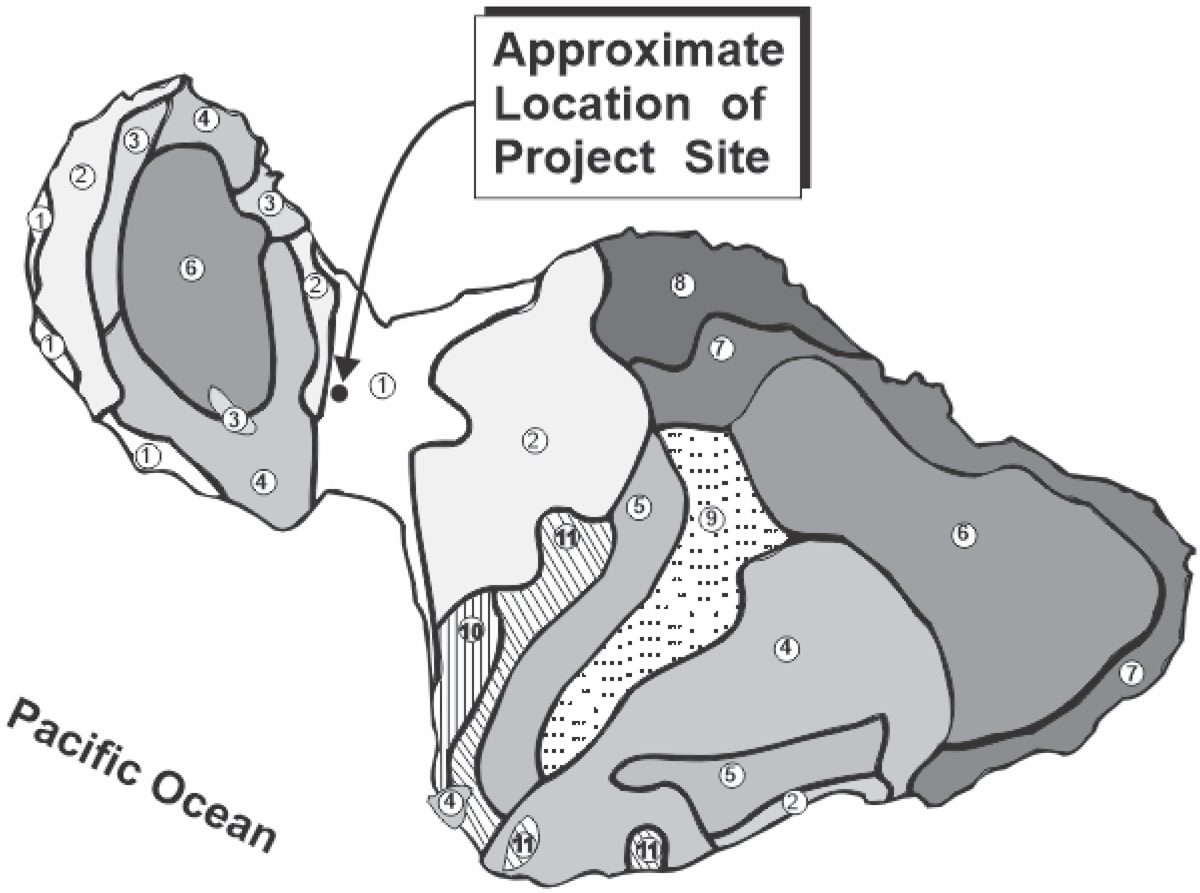
The project area is located in Waikapu and consists of soils within the Pulehu-Ewa-Jaucas association, which is characterized as having deep, nearly level to moderate slope, with well drained soils that have moderately fine to course texture (U.S. Dept, of Agriculture Soil Conservation Service 1972). See **Figure 7**. Underlying the project area for the Waiale Road Extension are soils mainly classified as Iao Clay (IcB), Pulehu Silt Loam (PpA), Pulehu Cobbly Silt Loam (PrB), and Pulehu Cobbly Clay Loam (PtB, PtA). The soil types found underlying the East Waiko Road area includes Jaucas Sand (JaC) and Puuone Sand (PZUE). See **Figure 8**.

b. **<u>Potential Impacts and Proposed Mitigation Measures</u>**

The proposed Waiale Road Extension project is compatible with the project site's underlying soil characteristics (i.e., there are no limitations to constructability associated with the underlying soil conditions). The primary elements of site work will involve construction of the roadway prism and installation of underground utilities and infrastructure. To control runoff, sedimentation, and erosion, Best Management Practices (BMPs) will be implemented in accordance with applicable provisions of the Maui County Code and the project-specific National Pollutant Discharge Elimination System (NPDES) permit. See **Table 4** below for an assessment of each of the design alternatives identified in Chapter II.

LEGEND

- ① Pulehu-Ewa-Jaucas association
- ② Waiakoa-Keahua-Molokai association
- ③ Honolua-Olelo association
- ④ Rock land-Rough mountainous land association
- ⑤ Puu Pa-Kula-Pane association
- ⑥ Hydrandepts-Tropaquods association
- ⑦ Hana-Makaalae-Kailua association
- ⑧ Pauwela-Haiku association
- ⑨ Laumaia-Kaipoipoi-Olinda association
- ⑩ Keawakapu-Makena association
- ⑪ Kamaole-Oanapuka association



Source: U.S. Department of Agriculture, Soil Conservation Service, 1972

Figure 7 Waiale Road Extension Project
Soil Association Map

NOT TO SCALE

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\Soils Assoc

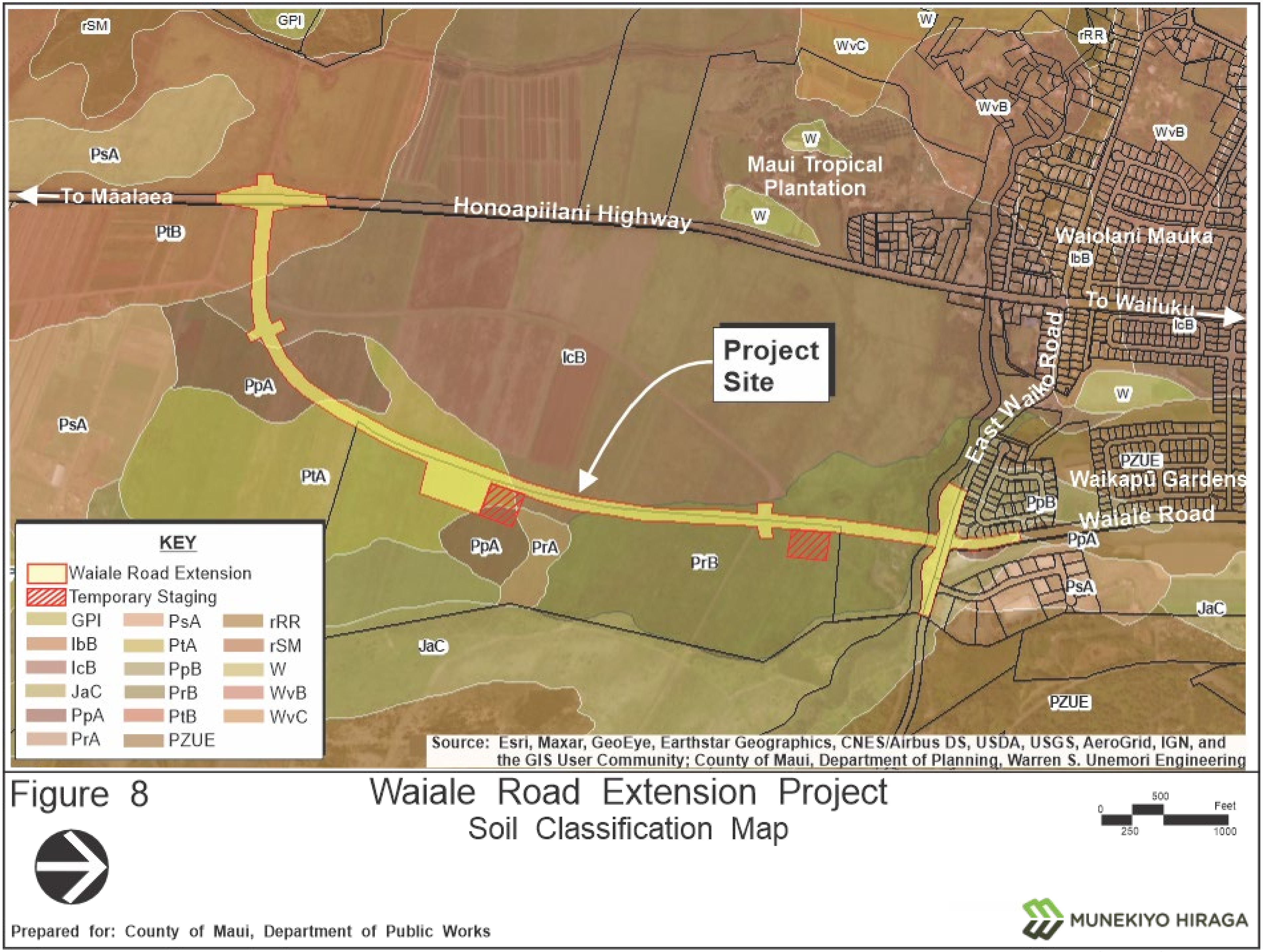


Figure 8

Waiale Road Extension Project

Soil Classification Map

Prepared for: County of Maui, Department of Public Works

Bowers\Waiale Road Extension\Applications\Figures\DEA\SOILS

Table 4. Impact Assessment of Design Alternatives on Topography and Soils

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	When compared to the alternative involving two (2) signalized and (2) roundabout intersections, the four (4) roundabout alternative will have a similar impact on topography and soils in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	The impact to topography and soils of the intersection alternative that would see the installation of two (2) signalized intersections does not differ from the that of the alternative that proposes roundabouts at all four (4) intersections.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The impact to topography and soils related to the bridge crossing alternatives does not significantly differ between the two (2) bridge options as the bridge options are feasible in the soil types within the project area. According to the Geotechnical Engineering Exploration report prepared for the project, a deep foundation system consisting of drilled shafts embedded into the underlying alluvial deposits can be used to support the abutment structures for the bridge. See **Appendix "B-1"** in **Appendix "D"**. Appropriate BMPs will be implemented during construction to minimize the potential impacts and control runoff from the site.
Bridge Crossing with Stream Bed and Bank Alterations	The impact to topography and soils related to the bridge crossing alternatives does not significantly differ between the two (2) bridge options as the bridge options are feasible in the soil types within the project area. According to the Geotechnical Engineering Exploration report prepared for the project, a deep foundation system consisting of drilled shafts embedded into the underlying alluvial deposits can be used to support the abutment structures for the bridge. See **Appendix "B-1"** in **Appendix "D".** Appropriate BMPs will be implemented during construction to minimize the potential impacts and control runoff from the site.

5. Agriculture

a. Existing Conditions

In 1977, the State Department of Agriculture developed a classification system to identify Agricultural Lands of Importance to the State of Hawaii (ALISH). The classification system is based primarily, though not exclusively, upon the soil characteristics of the lands. The three (3) classes of ALISH lands are: "Prime", "Unique", and "Other Important" agricultural land, with all remaining lands termed "Unclassified".

When utilized with modern farming methods, “Prime” agricultural lands have a soil quality, growing season, and moisture supply necessary to produce sustained crop yields economically. “Unique” agricultural lands possess a combination of soil quality, growing season, and moisture supply to produce sustained high yields of a specific crop. “Other Important” agricultural lands include those that have not been rated as “Prime” or “Unique”, but are of statewide or local importance for agricultural use. As reflected by the ALISH map for the project region, the majority of the project site is classified as “Prime”, while small portions are classified as “Other Important” agricultural lands. See **Figure 9**.

The University of Hawaii, Land Study Bureau (LSB) developed the Overall Productivity Rating, which classified soils according to five (5) levels, with “A” representing the class of highest productivity soils and “E” representing the lowest. The project site is located on lands designated “A” and “B”, with small portions designated “E” and “Not Classified”. See **Figure 10**.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The project site is located on fallow sugar cane fields characterized by invasive overgrowth, including dense thickets of kiawe and koa haole. The site is not being actively farmed and the proposed project is not anticipated to adversely impact agricultural productivity in the Waikapu region. The loss of 36 acres of agricultural lands is not considered large in the context of the 30,000 acres of agricultural land available on the island of Maui.

The Waiale Road Extension will support the planned Waikapu Country Town’s agriculture development plan, which involves the dedication of 800 acres of land to agricultural use through a conservation easement. Within the 800-acre preserve, several hundred acres will be developed as a public and/or private agricultural park with the goal of facilitating Maui’s agricultural development.

The proposed project is deemed to have beneficial results in terms of long-range infrastructure considerations. Best Management Practices (BMPs) for water quality and air quality will be implemented during the construction period to contain runoff, sedimentation, and dust that may be generated by construction activities. See **Table 5** below for an assessment of each of the design alternatives identified in Chapter II.

Figure 9

Waiale Road Extension Project
Agricultural Lands of Importance to the State of Hawaii Map

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\ALISH

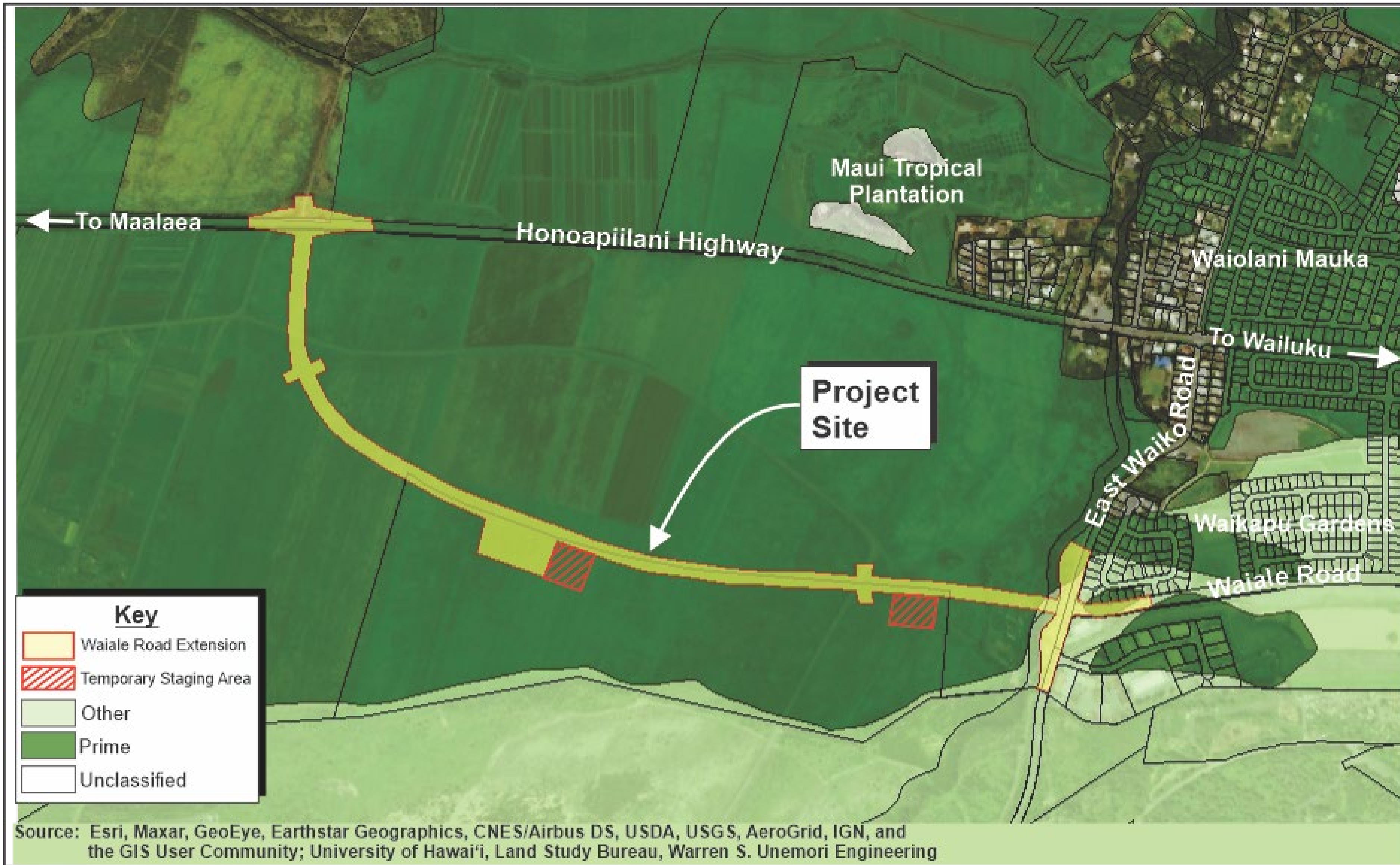


Figure 10

Waiale Road Extension Project
Land Study Bureau Map

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\LSB

Table 5. Impact Assessment of Design Alternatives on Agriculture

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The project site is comprised of fallow sugar cane land characterized by invasive overgrowth. As such, neither the four (4) roundabout intersection alternative, nor the alternative involving two (2) signalized intersections is anticipated to adversely impact agriculture in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	Neither intersection alternative is anticipated to have an adverse impact on agriculture in the region.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge crossing alternatives are not anticipated to have an impact on agriculture as the lands that will be utilized for the crossing are designated “Other” by the ALISH and rated "E" by the LSB. As such, the use of the land for the bridge crossing is land that is not necessarily suitable for agricultural purposes.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge crossing alternatives are not anticipated to have an impact on agriculture as the lands that will be utilized for the crossing are designated “Other” by the ALISH and rated "E" by the LSB. As such, the use of the land for the bridge crossing is land that is not necessarily suitable for agricultural purposes.

6. Flood and Tsunami Hazards

a. Existing Conditions

The project area is located near the eastern base of the West Maui Mountains. As indicated by the Flood Insurance Rate Map for the County of Maui, the majority of the project area is located within Zone X. Zone X is the flood insurance rate zone that corresponds to areas of 0.2 percent annual chance of flood. A small portion of the existing East Waiko Road right-of-way and the proposed crossing of the Waikapu Stream are located within Zone AE and AEF. Zone AE is a special flood hazard area indicating places that are subject to the one (1) percent annual chance (or 100-year) flood, with base elevations ranging from 318 to 342 AMSL. Zone AEF is a floodway area within Zone AE. See **Figure 11**.

The project area is located approximately 11,000 and 12,000 ft. inland of the Maui County Tsunami Evacuation and Extreme Tsunami Evacuation Zones from the northern (Kahului) and southern (Maalaea) shores of Maui. See **Appendix “D”,** Preliminary Engineering Report.

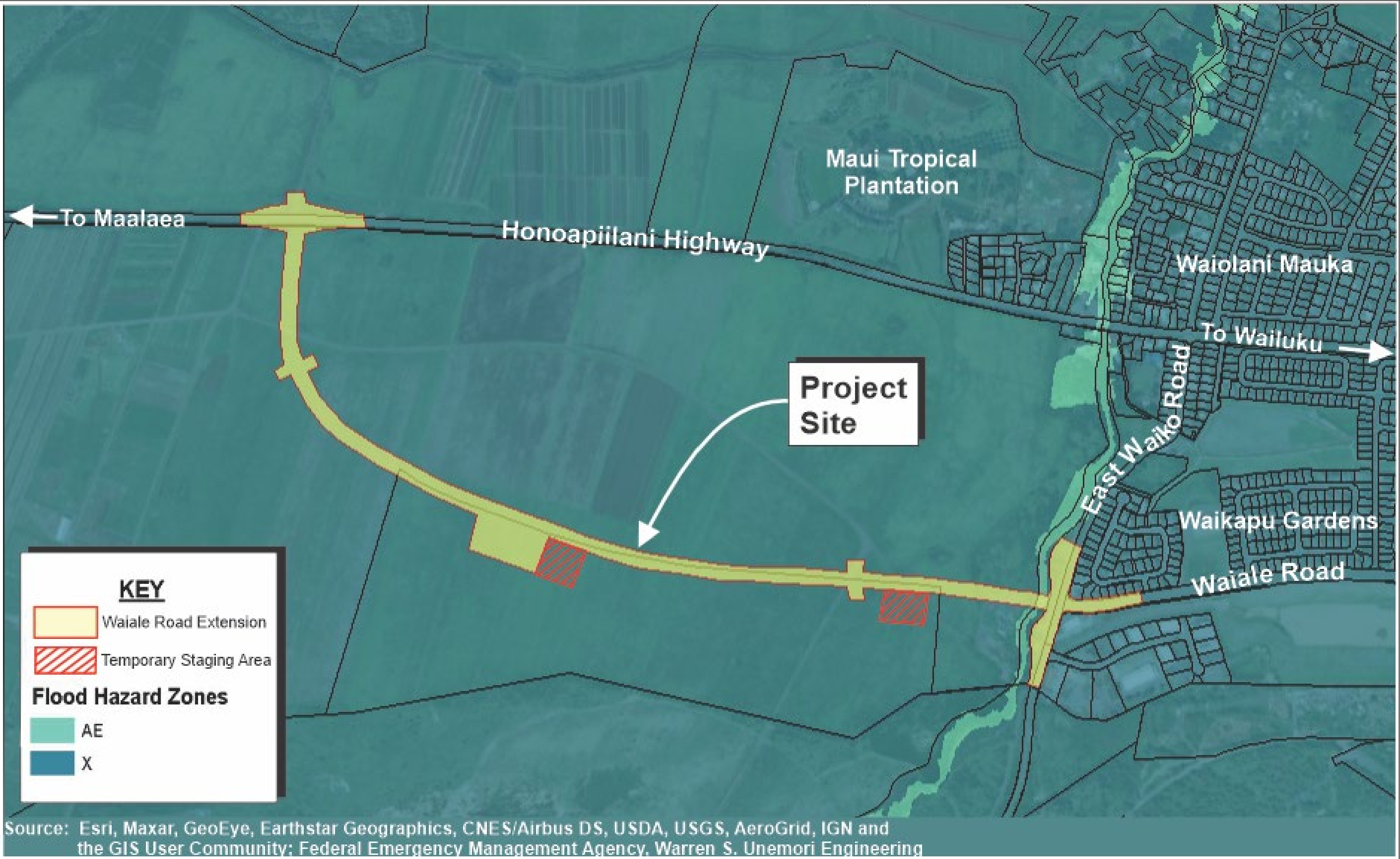


Figure 11

Waiale Road Extension Project
Flood Hazard Zones Map

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\Flood

b. **Potential Impacts and Proposed Mitigation Measures**

There are no restrictions on development for projects located within Flood Zone X. The crossing of Waikapu Stream will be achieved by a bridge structure design that will not interfere with the natural drainage characteristics of the Waikapu Stream. The bridge will be designed to accommodate a 100-year storm with a minimum 2-ft. freeboard, as required by FHWA and HDOT, in order to minimize the probability of overtopping. The bridge crossing alternative that would involve work in the stream bed and bank alteration would involve changes to the natural drainage characteristics of the Waikapu Stream. This bridge crossing alternative would also be designed to accommodate a 100-year storm with a minium 2-ft. freeboard. If any portion of the bridge is built within Zone AE, applicable flood permits will be requested and obtained prior to construction.

See **Table 6** below for an assessment of each of the design alternatives identified in Chapter I.

Table 6. Impact Assessment of Design Alternatives on Flood and Tsunami Hazards

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The entire project area is located outside of the Tsunami Inundation Zone, and the majority of the project area is located in Flood Zone X. A portion of the project area along Waikapu Stream is located in Flood Zone AE. The Waiale Road-East Waiko Road intersection will be developed in this area. If any improvements are to be built within Flood Zone AE, a flood permit will be sought and obtained prior to construction. With the incorporation of mitigation measures, neither intersection alternative is anticipated to have an adverse impact on flood and tsunami hazard in the region. The alternative involving a roundabout intersection at Waiale Road-East Waiko Road will require a slightly wider bridge when crossing the Waikapu Stream to accommodate the northbound approach to the roundabout. However, additional impacts are not anticipated as a result.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As discussed above, neither intersection is anticipated to have any adverse effects on flood or tsunami hazard in the region.

Table 6. Impact Assessment of Design Alternatives on Flood and Tsunami Hazards (Continued)

Bridge Crossing Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Bridge Crossing with No Stream Bed or Bank Alteration	As previously noted, this bridge alternative has been designed to accommodate the existing flow rates of Waikapu Stream, based on FEMA's 100-year storm event flows, with 2-ft. freeboard between the bridge soffit and the calculated water surface elevation during that storm event. Furthermore, the bridge is designed to span across the stream (with drilled shafts to be placed outside of the designated OHWM) to ensure that the stream is minimally impacted, and maintain a "no rise" condition with no loss of flow conveyance and no increase in the base flood elevation at the gulch for the 100-year flood discharge. Thus, no adverse impacts to tsunami or flood hazards are anticipated.
Bridge Crossing with Stream Bed and Bank Alterations	For the proposed alternative, the existing stream would be altered to reduce the general profile of the roadway, modifying its current alignment and cross section. This alternative would also meet FEMA's 100-year storm event flows, including the 2-ft. freeboard. However, this alternative would require extensive work within the stream channel (including excavation (estimated depths of up to 3-ft)), potential horizontal and vertical realignment of the stream channel, and modifications to the stream channel characteristics within the limits of channel reconstruction. It is anticipated the improvements would extend approximately 300-ft. upstream and 450-ft. downstream of the bridge crossing, resulting in approximately one (1) acre of stream channel disturbance for the reconstruction. Downstream (makai) of the bridge crossing, the stream channel would slowly transition back to existing conditions (e.g., reducing velocity, matching cross sections, etc.), to ensure that "no rise" conditions are met and there is no loss in flow conveyance. In addition, a temporary diversion channel is anticipated (to be located within adjacent privately-owned properties) to allow the by-pass of the existing, active stream flows during construction activities. As a result of the stream reconstruction, it is anticipated that the FEMA Flood Zone Maps would need to be amended in this localized area and additional coordination would be required with U.S. Army Corps of Engineers (USACE), Department of Health (DOH), and Commission on Water Resource Management (CWRM). As the project is outside of the Tsunami Evacuation Zones, no adverse impacts are expected.

7. Flora and Fauna

a. Existing Conditions

AECOS, Inc. prepared a natural resources assessment for the Waiale Road Extension project in June 2022. See **Appendix "E-1"**.

Flora

Vegetation across the project site is nearly all open grassland dominated by Guinea grass (*Megathyrsus maximus*), having covered the fallow sugar cane fields south of East Waiko Road. Ruderal herbs grow along the margins of farm roads. At Waikapu Stream, a riparian forest of mostly Java plum (*Syzygium cumini*) grows along the stream margins.

The botanical survey of the Project area identified 56 taxa of plants. The vast majority (93 percent) are non-native species. Three (3) indigenous species are present: moa (*Psilotum nudum*) and primrose willow (*Ludwigia octovalvis*) in the riparian zone of Waikapu Stream; and uhaloa (*Waltheria indica*) in ruderal (disturbed) areas. The percent of natives (7 percent) is typical for a lowland location on Maui. A single Polynesian introduction, coconut or niu (*Cocos nucifera*), and two (2) non-native ornamentals, be-still tree (*Thevetia peruviana*) and small crown flower or puakala‘unu (*Calotropis procera*), were recorded.

Fauna

Aquatic Fauna

AECOS, Inc. observed ten (10) aquatic species, comprising one (1) alga, two (2) odonata (damselflies and dragonflies), two (2) crustaceans, and three (3) fishes. No native indigenous or endemic species were observed in our survey of the middle reach of Waikapu Stream. Non-native mosquito fish (*Gambusia affinis*) and other poeciliids were common in the stream, as were Pacific prawn (*Macrobrachium lar*). Nearly the entire channel is shaded in a dense canopy of Java plum, inhibiting the growth of stream algae on rocks. Two (2) species of Hawaiian stream goby and two (2) species of native shrimp recorded in the Waikapu Stream system by the Division of Aquatic Resources (DAR) surveys (summarized in Parham et al., 2008) were not observed in AECOS, Inc.'s survey, although it is likely they occupy upper reaches of the stream. Additionally, no endangered damselfly was identified during this survey along the middle- to lower-reach of Waikapu Stream.

Blackburn's Sphinx moth

No tree tobacco or other plants in the family Solanaceae were found to occur within the project site.

Avian Fauna

A total of 102 individual birds of 18 species, representing ten (10) separate families, were recorded during the station counts. Two (2) species—Warbling White-eye (*Zosterops japonicus*) and Zebra Dove (*Geopilia striata*)—accounted for 39 percent of the total number of birds recorded. The most frequently recorded species was Warbling White-eye: 28 percent of the total birds recorded during station counts. All species recorded are well established alien species.

Mammals

At least 15 axis deer (*Axis axis*) and one (1) small Indian mongoose (*Herpestes javanicus*) were observed utilizing the fallow sugar cane fields in the project site. Trails made by axis deer crisscross the entirety of the project site, making travel through the dense Guinea grass relatively easy. Tracks of cat (*Felis catus*) were observed along the deer trails, while domestic dog (*Canis lupis familiaris*) could be heard nearby. No other mammals were observed, though it is highly probable that one (1) or more of the four (4) naturalized rodent species (Family Muridae) use resources on the property on a seasonal or temporal basis.

Section 7 of the Endangered Species Act

A species list was obtained from the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) website for the project area in July 2024 pursuant to Section 7 of the Endangered Species Act (ESA). See **Appendix "E-2"**. The species list for the project area provided a number of potential species in the area. These include the endangered Hawaiian hoary bat or opeapea (*Lasiurus cinereus semotus*); the endangered Hawaiian petrel or uau (*Pterodroma sandwichensis*), the threatened Newell's shearwater or ao *(Puffinus auricularis newelli*), and the endangered Hawaii Distinct Population Segment of the Band-rumped storm-petrel or akeake (*Oceanodroma castro*) (hereafter collectively referred to as Hawaiian seabirds); the endangered Hawaiian stilt or aeo (*Himantopus mexicanus knudseni*), the endangered Hawaiian coot or alae keokeo (*Fulica alai*), and the endangered Hawaiian duck or koloa (*Anas wyvilliana*) (hereafter collectively referred to as Hawaiian waterbirds); the threatened Hawaiian goose or nene (*Branta sandvicensis*); the endangered Blackburn's sphinx moth (*Manduca blackburni*); and the endangered Hawksbill Sea Turtle (*Eretmochelys imbricate*). It is noted that no federally designated Critical Habitats for any species occur within the project area, and no equivalent designation exists under State of Hawaii endangered species statutes.

It also identified 14 endangered flowering plants: aiea (*Nothocestrum latifolium*), enaena (*Pseudognaphalium sandwicensium var. molokaiense*), awiwi (*Schenkia sebaeoides*), Carter's Panicgrass (*Panicum fauriei var. carteri*), ihi (*Portulaca villosa*), kookoolau (*Bidens micrantha ssp. kalealaha*), kooloaula (*Abutilon menziesii*), Lanai Sandalwood (*iliahi*) (*Santalum haleakalae var. lanaiense*), ohai (*Sesbania tomentosa*), Round-leaved Chaff-flower (*Achyranthes splendens var. rotundata*), Spermolepis hawaiiensis, Uhiuhi (*Mezoneuron kavaiense*), Vigna o-wahuensis, and wahine noho kula (*Isodendrion pyrifolium*).

It is noted that no federally designated Critical Habitats for any species occur within the project area.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

<u>Flora</u>

AECOS, Inc. recorded no plant species within the project site listed as endangered or threatened under either federal or State of Hawaii endangered species statutes (HDLNR, 1998; U.S. Fish and Wildlife Service (USFWS), nd-b), and determined that project activities will not adversely impact botanical resources.

<u>Fauna</u>

<u>Aquatic Fauna</u>

Waikapu Stream flows from the West Maui Natural Area Reserve into the Kealia Pond National Wildlife Refuge. Many native aquatic species within these protected areas have an amphidromous lifecycle: eggs are laid in freshwater stream reaches, and hatched larvae drift downstream and out into the ocean where they develop for a time before migrating back into freshwater to grow to maturity (Ford and Kinzie, 1982; Kinzie, 1988). The following BMPs recommended by the report authors will be implemented to minimize or avoid impacts to these species:

- Downstream and upstream migration pathways will be maintained for native aquatic species with amphidromous life cycles.

- New structures will not include drains or grates that may entrain drifting larvae, nor overhanging culverts that may obstruct upstream movement of recruiting juveniles.

- Construction BMPs for work in aquatic environments will be incorporated into the Project plan to minimize the degradation of water quality and impacts to fish and wildlife resources.

Terrestrial Invertebrates

As previously noted, no tree tobacco or other plants in the family Solanaceae were found to occur within the project site. However, as recommended in the Natural Resources Assessment, a biologist familiar with Blackburn's sphinx moth and its host plants will survey areas of proposed project activities four (4) to six (6) weeks prior to the initiation of project construction. If moths, the native aiea (*Nothocestrum sp.*), or tree tobacco plants over 1 meter (m) (3 ft) tall are found during the survey, U.S. Fish & Wildlife Service (USFWS) will be contacted for additional guidance to avoid take.

Avian Fauna

Although no seabirds were detected during the Natural Resources Assessment, it is probable that the endangered Hawaiian Petrel or uau (*Pterodroma sandwichensis*), endangered Band-rumped Storm-Petrel or akeake (*Hydrobates castro*) and the threatened endemic Newell's Shearwater or ao (*Puffinus newelli*) overfly the project site. As recommended in AECOS's report, if night-time construction activity or equipment maintenance is proposed during any construction, all associated lights will be shielded and, if large flood/work lights are used, these will be placed on poles high enough to allow the lights to be pointed directly downward at the ground. If exterior lighting, including street lights, are installed in conjunction with the project, the lights will be shielded to reduce the potential for interactions of nocturnally flying seabirds with external lights or other man-made structures. All outdoor lighting will be "dark sky compliant" (HDLNR-DOFAW, 2016). No protected Hawaiian waterbirds were recorded during the survey despite the presence of riparian habitat in the project area. No habitat suitable for use by nene (*Branta sandwichensis*) occurs in the area.

Mammals

The mammals and other terrestrial macrofauna observed during the survey are not native to Hawaii and offer little value from an ecological perspective. The Hawaiian hoary bat is the only Endangered Species Act (ESA)-listed terrestrial mammal in Hawaii. To avoid potential deleterious impacts to roosting bats with pups, the DPW will not remove woody vegetation taller than 4.6 meters (15 ft.) during the bat pupping season between June 1 and September 15 (USFWS, 1998).

No federally designated Critical Habitat for any species occurs within the project area. No equivalent designation exists under State of Hawaii endangered species statutes.

In addition to those recommended in the Natural Resources Assessment report, DPW will implement the following mitigation measures identified by the USFWS in the species list and during Early Technical Assistance:

Hawaiian Hoary Bat (Opeapea)

To avoid and minimize impacts to the endangered opeapea, the following measures will be incorporated into the project description:

- Do not disturb, remove, or trim woody plants greater than 15 feet tall during the bat birthing and pup rearing season (June 1 through September 15).
- Do not use barbed wire for fencing.

Hawaiian Seabirds (Uau, Ao, and Akeake)

To avoid and minimize impacts to seabirds, the following measures will be incorporated into the project description:

- Fully shield all outdoor lights so the bulb can only be seen from below.
- Install automatic motion sensor switches and controls on all outdoor lights or turn off lights when human activity is not occurring in the lighted area.
- Avoid nighttime construction during the seabird fledging period, September 15 through December 15.

Listed seabirds have been documented colliding with communication towers, particularly in areas of high seabird passage rate. In general, self-supporting monopoles are the least likely to result in collisions, whereas lattice towers, particularly those that rely on guy-wires, have a greater risk. The proposed project will not involve the installation of any communication towers. Seabirds have been known to collide with fences, powerlines, and other structures near nesting colonies. To avoid and minimize the likelihood of collision, the following measures will be incorporated into the project description:

- Where fences extend above vegetation, integrate three (3) strands of polytape into the fence to increase visibility.
- For powerlines, guywires, and other cables, minimize exposure above vegetation height and vertical profile.

<u>Hawaiian Waterbirds (Koloa, Aeo and Alea Keokeo)</u>

The Natural Resources Assessment Report did not identify any Hawaiian waterbirds in the project area. Refer to **Appendix "E-1"**. Nevertheless, to avoid and minimize impacts to Hawaiian waterbirds, the following measures will be incorporated into the project description:

- The project will contact the USFWS during project planning for assistance in developing additional measures to avoid impacts to listed species (e.g., fencing, vegetation control, predator management).
- In areas where waterbirds are known to be present, post and implement reduced speed limits, and inform project personnel and contractors about the presence of endangered species onsite.
- Incorporate applicable Best Management Practices (BMPs) regarding work in aquatic environments into the project design.
- Have a biological monitor that is familiar with the species' biology conduct Hawaiian waterbird nest surveys where appropriate habitat occurs within the vicinity of the proposed project site prior to project initiation. Repeat surveys again within three (3) days of project initiation and after any subsequent delay of work of three (3) or more days (during which the birds may attempt to nest). If a nest or active brood is found:
    - Contact USFWS within 48 hours for further guidance.
    - Establish and maintain a 100-foot buffer around all active nests and/or broods until the chicks/ducklings have fledged. Do not conduct potentially disruptive activities or habitat alteration within this buffer.
    - Have a biological monitor that is familiar with the species' biology present on the project site during all construction or earth moving activities until the chicks fledge to ensure that Hawaiian waterbirds and nests are not adversely impacted.

During Early Technical Assistance, it was recommended that a biological monitor inspect the project site at the start of each day of construction to see if any nests had appeared. If a nest is discovered but no eggs are present, construction may proceed as planned. If any eggs are discovered, the biological monitor would contact USFWS within 48 hours for further guidance. The project will implement this recommendation.

Hawaiian Goose (Nene)

To avoid and minimize potential project impacts to nene, the following measures will be incorporated into the project description:

- Do not approach, feed, or disturb nene.
- If nene are observed loafing or foraging within the project area during the breeding season (September through April), have a biologist familiar with nene nesting behavior survey for nests in and around the project area prior to the resumption of any work.
- Repeat surveys after any subsequent delay of work of three (3) or more days (during which the birds may attempt to nest).
- Cease all work immediately and contact USFWS for further guidance if a nest is discovered within a radius of 150 feet of proposed project, or a previously undiscovered nest is found within the 150-foot radius after work begins.
- In areas where nene are known to be present, post and implement reduced speed limits, and inform project personnel and contractors about the presence of endangered species onsite.

Nene 4(d) rule: A 4(d) rule was established at the time the nene was downlisted to threatened status. Under the 4(d) rule, the following actions are not prohibited under the Act, provided the additional measures described in the downlisting rule are adhered to:

- Take by landowners or their agents conducting intentional harassment in the form of hazing or other deterrent measures not likely to cause direct injury or mortality, or nene surveys.
- Take that is incidental to conducting lawful control of introduced predators or habitat management activities for nene.
- Take by authorized law enforcement officers for the purpose of aiding or euthanizing sick, injured, or orphaned nene; disposing of dead specimens; and salvaging a dead specimen that may be used for scientific study.

During Early Technical Assistance consultation with the USFWS, it was noted that nene are susceptible to being crushed by falling construction equipment caused by high winds. As such, the proposed project will ensure that all construction materials are secured to the ground to protect any nene traversing the project area in the event that there are high winds.

Blackburn’s Sphinx Moth

No Blackburn’s sphinx moths or their eggs or larvae were observed during the Natural Resources Assessment, neither were any tree tobacco plants. To avoid and minimize potential project impacts to the Blackburn’s sphinx moth, the project will incorporate the following USFWS recommendations to assess whether it is present in the project area:

- A biologist familiar with the species should survey areas of proposed activities for Blackburn's sphinx moth and its larval host plants prior to work initiation.
    - Surveys should be conducted during the wettest portion of the year (usually November-April or several weeks after a significant rain) and within 4-6 weeks prior to construction.
    - Surveys should include searches for eggs, larvae, and signs of larval feeding (chewed stems, frass, or leaf damage).
    - If moths, eggs, larvae, native ʻaiea, or tree tobacco over three (3) feet tall are found during surveys, do not disturb them and contact USFWS for additional guidance to avoid take.

Though no Blackburn's spinx moths or tree tobacco plants were identified during the Natural Resources Assessment, tree tobacco propagates readily in disturbed fields and can attain a height greater than one (1) meter tall in less than six (6) weeks. At 1-meter tall, the plants may become a host for Blackburn's sphinx moth larvae. Therefore, the following recommendations will be implemented:

- Remove any tree tobacco less than three (3) feet tall.
- Monitor the site every 4-6 weeks for new tree tobacco growth before, during, and after the proposed ground-disturbing activity. This monitoring can be completed by any staff, such as groundskeeper or regular maintenance crew, if they are provided with picture placards of tree tobacco at different life stages.

<u>Hawksbill Sea Turtle</u>

While the project area located inland and away from the shoreline, FHWA recognizes that the project corridor contains open paths to coastal and wetland habitats. As such, the project will implement USFWS's BMPs for Work in or Around Aquatic Environments (2022). Additionally, to prevent construction-related erosion, measures are expected to be implemented from the inception of any ground disturbing activities and maintained as required (e.g., dust fences, silt fences, filtration berms, temporary sedimentation basins, etc.) pursuant to applicable provisions of:

- Storm Water Post-Construction Best Management Practices Manual (State of Hawaii Department of Transportation (dated February 2022));
- Chapter 20.08 of the Maui County Code (MCC), "Soil Erosion and Sedimentation Control"; Construction Best Management Practices (BMPs) for the County of Maui (dated May 2001);

- Title MC-15, Subtitle 01, Chapter 111, “Rules for the Design of Storm Water Treatment Best Management Practices” (adopted November 9, 2012); and,
- Any applicable conditions and requirements of the project-specific National Pollutant Discharge Elimination System (NPDES) Permit, including Hawaii Administrative Rules (HAR) Chapter 11-55, **Appendix “J”**.

Additionally, The Waiale Road Extension project will include the installation of drainage improvements that will minimally alter natural pre-development patterns and mitigate the increase in runoff generated by the proposed project, such that the runoff released downstream will be no greater than that under predevelopment conditions or the allowable runoff that the existing drainage systems were originally master-planned to accommodate from the project site.

All construction lighting and permanent lighting associated with the roadway and shared use path will comply with MCC, Chapter 20.35, “Outdoor Lighting”. Additionally, nighttime work will be minimized to the extent possible.

Flowering Plants

While there are 14 plants on the species list, because the project area has been previously disturbed for agricultural use, and because no plant species listed as endangered or threatened were identified during the Natural Resources Assessment, DPW does not anticipate the proposed project to have negative impacts on listed floral species.

To avoid or minimize potential adverse effects to listed plants that may occur on the proposed project site, the project will implement or has already implemented the following recommendations from USFWS:

- Minimize disturbance outside of existing developed or otherwise modified areas.
- When disturbance outside existing developed or modified sites is proposed, conduct a botanical survey for listed plant species within the project action area, defined as the area where direct and indirect effects are likely to occur.

In addition to the foregoing, the project will implement the USFWS’ recommended standard BMPs.

As no endangered or threatened species were identified recorded during the Natural Resources Assessment, with the implementation of the above-listed USFWS BMPs, the project is not anticipated to have a significant negative impact on flora and fauna.

Given the project's location inland and away from the shoreline, the proposed action is not anticipated to affect Essential Fish Habitat and aquatic or marine species.

See **Table 7** below for an assessment of each of the design alternatives identified in Chapter II.

Table 7. Impact Assessment of Design Alternatives on Flora and Fauna

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	Both intersection alternatives would involve roughly the same project area. As such, there is no difference in how they would impact flora and fauna.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	With the implementation of the BMPs described above, neither intersection alternative is anticipated to have any adverse impacts on native flora and fauna in the project area.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	This bridge alternative avoids work within the Waikapu Stream and as such, minimizes potential impacts to fauna within the stream. During construction of the project, BMPs will be implemented to minimize potential impacts to fauna within the project area.
Bridge Crossing with Stream Bed and Bank Alterations	This bridge alternative would require work within the Waikapu Stream. Appropriate construction methodology and BMPs would be developed and submitted to USFWS and DOFAW for review and approval prior to the start of construction. Temporary re-routing of the Stream may be needed in order to complete the bridge components. Upon completion of construction, this alternative would allow for continued flow of water in the Stream to allow for continued use by fauna.

8. Streams, Wetlands, and Reservoirs

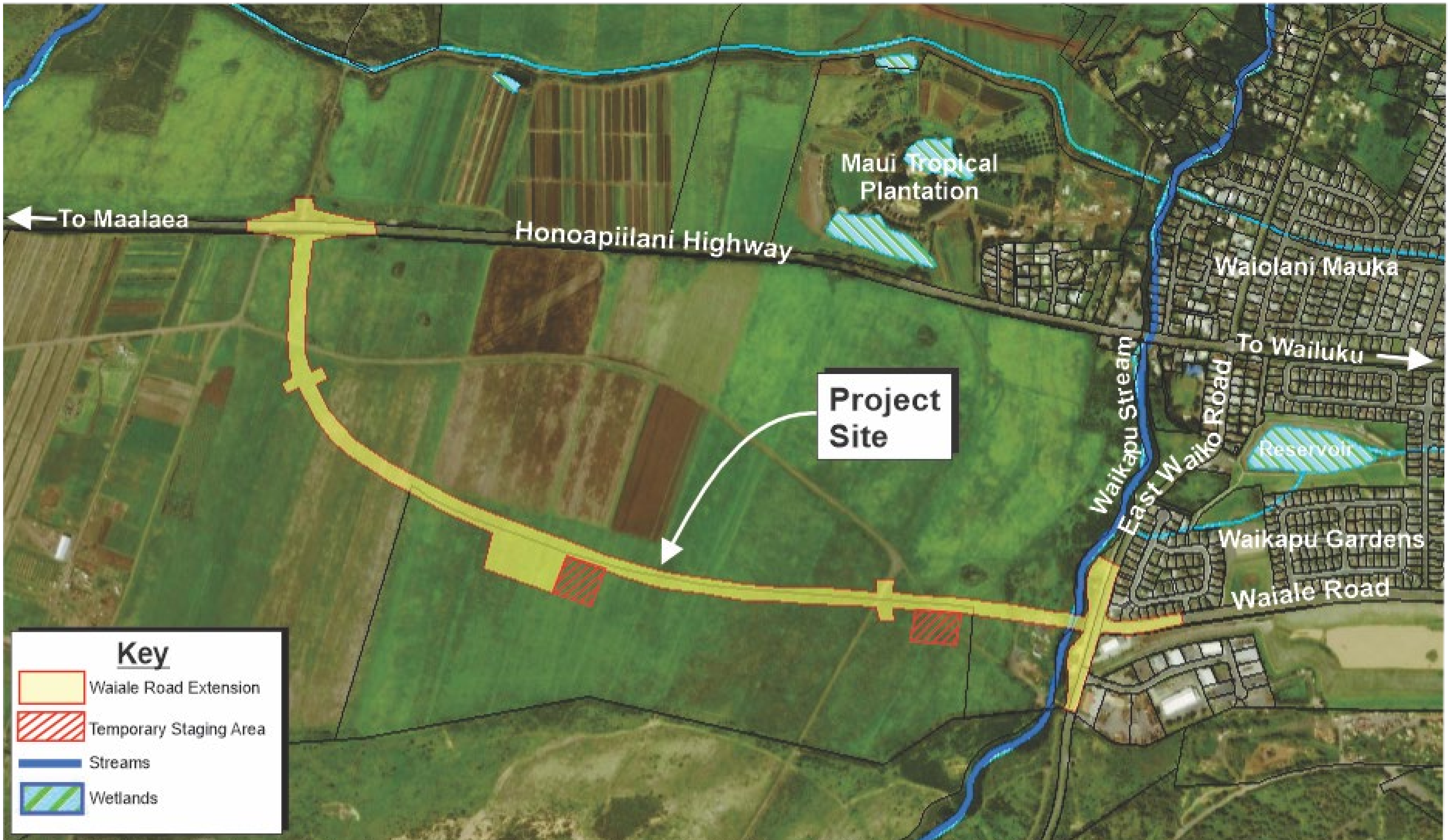
a. Existing Conditions

The USFWS National Wetlands Inventory (NWI) is a nationwide geospatial dataset of wetlands and other surface hydrology features (USFWS, nd-a). According to the NWI, there are wetlands that fall within the Freshwater Emergent Wetland and Freshwater Pond categories 700 +/- feet and further from the project site.

A narrow line crosses the project area in the location of Waikapu Stream and is identified as being within the Freshwater Forested / Shrub Wetland category. However, a detailed, on-ground biological survey and jurisdictional waters delineation conducted by AECOS, Inc. in 2022 confirmed that despite there being java plum fruit and other accumulated organic matter in some sections, the water appeared exceptionally clear throughout the stream, with no visible turbidity and no evidence of wetlands. See **Figure 12**.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The planned crossing of the Waikapu Stream provides for two (2) construction alternatives. One which will involve work outside of the OHWM for the stream, while the other will involve work within the stream. Appropriate BMPs will be incorporated for work near or within Waikapu Stream to mitigate potential impacts. While the USFWS NWI identified potential wetlands in the project area, the identified sites are at a minimum 700+\- feet away from the project site.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS AeroGRID, IGN, and the GIS User Community; State of Hawai'i, Department of Land and Natural Resources, Division of Aquatic Resources; U.S. Department of the Interior, Fish and Wildlife Service, Warren S. Unemori Engineering

Figure 12 Waiale Road Extension Project
Streams and Wetlands

0 250 500 1000 Feet

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\Streams

See **Table 8** below for an assessment of each of the design alternatives identified in Chapter II.

Table 8. Impact Assessment of Design Alternatives on Streams and Wetlands

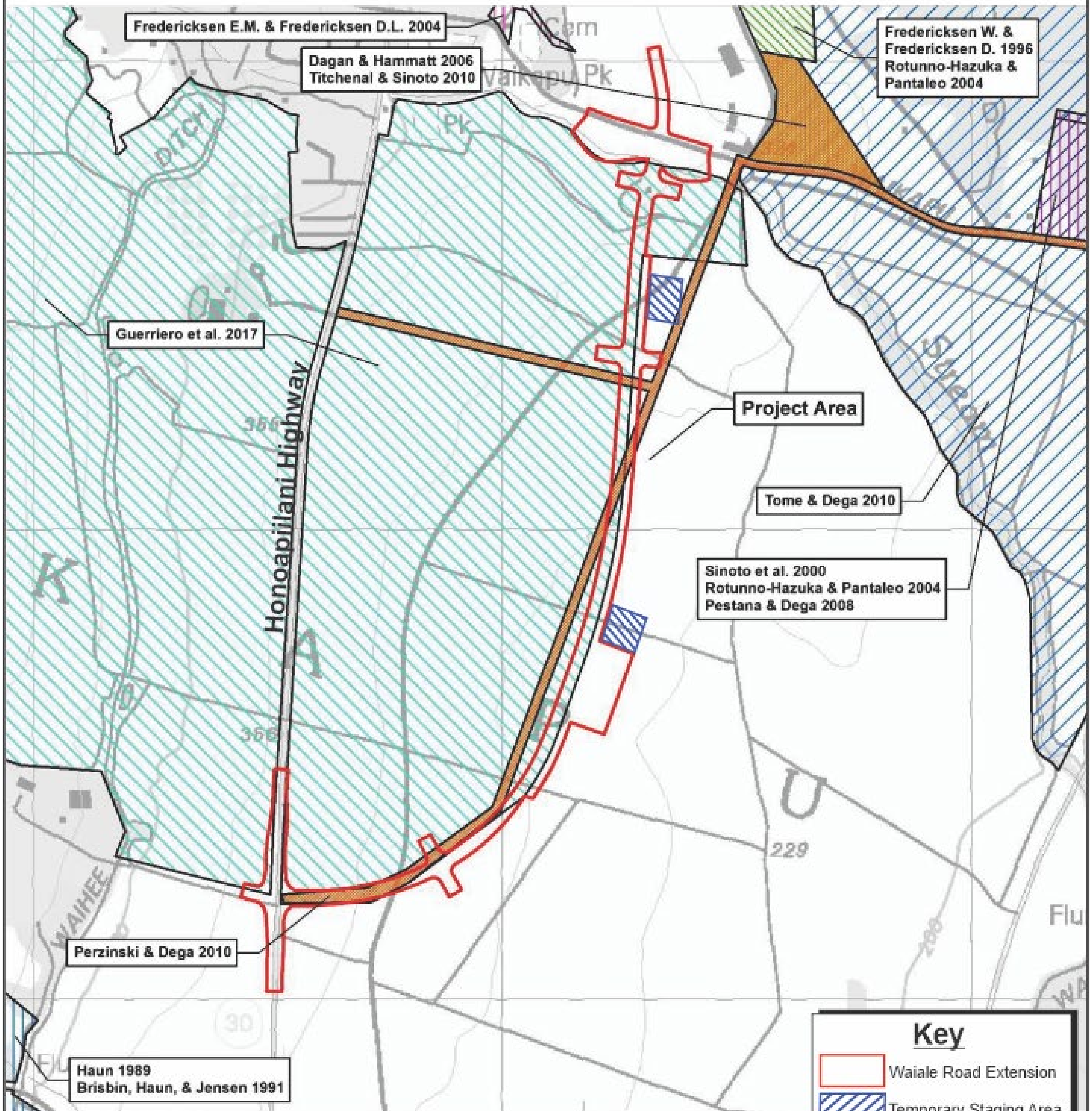
Intersection Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Four (4) Single-Lane Roundabouts	The intersection design alternative involving the construction of a roundabout at the Waiale Road-East Waiko Road intersection would result in a slightly larger footprint in that area. As such, the bridge crossing over Waikapu Stream would be wider under the four (4) roundabout intersection alternative. However, with the implementation of appropriate BMPs, adverse impacts to Waikapu Stream are anticipated to be avoided with the construction of either alternative.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As discussed above, with the implementation of appropriate BMPs, adverse impacts to Waikapu Stream are anticipated to be avoided with the implementation of either intersection design alternative.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The design alternative involving no bank protection will have less of an impact on Waikapu Stream, as no work would be conducted within the stream.
Bridge Crossing with Stream Bed and Bank Alterations	The design alternative involving grouted rock bank protection would have a larger impact on Waikapu Stream, as it would involve the installation of invert lining both upstream (approximately 300 ft.) and downstream (approximately 450 ft.) of the bridge crossing and grouted rock bank protection within the stream. However, with the implementation of appropriate BMPs, significant adverse impacts to the stream is not anticipated.

9. Archaeological and Historic Resources

a. Existing Conditions

An archaeological Literature Review and Field Inspection (LRFI) for the project corridor was conducted by Cultural Surveys Hawaii, Inc. (CSH) from December 2021 to February 2022. See **Appendix "F-1"**.

The literature review of the project vicinity revealed that a number of archaeological studies have been conducted in that area. See **Figure 13**. Findings from these studies are detailed in **Appendix "F-1"**. The project area has been subject to prior archaeological reviews for a variety of



Source: USGS Topographic Map, Wailuku (1997) Quadrangle, Cultural Surveys Hawaii

Figure 13 Waiale Road Extension Project
Archaeological Studies Conducted Within and Near the Project Area

NOT TO SCALE

MUNEKIYO HIRAGA

Prepared for: County of Maui, Department of Public Works

Bowers\Waiale Road Extension\Applications\Figures\DEA\ArchStudies projects. Studies were undertaken in the late 1980's, 2000's and most recently in 2017.

Prior to the current project, an effort to extend Waiale Road along a similar corridor was undertaken in 2009, prompting an archaeological inventory survey (AIS) that included a pedestrian surface survey and 64 backhoe-assisted test excavations. The AIS, which was conducted by Scientific Consultant Services, Inc. in 2010, identified one (1) historic property, SIHP number 50-50-04-06668 (-06668), a boulder terrace along the southern bank of Waikapu Stream, that was archaeologically tested, assessed as significant per Criterion "d", and recommended for no further work. No subsurface historic properties were identified during the 2010 AIS within the project area.

In addition to the literature review, an archaeological field inspection of the Waiale Road project site was conducted on December 1, 2021 and February 4, 2022.

The field inspection identified three (3) potential historic properties, referred to as CSH 1 through CSH 3 in the LRFI report, and confirmed the location of SIHP number 50-50-04-06668 within the project area. CSH 1 is a historic road alignment and former railroad corridor that crosses the project area in two (2) locations. CSH 2 is a drainage ditch that extends along the downslope edge of Honoapiilani Highway. CSH 3 includes mechanically stacked boulder retaining walls constructed at the northern bank of Waikapu Stream. CSH also re-identified SIHP number -06668. Additional documentation of these historic properties is provided in **Appendix "F-1"**. See **Figure 14**.

CSH concluded that while the potential for subsurface historic properties, including human burials, is lower in the project area than in nearby Puuone sand deposits, there remains a potential for subsurface historic properties to be present beneath the agricultural plow zone (3 to 4 ft. below the surface). As such, CSH recommended that the project proceed with an AIS that includes a subsurface testing element, and stated that consultation with the State Historic Preservation Division (SHPD) is required to determine historic preservation requirements for the project. SHPD concurred in their June 28, 2023 Chapter 6E-8 historic preservation review letter. DPW submitted an AIS testing strategy to the SHPD on November 8, 2023, which was accepted via Hawaii Cultural Resource Information System (HICRIS) comment on February 2, 2024.

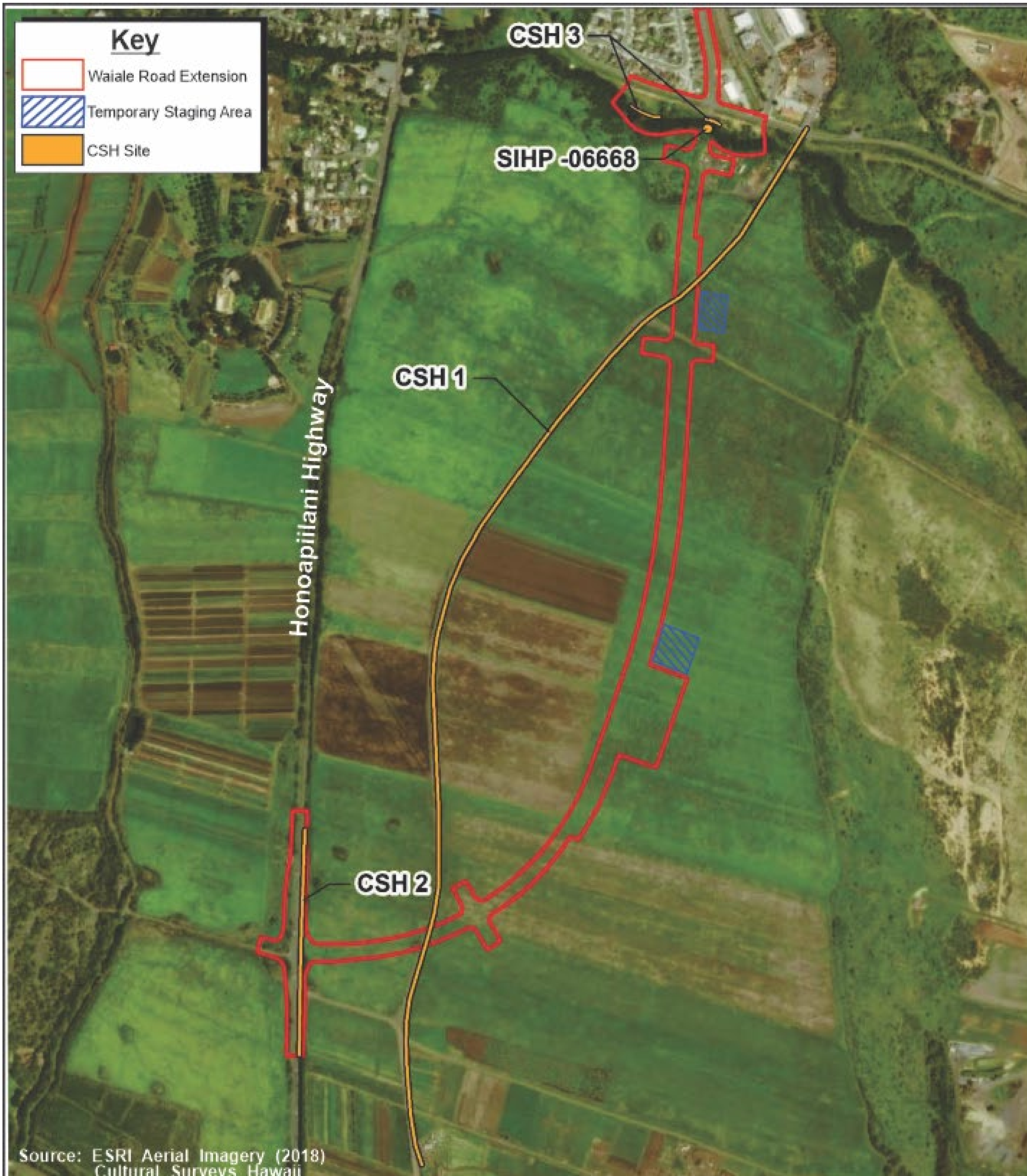


Figure 14 Waiale Road Extension Project
Identified Archaeological Findings
Within the Project Area

NOT TO SCALE

MUNEKIYO HIRAGA

Prepared for: County of Maui, Department of Public Works

Bowers\Waiale Road Extension\Applications\Figures\DEA\ArchFindings

The project's AIS fieldwork strategy noted that the Perzinski and Dega (2010) AIS included 25 test excavations within the current project area with negative findings. In order to supplement this previous archaeological testing effort, 60 additional test excavations were proposed, as well as a ground penetrating radar (GPR) survey of 10 transects and another 100 percent coverage pedestrian inspection. The AIS fieldwork was completed between April 29 and May 20, 2024. While working to complete the AIS report, CSH prepared and submitted to DPW an Executive Summary and a Notification of End of AIS Fieldwork. See **Appendix "F-2"** and **Appendix "F-3"**. Preliminary findings include updated documentation of SIHP No. -06668 and an assessment that the drainage ditch along Honoapiilani Highway (CSH 2) is likely a significant historic property. The AIS was unable to find material evidence of the former railroad alignment that was documented in the project's LRFI (CSH 1). The retaining wall on the northern bank of Waikapu Stream that was identified during the LRFI (CSH 3) was confirmed to be modern construction. One (1) historic property was identified during AIS subsurface testing near the intersection of the existing Waiale Road and East Waiko Road. The historic property, temporarily designated "CSH 4" by CSH, consisted of a subsurface post-Contact cultural deposit comprised of discarded household refuse material. During the completion of the project's draft AIS report, CSH will consult with SHPD to obtain an SIHP number for this historic property. Importantly, no human remains or human burials were identified within the project area. The results of the AIS will be described in a report that is currently being prepared and will be submitted for review and acceptance by SHPD.

Because the proposed project will be partially funded by the FHWA, compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA) is necessary. Section 106 requires Federal agencies to consider the effects on historic properties of projects they carry out, assist, fund, permit, license, or approve throughout the country. In the State of Hawaii, Section 106 regulations place particular emphasis on consultation with Native Hawaiian Organizations (NHO). In this regard, Section 106 consultation was initiated for the proposed project in December 2023. A letter requesting APE concurrence was submitted to the State Historic Preservation Officer (SHPO) via HICRIS on December 6, 2023. See **Appendix "F-4"**. In the letter, a request was made to the SHPO for information on all eligible historic properties/cultural sites within the APE and in the State's Inventory of Historic Places. In addition, the SHPO was asked to provide information on issues they may have relating to the proposed undertaking's potential effects on each significant historic property within 30 days of receipt. Pursuant to 36 Code of Federal Regulations (CFR) § 800.3(c)(4), because the SHPO did not respond to the request within 30 days, the FHWA and the HDOT elected to proceed with the Section 106 process. Following that decision, on September 24, 2024, the FHWA and the HDOT received a response from the SHPD, which recommended that in order to prepare a list of Native Hawaiian Organizations to consult as part of the Section 106 process, the FHWA refer to the Native Hawaiian Organization Notification List provided by the U.S. Department of the Interior and expand consultation to interested parties such as civic clubs and historic preservation organizations. The FHWA and the HDOT followed this course of action when preparing its list of NHOs to consult. Therefore, the FHWA's list and efforts are in accordance with the SHPD's recommendations.

On May 9, 2024, the DPW, on behalf of the HDOT and the FHWA, mailed letters requesting consultation from NHOs and other individuals and organizations with legal, economic, or historic preservation interest in the Waiale Road Extension Project within 30 days of receipt of the letter. See **Appendix "F-5"**. As of the beginning of October 2024, no NHOs or other interested individuals or organizations had responded to DPW's request for consultation. The FHWA is currently preparing an effect determination and request for concurrence letter to the SHPD, pursuant to Section 106. The proposed project will implement all SHPD recommendations and requirements.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The proposed project will comply with all requirements given by SHPD upon completion of the project's Chapter 6E-8 and BMPs recommended by CSH as a result of its Cultural Impact Assessment (CIA), which are described in the following section, III.A.10.b, Cultural Resources.

Based on the foregoing, adverse impacts to archaeological or historic resources are anticipated to be mitigated or avoided. See **Table 9** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 9. Impact Assessment of Design Alternatives on Archaeological and Historic Resources

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The four (4) roundabout design alternative is not anticipated to have any additional impacts to archaeological and historic resources when compared to the alternative involving two (2) signalized intersections.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	There is no difference between the two (2) alternatives when assessing their potential to adversely impact archaeological and historic resources in the project area.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	There is no anticipated difference between the two (2) bridge alternatives relative to potential effects for archaeological and historical resources. Compliance with the SHPD requirements will be undertaken for either bridge alternative.
Bridge Crossing with Stream Bed and Bank Alterations	There is no anticipated difference between the two (2) bridge alternatives relative to potential effects for archaeological and historical resources. Compliance with the SHPD requirements will be undertaken for either bridge alternative.

10. Cultural Resources

a. Existing Conditions

A CIA was prepared for the proposed project by Cultural Surveys Hawaii (CSH) to analyze the potential impacts the project may have on cultural features and practices associated with the project area. See **Appendix "G"**. Because native Hawaiian traditions view humans' relationship with land as being from mauka to makai, the geographic scope of the CIA extends beyond the project area and encompasses the entire ahupuaa of Waikapu.

The Wailuku and Waikapu ahupuaa share an east-west boundary and collectively constitute the entirety of the central isthmus of Maui, which is bounded by Iao Valley to the west, Kahului Harbor to the north, Paia and Haliimaile to the east, and Maalaea Harbor to the south.

In ancient times, Waikapu was an agriculturally abundant land known for its extensive loi, or wetland taro, cultivation. From the early 1800s onward into the late 20th century, land uses in Waikapu were dominated by commercial sugarcane cultivation and, to a lesser extent, pastoral endeavors.

The CIA documents the environmental and cultural significance of Waikapu from ancient times to today, identifying pre-and post-Contact land uses. The report authors describe ka lepo (soils), na makani (winds), na ua (rains), na kahawai (streams and freshwater), and ka likikikai and ka moana (the coast and the ocean) associated with Waikapu. They also provide various historical accounts, kaao and moolelo (legends and stories), wahi pana (storied places), mele (songs), oli (chants), and olelo noeau (proverbs) that explore topics such as place names, major battles, important natural features and resources, the activities of the akua (gods) and alii (ruling class), day-to-day life, and religious, agricultural, and commercial practices in the area. Additionally, the CIA report summarizes previous archaeological and cultural research that has been conducted within and in the vicinity of the proposed project area.

In doing so, the report authors establish the context for identifying and understanding cultural features and practices associated with the project area, allowing them to formulate and implement a sound CIA methodology.

As discussed in the above section, the FHWA initiated NHPA, Section 106 consultation with the SHPO and NHOs and individuals. As of the beginning of October 2024, no cultural resources have been identified as part of the Section 106 process.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The methodological framework for conducting the CIA began with an outreach program that identified individuals with knowledge of the cultural practices and features within and in the vicinity of the proposed project area. CSH attempted to contact native Hawaiian organizations, agencies, community members, and cultural and lineal descendants of the area to identify individuals with cultural expertise or knowledge of the project area and vicinity. They sent community outreach letters to 57 individuals and groups: 11 responded, one (1) provided written testimony, one (1) met with CSH for an in-depth interview, and one (1) participated in a phone interview. The three (3) individuals who provided consultation are:

1. Kamakana Ferreira, Lead Compliance Specialist for the Office of Hawaiian Affairs

2. Scott Fisher, Chief Conservation Officer, Hawaiian Islands Land Trust (HILT); Chief, Maui/Lanai Island Burial Council (MLIBC); and Kamaaina

3. Mr. Robert “Bobby” Pahia, Kalo Farmer; Founder, Hawaii Taro Farm; and Kamaaina

Based on the results of community consultation and background research conducted as part of the CIA, no ongoing cultural practices were identified within the project area. However, the project area is in the general vicinity of ongoing cultural practices, including ulu and kalo cultivation and burial sites and practices. Below is a summary of mitigation measures suggested in the CIA.

- Dr. Fisher is against more ground disturbance and recommends the project be suspended due to the prevalence of iwi kupuna in the area.
- Dr. Fisher is concerned about the impacts the proposed bridge crossing portion of the project will have on stream flow and water quality. Waikapu Stream and Kealia Pond are significant cultural and natural resources. Waikapu Stream specifically is utilized by Native Hawaiian families in the area to irrigate their loi kalo
- Mr. Ferreira minimally recommends archaeological monitoring as well as any proposed testing for this area.
- Project construction workers and all other personnel involved in the construction and related activities of the project should be informed of the possibility of inadvertent cultural finds, including human remains.
- In the event that any potential historic properties are identified during construction activities, all activities will cease and SHPD will be notified pursuant to HAR, Subsection 13-280-3.
- In the event that iwi kupuna are identified, all earth-moving activities in the area will stop, the area will be cordoned off, and SHPD and the Police Department will be notified pursuant to HAR, Subsection 13-300-40.
- In the event of an inadvertent discovery of human remains, the completion of a burial treatment plan, in compliance with HAR, Subsection 13-300 and HRS, Chapter 6E-43, is recommended.
- In the event that iwi kupuna or cultural finds are encountered during construction, project proponents should consult with cultural and lineal descendants of the area to develop a reinternment plan and

cultural preservation plan for proper cultural protocol, curation, and long-term maintenance.

With the implementation of the above mitigation measures, as applicable, the proposed project is not anticipated to have a negative impact on cultural features or practices in the project area. See **Table 10** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 10. Impact Assessment of Design Alternatives on Cultural Resources

Intersection Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Four (4) Single-Lane Roundabouts	Both intersection alternatives would involve roughly the same project area. As such, their impact on cultural resources would be the same.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As discussed above, both intersection alternatives would have the same level of impact on cultural resources in the project area.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	Similar to the intersection treatment alternatives, the bridge alternatives are anticipated to have the same level of impact on archaeological and cultural resources.
Bridge Crossing with Stream Bed and Bank Alterations	Similar to the intersection treatment alternatives, the bridge alternatives are anticipated to have the same level of impact on archaeological and cultural resources.

11. Noise Quality

a. Existing Conditions

An acoustic study was conducted for the proposed project by Y. Ebisu & Associates in March 2023. See **Appendix "H"**. The objective of the study was to evaluate potential noise impacts associated with the proposed improvements. The acoustic study used 2022 as the Base Year for computing changes in traffic noise levels associated with the Build Alternative, or the alternative involving the implementation of the proposed project, in the Future Year, 2045. To determine Base Year conditions, the study authors calculated the Hourly Equivalent (or Average) Sound Level (Leq(h)) along existing sections of Waiale Road, East Waiko Road, and Honoapiilani Highway in the vicinity of the project area during the applicable morning (AM) or evening (PM) peak traffic hour (whichever yielded the highest Leq(h) along each section).

According to the acoustic study, Base Year traffic noise levels along the study sections do not exceed the United States Federal Highway Administration (FHWA) and State of Hawaii, Department of Transportation (HDOT) criteria for noise abatement of 66 decibels (dB) Leq. Refer to **Appendix "H"**.

b. **Potential Impacts and Proposed Mitigation Measures**

In the short term, there may be impacts associated with construction activities along the project corridor. Construction-phase project components include grading, excavation, the construction of the bridge over Waikapu Stream, construction of retaining walls, paving and landscape installation. The total noise exposure from construction activities at any one receptor location is not expected to be continuous during the total construction period. Impacts are anticipated to be limited to temporary degradation of the quality of the acoustic environment in the immediate vicinity of project work areas. It is noted that the State Department of Health (DOH) currently regulates noise from construction activities under a permit system. In accordance with DOH regulations, the project contractor will implement BMPs including standard curfew periods, properly muffled equipment, administrative controls, and construction barriers, as required.

As referenced above, the acoustic study utilized the year 2045 as the Future Year for measuring long-term noise impacts. HDOT's noise abatement threshold can be reached either by generating traffic noise that exceeds a Leq of 66 dB or by causing an increase over existing background noise levels by 15 dB or more. The acoustic study found that, under the Build Alternative, traffic noise levels are not expected to exceed either noise abatement criteria at existing residences along Waiale Road and East Waiko Road in the Future Year 2045. Further, the abatement criteria will not be exceeded at any public use facilities or park lands within or in vicinity of the project area. The study report states that traffic noise mitigation measures should not be required at existing residences along Waiale Road and East Waiko Road under the Build Alternative, primarily due to existing sound attenuating walls in those areas. Because the condition of the existing walls may deteriorate, the study suggested DPW consider including those walls in the final limits of project construction, so that they can be repaired as necessary during the development of the Waiale Road Extension.

Y. Ebisu & Associates also concluded that traffic noise mitigation measures should not be required along the Waiale Road Extension, as lands along the roadway corridor are currently undeveloped.

In recognition of the potential for noise-sensitive Waikapu Country Town residences which may be developed prior to the completion of the Waiale Road Extension, the acoustic study includes anticipated buffer distances that would be required by Future Year 2045 so as not to exceed HDOT's noise abatement criteria. The required setback distances are relatively small along the Waiale Road Extension except at the north end of the project corridor where the traffic contributions from the Waikapu Country Town development are the dominating influence on the predicted future noise levels. Refer to **Appendix "H"**. Y. Ebisu & Associates recommended the following mitigation measures for future noise-sensitive developments:

- The inclusion of sound-attenuating walls along the Waiale Road Extension
- Where the inclusion of sound-attenuating walls is not feasible, closure and air-conditioning of the affected noise-sensitive buildings
- The inclusion of landscaped buffer zones between the roadway and future noise-sensitive buildings

See **Table 11** below for an assessment of each of the design alternatives identified in Chapter II.

Table 11. Impact Assessment of Design Alternatives on Noise Quality

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	Both short- and long-term noise impacts are anticipated with the implementation of the proposed project. The intersection design alternative selected for the proposed project will not impact traffic levels in the project area. As such, impacts are anticipated to be similar across both alternatives.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As described above, the two (2) intersection design alternatives are anticipated to have similar impacts on noise in the project area.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	Similar to the intersection alternatives, the short- and long-term noise impacts of the future bridge crossing are not anticipated to be significantly different. As such, impacts are anticipated to be similar across both bridge alternatives.
Bridge Crossing with Stream Bed and Bank Alterations	Similar to the intersection alternatives, the short- and long-term noise impacts of the future bridge crossing are not anticipated to be significantly different. As such, impacts are anticipated to be similar across both bridge alternatives.

12. Scenic and Open Space Resources

a. Existing Conditions

The project area is in the lee of both the East and West Maui mountains. The project site is not located within a scenic view corridor, nor is it a part

of a valuable open space resource area. Waikapu Gardens and industrial businesses are located to the north, Maui Tropical Plantation is to the west, Kuihelani Highway is to the east, and vacant agricultural lands are to the south.

b. Potential Impacts and Proposed Mitigation Measures

The proposed project consists of the extension of Waiale Road. Landscaping will be installed as part of the roadway improvements to ensure visual buffering and softening of the built landscape. Thus, mountain views to the west and ocean views to the north and south of the project site will not be impacted as a result of the proposed action. Given the project is for roadway improvements in fallow agricultural lands, adverse impacts to scenic or open space resources resulting from the project are not anticipated.

See **Table 12** below for an assessment of each of the design alternatives identified in Chapter II.

Table 12. Impact Assessment of Design Alternatives on Scenic and Open Space Resources

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The project site is not located in a scenic view corridor. However, landscaping will be installed as part of the roadway improvements to ensure visual buffering and to soften the built landscape. All roundabouts constructed will feature landscaped medians at all approaches to calm traffic. Additionally, the roundabouts do not require the use of traffic signal poles and arms. As such, the design alternative involving only roundabouts may have a slightly more beneficial impact on scenic resources than the design involving two (2) signalized intersections.

Table 12. Impact Assessment of Design Alternatives on Scenic and Open Space Resources (continued)

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As described above, the proposed project is not anticipated to have a significant adverse impact on scenic or open space resources. However, when compared to the alternative involving four (4) roundabout intersections, the alternative involving two (2) signalized intersections may be slightly more disruptive to the scenic quality of the project area, as it will employ less landscaping and involve the use of traffic signal poles and arms.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	This bridge crossing alternative will require the raising of the existing Waiale Road and East Waiko Road intersection by approximately two (2) feet, to meet the level requirements for the intersection transition. However, it is not anticipated to have negative impacts on scenic and open space resources.
Bridge Crossing with Stream Bed and Bank Alterations	This proposed bridge alternative would generally be at grade and as such, is not anticipated to have impacts to scenic and open space resources.

13. Hazardous Materials

a. Existing Conditions

The proposed Waiale Road Extension corridor traverses over former sugar cane fields characterized by invasive overgrowth. It is surrounded by vacant agricultural lands, industrial businesses, residential subdivisions, and the Maui Tropical Plantation. The site is not being actively farmed.

b. Potential Impacts and Proposed Mitigation Measures

The proposed Waiale Road Extension will not require the use or storage of chemicals or hazardous materials during long-term operations of the roadway. Use of fertilizers within the landscaped areas along the roadway right-of-way will be in a manner consistent with best landscape practices to avoid overuse of soil amendments and nutrients. With such practices, there are no anticipated adverse effects on groundwater resources attributed to fertilizer use.

See **Table 13** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 13. Impact Assessment of Design Alternatives on Hazardous Materials

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The proposed project will not involve the use or storage of chemicals or hazardous materials during long-term operations of the roadway. As such, neither the four (4) roundabout alternative, nor the alternative involving two (2) signalized intersections is anticipated to adversely impact hazardous materials in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	Neither intersection alternative is anticipated to have an adverse impact on hazardous materials in the region.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	There is no anticipated difference between the two (2) bridge alternatives relative to potential effects on hazardous materials.
Bridge Crossing with Stream Bed and Bank Alterations	There is no anticipated difference between the two (2) bridge alternatives relative to potential effects on hazardous materials.

B. SOCIO-ECONOMIC ENVIRONMENT

1. Regional Setting

a. Existing Conditions

From a regional standpoint, the project site is located within the Wailuku-Kahului Community Plan region, which is bounded by the northern shoreline from Poelua Bay to Baldwin Park to the north, Kailua Gulch and Lowrie Ditch to the east, Spanish Road to Waikapu to Honoapiilani Highway to Pohakea Gulch to the south, and the Wailuku Judicial District boundary to the west. The region's population is concentrated in the urban centers of Wailuku and Kahului. Wailuku also serves as the civic-financial-cultural center of the region, while Kahului serves as a business and industrial center. The region also includes the more rural settlements of Waihe‘e to the north and Waikapu and Pu‘unene to the southeast. Agricultural lands are adjacent on the lower slopes of the West Maui Mountains and in the central plain south and east of Kahului. The Kahului Harbor and the Kahului Airport are major land users along the Kahului shoreline. As major ports of entry for people and goods, they serve as an important center of jobs and economic activity (Wailuku-Kahului Community Plan, 2002).

b. **Potential Impacts and Proposed Mitigation Measures**

The proposed Waiale Road Extension project supports the County of Maui's efforts to address localized congestion and improve traffic flow along Waiale Road and East Waiko Road. The purpose of the project is to provide needed infrastructure that supports the existing and planned neighboring residential, commercial and industrial users along these two (2) roads. The project would additionally reduce the amount of industrial and other traffic utilizing East Waiko Road through the existing residential area and allow for economic growth in the surrounding area. The Wailuku-Kahului Community Plan identifies support for the proposed extension as part of the plan's Transportation Objectives and Policies. In this respect, adverse impacts to the regional character of the Waikapu area are not anticipated.

See **Table 14** below for an assessment of each of the design alternatives identified in Chapter II.

Table 14. Impact Assessment of Design Alternatives on Regional Setting

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The proposed project is needed to support existing and planned development in the region. As such, the overall impact of the project on the regional setting would be beneficial. According to the Traffic Impact Analysis Report (TIAR) prepared for the proposed project by Fehr and Peers, the implementation of the four (4) roundabout alternative may result in a lower LOS for vehicle movements at the Waiale Road-Honoapiilani Highway intersection than the implementation of the two (2) signalized intersection alternative. However, the use of roundabouts has also been shown to result in fewer and less severe vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure. Additionally, roundabouts allow for more landscaping, which could improve the Waiale Road Extension's compatibility with the regional setting.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	The implementation of either intersection alternative would have similar impacts on regional character. The use of a signalized intersection at Waiale Road-Honoapiilani Highway may result in a better LOS for vehicle movements than the use of a roundabout. However, signalized intersections provide more conflict points than roundabouts, possibly allowing for a higher frequency and severity of vehicle crashes.

Table 14. Impact Assessment of Design Alternatives on Regional Setting (continued)

Bridge Crossing Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Bridge Crossing with No Stream Bed or Bank Alteration	In relation to impacts to the regional setting, both bridge crossing alternatives would equally facilitate the traffic flows within the Waiale Road Extension.
Bridge Crossing with Stream Bed and Bank Alterations	In relation to impacts to the regional setting, both bridge crossing alternatives would equally facilitate the traffic flows within the Waiale Road Extension.

2. Population

a. Existing Conditions

According to the 2020 U.S. Census, the population of Maui County was 164,754, an increase of 6.4 percent since 2010, when the County had a population of 154,834 (U.S. Census Bureau, 2020). It is noted, however, that population growth over the past decade has been uneven, with stronger growth in the early part of the decade. Additionally, the 2020 U.S. Census resident count for Maui County is actually lower than the Census Bureau's previous population estimates for 2016 to 2019 (U.S. Census Bureau, 2019).

The State of Hawai'i, Department of Business, Economic Development and Tourism (DBEDT) publishes population projections through 2045. According to the latest forecast, which was published in 2018, Maui County's population is expected to grow to 211,500 by 2045 (State of Hawai'i, DBEDT, 2018).

The Wailuku region, within which the project area is located, had a population of 61,346 in 2000, according to the U.S. Census Bureau. By 2020, Wailuku had a population of 83,777, a near 37 percent increase (Maui County Data Book, 2022).

According to U.S. Census Bureau data, the Waikapu area had an estimated population of 3,437 in 2020 (U.S. Census Bureau, 2020). Buildout of the Waikapu Country Town project will add approximately 4,085 persons (Waikapu Country Town FEIS, 2016).

b. Potential Impacts and Proposed Mitigation Measures

In light of the projected growth in both the resident and visitor populations of the Waikapu region, the need for supporting infrastructure is anticipated to rise through 2030. The proposed Waiale Road Extension project is being planned to address associated impacts upon the region's roadway infrastructure. The proposed project is not a direct population generator. However, the proposed Waiale Road Extension will help to mitigate the impacts of the Waikapu Country Town project, which is a direct population generator.

See **Table 15** below for an assessment of each of the design alternatives identified in Chapter II.

Table 15. Impact Assessment of Design Alternatives on Population

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	Both intersection alternatives would support the existing and future population of the region, particularly when accounting for the development of Waikapu Country Town, which is anticipated to more than double the current population of Waikapu at full buildout.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	Both intersection alternatives would support the existing and future population of the region, particularly when accounting for the development of Waikapu Country Town, which is anticipated to more than double the current population of Waikapu at full buildout.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	Neither bridge design alternative is anticipated to impact population in the project area.
Bridge Crossing with Stream Bed and Bank Alterations	Neither bridge design alternative is anticipated to impact population in the project area.

3. Economy and Labor Force

a. Existing Conditions

The economy of Maui is heavily dependent upon the visitor industry. Many of the hotel and resort amenities are in South Maui and West Maui, with non-resort, smaller hotels located in Central Maui.

The economy of the Wailuku region is anchored by government services, with many County and State agency offices comprising the civic center of town near the High Street-Main Street intersection. Due to the level of access to government offices available in Wailuku, many professional services such as engineering, architectural, and accounting offices are located in this region.

Hawaii's economy through 2019 was strong, with record-setting visitor arrivals and low unemployment. The COVID-19 pandemic had far reaching impacts on the economy on Maui, in Hawaii, and across the nation. With the end of the pandemic and return of the visitor industry, Maui's economy was growing through the first half of 2023. However, the tragic wildfires in August 2023 will have significant impacts on the economy for several years. Although the project area was not directly impacted by the fires, the entire Maui community is experiencing economic disruption. The fire in Lāhainā destroyed approximately 2,200 structures, displacing thousands of families and impacting many businesses. The fires have had a significant impact on the tourism industry and the overall path of recovery will be a long-term process, dependent on the pace and manner of rebuilding. In 2022, Maui County's unemployment rate averaged 3.8 percent, comparable to the statewide rate of 3.5 percent. Following the fires, the University of Hawaii Economic Research Organization (UHERO) projected that Maui County's unemployment rate will stand at 6.2 percent, compared to 3.7 percent for the State as a whole (UHERO, 2023). For the year 2024, UHERO forecasts that the unemployment rate in Maui County will average 5.6 percent, compared to 3.1 percent across the State (UHERO, 2024).

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The proposed project is limited to the extension of Waiale Road and related roadway improvements.

In the short term, construction-related jobs will be created to build the proposed roadway extension. As previously stated, the proposed project is not a population generator and is not anticipated to have any adverse long-term impacts to the economy or labor force.

See **Table 16** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 16. Impact Assessment of Design Alternatives on Economy and Labor Force

Intesection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	In the short term, construction-related jobs would be created with the implementation of either intersection design alternative. Neither alternative is anticipated to have adverse impacts on the economy and labor force in the region. Both would provide an alternate route to Honoapiilani Highway to those commuting to and from work along that roadway.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	The intersection design alternative selected for the project will not influence its impact on the economy or labor force in the region.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on the economy and labor force.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on the economy and labor force.

4. Waikapu Country Town

a. Existing Conditions

As previously noted, the project site is adjacent to the master-planned Waikapu Country Town development which plans for 1,433 residential units, including 500 affordable units. It will also include neighborhood retail, commercial, employment, parks, school, and open space uses. The County of Maui and the Waikapu Country Town project have agreed to a public-private partnership to support the Waiale Road Extension, and provide for more affordable homes for the Maui community. As part of this agreement, the County of Maui has waived Waikapu Country Town’s road fees in exchange for the development of the 500 affordable units.

b. Potential Impacts and Proposed Mitigation Measures

The Waiale Road Extension project will be the primary roadway serving Waikapu Country Town, mitigating the development’s traffic impacts. The Waiale Road Extension project will support all transportation modes, protect non-motorized travelers, and provide an alternate route between the urban areas of Kahului and Wailuku. It is recognized as a long-range strategy to improve traffic flow within and around the Waikapu area. As discussed in Section B.2 of this Chapter, the development of Waikapu Country Town will more than double the population of Waikapu – adding about 4,085 people to the existing population of about 3,437 (U.S. Census Bureau, 2020). The implementation of the Waiale Road Extension would significantly reduce adverse traffic impacts – as elaborated on in section D.1 of this Chapter. Coordination between Waikapu Country Town and DPW regarding the project schedules is ongoing. See **Table 17** below for an assessment of each of the design alternatives identified in Chapter II.

Table 17. Impact Assessment of Design Alternatives on Waikapu Country Town

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The proposed project would provide needed infrastructure to Waikapu Country Town. In that regard, it is anticipated to have a beneficial impact. In the TIAR prepared for the proposed project, B.D. Neal & Associates writes that roundabouts tend to reduce both the number and severity of vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure. As such, the four (4) roundabout intersection alternative may be a safer alternative for area residents than the alternative that would install two (2) signalized intersections.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As described above, it is anticipated that both intersection alternatives would have an overall positive impact on Waikapu Country Town.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on the Waikapu Country Town development.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on the Waikapu Country Town development.

C. PUBLIC SERVICES

1. Police and Fire Protection

a. Existing Conditions

Police protection for the Wailuku and Waikapu region is provided by the Maui County Police Department headquartered on Mahalani Street, approximately four (4) miles from the project area. The region is served by the Department's Central Maui station, which is divided into three (3) sectors. Each sector is divided into three (3) beats, each patrolled by a single officer.

Fire prevention, suppression, and protection services for the Wailuku region is provided by the County Department of Fire and Public Safety's Wailuku station, located on Kinipopo Street in Wailuku Town, approximately three (3) miles from the project area. The region is also served by the Department's Kahului Station, located on Dairy Road, approximately four (4) miles from the project area.

b. <u>Potential Impacts and Proposed Mitigation Measures</u>

The proposed project will not affect the service area limits or personnel for police and fire protection. The provision of additional roadway redundancy, improvement of traffic flow, and reduction of delays will help to improve emergency response times for both the Department of Fire and Public Safety and the Police Department.

See **Table 18** below for an assessment of each of the design alternatives identified in Chapter II.

Table 18. Impact Assessment of Design Alternatives on Police and Fire Protection

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	Neither intersection design alternative will affect service area limits or personnel for police and fire protection. By improving traffic flow in the region, both alternatives would likely improve emergency response times. A signalized intersection at Waiale Road and Honoapiilani Highway would provide a slightly better LOS for vehicle movements at peak traffic hours, according to the TIAR prepared for the project. A roundabout at that intersection may, however, result in fewer vehicle incidents, meaning fewer calls to first responders.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	According to the TIAR prepared for the proposed project, a signalized intersection at the Waiale Road-Honoapiilani Highway intersection would provide a better LOS for vehicle movements at peak traffic hours, thereby allowing for better emergency response times. However, signalized intersections provide more points of conflict and increase the likelihood and severity of vehicle crashes when compared to roundabouts. As such, installing two (2) signalized intersections has the potential to result in slightly more calls to first responders when compared to the design alternative that proposes the construction of four (4) roundabouts.

Table 18. Impact Assessment of Design Alternatives on Police and Fire Protection (continued)

Bridge Crossing Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on police and fire protection.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on police and fire protection.

2. Medical Facilities

a. Existing Conditions

The major medical facility on the island is Maui Memorial Medical Center, which is located in Wailuku about four (4) miles from the project area. The approximately 219-bed facility provides general, acute, and emergency care services. Other private medical service providers in the Central Maui region that have regular hours include Maui Medical Group and Kaiser Permanente. The Wailuku-Kahului region is also home to dental offices that serve Maui residents and visitors.

b. Potential Impacts and Proposed Mitigation Measures

The proposed roadway improvement project is not anticipated to adversely affect the demand for or service capabilities of emergency medical or general care operations.

See **Table 19** below for an assessment of each of the design alternatives identified in Chapter II.

Table 19. Impact Assessment of Design Alternatives on Medical Facilities

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	Neither intersection design alternative is anticipated to adversely impact or affect the demand for or service capabilities of emergency or general care operations. Roundabout intersections provide fewer conflict points, thereby resulting in fewer and less severe vehicle incidents. With that in mind, it is possible that the four (4) roundabout intersection alternative may result in a slightly lower demand for emergency medical response to vehicle crashes.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As described above, neither design alternative is expected to have an adverse impact on the demand for service capabilities of emergency medical or general care operations. A signalized intersection at Waiale Road-Honoapiilani Highway would provide a better LOS for vehicle movements during peak traffic

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
	hours. As such, it is possible that emergency medical response times would be slightly lower during peak traffic hours with the implementation of the design alternative involving two (2) signalized intersections.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on medical facilities.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on medical facilities.

3. Educational Facilities

a. Existing Conditions

The State Department of Education (DOE) operates several schools in the Wailuku-Kahului region. Public school facilities within the Wailuku-Kahului District area include: two (2) high schools, Henry Perrine Baldwin High and Maui High (grades 9 to 12); two (2) intermediate schools, Iao Intermediate and Maui Waena Intermediate School (grades 6 to 8); and six (6) elementary schools (Grades K to 5), Wailuku Elementary, Waihee Elementary, Pomaikai Elementary, Kahului Elementary, Lihikai Elementary, and Puu Kukui Elementary School. The University of Hawaii, Maui College serves as the island's primary higher education facility.

The area is also served by several privately operated schools providing education for elementary, intermediate and high school students. Privately operated schools serving the Wailuku-Kahului region include St. Anthony School (grades K to 12), Kaahumanu Hou Christian School (grades K to 12), Emmanuel Lutheran School (K to 6) and Maui Adventist School (grades 1 to 8). In addition, there is one (1) private pre-school for 3 to 4 year olds of Native Hawaiian ancestry, operated by Kamehameha Schools, located in the Paukukalo subdivision.

b. Potential Impacts and Proposed Mitigation Measures

The proposed Waiale Road Extension project is not a population generator and adverse impacts on existing educational facilities in the region are not anticipated. However, the proposed project will help to mitigate the social impacts of the planned Waikapu Country Town development, which is a direct population generator and includes the construction of a new school.

See **Table 20** below for an assessment of each of the design alternatives identified in Chapter II.

Table 20. Impact Assessment of Design Alternatives on Educational Facilities

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	The Waiale Road Extension would have the same capacity whether four (4) roundabouts are installed or two (2) signalized intersections and two (2) roundabouts are installed. As such, both intersection design alternatives are anticipated to have the same impact on educational facilities.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	The intersection design alternative selected for the proposed project will not influence the project's impact on educational facilities.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on educational facilities.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on educational facilities.

4. <u>Recreational Facilities</u>

a. <u>Existing Conditions</u>

The Waikapu Community Center is located on East Waiko Road in the immediate vicinity of the project area. This County-owned facility includes a baseball field, basketball court, and community center building. In addition, Waikapu Gardens, a residential community, is located in the vicinity of the proposed project area and includes a passive park with picnic tables and walking trails. A nearby park, adjacent to the Hale Makana O Waiale Affordable Housing complex in Wailuku, contains a baseball field, basketball court, and playground equipment.

The Central Maui Regional Sports Complex is about a 3.5-mile drive to the northeast from the project area. The 665-acre complex includes eight (8) fields for softball, baseball and tee-ball, as well as flag football fields. There are four (4) comfort stations, two (2) concession stands, 520 parking stalls, one (1) electric vehicle stall, and 26 Americans with Disabilities Act (ADA) stalls.

b. Potential Impacts and Proposed Mitigation Measures

The proposed project is not a population generator. Therefore, the proposed project is not anticipated to adversely impact existing public recreational facilities. The proposed project right-of-ways will not pass through park lands, nor require any right-of-way from existing park lands. The proposed Waiale Road Extension will include shoulder bikeways, pedestrian sidewalks, and a shared use path (separate from the vehicle travel lanes) that will allow recreational activity along the new roadway. In this respect, the proposed project will be beneficial to the community.

See **Table 21** below for an assessment of each of the design alternatives identified in Chapter II.

Table 21. Impact Assessment of Design Alternatives on Recreational Facilities

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	There is no difference in impact on recreational facilities when comparing the two (2) intersection design alternatives in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As stated above, the two (2) intersection design alternatives would have the same impact on the recreational facilities.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on recreational facilities.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on recreational facilities.

5. Solid Waste Disposal

a. Existing Conditions

Single-family residential solid waste collection service is provided by the County of Maui. Residential solid waste collected by County crews is disposed of at the County's Central Maui Landfill facility, located approximately four (4) miles southeast of the Kahului Airport. In addition to County-collected refuse, the Central Maui Landfill also accepts commercial waste from private collection companies. A County supported green waste recycling facility is located at the Central Maui Landfill.

b. Potential Impacts and Proposed Mitigation Measures

Construction of the proposed Waiale Road Extension project will generate waste associated with site preparation and construction. Construction waste will be disposed of at an approved facility. As the proposed action is limited to the extension of an existing roadway, post-construction generation of solid waste as a result of the completed roadway is anticipated to be limited to greenwaste associated with landscape maintenance and a small amount of roadway trash.

See **Table 22** below for an assessment of each of the design alternatives identified in Chapter II.

Table 22. Impact Assessment of Design Alternatives on Solid Waste Disposal

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	There is no significant difference in impact on solid waste disposal when comparing the two (2) intersection design alternatives. All roundabouts will be sized to accommodate garbage trucks.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As noted above, the two (2) intersection design alternatives would have similar impacts on solid waste disposal in the area.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on solid waste disposal.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on solid waste disposal.

D. INFRASTRUCTURE

1. Roadways

a. Existing Conditions

Access to the Waikapu region is provided via Honoapiilani Highway traveling both south from Central Maui and north from West or South Maui. See **Table 23** below for a summary of major roadways in the vicinity of the project site.

Table 23. Major Roadways

	Roadway	Description
1	**Waiale Road**	Waiale Road is a north-south, two-lane collector road that starts as an extension of Lower Main Street and terminates at East Waiko Road. The posted speed limit is

	Roadway	Description
		20 miles per hour (mph). Waiale Road serves as the only access road for residents of the Waikapu Gardens neighborhood located between Kuikahi Drive and East Waiko Road.
2	**Honoapiilani Highway**	Honoapiilani Highway provides regional access between West Maui, South Maui, and Central Maui. In the vicinity of the project area, it is a north-south, two-lane arterial highway with separate lanes for left and right turns at several intersections. Parking is not permitted on most segments of Honoapiilani Highway, and sidewalks are not provided. The posted speed limit ranges between 30 and 45 mph.
3	**Kuihelani Highway**	Kuihelani Highway is a north-south, four-lane divided arterial roadway with a posted speed limit of 45 or 55 mph in the vicinity of the project area. It begins at its intersection with Puunene Avenue and Dairy Road in Kahului and extends southward until it terminates at its intersection with Honoapiilani Highway north of Maalaea Harbor.
4	**Kuikahi Drive**	Kuikahi Drive is an east-west, two-lane collector road. West of its intersection with Honoapiilani Highway, Kuikahi Drive traverses the Wailuku Heights neighborhood and terminates at a cul-de-sac. East of Honoapiilani Highway, Kuikahi Drive provides access to the Maui Lani Village Center before it transitions to Maui Lani Parkway. The posted speed limit in the vicinity of the project area is 20 to 40 mph.
5	**South Kamehameha Avenue**	South Kamehameha Avenue is a two-lane, north-south collector road that begins at its intersection with Hana Highway and extends south through residential neighborhoods in Kahului and Maui Lani, terminating at Pomaikai Elementary School. In the area described in the TIAR, sidewalks are provided along most segments, and the posted speed limit is 20 mph.
6	**Maui Lani Parkway**	Maui Lani Parkway is a two-lane, east-west collector road with a landscaped median. It begins at its intersection with Kuihelani Highway, then terminates and transitions to Kuikahi Drive west of Amoa Street. The posted speed limit is 20 mph.
7	**Waiko Road**	Waiko Road is a two-lane, east-west collector road. It is signed as "West Waiko Road" west of Honoapiilani Highway and "East Waiko Road" east of Honoapiilani Highway. Waiko Road begins in a residential neighborhood west of Honoapiilani Highway and traverses through mostly residential and industrial areas, terminating at its intersection with Kuihelani Highway. In the project area, Waiko Road is a narrow, gently curving 20 to 30 mph road with limited sidewalks and few opportunities for street parking.
8	**Tropical Plantation Driveway/**	Tropical Plantation Driveway is a two-lane, east-west driveway serving the Maui Tropical Plantation. Upon buildout of the Waikapu Country Town, Tropical Plantation

	Roadway	Description
	Main Street (Future)	Driveaway will be reconstructed as part of the planned "Main Street" and will have a signalized intersection with Honoapiilani Highway. Main Street will continue west and connect with the Waiale Road Extension at a single-lane roundabout.
9	**Makai Parkway (Future)**	Makai Parkway is a planned two-lane roadway that will traverse the planned Waikapu Country Town development east of Honoapiilani Highway. It will intersect with Main Street to the north and the Waiale Road intersection to the south. It was referred to as the "north south collector street" in the Waikapu Country Town TIAR.

To address the impacts of the proposed Waiale Road Extension project on the surrounding roadway system, a Traffic Impact Analysis Report (TIAR) was prepared by Fehr & Peers. Refer to **Appendix "A"**. A summary of the TIAR's technical methodology is presented in the next section.

b. Potential Impacts and Proposed Mitigation Measures

The anticipated build-out of the proposed action will likely occur in 2026, however, for planning purposes, the year 2045 was used to prepare the traffic forecast. This was done to allow for analysis of other improvements and projects within the project area. The TIAR evaluated 12 intersections in the project study area during the weekday morning (AM) and evening (PM) peak hours under each of the following scenarios:

- Existing (2022) Conditions
- Future (2045) No Project Conditions:
  - This scenario assumes two (2) proposed signalized intersections to be constructed as part of the Waikapu Country Town project: one (1) at the Honoapiilani Highway-Main Street (Maui Tropical Plantation Driveway) intersection and one (1) at the Waiale Road-Honoapiilani Highway intersection. Under this scenario, the new segment of Waiale Road would run only between Honoapiilani Highway and the Makai Parkway. This scenario also assumes a new three-legged roundabout intersection at Waiale Road-Makai Parkway.
- Future (2045) With Project Conditions:
  - This scenario assumes roundabout intersections at the
    1) Waiale Road-East Waiko Road,
    2) Waiale Road-Main Street,
    3) Waiale Road-Honoapiilani Highway, and
    4) Waiale Road-Makai Parkway.

- The TIAR also analyzed a project scenario alternative that assumes signalized intersections at Waiale Road-East Waiko Road and Honoapiilani Highway-Waiale Road and roundabouts at Waiale Road-Main Street and Waiale Road-Makai Parkway.

The Maui Travel Demand Model was used to forecast the increase in traffic in the Future Year (2045) with and without the project. Specific projects near the proposed project site were added to the model based on coordination with the County of Maui.

Under Future Year (2045) No Project Conditions, five (5) of the 12 study intersections are projected to continue operating at acceptable levels of service (LOS) (LOS D or better). Seven (7) intersections are projected to operate at LOS E or F. See **Table 24** below.

Table 24. Intersections Analysis, Existing and Future Year (2045) No Project Conditions

	Intersections	**2045 Intersection Control**	**Peak Hour**	**LOS: Existing Conditions**	**LOS: Future Year (2045) No Project**
1	Honoapiilani Highway and Kuikahi Drive	Signal	AM	C	**F**
			PM	B	**E**
2	Waiale Road and Kuikahi Drive	Signal	AM	C	**F**
			PM	C	**F**
3	South Kamehameha Avenue and Maui Lani Parkway	Roundabout	AM	D	**F**
			PM	C	**F**
4	Kuihelani Highway and Maui Lani Parkway	Signal	AM	B	D
			PM	C	**E**
5	Honoapiilani Highway and Waiko Road	Signal	AM	B	**F**
			PM	C	**F**
6	Waiale Road and Waiko Road	Side Street Stop Controlled	AM	C	**F**
			PM	C	**F**
7	Kuihelani Highway and Waiko Road	Signal	AM	B	C
			PM	B	C
8	Honoapiilani Highway and Main Street	Signal	AM	D	**E**
			PM	**F**	D
9	Waiale Road and Main Street	NA	AM	-	-
			PM	-	-

	Intersections	2045 Intersection Control	Peak Hour	LOS: Existing Conditions	LOS: Future Year (2045) No Project
10	Honoapiilani Highway and Waiale Road	Signal	AM	-	C
			PM	-	B
11	Waiale Road and Makai Parkway	Roundabout	AM	-	A
			PM	-	A
12	Honoapiilani Highway and Kuihelani Highway	Signal	AM	B	C
			PM	B	C
Source: Fehr & Peers					

Large increases in delay are expected due to increases in peak hour traffic volumes with only minor changes at certain study intersections, while no substantial roadway capacity improvements are planned across the study area. Some peak hour volumes, particularly those along Honoapiilani Highway and Waiko Road, are expected to more than double over the 23-year study period.

Compared to Future Year (2045) No Project conditions, the construction of the proposed Waiale Road Extension would reduce total vehicle miles of travel in the vicinity of the project area by 1.5 percent, reduce delays, and improve LOS at intersections along Honoapiilani Highway. Minor delay increases are projected at some other intersections. Additionally, the projected shift in traffic volumes would exacerbate projected LOS F conditions at the Waiale Road-Kuikahi Drive intersection. See **Table 25** below.

Table 25. Intersections Analysis, Future Year (2045) No Project and Future Year (2045) With Project Conditions

	Intersections	Control	Peak Hour	LOS: Future Year (2045) No Project	LOS: Future Year (2045) With Project
1	Honoapiilani Highway and Kuikahi Drive	Signal	AM	**F**	**E**
			PM	**E**	D
2	Waiale Road and Kuikahi Drive	Signal	AM	**F**	**F**
			PM	**F**	**F**

	Intersections	Control	Peak Hour	LOS: Future Year (2045) No Project	LOS: Future Year (2045) With Project
3	South Kamehameha Avenue and Maui Lani Parkway	Roundabout	AM	**F**	**F**
			PM	**F**	**F**
4	Kuihelani Highway and Maui Lani Parkway	Signal	AM	D	D
			PM	**E**	**E**
5	Honoapiilani Highway and Waiko Road	Signal	AM	**F**	C
			PM	**F**	D
6	Waiale Road and Waiko Road	Roundabout	AM	**F**	D
			PM	**F**	C
7	Kuihelani Highway and Waiko Road	Signal	AM	C	D
			PM	C	C
8	Honoapiilani Highway and Main Street	Signal	AM	**E**	C
			PM	D	C
9	Waiale Road and Main Street	Roundabout	AM	-	A
			PM	-	A
10	Honoapiilani Highway and Waiale Road	Roundabout	AM	C	D
			PM	B	D
11	Waiale Road and Makai Parkway	Roundabout	AM	A	A
			PM	A	A
12	Honoapiilani Highway and Kuihelani Highway	Signal	AM	C	C
			PM	C	C
Source: Fehr & Peers					

The reduction in delays at the majority of the intersections analyzed in the TIAR is due to the additional roadway capacity that would be provided by the project. Specifically, delays at intersections along Honoapiilani Highway will be significantly reduced because the Waiale Road Extension would provide a parallel route.

With regard to the Future Year (2045) With Project alternative involving signalized intersections at Waiko Road-Waiale Road and Waiale Road-Honoapiilani Highway, the TIAR writes that in order to achieve LOS D or better at Waiko Road-Waiale Road, the signalized intersection would need a dedicated left-turn lane and shared through-right-turn lane at all approaches.

At Honoapiilani Highway-Waiale Road, a signalized intersection would provide a slightly better LOS for vehicle movements than a roundabout with the installation of single-lane approaches on Waiale Road, a dedicated left-turn lane, and a shared through-right-turn lane on the north and south approaches.

Based on their findings, Fehr & Peers recommended constructing roundabout configurations at the Waiale Road-Honoapiilani Highway, Waiale Road-Makai Parkway, Waiale Road-Main Street, and Waiale Road-East Waiko Road intersections. Not only are single-lane roundabouts projected to operate acceptably with single-lane approaches in 2045 but, when compared to traditional intersection design, roundabouts have the potential to reduce both the number and severity of vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure. The TIAR suggests considering mutli-lane approaches to the roundabouts at Waiale Road-Honoapiilani Highway and Waiale Road-Waiko Road if additional land use is anticipated beyond what was assumed in the study or to accommodate future roadway widening to further improve projected traffic operations.

See **Table 26** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 26. Impact Assessment of Design Alternatives on Roadways

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	As stated above, compared to Future Year (2045) without the project, the construction of the Waiale Road Extension would reduce total vehicle miles of travel in the vicinity of the project by 1.5 percent, reduce delays, and improve LOS at intersections along Honoapiilani Highway with the implementation of either design alternative. Based on their findings, Fehr & Peers recommended constructing four (4) roundabout configurations. Not only are single-lane roundabouts projected to operate acceptably with single-lane approaches in 2045, but when compared to traditional intersection design, roundabouts have the potential to reduce both the number and severity of vehicle crashes, as they reduce the number of conflict points and act as a traffic calming measure.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	At the Honoapiilani Road-Waiale Road intersection, a signalized intersection would provide a better LOS for vehicle movements than a roundabout with the installation of single-lane approaches on Waiale Road, a dedicated left-turn lane, and a shared through-right-turn lane on the north and south approaches.

Table 26. Impact Assessment of Design Alternatives on Roadways (continued)

Bridge Crossing Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on roadways.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on roadways.

2. Water System

a. Existing Conditions

The County's potable water service in the vicinity of the project area consists of an existing 12-inch waterline being supplied from the 300,000-gallon tank near the mauka terminus of West Waiko Road. The storage tank is located at an elevation of 764 feet. The existing 12-inch waterline crosses Honoapiilani Highway and extends to the Waiko Baseyard Subdivision east of the project site. Refer to **Appendix "D"**, Preliminary Engineering and Drainage Report.

There are currently no non-potable, recycled (R1) water systems in the vicinity of the project area.

b. Potential Impacts and Proposed Mitigation Measures

New distribution waterlines will be installed in conjunction with the construction of the proposed project, wherever practicable, to minimize disruptions to the community and traffic. DPW proposes to install a 12-inch water main along the Waiale Road Extension to provide water service to the future Central Maui Wastewater Reclamation Facility (WWRF), as well as fire protection (i.e., fire hydrants) along the roadway corridor, and appurtenances for initial irrigation of the landscaping associated with the proposed project.

In accordance with the current water system standards, fire hydrants are proposed to be installed with a maximum spacing of 350 feet along the existing residential subdivision areas, unless otherwise required by the respective governing agencies.

The current Waikapu Country Town Recycled reclaimed (R1) Water System Master Plan anticipates the installation of a 4.0 million-gallon (MG) capacity open storage reservoir mauka (west) of Honoapiilani Highway (by others). This reservoir will use an 18-inch reclaimed (R1) waterline to connect to the future Central Maui WWRF, which will also function as a distribution line (by others). This 18-inch line will be located within the Waikapu Country Town roadways, mauka of Honoapiilani Highway.

To facilitate the foregoing, DPW proposes to install an 18-inch reclaimed (R1) waterline from its future connection point at Honoapiilani Highway to the vicinity of the future access to the Central Maui WWRF. The 18-inch reclaimed (R1) waterline will extend to the Central Maui WWRF in conjunction with the construction of said facility (by others). From the future access, DPW proposes to install a 12-inch reclaimed (R1) waterline across the Waikapu Stream (supported by the bridge) and will make provisions to extend the line along East Waiko Road and a portion of the existing Waiale Road, in coordination with the County of Maui, Department of Environmental Management.

The Waiale Road Extension project is not anticipated to generate a significant increase in water demand, except for capacity required for incidental landscape irrigation along the roadway corridor, which includes the adjoining shared use path and landscaped detention and retention basins. No drinking fountains are proposed along this segment of the Waiale Road Extension.

Average daily landscape irrigation demands are expected to be approximately 84,920 gallons per day (gpd) during the initial plant establishment period and reduced to 46,880 gpd once the plant establishment period is completed. Water service for landscaping irrigation is expected to be provided by new, strategically placed water meters, ranging from 3/4 to 1-1/2-inch in size, as the peak irrigation demand is not expected to exceed 50 gallons per minute (gpm) for any given service area.

Though the landscape irrigation will initially be supplied by the 12-inch domestic waterline, it will be constructed to transfer the supply to the reclaimed (R1) waterline once the Central Maui WWRF is operational. Refer to **Appendix "D"**.

See **Table 27** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 27. Impact Assessment of Design Alternatives on Water System

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	There is no difference in impact on the water system when comparing the two (2) intersection design alternatives in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As stated above, the two (2) intersection design alternatives would have the same impact on the water system.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on the water system.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on the water system.

3. Wastewater System

a. Existing Conditions

The County's wastewater facilities generally collect wastewater from the Wailuku and Kahului areas and convey it through a series of gravity sewer lines and pumping stations with force mains along the existing Waiale Road and Lower Main Street to the Wailuku-Kahului Wastewater Reclamation Facility (W-K WWRF) near Kanaha Pond.

Within the proposed project vicinity, an existing 4-inch force main is installed along East Waiko Road to account for the wastewater generated within the Waiko Baseyard Subdivision, located east (makai) of the project area. Refer to **Appendix "D"**.

b. Potential Impacts and Proposed Mitigation Measures

In response to the projected population growth to serve planned and existing housing developments in Central Maui, a new Kehalani Wastewater Pump Station (WWPS) will be constructed in conjunction with County's Central Maui WWRF on the southern region of the existing stormwater detention basin for the Kehalani makai area (directly across from Maui Memorial Park Garden of Meditation Expansion at the Olomea Street-Waiale Road intersection). The new WWPS will help to alleviate capacity restraints at the existing W-K WWRF.

Wastewater will be conveyed from the future Kehalani WWPS along the existing Waiale Road using an anticipated 18-inch force main toward the northern region of the project vicinity (by others). DPW proposes to install an 18-inch force main within the Waiale Road Extension corridor, which will extend across the new bridge (supported by the bridge structure) before transitioning to a 24-inch gravity main line along the corridor to accommodate connectivity to the Waikapu Country Town development. The 24-inch gravity main line will continue along the corridor toward the southwest corner of the undeveloped, County-owned parcel TMK (2)3-6-003:004 and a stubout for future extension to the Central Maui WWRF (by others) will be provided.

DPW is currently evaluating an alternate routing of the 24-inch gravity sewer line across TMK (2)3-6-002:004. The preferred routing will be represented in the final construction documents for proposed project.

In addition, a new 18-inch gravity sewer line is proposed for installation along Honoapiilani Highway to provide connectivity to a 12-inch sewer line providing wastewater service to the west (mauka) portion of the Waikapu Country Town development (which will include the installation of a 12-inch stubout at Old Quarry Road, installed in conjunction with the Waiale Road Extension). It will also provide for future connection to the future Maaleaa pump station conveyance system (by others).

Minor relocations and adjustments of the existing sewer force main on East Waiko Road and minor adjustments to any existing manholes and appurtenances to final finish grades are expected to be undertaken with the proposed project.

The proposed Waiale Road Extension project is not, in itself, a population generator and is not anticipated to generate significant additional wastewater demand.

See **Table 28** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 28. Impact Assessment of Design Alternatives on Wastewater System

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	There is no difference in impact on the wastewater system when comparing the two (2) intersection design alternatives in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As stated above, the two (2) intersection design alternatives would have the same impact on the wastewater system.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on the wastewater system.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on the wastewater system.

4. Drainage System

a. Existing Conditions

A Preliminary Drainage Report was prepared by Warren S. Unemori Engineering, Inc. to assess and describe the anticipated impacts of the Waiale Road Extension project to drainage in the area and discuss the drainage improvements included in the proposed project scope. See **Appendix "D"**.

Warren S. Unemori, Engineering evaluated the project area in two (2) distinct drainage sections, which are described below.

Section A – Vicinity of Honoapiilani Highway to Waikapu Stream – The majority of the project corridor lies within an existing drainage area that begins on Mauna Kahalawai, or the West Maui Mountains, (just south of Waikapu Valley), crosses Honoapiilani Highway, and extends to Kuihelani Highway. The overall drainage area consists of approximately 1,540 acres and is currently undeveloped, except for the Honoapiilani Highway roadway corridor and its associated culvert crossings. The portion of the drainage area associated with the Waiale Road Extension is 15.40 acres. It generally consists of open grassland covering fallow sugarcane fields and scattered rock piles. Several agricultural access roads (e.g., gravel roads, dirt roads, etc.) have been used in agricultural production. The existing runoff in this drainage area travels aboveground eastward from Honoapiilani Highway towards Kuihelani Highway through existing culverts and ultimately to the ocean.

Section B – Waikapu Stream to Northerly Terminus – From the northern bank of Waikapu Stream to the paved roadway of East Waiko Road, the land is currently undeveloped. The existing runoff generated in this undeveloped area and East Waiko Road travels east (mauka to makai) and is conveyed overland or in shallow roadside swales until it enters Waikapu Stream downstream of the new bridge crossing.

Waikapu Stream flows from the West Maui Natural Area Reserve eastward, turning southward where it passes through the project area to the south of the existing Waiale Road-Waiko Road intersection, eventually draining into the ocean through Kealia Pond National Wildlife Refuge at Maalaea Bay. In the vicinity of the project area, Waikapu Stream is contoured by earthen berms and large boulders lining the top banks of the stream to protect the adjacent fields from flooding.

b. Potential Impacts and Proposed Mitigation Measures

The Waiale Road Extension project will include the installation of drainage improvements that will minimally alter natural pre-development patterns and mitigate the increase in runoff generated by the proposed project, such that the runoff released downstream will be no greater than that under pre-development conditions or the allowable runoff that the existing drainage systems were originally master-planned to accommodate from the project site. The drainage system will be designed to accommodate the ultimate layouts and improvements required by the County at the proposed intersections and those needed by future adjoining developments (i.e., Waikapu Country Town).

In the absence of any onsite stormwater detention systems, the total onsite surface runoff that could potentially be generated with the construction of the proposed project is approximately 81 cubic feet per second (cfs), based on a 50-year frequency interval, 1-hour duration storm. The total increase in surface runoff anticipated to be generated by the project is 38 cfs.

To mitigate the increase in surface runoff and limit the peak onsite runoff so there will be no net increase in onsite runoff leaving the project site, an aboveground landscaped detention basin, hereafter referred to as Detention Basin No. 1, and an aboveground landscaped retention basin, hereafter referred to as Retention Basin No. 2, will be constructed.

Section A – Vicinity of Honoapiilani Highway to Waikapu Stream – The onsite surface runoff generated by the new roadway improvements along the Waiale Road Extension corridor will be captured by new catch basins and conveyed in underground pipe systems to Detention Basin No. 1

through an outlet structure. Detention Basin No. 1 will be sized to limit peak onsite runoff to no more than pre-existing release rates.

Additionally, DPW has agreed to install culverts crossing Honoapiilani Highway and the Waiale Road Extension to accommodate the future Waikapu Country Town development, in accordance with the development's latest storm drain master plan.

Existing runoff generated by the remainder of the larger drainage area will be conveyed, as needed, through the master-planned culvert crossings and allowed to discharge downstream, as it is presently doing. Upon the construction of Waikapu Country Town, the master-planned culverts will be extended to a regional detention basin installed in conjunction with the development.

Waikapu Stream – A new concrete bridge is proposed for the Waiale Road Extension crossing at Waikapu Stream. The bridge has been designed to accommodate the existing flow rate of Waikapu Stream of 2,000 cfs. The bridge is design to span across the stream (with drilled shafts to be constructed outside of the designated Ordinary Highwater Mark) to ensure the stream is minimally impacted. The bridge is designed to maintain a "no rise" condition with no loss of flow conveyance and no increase in the base flood elevation at the gulch for the 100-year flood discharge. Therefore, it will allow the runoff to continue down the existing drainage channels toward Kuihelani Highway and eventually southward toward the Kealia Pond National Wildlife Refuge at Maalaea Bay, where it will drain into the ocean, as it is currently doing.

Section B – Waikapu Stream to Northerly Terminus – To discuss drainage improvements proposed to mitigate the anticipated increase in runoff in Section B, Warren S. Unemori Engineering, Inc. established two (2) subsections: Section B-1, from Waikapu Stream to STA 80+40±, and Section B-2, from STA 80+40± to the northerly terminus. Refer to **Appendix "D"**.

For Section B-1, the generated runoff will be collected in catch basins and conveyed to Retention Basin No. 2 through a piped drainage system. Retention Basin No. 2 will be sized to mitigate the increase of runoff, such that no more than pre-existing rates will be allowed to discharge into Waikapu Stream, as they are currently doing.

For Section B-2, the generated runoff will be collected into a new catch basin (which will replace an existing grated inlet catch basin near the intersection of the existing Waiale Road and Ohana Hana Street) and convey the runoff into an existing basin installed in conjunction with Waikapu Gardens, as it is presently doing.

All drainage improvements will be implemented pursuant to the current County of Maui "Rules for the Design of Storm Drainage Facilities" and the "Rules for the Design of Storm Water Treatment Best Management Practices" (2012).

See **Table 29** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 29. Impact Assessment of Design Alternatives on Drainage System

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	There is no difference in impact on the drainage system when comparing the two (2) intersection design alternatives in the project area.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As stated above, the two (2) intersection design alternatives would have the same impact on the drainage system.
Bridge Crossing Design Alternatives	**Potential Impacts and Proposed Mitigation Measures**
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge crossing design alternative selected for the proposed project will not affect its impact on the drainage system. As previously noted, the bridge alternative with no bank protection has been designed to accommodate the existing Waikapu Stream flow and maintain a "no rise" condition. There would be no loss of flow conveyance or loss of base flood elevation. Refer to **Appendix "D"**. As such, adverse impacts to the drainage system are not anticipated.
Bridge Crossing with Stream Bed and Bank Alterations	This bridge alternative may revise the characteristics of the stream in the vicinity of the roadway crossing as the invert and banks of the channel would be improved and may require a LOMR from FEMA.

5. Electrical, Telephone, and Cable Television Services

a. Existing Conditions

Electrical, telephone, and cable TV service in the Waikapu-Wailuku region is provided by Hawaiian Electric Company (HECO), Hawaiian Telcom, and Spectrum, respectively, and along the primary utility corridor for HECO's

69kV overhead transmission line that runs along Honoapiilani Highway and East Waiko Road.

b. Potential Impacts and Proposed Mitigation Measures

Electrical, telephone, and cable TV overhead utility poles (which include the 69kV transmission line, communication lines, etc.) in the vicinity of the proposed Waiale Road Extension's intersections with Honoapiilani Highway and East Waiko Road will be relocated and replaced as necessary, to accommodate the new roundabout or traffic signal configurations. At these locations, the existing overheard electrical and communication lines will be maintained overhead.

A new underground electrical and communication system (including aboveground transformers, primary switches, handholes, duct lines, etc.) will be installed in conjunction with the proposed project (including the crossing of Waikapu Stream within the bridge structure) to provide service to the future Central Maui WWRF and Waikapu Country Town, as needed.

The proposed project is not, in itself, a population generator and is not anticipated to have an adverse impact on electrical, telephone, or cable TV service.

See **Table 30** below for an assessment of the potential impacts and proposed mitigation measures for each of the design alternatives identified in Chapter II.

Table 30. Impact Assessment of Design Alternatives on Electrical, Telephone, and Cable Television Services

Intersection Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Four (4) Single-Lane Roundabouts	There is no difference in impact on electrical, telephone and cable television services when comparing the two (2) intersection design alternatives. The design alternative selected may impact the placement of utility poles.
Two (2) Signalized Intersections and Two (2) Single-Lane Roundabouts	As stated above, the two (2) intersection design alternatives would have the same impact on electrical, telephone, and cable television services.

Table 30. Impact Assessment of Design Alternatives on Electrical, Telephone, and Cable Television Services (continued)

Bridge Crossing Design Alternatives	Potential Impacts and Proposed Mitigation Measures
Bridge Crossing with No Stream Bed or Bank Alteration	The bridge design alternative selected for the proposed project will not affect its impact on electrical, telephone, and cable television services.
Bridge Crossing with Stream Bed and Bank Alterations	The bridge design alternative selected for the proposed project will not affect its impact on electrical, telephone, and cable television services.

E. <u>CUMULATIVE AND SECONDARY IMPACTS</u>

Cumulative impacts are defined as the impact on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions.

There are no other immediately foreseeable regional roadway improvement projects of comparable scale that would contribute to impacts of broader scope and scale. In addition, there are no other projects completed in the recent past or projects currently being undertaken that would provide the same capacity and functionality as that of the proposed Waiale Road Extension project. As noted previously, alternative roadway improvement concepts include options on roadway section layouts, options on the pedestrian access, intersection treatments and the bridge crossing construction. All of these alternatives would occur within the scope of the proposed project, and would, therefore, not need to be considered as additional to or separate from the project when accounting for cumulative impacts.

It is noted that the construction of the proposed road would remove a potential barrier for development in the area by providing traffic mitigation. It is noted that any future development in the area would undergo separate environmental review for potential impacts related to the specific project. For example, the Waikapu Country Town project completed its own Chapter 343 HRS Environmental Impact Statement document and underwent multiple public reviews by the Maui Planning Commission, Maui County Council, and State Land Use Commission in relation to the proposed development and potential impacts and mitigation measures.

In this regard, there are no significant cumulative impacts associated with the proposed project.

Secondary impacts are those which have the potential to occur later in time or farther in distance, but are still reasonably foreseeable. They can be viewed as actions of others that are taken because of the presence of the project. Secondary impacts from highway projects, for example, can occur because such projects may have the potential to induce development by removing one of the impediments to growth, such as transportation access.

With the proposed mitigation measures in place, the proposed project is not anticipated to have significant secondary impacts. The project corridor will further connect existing (completed) roadway systems in the developed residential areas of the Waikapu region. Existing County infrastructure systems (e.g., water system, reclaimed water system) are located in the immediate vicinity of the project site and will be extended and/or relocated to align with the extension of Waiale Road. In the short term, construction of the proposed project area will generate employment and revenues for the construction industry and related fields. Over the long term, the proposed action will alleviate existing and future traffic congestion within the Waikapu region.

In summary, the proposed action is not anticipated to result in significant adverse secondary impacts.

RELATIONSHIP TO GOVERNMENTAL PLANS, POLICIES, AND CONTROLS

IV

IV. RELATIONSHIP TO GOVERNMENTAL PLANS, POLICIES, AND CONTROLS

A. STATE LAND USE DISTRICTS

Pursuant to Chapter 205, Hawaii Revised Statutes (HRS), all lands in the State have been placed into one (1) of four (4) major land use districts by the State Land Use Commission. These land use districts are designated "Urban", "Rural", "Agricultural", and "Conservation". The project site is split between the "Urban" and "Agricultural" districts with a small portion of the improvements on Honoapiilani Highway located within the "Rural" district. See **Figure 15**. The proposed project is limited to a roadway extension and related infrasture improvements, which are allowed in the "Urban", "Agricultural" and "Rural" districts.

B. HAWAII STATE PLAN

Chapter 226, HRS, also known as the Hawaii State Plan, is a long-range comprehensive plan which serves as a guide for the future long-term development of the State by identifying goals, objectives, policies, and priorities, as well as implementation mechanisms. The Plan consists of three (3) parts. Part I includes the Overall Theme, Goals, Objectives, and Policies; Part II includes provisions for Planning, Coordination, and Implementation; and Part III establishes Priority Guidelines. Part II of the State Plan covers its administrative structure and implementation process. An analysis of the project's applicability to Part I and Part III of the Hawaii State Plan is provided in **Appendix "I-1"**.

The proposed action does not contravene the goals, objectives and policies of the Hawaii State Plan.

C. STATE FUNCTIONAL PLANS

A key element of the Statewide Planning System is the Functional Plans which set forth the policies, statewide guidelines, and priorities within a specific field of activity. There are 13 Functional Plans which have been developed by the State agency primarily responsible for a given functional area. Together with the County General Plans, the State Functional Plans establish more specific strategies for implementation.

Thirteen (13) Functional Plans have been prepared by State agencies. **Table 31** provides an assessment of the relationship between the proposed action and each of the 13 Functional Plans.

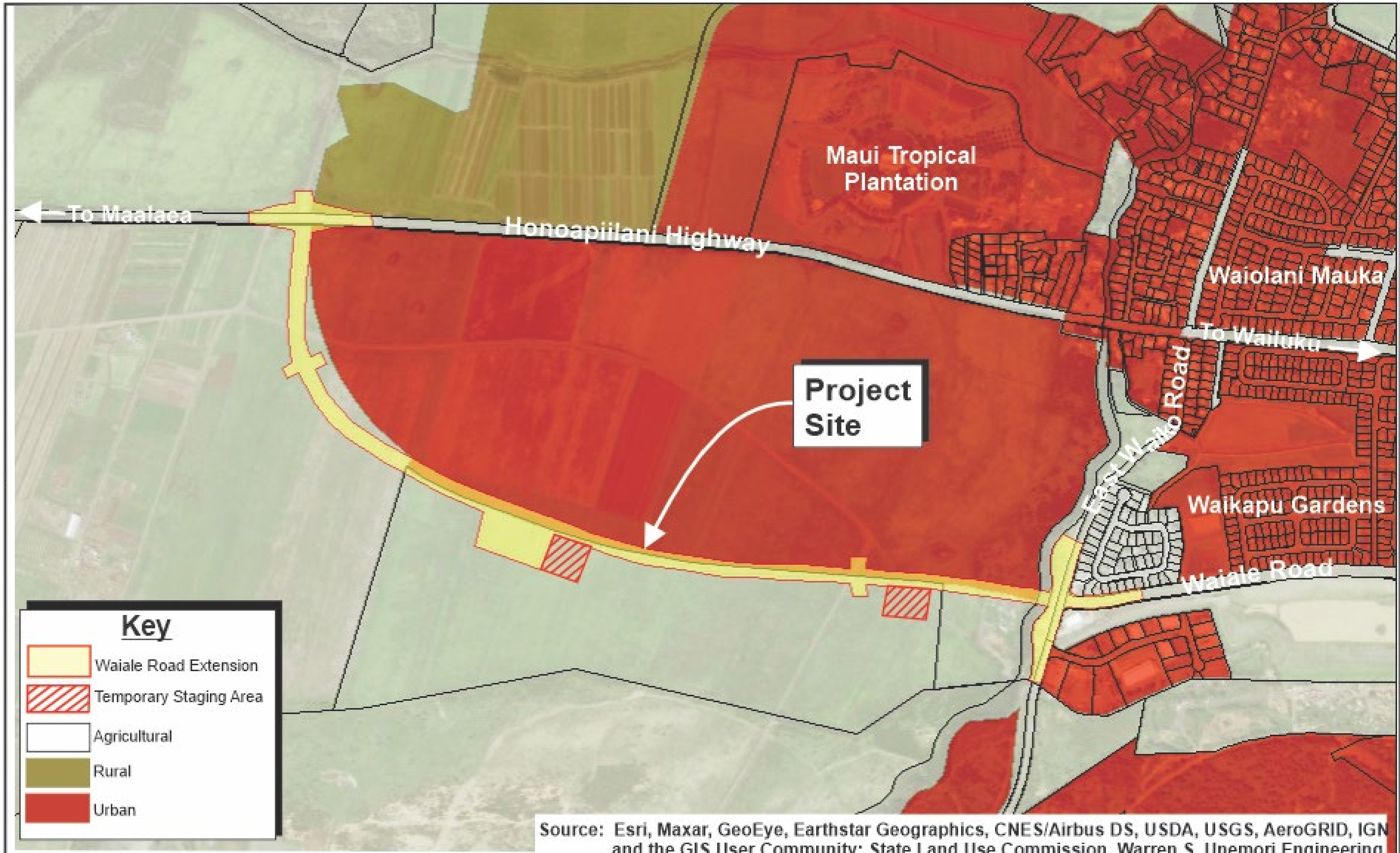


Figure 15

Waiale Road Extension Project
State Land Use Districts Map

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\SLUD

Table 31. Relationship Between the Proposed Waiale Road Extension Project and the State Functional Plans

	State Functional Plan	State Coordinating Agency	Purpose	Analysis
1	Agriculture Functional Plan (1991)	Department of Agriculture	Continued viability of agriculture throughout the State	The project site is not being actively farmed and represents a nonsignificant amount of agricultural lands available on the island of Maui. Therefore, the proposed action does not affect agricultural viability parameters of the Agricultural Functional Plan.
2	Conservation Lands State Functional Plan (1991)	Department of Land and Natural Resources	Addresses issues of population and economic growth and its strain on current natural resources; broadening public use of natural resources while protecting lands and shorelines from overuse; additionally, promotes the aquaculture industry	The proposed action does impinge upon Conservation lands. The project is not in proximity to coastal waters. BMPs will be employed during construction to ensure that downstream coastal resources are not adversely affected.
3	Education State Functional Plan (1989)	Department of Education	Improvements to Hawaii's educational curriculum, quality of educational staff, and access to adequate facilities	The proposed Waiale Road Extension project does not affect, nor is it affected by the Educational Functional Plan.
4	Employment State Functional Plan (1990)	Department of Labor and Industrial Relations	Improve the qualifications, productivity, and effectiveness of the State's workforce through better education and training of workers as well as efficient planning of economic development, employment opportunities, and training activities	While the proposed action will involve the hiring and retention of construction industry trades, these are viewed as temporary conditions, during the time of project construction. Nonetheless, such employment does provide for learning and skill-building for individuals working on the project.
5	Energy State Functional Plan (1991)	Department of Business, Economic Development and Tourism	Lessen the reliance on petroleum and other fossil fuels in favor of alternative sources of energy so as to keep up with the State's increasing energy demands while also becoming a more sustainable island state; achieving dependable, efficient, and economical statewide energy systems	The proposed action does not have direct implications for advancing a sustainable energy future.

	State Functional Plan	State Coordinating Agency	Purpose	Analysis
6	Health State Functional Plan (1989)	Department of Health	Improve health care systems by providing for those who don't have access to private health care providers; increasing preventative health measures; addressing 'quality of care' elements in private and public sectors to cut increasing costs	The proposed action does not affect healthcare systems parameters.
7	Higher Education Functional Plan (1984)	University of Hawaii	Prepare Hawaii's citizens for the demands of an increasingly complex world through providing technical and intellectual tools	Higher education needs are not advanced by the proposed roadway extension project.
8	Historic Preservation State Functional Plan (1991)	Department of Land and Natural Resources	Preservation of historic properties, records, artifacts and oral histories; provide public with information/education on the ethnic and cultural heritages and history of Hawaii	An AIS and CIA have been prepared for the project area. These studies recognize the significance of treating historic resources and cultural practices with respect and appropriate mitigation, as the resources in the project area contribute to the broader understanding and appreciation of the region's cultural heritage. Based on the results of the CIA and AIS, the project is not anticipated to impact any culturally, historically, or archaeologically significant properties.
9	Affordable Housing State Functional Plan (2017)	Hawaii Housing Finance and Development Corporation	Provide affordable rental and for-sale housing; increase homeownership and amount of rental housing units; acquiring public and privately-owned lands for future residential development; maintain a statewide housing data system	The proposed action provides critical infrastructure to support the separate but adjacent Waikapu Country Town development to the west, which plans for 1,433 residential units, including 500 affordable units. The County of Maui and the Waikapu Country Town project have agreed to a public/private partnership to support the Waiale Road Extension, and provide for more affordable homes for the Maui community.

	State Functional Plan	State Coordinating Agency	Purpose	Analysis
10	Human Services State Functional Plan (1989)	Department of Human Services	Refining support systems for families and individuals by improving elderly care, increasing preventative measures to combat child/spousal abuse and neglect; providing means for 'self-sufficiency'	The proposed action is not affected by, nor does it hold implications for the Human Services Functional Plan.
11	Recreation State Functional Plan (1991)	Department of Land and Natural Resources	Manage the use of recreational resources via addressing issues: (1) ocean and shoreline recreation, (2) mauka, urban, and other recreation opportunities, (3) public access to shoreline and upland recreation areas, (4) resource conservation and management, (5) management of recreation programs/facilities/areas, and (6) wetlands protection and management	The proposed roadway action does not advance the purpose of the Recreation Functional Plan. It is noted, however, that the project's shared use path does provide an alternative mode of mobility which holds recreational value.
12	Tourism State Functional Plan (1991)	Department of Business, Economic Development and Tourism	Balance tourism/economic growth with environmental and community concerns; development that is cognizant of the limited land and water resources of the islands; maintaining friendly relations between tourists and community members; development of a productive workforce and enhancement of career and employment opportunities in the visitor industry	The Tourism Functional Plan is not affected by, nor does it affect the proposed action.
13	Transportation State Functional Plan (1991)	Department of Transportation	Development of a safer, more efficient transportation system that also is consistent with planned physical and economic growth of the state; construction of facility and infrastructure improvements; develop a transportation system balanced with new alternatives; pursue land use initiatives which help reduce travel demand	The proposed action represents a long-recognized roadway component needed to address localized congestion and improve traffic flow to support the existing and planned neighboring residential, commercial and industrial users along Waiale Road and East Waiko Road. In this regard, the project provides greater efficiency in the transportation system.

D. GENERAL PLAN OF THE COUNTY OF MAUI

As indicated by the Maui County Charter, the purpose of the general plan shall be to:

> *... indicate desired population and physical development patterns for each island and region within the county; shall address the unique problems and needs of each island and region; shall explain opportunities and the social, economic, and environmental consequences related to potential developments; and shall set forth the desired sequence, patterns and characteristics of future developments. The general plan shall identify objectives to be achieved, and priorities, policies, and implementing actions to be pursued with respect to population density, land use maps, land use regulations, transportation systems, public and community facility locations, water and sewage systems, visitor destinations, urban design, and other matters related to development.*

Chapter 2.80B of the Maui County Code, relating to the General Plan and Community Plans, implements the foregoing Charter provision through enabling legislation which calls for a Countywide Policy Plan, a Maui Island Plan, and regional Community Plans.

1. Countywide Policy Plan

The Countywide Policy Plan was adopted in March 2010 and is a comprehensive policy document for the islands of Maui County to the year 2030. The plan replaces the General Plan of the County of Maui 1990 Update and provides the policy framework for the development of the Maui Island Plan as well as for updating the nine (9) detailed Community Plans. The Countywide Policy Plan provides broad goals, objectives, policies and implementing actions that portray the desired direction of the County's future. Discussion of the proposed project's applicability to the relevant goals, objectives, policies, and implementing actions of the Countywide Policy Plan is provided in **Appendix "I-2"**.

The proposed Waiale Road Extension project does not contravene the goals, objectives and policies of the Countywide Policy Plan.

2. Maui Island Plan

The Maui Island Plan (MIP) is applicable to the island of Maui only, providing more specific policy-based strategies for population, land use, transportation, public and community facilities, water and wastewater systems, visitor destinations, urban design, and other matters related to future growth.

As provided by Chapter 2.80B, the MIP shall include the following components:

1. *An island-wide land use strategy, including a managed and directed growth plan*

2. *A water element assessing supply, demand and quality parameters*

3. *A nearshore ecosystem element assessing nearshore waters and requirements for preservation and restoration*

4. *An implementation program which addresses the County's 20-year capital improvement requirements, financial program for implementation, and action implementation schedule*

5. *Milestone indicators designed to measure implementation progress of the MIP*

The MIP addresses a number of planning categories with detailed policy analysis and recommendations which are framed in terms of goals, objectives, policies and implementing actions.

Additionally, an essential element of the MIP is its directed growth plan which provides a management framework for future growth in a manner that is fiscally, environmentally, and culturally prudent. Among the directed growth management tools developed through the MIP process are maps delineating urban growth boundaries (UGB), small town boundaries (STB) and rural growth boundaries. The respective boundaries identify areas appropriate for future growth and their corresponding intent with respect to development character.

The majority of the proposed project area is located within the UGB and STB of the MIP. Portions of the project site are located in the Park and Protected areas of the MIP. In this regard, it is consistent with the directed growth strategy defined via growth maps adopted in the MIP. Further, as infrastructure improvements, the proposed project is an allowable use and consistent with the MIP. See **Figure 16** and **Figure 17**. The MIP also noted that the surrounding area is planned for future growth. See **Figure 18**.

A summary of the project's relationship to the MIP is detailed in **Appendix "I-3"**.

The proposed action does not contravene the goals, objectives and policies of the MIP.

E. <u>WAILUKU-KAHULUI COMMUNITY PLAN</u>

Within Maui County, there are nine (9) community plan regions. From a General Plan implementation standpoint, each region is governed by a Community Plan which sets forth desired land use patterns, as well as goals, objectives, policies, and implementing actions

Figure 16

Waiale Road Extension Project
Maui Island Plan Growth Boundary

0 250 500 1000 Feet

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\MIPGrowth

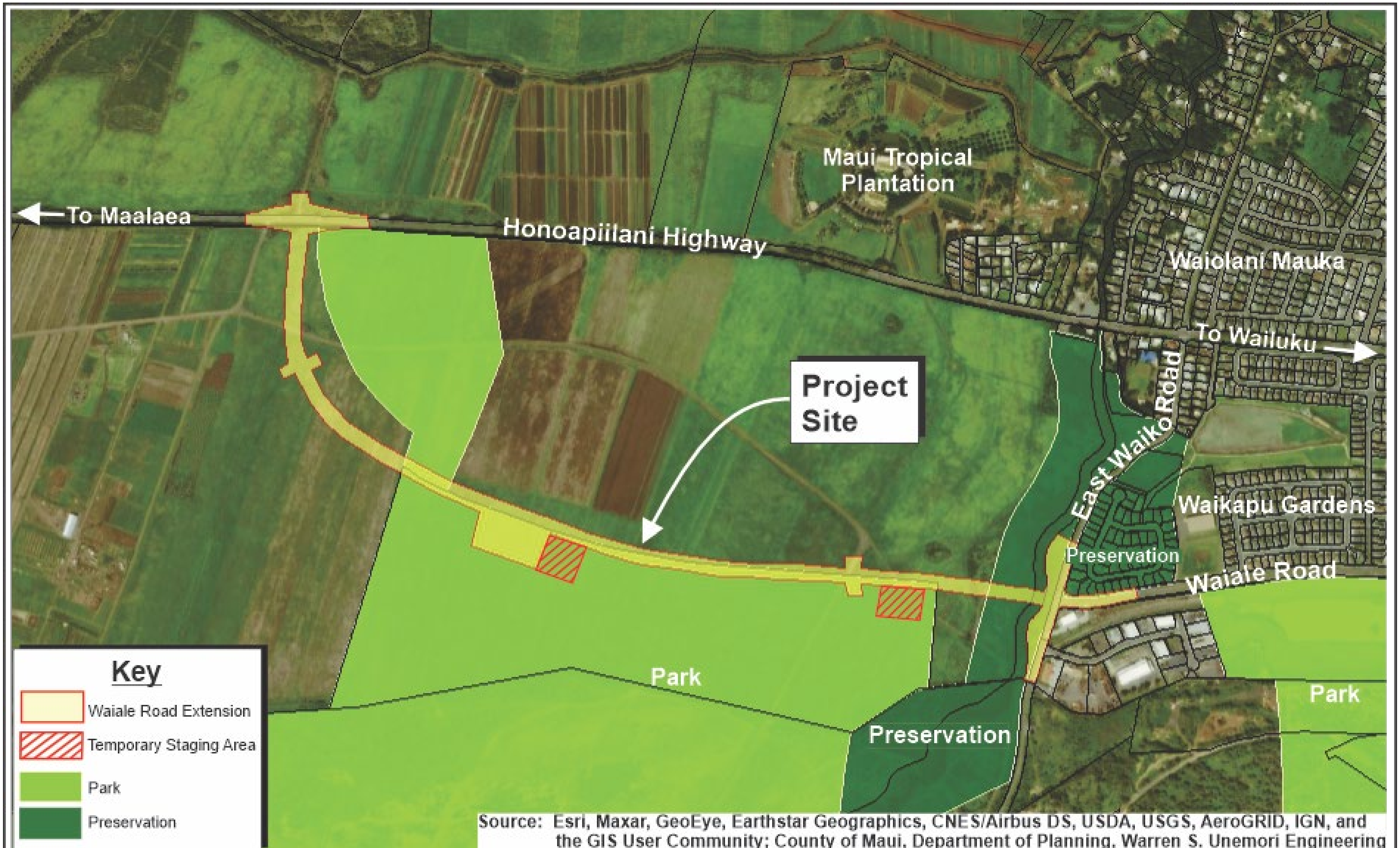


Figure 17

Waiale Road Extension Project
Maui Island Plan Protected Areas Map

0 250 500 1000 Feet

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\MIPProtected

Figure 18

Waiale Road Extension Project
Maui Island Planned Growth Areas

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\GrowthAreas for a number of functional areas, including infrastructure-related parameters. The project site is located within the Wailuku-Kahului Community Plan region.

Land use guidelines are set forth by the Wailuku-Kahului Community Plan Land Use Map. As shown in **Figure 19**, the proposed project site is designated as a planned roadway on the Wailuku-Kahului Community Plan map. The proposed project is, therefore, consistent with the underlying land use designations of the Community Plan.

The proposed project area is in conformance with the Wailuku-Kahului Community Plan as summarized below:

1. **Land Use**

   The proposed project site is located within the UGB as designated within the MIP. Furthermore, the project site is located on lands with appropriate existing land use designations with respect to the Wailuku-Kahului Community Plan and Maui County Zoning to support the proposed roadway extension project. It is also noted that the project site is not located within the SMA.

   As previously stated, the planned improvements have been designed with the pedestrian in mind and include the development of sidewalks, bicycle lanes, and landscaping features. The proposed project also includes installation of underground utilities to support future County infrastructure connections and needs.

2. **Cultural Resources**

   A LRFI, AIS, and CIA for the project area have been undertaken. Refer to **Appendix "F-1", Appendix "F-2"**, and **Appendix "G"**, respectively. Based on the results of community consultation and background research conducted as part of the CIA, no ongoing cultural practices were identified within the project area. With the implementation of the mitigation measures recommended by CSH, impacts to cultural resources are anticipated to be avoided. In addition, the project will comply with all requirements from SHPD upon completion of their Chapter 6E-8 review of the project.

3. **Physical and Social Infrastructure**

   The proposed Waiale Road Extension project, from East Waiko Road to Old Quarry Road at the intersection of Honoapiilani Highway, will address localized congestion and improve traffic flow in the surrounding area. The purpose of the project is to provide needed infrastructure that supports the existing and planned neighboring residential, commercial and industrial users along these

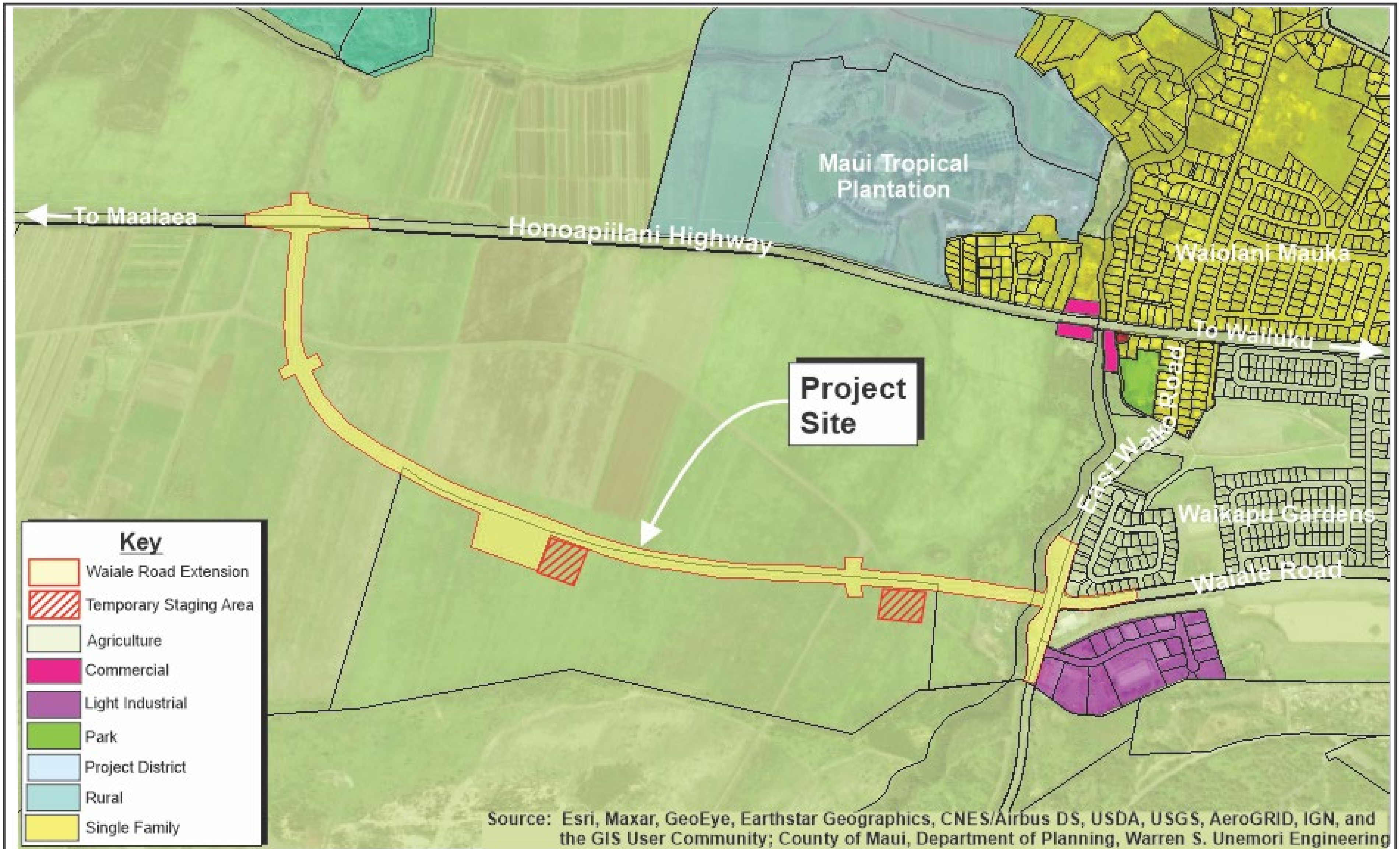


Figure 19

Waiale Road Extension Project

Wailuku-Kahului Community Plan Map

0 250 500 1000 Feet

Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\WKC two (2) roads. The project would additionally reduce the amount of industrial and other traffic utilizing East Waiko Road through the existing residential area and allow for economic growth in the surrounding area. The project also supports improved safety and mobility for non-motorized users, such as bicyclists and pedestrians, by including shoulder bikeways, pedestrian sidewalks and a shared-use path.

A summary of the project's relationship to the Wailuku-Kahului Community Plan is detailed in **Appendix "I-4"**.

F. MAUI COUNTY ZONING

Lands bordering the Waiale Road Extension are designated "Waikapu Country Town District" and "Agricultural" by Maui County Zoning. The proposed roadway extension and related improvements are permitted uses and are consistent with the underlying County Zoning designations. See **Figure 20**.

G. FEDERAL REGULATORY REQUIREMENTS

1. Department of the Army

The Department of the Army (DA) permit program is authorized by Section 10 of the Rivers and Harbors Act of 1899, and Section 404 of the Clean Water Act. Section 10 of the Rivers and Harbors Act of 1899 requires authorizations from the DA prior to the undertaking of any work in, over or under navigable waters of the United States, or which affects the course, location, condition or capacity of such waters. Section 404 of the Clean Water Act requires permit authorization to discharge dredged or fill material into the waters of the United States, including wetlands.

Inasmuch as the project involves elements that cross Waikapu Stream, the proposed project is subject to the authorization requirements of the DA. See **Appendix "K-1"** and **Appendix "K-2"**.

2. Section 401 Water Quality Certification

Under Section 401 of the Clean Water Act, the Department of Health (DOH), Clean Water Branch (CWB) is responsible for processing Section 401 Water Quality Certifications (WQC) for any project/activity that requires a federal license or permit and may result in a water pollutant discharge to State surface waters. In this instance, the triggering federal permit would be a DA permit. Should a DA permit not be required in connection with the proposed action, a Section 401 WQC would not be triggered.

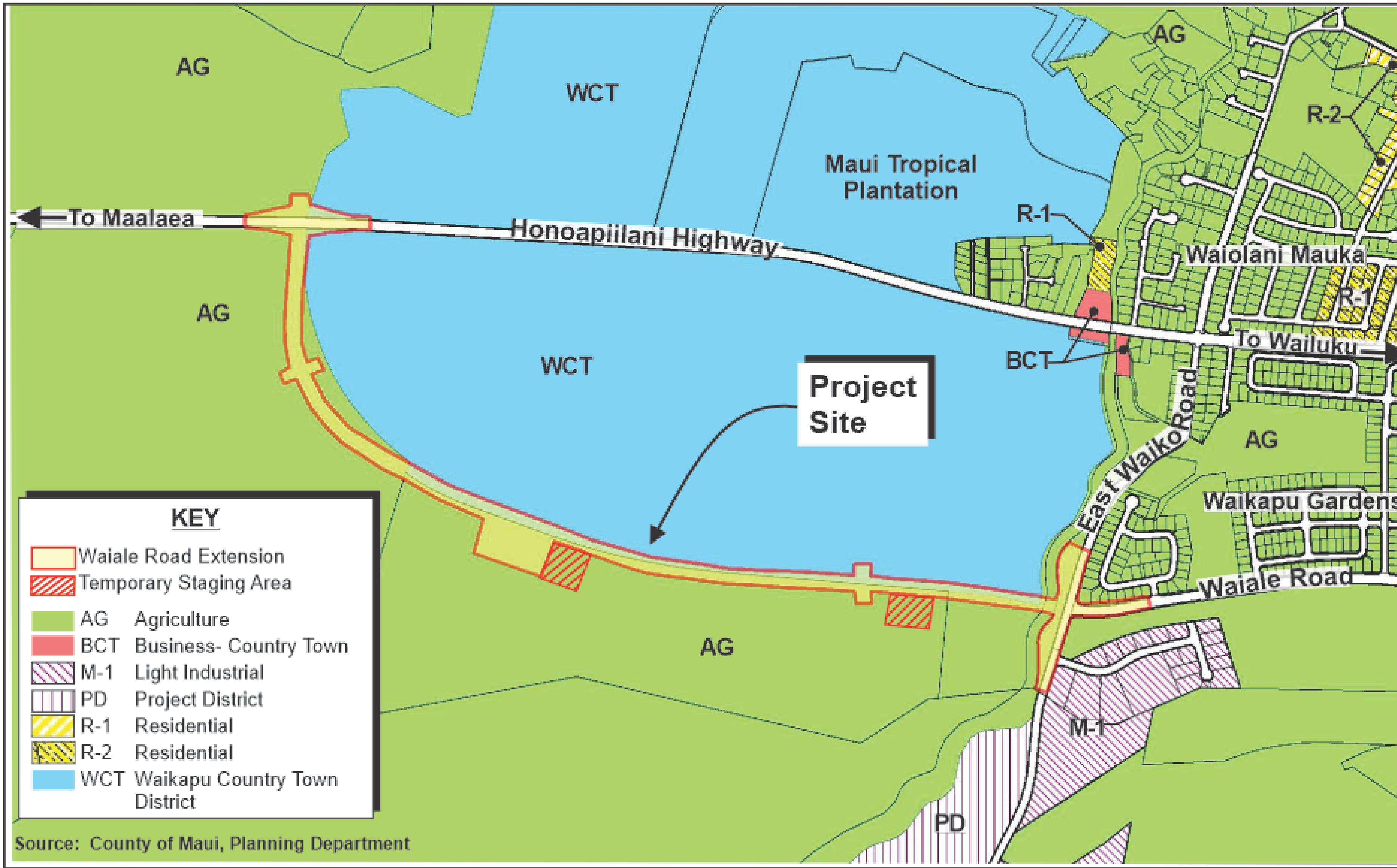
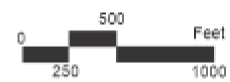


Figure 20

Waiale Road Extension Project

Maui County Zoning Map



Prepared for: County of Maui, Department of Public Works

MUNEKIYO HIRAGA

Bowers\Waiale Road Extension\Applications\Figures\DEA\Zoning

3. Coastal Zone Management Consistency Review

The national Coastal Zone Management Act (CZMA), Section 307, requires Federal agency activities and development projects affecting any coastal use or resource, or activities requiring a Federal permit or license that affect coastal uses and resources to be undertaken in a manner consistent to the maximum extent practicable with the State's CZM program. The Federal trigger in this instance would be the requirement for a DA permit.

4. Section 4(f) of the Department of Transportation Act

Section 4(f) refers to the section of the U.S. Department of Transportation Act of 1966 which provided for consideration of park and recreation lands, wildlife and waterfowl refuges, and historic sites during transportation project development. Requirements of Section 4(f) apply only to the U.S. Department of Transportation (U.S. DOT) and are implemented by the Federal Highway Administration (FHWA) and the Federal Transit Administration. Inasmuch as the proposed Waiale Road Extension project is a Federal Aid project that will receive Federal funding, Section 4(f) would be an applicable consideration. Section 4(f) properties include significant publicly owned parks, recreation areas, and wildlife or waterfowl refuges, as well as any publicly or privately owned historic site listed or eligible for listing on the National Register of Historic Places.

With respect to the proposed Waiale Road Extension project, there are no publicly owned parks, recreation areas, or wildlife and waterfowl refuges which will be affected by the proposed action. Work will primarily occur within unimproved lands owned by the County of Maui and Waiale 905 Partners, LLC, with additional bridge-related work being conducted within a portion of Waikapu Stream. Land uses adjacent to the project limits have been previously disturbed for agricultural uses. With respect to historic properties, Section 106 consultation with the SHPO and interested Native Hawaiian Organizations and individuals has been initiated. The FHWA is currently preparing an effect determination and request for concurrence letter to the SHPD. The proposed project will implement all SHPD recommendations and requirements. This will ensure that adverse impacts to archaeological or historic resources are mitigated or avoided.

5. Section 6(f) of the Land and Water Conservation Fund Act

Section 6(f) is included in the Land and Water Conservation Fund Act (LWCF) of 1965. The LWCF is a Federal program that was established by Congress in 1964 to provide funds and matching grants to federal, state and local governments for the acquisition of land and water, and easements on land and water, for recreational benefits. The LWCF is administered by the Department of Interior's

National Park Service (NPS). The NPS oversight pertains to projects that would cause impacts on or the permanent conversion of recreational property acquired with LWCF monies. Under Section 6(f), it is prohibited to convert property acquired or developed with LWCF grant money to non-recreational purposes without approval from the NPS. As noted above (Section 4(f) discussion), there are no recreational properties affected by the proposed Waiale Road Extension project.

6. Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to consider the effects on historic properties of projects they carry out, assist, fund, permit, license, or approve throughout the country. As noted previously, the proposed Waiale Road Extension project is a Federal-Aid project and accordingly, will require Section 106 compliance. In the State of Hawaii, Section 106 regulations place particular emphasis on consultation with Native Hawaiian Organizations (NHO). In this regard, Section 106 consultation was initiated for the proposed project in December 2023. A letter requesting APE concurrence was submitted to the State Historic Preservation Officer (SHPO) via HICRIS on December 6, 2023. Refer to **Appendix "F-4"**. In the letter, a request was made to the SHPO for information on all eligible historic properties/cultural sites within the APE and in the State Inventory of Historic Places. In addition, the SHPO was asked to provide information on issues they may have relating to the proposed undertaking's potential effects on each significant historic property within 30 days of receipt. Pursuant to 36 CFR§ 800.3(c)(4), because the SHPO did not respond to the request within 30 days, the FHWA and the HDOT elected to proceed with the Section 106 process. Following that decision, on September 24, 2024, the FHWA and the HDOT received a response from the SHPD, which recommended that in order to prepare a list of Native Hawaiian Organizations to consult as part of the Section 106 process, the FHWA refer to the Native Hawaiian Organization Notification List provided by the U.S. Department of the Interior and expand consultation to interested parties such as civic clubs and historic preservation organizations. The FHWA and the HDOT followed this course of action when preparing its list of Native Hawaiian Organizations to consult. Therefore, the FHWA's list and efforts are in accordance with the SHPD's recommendations.

On May 9, 2024, the DPW, on behalf of the HDOT and the FHWA, mailed letters requesting consultation from NHOs and other individuals and organizations with legal, economic, or historic preservation interest in the Waiale Road Extension Project within 30 days of receipt of the letter. Refer to **Appendix "F-5"**. As of October 2024, no NHOs or other interested individuals or organizations had responded to the DPW's request for consultation. The FHWA is currently preparing an effect determination and request for concurrence letter to the SHPD. The proposed project will implement all SHPD recommendations and requirements. This will ensure that adverse impacts to archaeological or historic resources are mitigated or avoided.

7. Section 7 of the Endangered Species Act

The Endangered Species Act (ESA) directs all Federal agencies to work to conserve endangered and threatened species and to use their authorities to further the purposes of the Act. Section 7 of the Act, called "Interagency Cooperation," is the mechanism by which Federal agencies ensure the actions they take, including those they fund or authorize, do not jeopardize the existence of any listed species. As the proposed Waiale Road Extension project will be federally funded, Section 7 consultation will be undertaken.

In this regard, consultation will be initiated with the U.S. Fish and Wildlife Service (USFWS) to identify potential types of listed species that may occur in the proposed action area and what effect the proposed action may have on those species. The FHWA obtained an official species list from the USFWS IPaC website for the project APE on June 24, 2024. Refer to **Appendix "E-2"**. The FHWA is currently preparing a letter requesting informal consultation with the USFWS and concurrence with its effect determination with respect to Section 7. Mitigation measures recommended by the USFWS will be implemented.

8. Clean Water Act

The Clean Water Act, 33 United States Code (USC) §1251 et seq. (1972), is implemented by the U.S. Environmental Protection Agency (EPA). The basis for this act was first enacted in 1948 as the Federal Water Pollution Control Act. It was substantially amended in 1972, when it became known as the Clean Water Act. It aims to restore and maintain the quality of the U.S.'s surface water by providing the framework for regulating discharges of pollutants and establishing quality standards for surface waters. The Clean Water Act gave the EPA the authority to set wastewater standards for the industry. The Clean Water Act outlawed the discharge of any pollutant from a point source into navigable waters of the U.S. without an NPDES permit issued by the Administrator of the EPA.

DPW will obtain a NPDES permit for the proposed project.

9. Clean Air Act

The Clean Air Act (CAA), 42 USC § 7401 et seq., is a Federal law that regulates all sources of air emissions – stationary and mobile. It authorizes the EPA to establish National Ambient Air Quality Standards (NAAQS) to improve air quality, reduce air pollution, and protect public health. The CAA was amended in 1977 and again in 1990 to strengthen requirements for reducing or maintaining emissions (Bureau of Ocean Energy Management, accessed April 2024). The CAA requires each state to develop a State Implementation Plan (SIP) to achieve the Federal NAAQS. In Hawaii, the Department of Health (DOH) administers the SIP and as part of that operates a permitting program to control air pollution.

Potential short- and long-term impacts to air quality that may result from the implementation from the proposed Waiale Road Extension project are discussed in Chapter II. To evaluate the impacts on air quality and GHG emissions, a study was undertaken by B.D. Neal & Associates in December 2023 to specifically consider the proposed Waiale Road Extension project. Refer to **Appendix "C"**.

The primary short-term air quality concern regarding the construction phase of the project is fugitive dust caused by grading and dirt-moving activities associated with site clearing and preparation work. As such, a dust control plan will be implemented in compliance with State air pollution control regulations. The following BMPs suggested by B.D. Neal & Associates will be included in the plan, as applicable: watering of active work areas, using wind screens, keeping adjacent paved roads clean, and covering open-bodied trucks. Other dust control measures that will be considered include limiting the area that is disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked, and paving and landscaping project areas early in the construction schedule. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, minor disruptions to traffic, and workers' vehicles may also impact air quality during the construction phase. The report recommended mitigating exhaust emissions by moving construction equipment and workers to and from the project site during off-peak traffic hours.

With respect to long-term impacts, B.D. Neal & Associates concluded that, due to the negligible impact the project is expected to have, implementing mitigation measures for long-term traffic-related air quality impacts is likely unnecessary and unwarranted. The project is expected to result in improved traffic flow and reduced intersection delay in the project area, thereby providing for a reduction in GHG.

Based on the foregoing, the proposed project would comply with all federal and state air quality standards.

10. Magnuson-Stevenson Fishery Conservation and Management Act

The Magnuson-Stevenson Fishery Conservation and Management Act (MSA) is the primary law that governs marine fisheries management in U.S. federal waters. It aims to prevent overfishing, rebuild overfished stocks, increase long-term economic and social benefits, ensure a safe and sustainable supply of seafood, and protect habitat that fish need to spawn, breed, feed, and grow to maturity. The

MSA authorizes eight (8) Regional Fisheries Management Councils across the U.S. to develop and implement fishery management plans (FMP), which are then reviewed, approved, and implemented by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NFMS). Among other functions, FMPs identify essential fish habitat (EFH), areas that require conservation and enhancement.

Federal agencies that fund, permit, or undertake activities that may adversely affect EFH (including areas outside of EFH, such as mauka or upstream areas) are required to consult with NFMS regarding potential impacts and implement all NFMS recommendations.

One hundred percent of runoff from the proposed project will be managed onsite through a combination of new and existing drainage improvements. Due to the project's location inland and away from the shoreline, the proposed action is not anticipated to affect EFH, and consultation with NMFS is not applicable.

11. <u>Fish and Wildlife Coordination Act</u>

In order to conserve wildlife resources and provide for the improvement of those resources, the Fish and Wildlife Coordination Act requires federal agencies that are authorizing, funding, or carrying out an action that would result in the control or modification of a natural stream or body of water to consult with USFWS. The USFWS is directed to evaluate these federal water-resource development actions and provide recommendations to minimize potential impacts.

The FHWA is currently preparing a letter requesting informal consultation with the USFWS and concurrence with its effect determination with respect to the Fish and Wildlife Coordination Act. The USFWS, National Wetlands Inventory (NWI) is a nationwide geospatial dataset of wetlands and other surface hydrology features (USFWS, nd-a). According to the NWI, Waikapu Stream, identified as being within the Freshwater Forested/Shrub Wetland category, is the only hydrology feature within the project APE. However, a detailed, on-ground biological survey and jurisdictional waters delineation conducted by AECOS, Inc. in 2022 confirmed that despite there being java plum fruit and other accumulated organic matter in some sections, the water appeared exceptionally clear throughout the stream, with no visible turbidity and no evidence of wetlands. Though according to the NWI there are wetlands that fall within the Freshwater Emergent Wetland and Freshwater Pond categories 700 +/- feet and further from the project site, NWI does not map any wetlands in or near the project site. The planned crossing of the Waikapu Stream provides for two (2) construction alternatives, one (1) which will involve work outside of the Ordinary High Water Mark (OHWM) for the stream, while the other will involve work within the stream. The proposed project will include BMPs approved by the Department of Army and the State Department of Health, should there be work within the Waikapu Stream.

As recommended by USFWS during Early Technical Assistance, the DPW will implement its BMPs for Work In and Around Aquatic Environments and the Pacific Islands Fish and Wildlife Office's Invasive Species Biosecurity Protocols.

Based on the foregoing, the project may affect, but is not likely to affect, any natural streams or bodies of water.

12. <u>Migratory Bird Treaty Act</u>

The Migratory Bird Treaty Act (MBTA) of 1918 (16 USC §703 at seq.), as amended, protects listed migratory birds by making it unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird, or any part, nest or egg of a migratory bird, unless authorized by a permit issued by USFWS. The FHWA is currently preparing a letter requesting informal consultation with the USFWS and concurrence with its effect determination with respect to the MBTA.

The proposed project will not involve any of the actions prohibited under the MBTA. Pursuant to section 7(c) of the Endangered Species Act of 1973, DPW generated a threatened and endangered species list for the proposed project using USFWS's Pacific Islands Fish and Wildlife Office's (PIFWO) Information for Planning and Consultation (IPaC) web portal. See **Appendix "E-2"**. The species list identifies seven (7) threatened or endangered birds that have the potential to occur within the project area, all of which are protected by the MBTA. In addition, the species list identifies eight (8) Birds of Conservation Concern (BCC), which are protected by the MBTA but not listed, that may be present in the project area: the apapane (*Himatione sanguinea*), black noddy (*Anous minutus melanogenys*), bristle-thighed curlew (*Numenius tahitiensis*), Bulwer's petrel (*Bulweria bulwerii*), Hawaii amakihi (*Chlorodrepanis virens*), Maui alauahio (*Paroreomyza montana*), red-tailed tropicbird (*phaethon rubricauda melanorhynchos*), and wanderline tattler (*Tringa incana*). The proposed project will implement all BMPs recommended by the USFWS, including those given during Early Technical Assistance, as well as those recommended by AECOS, which conducted the Biological Resources Survey for the proposed project. The SHPD's concurrence with the FHWA's effect determination is pending.

13. <u>Social and Environmental Justice</u>

Pursuant to Executive Order 12898 of February 11, 1994, Federal Actions are required to address environmental justice in minority populations and low-income populations. The proposed project improvements are not anticipated to negatively impact minority populations and low-income populations. The proposed project will provide infrastructure improvements to allow for the development of affordable housing in the area.

14. Executive Order 13045 – Protection of Children from Environmental Health Risks and Safety Risks

Executive Order (EO) 13045, Protection of Children from Environmental Health Risks and Safety Risks, requires each Federal agency to identify and assess environmental health and safety risks that may disproportionately affect children and ensure that its programs, policies, activities, and standards address these potential risks. “Environmental health risks and safety risks” are those risks to health and safety attributable to substances or products that children are likely to come into contact with or ingest, such as air, water, food, soil, and products.

Though the proposed project will be constructed on and in the midst of vacant agricultural land, the approved Waikapu Country Town project will be developed adjacent to the Waiale Road Extension in the future. Included in the developments proposed as part of the Waikapu Country Town project are an elementary school. As such, the requirements of EO 13045 are relevant to the proposed Waiale Road Extension project.

The proposed project is limited to the extension of a roadway and related improvements. As discussed above, the air quality study prepared for the proposed project concluded that the Waiale Road Extension will improve regional air quality in the long-term by reducing mobile source emissions. Short-term, construction-related air quality impacts will be mitigated through the implementation of appropriate BMPs.

With regard to noise impacts, Y. Ebisu & Associates conducted an acoustic study for the proposed project in March 2023. The total noise exposure from construction activities at any one receptor location is not expected to be continuous during the total construction period. Impacts are anticipated to be limited to temporary degradation of the quality of the acoustic environment in the immediate vicinity of project work areas. It is noted that the State Department of Health (DOH) currently regulates noise from construction activities under a permit system. In accordance with DOH regulations, the project contractor will implement BMPs including standard curfew periods, properly muffled equipment, administrative controls, and construction barriers, as required. With respect to long-term noise, Y. Ebisu & Associates reported that no mitigation measures should be required, as the lands adjacent to the proposed project area are undeveloped. Nevertheless, the study recommended mitigation measures in anticipation of future noise-sensitive developments, including the installation of noise attenuating walls and landscaped buffer zones. Any future noise attenuating walls or landscaping would be installed by others at the time of the development. Additionally, a County-approved Traffic Control Plan will be required by the project's Roadway Permit.

The Waiale Road Extension will support the existing and future land uses surrounding the roadway, including the residents of Waikapu Country Town and those using the planned elementary school. With the implementation of the mitigation measures identified in this EA document, disproportionately high negative long-term impacts to the environmental health and safety of children are not anticipated.

15. Executive Order 13112 – Invasive Species

Executive Order 13112, issued in 1999, requires Federal agencies to identify any actions that may affect the status of invasive species and prohibits them from authorizing, funding or carrying out actions that the agencies believe would cause or promote the introduction or spread of invasive species, unless they determine that the benefits of the action clearly outweigh the potential harm and enact all feasible measures to minimize the risk of harm.

No activity proposed as part of the Waiale Road Extension project is anticipated to cause or promote the introduction or spread of invasive species.

16. Executive Order 11990 – Protection of Wetlands

Executive Order 11990, enacted in 1977, requires each Federal agency to minimize the destruction, loss, or degradation of wetlands and preserve and enhance their natural value when carrying out any responsibilities. It also prohibits Federal agencies from undertaking or assisting with construction in wetlands unless the agency finds that there is no practicable alternative and the action implements all practicable measures to minimize harm to the wetland being used.

The USFWS National Wetlands Inventory (NWI) is a nationwide geospatial dataset of wetlands and other surface hydrology features (USFWS, nd-a). According to the NWI, there are wetlands that fall within the Freshwater Emergent Wetland and Freshwater Pond categories approximately 700 ft. and further from the project site.

A narrow line crosses the project area in the location of Waikapu Stream and is identified as being within the Freshwater Forested / Shrub Wetland category. However, a detailed, on-ground biological survey and jurisdictional waters delineation conducted by AECOS, Inc. in 2022 confirmed that despite there being java plum fruit and other accumulated organic matter in some sections, the water appeared exceptionally clear throughout the stream, with no visible turbidity and no evidence of wetlands.

Onsite drainage mitigation measures will be implemented to address the increase in stormwater runoff associated with the development of the proposed roadway extension. With respect to short-term, construction-related impacts, BMPs will be implemented to mitigate the transport of loose earthen materials downstream. With the implementation of both short-term and permanent BMPs, the proposed project is not anticipated to harm any wetlands.

17. Environmental Protection Agency's Sole Source Aquifer Program

Established under Section 1424(e) of the Safe Drinking Water Act, the sole source aquifer program aims to protect sources of drinking water from contamination from Federal actions by allowing the EPA to designated an aquifer as the sole source of drinking water and create a review area. The EPA is authorized to review any federally funded project that falls within a review area to ensure that it does not contaminate the sole source aquifer.

According to the EPA's online Interactive Map of Sole Source Aquifers, there are no sole source aquifers designated on Maui.

H. STREAM CHANNEL ALTERATION PERMIT

The Commission on Water Resource Management's (CWRM) Stream Protection and Management Branch is responsible for protecting stream channels from alteration whenever practicable and for managing the sharing of surface water resources.

A Stream Channel Alteration Permit (SCAP) is required for any temporary or permanent activity within the stream bed or banks that may: (1) Obstruct, diminish, destroy, modify, or relocate a stream channel; (2) Change the direction of flow of water in a stream channel; (3) Place any materials or structures in a stream channel; or (4) Remove any material or structure from a stream channel.

Work proposed in the Waikapu Stream would be related to one of the alternatives for the installation of the bridge crossing over the stream. Associated work includes the provision of grouted rubble pavement (GRP) for streambed protection on both the inlet and outlet sides of the bridge structures. A second alternative under review for the bridge crossing would not involve work within the stream as the bridge components would be located outside of the OHWM for the stream.

Coordination and consultation with the CWRM will be undertaken to ensure that applicable requirements of Title 13, Chapter 169, Subchapter 5, of the Hawaii Administrative Rules, relating to Stream Channel Alteration Permits are appropriately addressed pending final determination of the bridge crossing alternative.

EARLY AND CONTINUING CONSULTATION

V

V. EARLY AND CONTINUING CONSULTATION

A. EARLY CONSULTATION WITH AGENCIES AND ORGANIZATIONS

As part of the early consultation and coordination process, written request for comments and input were sent to Federal, State of Hawaii, and County of Maui agencies. In addition, request for comments and input were sent to local organizations who may have an interest in the project. A total of 15 Federal agencies, 23 State of Hawaii agencies, and 18 County of Maui agencies were consulted. In addition, eight (8) organizations were consulted. The list of agencies and organizations consulted are provided in **Appendix "J"**. Written comments were received from a number of agencies. Responses to those comments were prepared and provided to the commenting agency. The comment letters and responses are included in **Appendix "J".**

B. SUMMARY OF COMMUNITY OUTREACH EFFORTS

1. Meeting with Maui County Council Water and Infrastructure Committee

DPW presented to the Maui County Council's Water and Infrastructure Committee on June 19, 2023 to provide an update on the Waiale Road Extension project. No legislative action was taken during the meeting. The project team presented slides to share the project background and scope, including utilities, the current design, the regulatory processes being undertaken by the project, and the project timeline and budget. The project team also presented on several topics requiring focused consideration, including archaeological and cultural concerns, the relocation of HECO transmission poles, potential stream permit requirements, ROW acquisition, and rising construction costs and supply chain issues.

One (1) member of the public provided testimony, expressing support for the project, and suggesting that the County consider developing housing and a school on the lands adjacent to the roadway. The testifier also recommended providing for a bus stop in the project design, and building the road wide enough to accommodate four (4) lanes, if future expansion is needed. Additionally, the Council committee members asked questions regarding project funding, the Public Utilities Commission process to relocate the HECO transmission poles, the bridge design alternatives, the intersection design alternatives, mitigating traffic at the Kuikahi Drive-Waiale Road intersection, access to the future wastewater treatment plant planned to be developed east of the Waiale Road Extension, archaeology in the project area, and fauna in Waikapu Stream.

2. Meetings with Waikapu Community Association General Membership

A meeting with the Waikapu Community Association's (WCA) general membership was held on July 28, 2023. The purpose of the meeting was to introduce the project to the WCA. The project team presented slides to share the project background and scope, including utilities, the current design, the regulatory processes being undertaken by the project, and the project timeline and budget.

A second meeting with the WCA was held via Zoom on June 10, 2024. The project team reviewed the project background and scope and provided updates on the project design, timeline, the results of various studies, including the TIAR, and the progress of the Environmental Assessment. The members of the WCA were then given the opportunity to ask questions of the project team. The WCA members asked questions related to the intersection and bridge crossing designs, the locations of the future intersections or roundabouts, the anticipated date to begin construction, measures being implemented to mitigate flooding, and whether the project had been revised to reduce the number of intersections or roundabouts. They also asked for clarification regarding what agency would be the accepting agency of the EA and for details regarding the implementation of traffic calming measures. Several members of the WCA also shared comments about areas outside of the proposed Waiale Road Extension project area, including thoughts on traffic congestion at the existing Waiale Road-Kuikahi Drive intersection and a question as to whether the dust fence along TMK (2)3-5-002:014 would be repaired.

3. Public Informational Meeting – June 20,2024

A public informational meeting was held via the Zoom platform on June 20, 2024 in anticipation of the publication of the Draft EA. A summary of the meeting is provided in **Appendix "L"**. Twenty-three (23) letters were mailed to owners of property in the Waikapu Light Industrial area, as well as those whose properties will be directly impacted by the project. In addition, a press release with details on how to attend the meeting was published in the Maui News and on the DPW's website. Thirty-two (32) members of the community attended the meeting.

The project team presented slides to share the project background and scope, including utilities, the current design, the regulatory processes being undertaken by the project, and the project timeline and budget. Then, attendees were invited to ask questions about the project. One (1) community member expressed support for the project and roundabouts. Others asked questions related to the bridge crossing (whether it would be designed to accommodate more than the 100-year storm), the roundabout or intersection locations, whether crosswalks are included in the project design, and whether DPW could extend the Area of Potential Effects

(APE). Attendees also commented on the lack of sidewalks outside of the project area but within its vicinity, the improper use of existing shared use paths, and traffic mitigation and calming measures planned for areas nearby the project area.

DPW is tentatively planning to host a second public informational meeting during the 30-day public comment period for the Draft EA.

SUMMARY OF ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

VI

VI. SUMMARY OF ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

An assessment of the proposed project's potential construction-related impacts, as well as its potential impacts on ambient noise, air quality, the physical environment, and the socio-economic wellbeing of the community was carried out as part of an environmental assessment documentation process. DPW also initiated consultation with the State Historic Preservation Division (SHPD) and various Native Hawaiian organizations, and CSH conducted a cultural impact assessment (CIA). The proposed project will have a limited, unavoidable construction-related impact on the environment, as described in Chapter III.

Construction-related impacts include those related to noise generation occurring from heavy equipment used for site preparation and construction activities. In addition, temporary air quality impacts associated with dust generation from construction activities and exhaust emissions discharged by construction equipment are also likely. However, during construction, these impacts are temporary and will be mitigated through the use of appropriate Best Management Practices (BMPs), such as watering active work areas, using wind screens, keeping adjacent paved roads clean, and covering open-bodied trucks. It is noted that the State Department of Health currently regulates noise from construction activities under a permit system. Noise restrictions under the existing regulatory framework are designed to minimize noise impacts on noise sensitive receptors along the roadway corridor.

Upon completion, the proposed project is not expected to be a source of long-term adverse air or noise conditions. A study on Greenhouse Gas (GHG) Emissions undertaken in December 2023 compared projected carbon monoxide emissions in the year 2045 with and without the Waiale Road Extension and found no measurable difference. Furthermore, because the project is anticipated to result in improved traffic flow and reduced intersection delay, it is expected to provide for a reduction in GHG. Refer to **Appendix "C"**.

With regard to long-term noise impacts, as a result of an acoustic study conducted for the project in March 2023, Y. Ebisu & Associates found that traffic noise mitigation measures should not be required at existing residences along the Waiale Road and East Waiko Road, primarily due to existing sound attenuating walls in those areas. The study also stated that traffic noise mitigation measures should not be required along the Waiale Road Extension, as lands along the corridor are currently undeveloped. Nevertheless, in recognition of the potential for noise-sensitive Waikapu Country Town residences to be developed prior to the completion of the Waiale Road Extension, the consultant recommended several mitigation measures for future noise-sensitive developments, including the installation of sound-attenuating walls and the use of setback distances and landscaped buffer zones in the future, when adjacent areas are developed. With the implementation of the proposed mitigation measures, long-term adverse impacts to noise and air quality in the project area are not anticipated. Refer to **Appendix "H"**.

During construction of the project, traffic-related impacts are anticipated along the roadways where work is being done and a traffic control plan will be implemented. Communication with County agencies such as the Maui Police Department, Fire Department, Department of Transportation, and Maui Economic Opportunity will be done in advance of any possible road closures. These impacts will be in the short term, during construction and will not continue once the project is complete.

In the long term, the proposed Waiale Road Extension project will create roadway redundancy for Central Maui residents, thereby reducing traffic congestion and supporting planned residential and commercial growth in Waikapu. It will also improve safety and mobility for non-motorized users and enhance emergency response.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

VII

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed action will not entail a substantial commitment of public services or facilities. The proposed Waiale Road Extension and related improvements, including the development of a shared use path for pedestrians and cyclists, will primarily occur within an existing access and utility easement that will be subdivided and dedicated to the County. It will create roadway redundancy in an area that is anticipated to undergo significant residential and commercial development in the foreseeable future. Where private lands are required for easements or limited right-of-way acquisition, compensation will be provided to owners. Implementation of the proposed project area will involve a commitment of energy, labor, fiscal, and material resources. The use of these resources, when weighed against the expected benefit derived from the project, is not considered an adverse commitment.

SIGNIFICANCE CRITERIA ASSESSMENT AND ANTICIPATED DETERMINATION

VIII

VIII. SIGNIFICANCE CRITERIA ASSESSMENT AND ANTICIPATED DETERMINATION

The “Significance Criteria”, Section 13 of the Hawai‘i Administrative Rules (HAR), Title 11, Chapter 200.1, “Environmental Impact Statement Rules”, was reviewed and analyzed to determine whether the proposed project area will have significant impacts on the environment. The following criteria and analysis are provided.

1. <u>Irrevocably commit a natural or cultural resource.</u>

The project area will occur within developed areas, surrounded by residential land uses. It primarily involves existing roadway and easements and right-of-ways (ROWs). As documented by the Biological Resources Survey report and the accompanying analysis represented in Chapter III, with the implementation of the BMPs recommended by AECOS, Inc., negative impacts to natural resources are likely to be avoided with implementation of the proposed project. Refer to **Appendix “E-1”**.

The project will occur in an environment that was previously used for sugar cane cultivation in an 80-foot wide corridor that has been long-planned for the Waiale Road Extension. The CIA report prepared for the project did not identify any cultural practices within the project area. Refer to **Appendix “G”**.

Consultation with the State Historic Preservation Division (SHPD) has been initiated. Following the preparation of an LRFI, CSH recommended that an AIS be conducted. SHPD concurred and approved CSH’s AIS testing strategy. CSH conducted AIS testing in April and May 2024 and the AIS report will be included in the Final EA for this project. DPW will comply with all requirements from the SHPD upon completion of its Chapter 6E-8 review of the project. Refer to **Appendix “F-1” and Appendix “F-2”**. Section 106 consultation is ongoing.

2. <u>Curtail the range of beneficial uses of the environment.</u>

The proposed action is limited to the extension of Waiale Road and related improvements, including a shared use path for pedestrians and cyclists, primarily within existing ROWs in an area that was previously used for sugarcane cultivation. The project will not curtail the range of beneficial uses of the environment.

3. <u>Conflict with the State’s environmental policies or long-term environmental goals established by law.</u>

The proposed action conforms with the State’s Environmental Policy and Guidelines as set forth in Chapter 344, Hawai‘i Revised Statutes (HRS).

4. **<u>Have a substantial adverse effect on the economic welfare, social welfare, or cultural practices of the community and State.</u>**

The proposed project will provide added roadway redundancy to the region, which will have a positive impact on economic and social welfare. The CIA report prepared for the project did not identify any cultural practices within the project area. Refer to **Appendix "G"**. In addition, the AIS report will be included in the Final EA for this project. The DPW will comply with all SHPD requirements upon completion of its Chapter 6E-8 review of the project. Refer to **Appendix "F-2"**. Section 106 consultation is ongoing. Based on the foregoing, the proposed project is not anticipated to have an adverse effect on the economic welfare, social welfare, or cultural practices of the community and State.

5. **<u>Have a substantial adverse effect on public health.</u>**

No adverse impacts to public health and welfare are anticipated as a result of the proposed action.

6. **<u>Involve adverse secondary impacts, such as population changes or effect on public facilities.</u>**

The proposed project is not a population generator. With the proposed mitigation measures in place, the proposed project is not anticipated to have significant secondary impacts. The project corridor will further connect existing (completed) roadway systems. Existing County infrastructure systems (e.g., water system, reclaimed water system) are located in the immediate vicinity of the project site and will be extended and/or relocated to align with the extension of Waiale Road.

7. **<u>Involves a substantial degradation of environmental quality.</u>**

Construction activities associated with the proposed Waiale Extension project will have temporary effects on ambient air and noise quality. Appropriate Best Management Practices (BMPs) will be employed to mitigate the nuisance effects to air, downstream water quality, and noise during construction.

From a long-term perspective, the project will not result in a substantial degradation of environmental quality. The project will create roadway redundancy in an area that is designated for growth in the Maui Island Plan. As a result, the project is anticipated to reduce vehicle emissions in the area by easing traffic congestion. No adverse impacts to air quality are anticipated and noise mitigation in the form of sound-attenuating walls to be installed by future development adjacent to the site, will be implemented where necessary such that significant adverse impacts to noise conditions are not anticipated.

8. **Be individually limited but cumulatively have substantial adverse effect upon the environment or involves a commitment for larger actions.**

There are no other immediately foreseeable significant roadway improvement projects in the Waikapu area. The proposed action is part of the County of Maui's initiative to upgrade its transportation network to increase capacity, improve traffic circulation, alleviate traffic congestion, and provide a safe corridor complete with pedestrian and bicycle facilities. The project will provide roadway redundancy in an area that is designated for growth and affordable housing. There are no adverse cumulative effects associated with the project.

9. **Have a substantial adverse effect on a rare, threatened, or endangered species, or its habitat.**

A Natural Resources Assessment was completed for the proposed project area. Refer to **Appendix "E-1"**. It found that the vegetation throughout the project area is dominated by non-native species. While three (3) native plant species were identified, none of them are listed as endangered or threatened under either Federal or State endangered species statutes. The project is not expected to have any significant negative impacts on botanical resources in this part of Maui and no recommendations regarding botanical resources were deemed necessary or appropriate.

The survey report noted Waikapu Stream, which traverses the project area, flows from the West Maui Natural Area Reserve into the Kealia Pond National Wildlife Refuge. As such, BMPs were recommended to minimize or avoid impacts to aquatic species that may be located downstream of the project area.

Additionally, though no Blackburn's spinx moths or its host plant were identified in the project, AECOS, Inc. recommended that the project area be surveyed four (4) to six (6) weeks prior to the initiation of construction. The report also recommended BMPs to protect the endangered Hawaiian Petrel or uau (*Pterodroma sandwichensis*), endangered Band-rumped Storm-Petrel or akeake (*Hydrobates castro*), the threatened endemic Newell's Shearwater or ao (*Puffinus newelli*), and the Hawaiian hoary bat, despite those species having not been seen during the survey.

No federally designated Critical Habitat for any species occurs within the project area.

With the implementation of the recommended BMPs, the proposed project is not anticipated to have an adverse effect on any rare, threatened, or endangered species, or its habitat.

10. <u>Have a substantial adverse effect on air or water quality or ambient noise levels.</u>

Construction activities associated with the proposed Waiale Road Extension project will have temporary effects on ambient air and noise quality. Appropriate Best Management Practices (BMPs) will be employed to mitigate the nuisance effects to air, downstream water quality, and noise during construction.

From a long-term perspective, the project is anticipated reduce vehicle emissions in the area by easing traffic congestion. In the context of the region's current air quality, there are no impacts that would adversely affect air quality. Based on the findings of the acoustic study, where reduction of traffic noise levels is needed, mitigation in the form of sound-attenuating walls will be implemented by future development.

Onsite drainage mitigation measures will be implemented to address the increase in stormwater runoff associated with the development of the proposed roadway extension. These improvements will ensure that downstream or adjacent properties are not impacted by project implementation.

11. <u>Have a substantial adverse effect on or be 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.</u>

As indicated by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the area, the majority of the project corridor is within Flood Zone X. However, there are portions of the project site that are within Flood Zones AE and AEF. As such, development of the project will be in accordance with the standards for development set forth by Section 19.62.060, Maui County Code, relating to Flood Hazard Areas. If any portion of the bridge is built within Zones AE or AEF, applicable flood permits will be obtained prior to construction.

The project area is located approximately 11,000 to 12,000 ft. inland of the Maui County Tsunami Evacuation and Extreme Tsunami Evacuation Zones from the northern (Kahului) and southern (Maalaea) shores of Maui. As the proposed action is limited to the extension of an existing roadway and related improvements, it is not anticipated to increase exposure to tsunami risks for the surrounding neighborhoods. The project will provide additional evacuation routes in the case of an emergency.

The project site is located outside the 3.2-foot sea-level rise exposure area. Therefore, impacts related to sea-level rise are not anticipated. As a roadway project, the proposed action is not anticipated to suffer damage by being located in an environmentally sensitive area, nor is it anticipated to have any significant adverse impacts on environmentally sensitive areas.

12. **Have a substantial adverse effect on scenic vistas and viewplanes, during day or night, identified in county or state plans or studies.**

The proposed project is limited to the extension of Waiale Road and related improvements, including a shared use path for pedestrians and cyclists. The roadway and shared use path will be at grade. Vertical features included in the project scope are limited to light fixtures and other amenities associated with the shared use path, landscaping and utility poles. As such, the proposed project will not adversely impact scenic vistas and viewplanes.

13. **Require substantial energy consumption or emit substantial greenhouse gases.**

The air quality and greenhouse gas (GHG) emissions study prepared for the project concluded that the proposed project would result in minor short-term exhaust emissions from stationary and mobile construction equipment. However, these emissions will be mitigated by moving construction equipment to and from the project site during off-peak hours. The project is not anticipated to impact carbon monoxide emissions in the project area. Because it is expected to improve traffic flow and reduce intersection delay, the proposed project is anticipated to provide for a reduction in GHG.

Based on the foregoing findings, in accordance with HRS Chapter 343 and HAR 11-200.1, it is anticipated that the proposed action will result in an Anticipated Finding of No Significant Impact (AFNSI).

LIST OF PERMITS AND APPROVALS

IX

IX. LIST OF PERMITS AND APPROVALS

Federal

1. Compliance with National Environmental Policy Act
2. Compliance with Section 7, Endangered Species Act
3. Compliance with Section 106, National Historic Preservation Act
4. Coastal Zone Management Consistency, as applicable
5. Section 404, Clean Water Act, Nationwide Permit (U.S. Army Corps of Engineers), as applicable

State

1. Hawaii Administrative Rules (HAR) Chapter 11-46, Community Noise Control, as applicable
2. National Pollution Discharge Elimination System (NPDES) Permit, as applicable
3. Hawaii Revised Statutes (HRS) Chapter 6E Review
4. Work to Perform on State Highway
5. Disability and Communication Access Board (DCAB) Review
6. Public Utilities Commission Approval for 69kV Relocation
7. 401 Water Quality Certification, as applicable

County of Maui

1. HRS Chapter 343 Environmental Review
2. Construction Permits (Grading, Building, Plumbing, Electrical)
3. Flood Development Permit, as applicable
4. Roadway Permit

REFERENCES X

X. REFERENCES

CH2MHILL, Federal-Aid Highways 2035 Transportation Plan for the District of Maui, prepared for State of Hawaii, Department of Transportation, Highways Division, July 2014.

City and County of Honolulu, Department of Design and Construction, Final Environmental Assessment Salt Lake Boulevard Widening – Phase 3, June 2019.

Code of Federal Regulations, § 10.13 List of Birds Protected by the Migratory Bird Treaty Act, As amended July 31, 2023.

County of Maui, 2030 General Plan, Countywide Policy Plan, March 2010.

County of Maui, 2030 General Plan, Maui Island Plan, December 2012.

County of Maui, Office of Economic Development, Maui County Data Book 2018.

County of Maui, Office of Economic Development, Maui County Data Book 2020.

County of Maui, Office of Economic Development, Maui County Data Book 2022.

Federal Emergency Management Agency; Flood Insurance Rate Map Community/Panel No. 1500030391E, September 25, 2009.

Foote etal, U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of the Islands of Kauʿai, Oʿahu, Maui, Molokaʿi, and Lānaʿi, State of Hawaiʿi. 1972

Gershman, Brickner & Bratton, Inc., Integrated Solid Waste Management Overview, prepared for County of Maui, Department of Environmental Management, Solid Waste Division, February 17, 2009.

GovInfo, Executive Order 13112 of February 3, 1999 – Invasive Species, February 3, 1999.

Hawaii Department of Health, Clean Air Branch, Hawaii Greenhouse Gas Emissions Report for 2015, Final Report, January 2019.

Hawaii Public Utilities Commission, "Report to the 2019 Legislature on Hawaii's Renewable Portfolio Standards", December 2018.

Hawaii Tourism Authority, https://www.hawaiitourismauthority.org/research/annual-visitor-research-reports/, accessed, September 2020.

IPCC (2007). Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. EXIT Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Maui Metropolitan Planning Organization, Hele Mai Maui, Long Range Transportation Plan 2040, Final Plan, December 2019.

Mid-Atlantic Fishery Management Council, Magnuson-Stevens Fishery Conservation and Management Act, https://www.mafmc.org/magnuson-stevens-act, Accessed April 2024.

National Archives, Executive Order 12898 of February 11, 1994 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, https://www.archives.gov/files/federal-register/executive-orders/pdf/12898.pdf, February 11, 1994.

National Audubon Society, The Migratory Bird Treaty Act, Explained, https://www.audubon.org/news/the-migratory-bird-treaty-act-explained, Accessed April 2024.

National Oceanic and Atmospheric Administration Fisheries, Laws & Polices: Magnuson-Stevens Act, https://www.fisheries.noaa.gov/topic/laws-policies, Accessed April 2024.

Pacific Fishery Management Council, Fact Sheet: The Magnuson-Stevens Act, https://www.pcouncil.org/fact-sheet-the-magnuson-stevens-act/, Modified on October 18, 2021.

State of Hawaii, Department of Agriculture; Agricultural Lands of Importance to the State of Hawaii.

State of Hawaii, Department of Education, https://www.hawaiipublicschools.org/ConnectWithUs/MediaRoom/PressReleases/Pages/2021-22-enrollment-figures-for-public-and-charter-schools.aspx accessed March 2022.

State of Hawaii, Department of Labor and Industrial Relations, https://www.hiwi.org/admin/gsipub/htmlarea/uploads/LFR_LAIS_urate_current.pdf, accessed May 2022.

State of Hawaii, Department of Transportation, Highways Division, Final Environmental Assessment Kawela Bridge and Nanahu Bridge Replacement Project, February 2017.

State of Hawaii, The Hawaii State Plan, https://www/capitol.hawaii.gov/hrscurrent/VOL04_CH021-057/HRS0226/, accessed February 2018.

The Economic Research Organization at the University of Hawaii, Expansion Intact, But Counties Poised for Slow Growth, https://uhero.hawaii.edu/wp-content/uploads/2024/05/24Q2_Forescast/pdf, May 10, 2024.

The Economic Research Organization at the University of Hawaii, Wildfires Deliver Heavy Blow to Maui Economy, https://uhero.hawaii.edu/wp-content/uploads/2023/09/23Q3_Forecast.pdf, September 22, 2023.

U.S. Bureau of Reclamation, Fish and Wildlife Coordination Act, https://www.usbr.gov/power/legislation/fwca.pdf, Accessed April 2024.

U.S. Census Bureau, 2020 Census Summary File 1, accessed March 2022.

U.S. Department of Justice, Environmental and Natural Resources Division, The Clean Water Act, https://www.justice.gov/enrd/water, Updated on January 20, 2024.

U.S. Department of the Interior, Bureau of Ocean Energy Management, Air Quality Act (1967) or The Clean Air Act (CAA), https://www.boem.gov/air-quality-act-1967-or-clean-air-actcaa#:~:text=The%20Clean%20Air%20Act%20(CAA)%20(42%20U.S.C.,public%20health%20and%20the%20environment, Accessed April 2024.

U.S. Environmental Protection Agency, Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks, https://www.epa.gov/children/executive-order-13045-protection-children-environmental-health-risks-and-safety-risks, April 21, 1997.

U.S. Environmental Protection Agency, GHG Reporting Program Data, 2017, https://ghgdata.epa.gov/ghgp/main.do, Accessed August 27, 2019.

U.S. Environmental Protection Agency, History of the Clean Water Act, https://www.epa.gov/lawsregulations/history-clean-water-act, Updated on June 22, 2023.

U.S. Environmental Protection Agency, Map of Sole Source Aquifer Locations, https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=9ebb047ba3ec41ada1877155fe31356b, Accessed April 2024.

U.S. Environmental Protection Agency, Overview of the Drinking Water Sole Source Aquifer Program, https://www.epa.gov/laws-regulations/summary-clean-water-act, Updated on September 7, 2023.

U.S. Environmental Protection Agency, Protection of Wetlands (Executive Order 11990), https://www.epa.gov/cwa-404/protection-wetlands-executive-order-11990, May 24, 1977.

U.S. Environmental Protection Agency, Sole Source Aquifers for Drinking Water, https://www.epa.gov/dwssa#:~:text=Under%20the%20Safe%20Drinking%20Water,and%20establish%20a%20review%20area, Updated on March 12, 2024.

U.S. Environmental Protection Agency, Summary of Clean Water Act, https://www.epa.gov/laws-regulations/summary-clean-water-act, Updated on June 22, 2023.

U.S. Environmental Protection Agency, Summary of Executive Order of 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-addressenvironmental-justice, Updated on July 3, 2023.

U.S. Fish & Wildlife Service, Fish and Wildlife Coordination Act, https://www.fws.gov/la/fishand-wildlife-coordinationact#:~:text=The%20Fish%20and%20Wildlife%20Coordination,on%20fish%20and%20wildlife%20resources, Accessed April 2024.

U.S. Fish & Wildlife Service, Fishery Conservation and Management Act, https://www.fws.gov/law/fishery-conservation-and-management-act, Accessed April 2024.
U.S. Fish & Wildlife Service, Migratory Bird Treaty Act of 1918, Accessed April 2024.

APPENDIX

A

TRAFFIC IMPACT
ANALYSIS REPORT

Waiale Road Extension

Transportation Impact Analysis Report

Prepared for:
Bowers & Kubota

October 2023

SD21-0409

FEHR PEERS

Table of Contents

Appendices

List of Figures

List of Tables

Executive Summary

The County of Maui, Department of Public Works (DPW) is planning to construct the Waiale Road Extension (project). It would extend the existing portion of Waiale Road, which currently terminates at East Waiko Road, approximately 8,600 feet south to Honoapiilani Highway. The planned extension will be designed to support all transportation modes. Currently, there is an existing 80'-0" easement for the roadway extension (Subdivision File No. 3.2278). This will need to be subdivided to create a roadway lot (in favor of County of Maui), which would also need to be widened at each of the intersections to accommodate the proposed roundabouts associated with the project. The right-of-way will provide two through lanes, shoulder bikeways, pedestrian sidewalks, a shared-use path, and grassy swales. It will improve local access and provide travelers with an alternate route in and around the urban areas of Kahului and Wailuku.

For this transportation impact analysis report (TIAR), long-term traffic forecasts were prepared with the project in place and for the No Project Alternative. Traffic operations with both traditional intersection control and modern roundabouts at intersections along the Waiale Road Extension were analyzed to determine the effects of the project.

The following scenarios were evaluated to assess the transportation benefits and impacts associated with the project.

- Existing (2022) Conditions
- Future (2045) No Project Conditions
    - This scenario assumes proposed signalized intersections at Waiale Road/Main Street and Honoapiilani Highway/Waiale Road.
- Future (2045) With Project Conditions
    - This scenario assumes proposed roundabout intersections at Waiale Road/East Waiko Road, Waiale Road/Main Street, Waiale Road/Makai Parkway Street and Honoapiilani Highway/Waiale Road.
    - A second with project scenario was analyzed which assumes proposed signalized intersections at Waiale Road/East Waiko Road and Honoapiilani Highway/Waiale Road, and roundabouts at Waiale Road/Main Street and Waiale Road/Makai Parkway.

A total of twelve (12) study intersections were analyzed in the project study area during the weekday morning (AM) and evening (PM) peak hours for Existing (2022) conditions, Future (2045) No Project conditions, and Future (2045) With Project conditions.

Construction of the proposed Waiale Road Extension would reduce total vehicle miles of travel in Central Maui and reduce delays and improve levels of service at intersections along Honoapiilani Highway. Minor delay increases are projected at some other intersections. The reduction in delays at most of the analyzed intersections in the study area is due to the fact that the proposed project would provide additional roadway capacity in Central Maui. In particular, delay at intersections along Honoapiilani Highway will be reduced relative to No Project conditions because the Waiale Road Extension will provide a new parallel route.

Single-lane roundabouts will operate acceptably at all intersections where roundabouts are proposed. Multi-lane approaches to these roundabouts should be considered at Honoapiilani Highway/Waiale Road and Waiale Road/East Waiko Road if additional land use growth is anticipated beyond what was assumed in this study or to accommodate future roadway widening to further improve projected traffic operations.

If signalized, the Waiale Road/Waiko Road intersection would need one dedicated left-turn lane and one shared through/right-turn lane on all approaches. At Honoapiilani Highway/Waiale Road, the Waiale Road approaches would provide a single shared lane and the Honoapiilani Highway approaches would provide one left-turn lane and one shared through/right-turn lane.

Fehr & Peers recommends roundabout configurations for Waiale Road/Honoapiilani Highway, Waiale Road/Mauka Parkway, Waiale Road/Main Street and Waiale Road/Waiko Road. Not only are they projected to operate acceptably in 2045 with single-lane approaches but, relative to traditional intersection design, roundabouts have the potential to reduce both the number and severity of crashes since they reduce the number of conflict points and act as a traffic calming measure. Maui County and the State of Hawaii will ultimately determine the type of intersection control and roadway configuration at these intersections.

1. Introduction and Methodologies

This report documents a study conducted by Fehr & Peers of the planned extension of Waiale Road between East Waiko Road and Honoapiilani Highway in Waikapu on the island of Maui (both East Waiko Road and West Waiko Road will be referred to as Waiko Road for the remainder of this report). The Waiale Road Extension will be okuikwned, operated, and maintained by the County of Maui. This TIAR was conducted in accordance with the standard procedures and practices of the affected government agencies and addresses the potential impact of the project on all modes of travel. Traffic operations at selected intersections in the study area were analyzed under Existing (2022) conditions, Future (2045) No Project conditions, and Future (2045) With Project conditions, and a multi-modal assessment of mobility along the Waiale Road Extension was conducted. The location of the project and study intersections in the vicinity is shown in **Figure 1**.

1.1 Project Description and Background

The County of Maui, Department of Public Works (DPW) is planning to construct the Waiale Road Extension (project). It would extend the existing portion of Waiale Road, which currently terminates at East Waiko Road, approximately 8,600 feet south to Honoapiilani Highway. The planned extension will be designed to support all transportation modes. Currently, there is an existing 80'-0" easement for the roadway extension (Subdivision File No. 3.2278). This will need to be subdivided to create a roadway lot (in favor of County of Maui), which would also need to be widened at each of the intersections to accommodate the potential for roundabouts associated with the project. The right-of-way will provide two through lanes, shoulder bikeways, pedestrian sidewalks, a shared-use path, and grassy swales. It will improve local access and provide travelers with an alternate route in and around the urban areas of Kahului and Wailuku.

Honoapiilani Highway in Waikapu and Wailuku is expected to experience increased traffic congestion as additional land development occurs. Long-range plans, such as the 2002 Wailuku-Kahului Community Plan and the Hele Mai Maui Long-Range Transportation Plan 2040 (completed in 2019), have included support for the proposed extension of Waiale Road south to Honoapiilani Highway. The ongoing *I Mua Central Maui* long-range plan *(Draft Plan June 2023)* also anticipates construction of the Waiale Road Extension. Studies for individual development projects have assumed that the Waiale Road Extension would be constructed. In 2014, the County completed an Environmental Assessment (EA) for the construction of the Waiale Road Extension and to also make improvements to Waiko Road. The project, which is the subject of this study, is limited to construction of the proposed Waiale Road Extension. Conceptual designs for roundabouts at the four intersections on the project are shown in **Appendix A**.

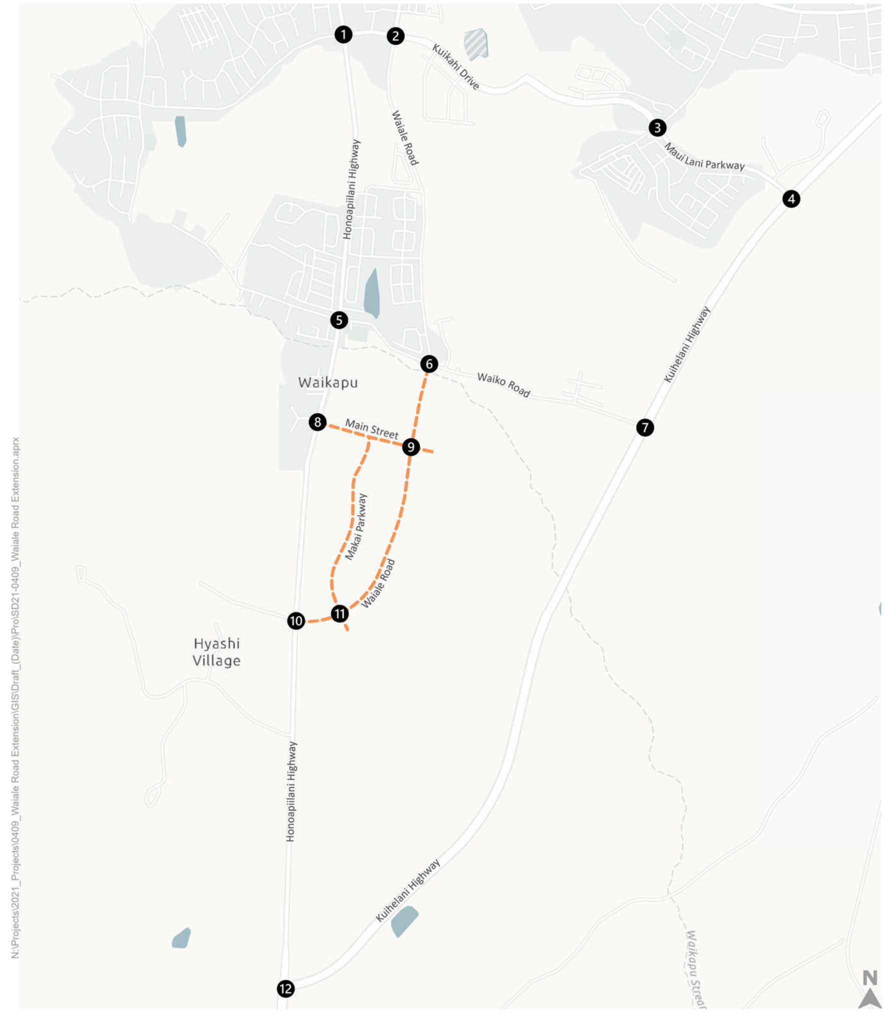
One alternative is fully analyzed in this report. This alternative assumes that the intersections at the northern and southern termini of the project would be constructed as signalized intersections rather than as roundabouts. A conceptual design for the Waiko Road/Waiale Road intersection with signalization is shown in **Appendix A**. Other project alternatives, such as widening Honoapiilani Highway through Central

Maui, were considered but not carried forward for detailed analysis because they would not align with the purpose and need statement for the project. In addition, a Travel Demand Management (TDM) alternative was considered but not studied further because that would involve access management through roadway pricing, providing preferential treatment for high-occupancy vehicles or express buses (which would require widening at intersections and/or an additional lane on the highway), encouraging traditional TDM measures at employment centers, and improving operations of parallel facilities.

1.2 Study Area

The following analysis focused on evaluating the Future Year (2045) transportation operations for the No Project and With Project alternatives. The analyzed intersections are listed below and shown on **Figure 1**:

1. Honoapiilani Highway/Kuikahi Drive
2. Waiale Road/Kuikahi Drive
3. South Kamehameha Avenue/Maui Lani Parkway
4. Kuihelani Highway/Maui Lani Parkway
5. Honoapiilani Highway/Waiko Road
6. Waiale Road/Waiko Road
7. Kuihelani Highway/Waiko Road
8. Honoapiilani Highway/Maui Tropical Plantation Driveway/Main Street
9. Waiale Road/Main Street (future intersection)
10. Honoapiilani Highway/Waiale Road (future intersection)
11. Waiale Road/Makai Parkway (future intersection)
12. Honoapiilani Highway/Kuihelani Highway



Study Intersections
New Roads

Figure 1
Study Area

This study analyzes the changes in traffic operations for the alternatives under typical weekday AM and PM peak hour traffic conditions. The AM and PM peak hours for each intersection are defined as the highest one-hour totals of traffic at each intersection during the commute peak periods from 6:00 AM to 9:00 AM and from 3:00 PM to 6:00 PM on a weekday.

1.3 Study Scenarios

The operations of the study intersections and corridor were evaluated during the weekday AM and PM peak hours for the following study scenarios:

- **Existing (2022) Conditions** – Traffic counts at study intersections were collected in May 2022. Given the ongoing COVID-19 pandemic, traffic counts may not reflect typical levels of peak hour volumes. Counts were compared to historic data for intersections in the study area. Differences at the time of counts were determined to be nominal and no adjustments to counts were made. Counts collected in 2022 are provided in **Appendix B**.
- **Future (2045) No Project Conditions** – Existing peak hour counts were used as the basis for applying the estimated future traffic growth as forecast by the Maui Travel Demand Model through 2045. A list of relevant proposed land use projects was compiled and approved by Maui County to be added to the model. Projects were only added if land use growth in the model's transportation analysis zones (TAZ) did not already account for the projects. A full list of land use projects and transportation projects included in the model is provided in **Appendix C**.

  Adjustments to the model roadway network were also made to better reflect roadway conditions in the study area. Consistent with the approved development plans for the Waikapu County Town project, the model network was modified to reflect the new roadway connections it will construct. While the entire Waiale Road Extension would not be constructed, the southernmost segment would be constructed by the Waikapu Country Town project to provide local access. The following improvements are consistent with the Waikapu Country Town project and assumed for this study scenario:

  - A new four-legged signalized intersection at the existing intersection of Honoapiilani Highway/Maui Tropical Plantation Driveway. While the makai leg is not yet formally named, this study uses the name Main Street which was used in the TIAR for that project.
  - A new three-legged roundabout intersection at Waiale Road/Makai Parkway.
  - A new signalized intersection at Honoapiilani Highway/Waiale Road. This new segment of Waiale Road will run only between Honoapiilani Highway and Waikapu Country Town's Makai Parkway and will not connect to Waiko Road.
- **Future (2045) With Project Conditions** – In addition to the assumed No Build land uses and roadway network changes, this scenario assumes construction of Waiale Road between Waiko Road and Makai Parkway with four (4) roundabout intersections. The Maui Travel Demand Model was used to forecast Future (2045) With Project volumes and determine how volumes would shift given the opening of the proposed roadway extension.

  - **Future (2045) With Project Signal Alternative Conditions** – This scenario assumes Future (2045) With Project land uses, network, and volumes described above but with two of the four intersections along the Waiale Road Extension constructed as signalized intersections rather than as roundabout intersections (at Waiko Road and at Honoapiilani Highway).

1.4 Analysis Methodology

The analysis of roadway operations performed for this study is based on procedures presented in the *Highway Capacity Manual 6th Edition* (HCM 6), published by the Transportation Research Board in 2016. The operations of roadway facilities are described with the term "level of service" (LOS). LOS is a qualitative description of traffic flow based on factors such as speed, travel time, delay, and freedom to maneuver. Six levels are defined, from LOS A, with the least congested operating conditions, to LOS F, with the most congested operating conditions. LOS E represents "at-capacity" operations. Operations are designated as LOS F when volumes exceed capacity, resulting in stop-and-go conditions.

1.4.1 Signalized Intersections

The methodology described in "Chapter 19: Signalized Intersections" of the *HCM 6* was used to prepare the LOS calculations for the signalized study intersections. This LOS method analyzes a signalized intersection's operation based on the average control delay per vehicle. Control delay alone is used to characterize LOS for the entire intersection or for an approach. Control delay includes the initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The average control delay for signalized intersections is calculated using Synchro 11.0 analysis software and is correlated to a LOS designation, as shown in **Table 1**.

Table 1: Signalized Intersection LOS Definitions

Level of Service	Description	Delay in Seconds
A	Progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.	≤ 10.0
B	Progression is good, cycle lengths are short, or both. More vehicles stop than with LOS A, causing higher levels of average delay.	> 10.0 to 20.0
C	Higher congestion may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level, though many still pass through the intersection without stopping.	> 20.0 to 35.0
D	The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.	> 35.0 to 55.0
E	This level is considered by many agencies to be the limit of desirable delay. These high-delay values generally indicate poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences.	> 55.0 to 80.0
F	This level is considered undesirable with oversaturation, which is when arrival flow rates exceed the capacity of the intersection. This level may also occur at high V/C ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be contributing factors to such delay levels.	> 80.0

Source: *Highway Capacity Manual 6th Edition*, Transportation Research Board, 2016.

1.4.2 Stop-Controlled Intersections and Roundabouts

The operation of the unsignalized intersections were evaluated using the methodology contained in "Chapter 20: Two-Way Stop-Controlled Intersections" and "Chapter 22: Roundabouts" of the *HCM 6*. LOS ratings for stop-sign-controlled and roundabout intersections are based on the average control delay expressed in seconds per vehicle. At a two-way- or side-street-stop-controlled (SSSC) intersection, the average control delay is calculated for the minor-street stopped movement and the major-street left turns, not for the overall intersection. For approaches composed of a single lane, the control delay is computed as the average of all movements in that lane. At a roundabout intersection, the average control delay is calculated for the entire intersection. As shown in **Table 2**, LOS F is assigned to the movement if the volume-to-capacity (V/C) ratio for the movement exceeds 1.0, regardless of control delay. The average control delay for unsignalized intersections is calculated using Synchro 11.0 analysis software and is correlated to a LOS designation, as shown in **Table 2**.

Table 2: Unsignalized Intersection LOS Definition

Level of Service (V/C ≤ 1.0)	Level of Service (V/C > 1.0)[1]	Description	Delay in Seconds
A	F	Little or no delay	≤ 10.0
B	F	Short traffic delay	> 10.0 to 15.0
C	F	Average traffic delays	> 15.0 to 25.0
D	F	Long traffic delays	> 25.0 to 35.0
E	F	Very long traffic delays	> 35.0 to 50.0
F	F	Extreme traffic delays with intersection capacity exceeded	> 50.0

Source: *Highway Capacity Manual 6th Edition*, Transportation Research Board, 2016.
Notes:
[1] For approach-based and intersection-wide assessments, such as that used for all-way stop controlled intersections, LOS is defined solely by control delay.

1.4.3 Evaluation of Changes in Roadway Operations

The analysis of 2045 conditions compares No Project operations with conditions when the project has been constructed to determine whether project implementation is expected to degrade or improve operations in the study area. Based on previous studies conducted for the County of Maui and the Hawaii Department of Transportation (HDOT), the minimum desired operating standard for a signalized intersection is LOS D. HDOT and the County acknowledge that some facilities may operate at worse levels during peak hours. When evaluating intersection operations at any location, other factors are considered in the analysis, such as traffic volumes and potential secondary impacts to pedestrian, bicycle, and transit travel.

Undesirable changes in roadway operations are categorized as either project-specific or cumulative. Changes are considered project-specific at a signalized study intersection if a change in traffic operations resulting from the project alone would degrade LOS D or better operations to LOS E or F operations. Changes are considered cumulative at a signalized intersection if a change in traffic operations resulting from the project would exacerbate projected LOS E or F operations and would increase the intersection delay by more than five seconds. Desirable changes to traffic operations can also occur where a study alternative reduces intersection or corridor delay and may improve the LOS grade.

For unsignalized intersections, the criterion for undesirable changes is the same as for signalized intersections, as described above (i.e., LOS D or better to E or F). However, the project is determined to have a significant impact if a change in traffic operations resulting from the project worsens delay at an intersection with a controlled approach operating at an undesirable level (i.e., LOS E or F) and one or more volume-based signal warrants are met. Similar to signalized intersections, a study alternative may result in operations benefits by reducing the intersection or corridor delay, potentially improving the LOS.

HDOT and the County have not approved detailed criteria for significant pedestrian, bicycle, and transit impacts. However, these impacts are generally evaluated based on whether a project would: 1) conflict with existing or planned pedestrian, bicycle, or transit facilities and services; or, 2) create substantive walking, bicycling, or transit use demand without providing adequate and appropriate facilities for non-motorized mobility. Existing facilities for pedestrians, bicycles, and transit users were inventoried to evaluate the quality and scope of facilities and services currently in place. The assessments of planned pedestrian, bicycle, and transit facilities were conducted using information in planning documents, such as the Hele Mai Maui Long-Range Transportation Plan 2040. For these modes, if the project is expected to conflict with existing or planned improvements to pedestrian and bicycle facilities, or if the project is expected to generate a substantial demand that could warrant additional transit service, then the project would be determined to have a project-specific effect on non-motorized modes of transportation.

2. Existing Conditions

This section describes the existing pedestrian, bicycle, and transit facilities, as well as the roadway network located within the project study area. A discussion of the existing intersection LOS operation results is also included in this section.

2.1 Local Roadway Network

The key roadways providing vehicular access in the vicinity of the study corridor are described below:

Waiale Road (Route 3180) is a north-south, undivided collector road that starts as an extension of Lower Main Street and terminates at Waiko Road. The roadway provides two travel lanes (one in each direction) and serves as the only access road for residents of the Waikapu Gardens neighborhood located between Kuikahi Drive and Waiko Road. The posted speed limit is 20 mph. Striped shoulders are used by bicyclists.

Honoapiilani Highway (Route 30) provides regional access between West Maui and Central Maui. The roadway is initially classified as a principal arterial in downtown Wailuku and where it extends south to Waikapu and Maalaea. As the roadway runs through Lahaina in West Maui, it transitions into a minor arterial. Through the regions of Kapalua and Honolua, it is classified as a collector roadway, and ends near Honokohau Bay, where it becomes Kahekili Highway. In the project area, it is an undivided arterial which runs north-south and provides two travel lanes (one in each direction) with separate lanes for left and right turns at several intersections. Parking is not permitted on most segments of Honoapiilani Highway, and sidewalks are not provided. The posted speed limit ranges between 30 to 45 miles per hour (mph). Striped shoulders are used by bicyclists.

Kuihelani Highway (Route 380) is a north-south, four-lane divided arterial with a posted speed limit of 45 or 55 mph in the study area. The roadway begins at its intersection with Puunene Avenue and Dairy Road in Kahului and extends southward until it terminates at its intersection with Honoapiilani Highway north of Maalaea Harbor.

Kuikahi Drive (Route 3210*)* is an east-west, undivided collector road with two travel lanes (one in each direction). West of its intersection with Honoapiilani Highway, Kuikahi Drive passes through the Wailuku Heights Development until it terminates at a cul-de-sac. East of Honoapiilani Highway, Kuikahi Drive provides access to retail and commercial land uses. East of Paa Drive, Kuikahi Drive terminates and transitions to Maui Lani Parkway. The posted speed limit is 20 to 30 mph in the study area.

South Kamehameha Avenue is a north-south collector road with two travel lanes (one in each direction). Kamehameha Avenue begins at its intersection of Hana Highway and extends southward through the Maui Lani development until it terminates just south of Pomaikai Elementary School. In the project study area, sidewalks are provided along most segments and the posted speed limit is 20 mph.

Maui Lani Parkway is an east-west, divided collector road with two travel lanes (one in each direction) and a raised median. West of Amoa Street, Maui Lani Parkway terminates and transitions to Kuikahi Drive. The posted speed limit is 20 mph.

Waiko Road (Route 3185) is an east-west, undivided collector road with two travel lanes (one in each direction). It is signed as "West Waiko Road" west of Honoapiilani Highway and "East Waiko Road" east of Honoapiilani highway. Waiko Road begins in a residential neighborhood west of Honoapiilani Highway and traverses through mostly residential and industrial uses until it terminates at its intersection with Kuihelani Highway. In the project area, Waiko Road is a narrow, gently curving 20 to 30 mph road with no sidewalks provided and limited street parking opportunities.

Tropical Plantation Driveway is an east-west, two lane driveway serving the Maui Tropical Plantation. Upon buildout of Waikapu Country Town, this driveway will be reconstructed as a part of the planned "Main Street" and will have a signalized intersection at Honoapiilani Highway. Main Street will continue further west and connect with the Waiale Road Extension at a roundabout intersection.

Makai Parkway is a planned two-lane roadway running through the planned Waikapu Country Town community east of Honoapiilani Highway. It will intersect both Main Street and the Waiale Road Extension to the south. This was referred to as the north south collector street in the Waikapu Country Town TIAR.

2.2 Existing Transit Facilities and Services

The Maui Bus service, operated by Roberts Hawaii, provides public transit service around the island with thirteen (13) bus routes. Each route operates seven days a week, including holidays.

The Lahaina Islander Route (#20) is the only Maui Bus that serves the Waikapu area, which provides hourly service between the Wharf Cinema Center in Lahaina, Ma'alaea Harbor Village, and Waikapu. It originates and terminates at the Queen Ka'ahumanu Center in Kahului. In the study area, this route operates along Honoapiilani Highway with a bus stop near the intersection of Honoapiilani Highway and Waiko Road.

2.3 Existing Pedestrian Facilities and Activity

Pedestrian facilities consist of sidewalks, crosswalks, and pedestrian signals at signalized intersections. Pedestrian facilities do not currently exist at either end of the planned Waiale Road Extension and existing pedestrian facilities are limited along the major roadways that serve the project study area. For example, sidewalks are not provided on either side of Honoapiilani Highway, Kuihelani Highway, Waiko Road, and most of Waiale Road, while sidewalks are provided only on one side of Kuikahi Drive and most portions of Maui Lani Parkway.

Most signalized intersections along the study corridor have marked crosswalks on intersection legs where pedestrian crossings are allowed. Most of the study intersections serve minimal amounts of pedestrian activity. Maui Lani Parkway/South Kamehameha Avenue had the highest number of pedestrians crossings with over 28 total crossings on all intersection legs during the AM peak hour because of its proximity to Pomaikai Elementary School.

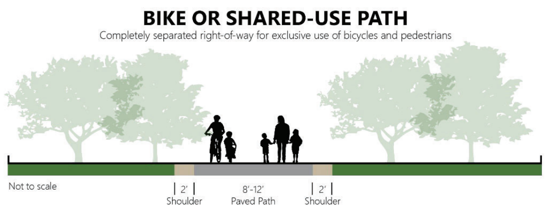
Existing pedestrian facilities at the existing study intersections are described below:

- Intersection 1: Honoapiilani Highway (Highway 30) & Kuikahi Drive
    - Signalized with marked crosswalks and pedestrian signals on three legs
- Intersection 2: Waiale Road & Kuikahi Drive
    - Signalized with marked crosswalks and pedestrian signals on all four legs
- Intersection 3: S. Kamehameha Avenue & Maui Lani Parkway
    - Roundabout with marked crosswalks on all legs
- Intersection 4: Kuihelani Parkway (Highway 380) & Maui Lani Parkway
    - Signalized with no marked crosswalks or pedestrian signals
- Intersection 5: Honoapiilani Highway (Highway 30) & Waiko Road
    - Signalized with marked crosswalks and pedestrian signals on three legs
- Intersection 6: Waiale Road & Waiko Road
    - Side-street stop-controlled with no marked crosswalks on all legs
- Intersection 8: Kuihelani Highway (Highway 380) & Waiko Road
    - Signalized with marked crosswalks and pedestrian signals on two legs
- Intersection 14: Honoapiilani Highway (Highway 30) & Kuihelani Highway (Highway 380)
    - Signalized with no marked crosswalks or pedestrian signals

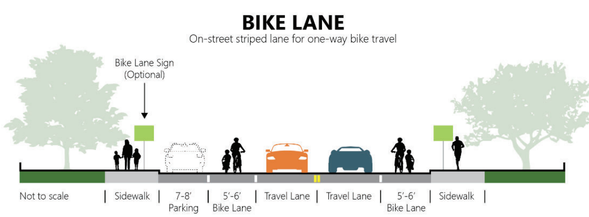
2.4 Existing Bicycle Facilities and Activity

Bicycle facilities generally consist of four types of facilities, which are outlined below:

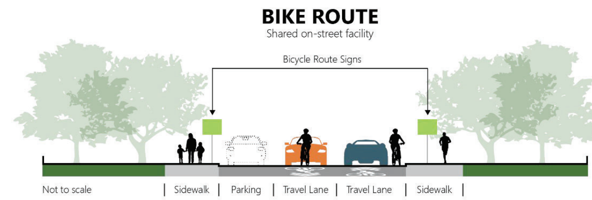
- *Bike or Shared Use Paths* provide a separate right-of-way and are designated for the exclusive use of bicycles and pedestrians (or exclusively bicycles) with vehicle and pedestrian cross-flow minimized. Generally, the minimum pavement width for a two-directional bike or multi-use path is eight (8) feet plus graded shoulders, but a ten (10) foot or wider path is desirable.



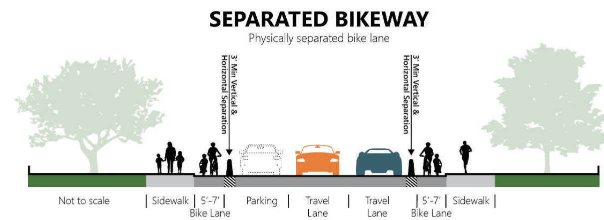
- *Bike Lanes* provide a restricted right-of-way and are designated for the use of bicycles with a striped lane on a street or highway. Bicycle lanes are generally five (5) feet wide. Adjacent vehicle parking and vehicle/pedestrian cross-flow are permitted.



- *Bike Route or Signed Shared Roadways* provide for a right-of-way designated by signs or shared lane pavement markings, or "sharrows," for shared use with pedestrians or motor vehicles.



- *Separated Bikeways or Cycle Tracks* provide a restricted right-of-way with physical separation and are designated for the use of bicycles in or directly adjacent to a roadway with a raised barrier, such as curbs or bollards. Separated bikeways are typically at least five (5) feet wide with a minimum three (3) foot minimum horizontal separation from an adjacent vehicle parking or travel lane [although a two (2) foot median could be used next to a travel lane with lower vehicle speeds]. Adjacent vehicle parking is permitted and vehicle/pedestrian cross-flow is restricted to selected locations (e.g., driveways) indicated by breaks in the barrier and buffer.



In the project study area, there are limited existing bicycle facilities. Bicycle lanes exist along some north and south segments of Honoapiilani Highway and Waiale Road. Roadway shoulders are wide enough on some segments to act as de facto bicycle lanes. Maui Lani Parkway provides a bicycle lane between Kamehameha Avenue and Kuihelani Highway.

Most of the study intersections serve minimal amounts of bicycle activity. Maui Lani Parkway/South Kamehameha Avenue had the highest number of bicyclists with 21 total crossings on all intersection legs during the AM peak hour because of its proximity to Pomaikai Elementary School.

2.5 Crash History

HDOT provides a summary of fatal crashes across the state for 2012 through 2021 on their online Fatal Crash Dashboard and webmap. In the study area, only two fatal crashes were recorded, both at the Waiko Road/Kuihelani Highway intersection in 2016 and 2017. Both had drugs or alcohol as the primary contributing factor to the crash.

2.6 Existing Traffic Volumes, Lane Configurations, and Operations

Existing intersection turning movement counts and lane configurations are shown on **Figure 2**. This data was used to quantify traffic operations at each of the study intersections. **Table 3** shows current operations at the study intersections. Detailed LOS worksheets showing input data and calculations for each turning movement and for the intersection as a whole are included in **Appendix D**. Traffic count data sheets are provided in **Appendix B**.

All intersections operate at acceptable levels of service (LOS D or better), with the exception of one location:

- Intersection 8: Honoapiilani Highway/Maui Tropical Plantation Driveway (LOS F in the PM peak hour). This intersection is currently controlled by a stop sign on the minor (makai-bound) approach. During the PM peak period, side street delay exceeds 50 seconds per vehicle and the intersection operates at LOS F during the PM peak hour.

There are limitations to the HCM 6th Edition analysis approach and Synchro 11 software that do not capture some aspects of observed congestion in the study area. Southbound delays at Waiale Road/Kuikahi Drive were observed to be higher than reported. The analysis methodology does not capture the effects of queue spillback from turn pockets, in this case the southbound left turn pocket, which may exacerbate average vehicle delays beyond what is reported.

Table 3: Existing (2022) Intersection Levels of Service

	Intersection	Control	Peak Hour	Intersection Delay (sec/veh)[1]	Intersection LOS[1]
1	Honoapiilani Highway/Kuikahi Drive	Signal	AM	21.8	C
			PM	19.5	B
2	Waiale Road/Kuikahi Drive	Signal	AM	25.7	C
			PM	23.9	C
3	South Kamehameha Avenue/Maui Lani Parkway	Roundabout	AM	30.0	D
			PM	21.8	C
4	Kuihelani Highway/Maui Lani Parkway	Signal	AM	18.3	B
			PM	23.5	C
5	Honoapiilani Highway/Waiko Road	Signal	AM	11.0	B
			PM	23.6	C
6	Waiale Road/Waiko Road	Side Street Stop Controlled	AM	16.0	C
			PM	17.9	C
7	Kuihelani Highway/Waiko Road	Signal	AM	13.5	B
			PM	10.8	B
8	Honoapiilani Highway/Maui Tropical Plantation/Main Street	Side Street Stop Controlled	AM	33.2	D
			PM	**52.5**	**F**
9	Waiale Road/Main Street	Future Intersection	AM		
			PM		
10	Honoapiilani Highway/Waiale Road	Future Intersection	AM		
			PM		
11	Waiale Road/Makai Parkway	Future Intersection	AM		
			PM		
12	Honoapiilani Highway/Kuihelani Highway	Signal	AM	15.1	B
			PM	17.4	B

Source: Fehr & Peers, 2023 using Synchro 11.
Notes:
[1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.

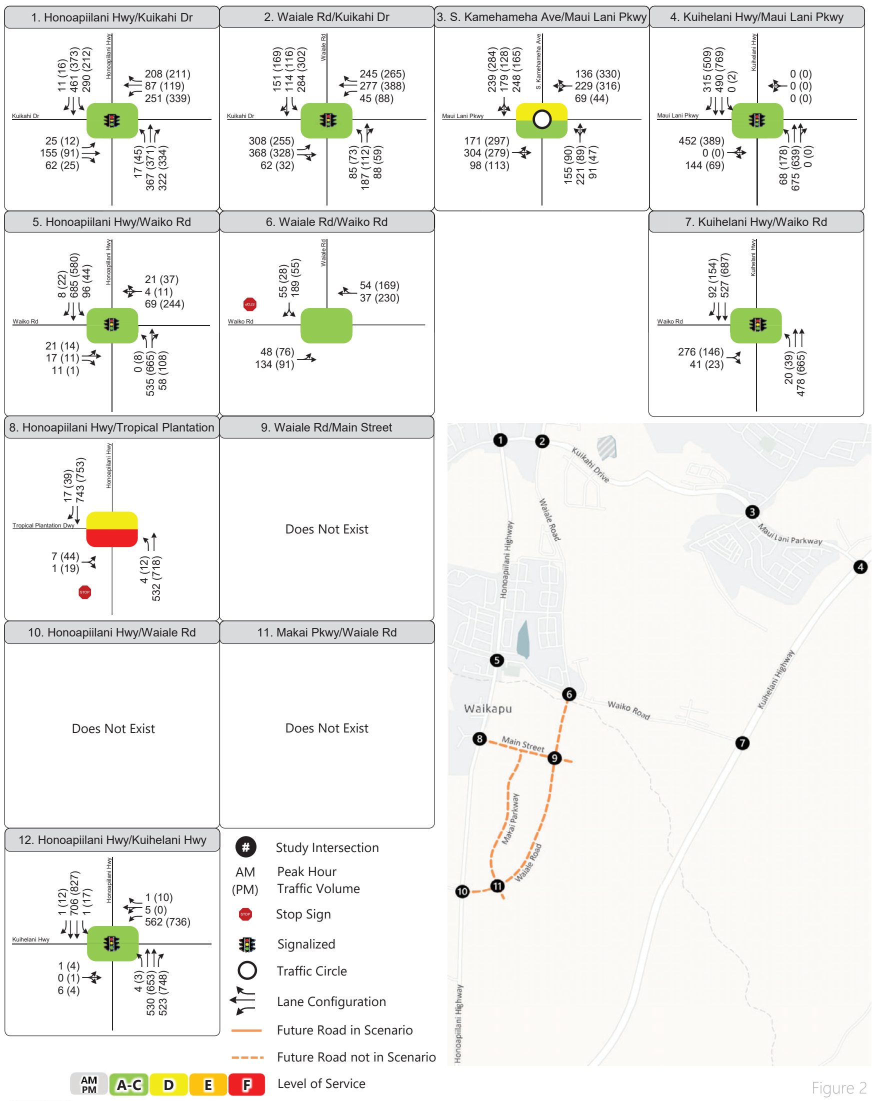


Figure 2

Peak Hour Data and Operations - Existing (2022) Conditions

3. Future (2045) No Project Conditions

To evaluate the potential effects of the planned project, it was necessary to first develop estimates of future traffic conditions in the area without any project improvements. Future (2045) No Project traffic conditions reflect traffic increases based on regional growth and development near the study site by the time the project would be expected to be fully implemented, serving both existing and planned development.

No roadway network changes were assumed in the study area compared to existing conditions except for two locations:

- The Honoapiilani Highway/Maui Tropical Plantation Driveway/Main Street intersection will be signalized and a fourth leg will be added as part of the construction of the Waikapu Country Town project.
- Honoapiilani Highway/Waiale Road is a new intersection that will be constructed with the Waikapu Country Town project. This portion of Waiale Road would not connect to the northern section of Waiale Road and would only serve as the southern access to Waikapu Country Town and future development on County land to the east, as shown in Figure 3. In this scenario, the intersection would be signalized. The Waikapu Country Town project EIS documents were referenced to obtain the anticipated lane configurations and intersection control for this intersection without the full extension of Waiale Road in place.

3.1 Future (2045) No Project Traffic Projections

Growth in traffic was forecast using the Maui Travel Demand Model. Fehr & Peers coordinated with County of Maui staff to determine specific projects to add to the future year model near the project to better reflect expected land use conditions near the project site upon completion of the project. This list, including project size, is shown in **Appendix C**. Notable projects assumed include Maui Lani, Waikapu Affordable Housing, Valley Isle Fellowship, and Emmanuel Lutheran Campus. Outside of the vicinity of the project in the Wailuku-Kahului area, all growth assumptions in the model between its base year (2019) and future year (2045) were held constant. The model used a blanket growth rate for land uses between the base and future year based on Hawaii Department of Business, Economic Development and Tourism (DBEDT) Data.

Traffic volume outputs from the base and future year models were used to determine growth in volumes on roadway links and at each intersection. Analysis of future signalized Intersection operations assumed optimization of cycle lengths and traffic signal phasing splits.

3.2 Future (2045) No Project Intersection Level of Service

Figure 3 illustrates the forecasted peak hour traffic volumes and lane configurations for Future (2045) No Project Traffic Conditions.

Levels of service (LOS) calculations were conducted to evaluate the operating levels of the study intersections under Future (2045) No Project conditions with the forecasted growth in traffic. The results of the LOS analysis for the study intersections under this scenario are presented in **Table 4.** The corresponding LOS calculation sheets are included in **Appendix D**.

Five (5) of the 12 study intersections are projected to continue operating at acceptable levels of service (LOS D or better). Seven (7) intersections are projected to operate at levels of service E or F in the Future (2045) No Project scenario:

- Intersection 1: Honoapiilani Highway/Kuikahi Drive (LOS F in the AM peak hour, LOS E in the PM peak hour).
- Intersection 2: Waiale Road/Kuikahi Drive (LOS F in the AM and PM peak hours).
- Intersection 3: South Kamehameha Avenue/Maui Lani Parkway (LOS F in the AM peak hour, LOS E in the PM peak hour).
- Intersection 4: Honoapiilani Highway/Kuikahi Drive (LOS F in the AM and PM peak hours).
- Intersection 5: Honoapiilani Highway/Waiko Road (LOS F in the AM and PM peak hours).
- Intersection 6: Waiale Road/Waiko Road (LOS F in the AM and PM peak hours).
- Intersection 8: Honoapiilani Highway/Maui Tropical Plantation Driveway (LOS E in the AM peak hour).

The changes in operations from Existing (2022) Conditions are the result of regional and local land use growth. Large increases in delay are expected due to increases in peak hour traffic volumes with minor changes at certain study intersections but no substantial physical capacity improvements are planned across the study area. Some peak hour volumes, in particular along Honoapiilani Highway and Waiko Road, are expected to more than double over the 23-year study period. Seven (7) of the eleven (11) study intersections that exist in this scenario are projected to operate at LOS E or F in one or both peak hours.

Similar to what is noted in the discussion of Existing Conditions, southbound delays at Waiale Road/Kuikahi Drive may be higher in the field than shown in the level of service worksheet in Appendix D. The southbound left-turn movement is projected to experience a delay in excess of 120 seconds, which is expected to continue to impede the ability of other southbound traffic to pass through the intersection.

Table 4: Future (2045) No Project Intersection Levels of Service

	Intersection	2045 Intersection Control	Peak Hour	Existing Conditions		Future No Project		Change
				Intersection Delay (sec/veh)[1]	Intersection LOS[1]	Intersection Delay (sec/veh)[1]	Intersection LOS[1]	
1	Honoapiilani Highway/Kuikahi Drive	Signal	AM	21.8	C	**84.7**	**F**	62.9
			PM	19.5	B	**70.6**	**E**	51.1
2	Waiale Road/Kuikahi Drive	Signal	AM	25.7	C	**94.8**	**F**	69.1
			PM	23.9	C	**83.2**	**F**	59.3
3	South Kamehameha Avenue/Maui Lani Parkway	Roundabout	AM	30.0	D	**>120**[2]	**F**	>120.0
			PM	21.8	C	**>120**[2]	**F**	>120.0
4	Kuihelani Highway/Maui Lani Parkway	Signal	AM	18.3	B	50.4	D	32.1
			PM	23.5	C	**64.5**	**E**	41.0
5	Honoapiilani Highway/Waiko Road	Signal	AM	11.0	B	**118.2**	**F**	107.2
			PM	23.6	C	**>120**[2]	**F**	>120
6	Waiale Road/Waiko Road	Side Street Stop Controlled	AM	16.0	C	**>120**[2]	**F**	>120.0
			PM	17.9	C	**>120**[2]	**F**	>120.0
7	Kuihelani Highway/Waiko Road	Signal	AM	13.5	B	32.4	C	18.9
			PM	10.8	B	27.1	C	16.3
8	Honoapiilani Highway /Main Street	Signal[3]	AM	33.2	D	**62.5**	**E**	29.3
			PM	**52.5**	**F**	52.8	D	0.3
9	Waiale Road/Main Street	NA	AM	-	-	-	-	-
			PM	-	-	-	-	-
10	Honoapiilani Highway/Waiale Road	Signal	AM	-	-	20.6	C	-
			PM	-	-	18.0	B	-
11	Waiale Road/Makai Parkway	Roundabout	AM	-	-	3.8	A	-
			PM	-	-	3.9	A	-
12	Honoapiilani Highway/Kuihelani Highway	Signal	AM	15.1	B	23.6	C	8.5
			PM	17.4	B	29.8	C	12.4

Source: Fehr & Peers, 2023 using Synchro 11.
Notes:
[1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.
[2] Average delay per vehicle exceeds 120 seconds.
[3] Future No Project intersection control differs from Existing intersection control

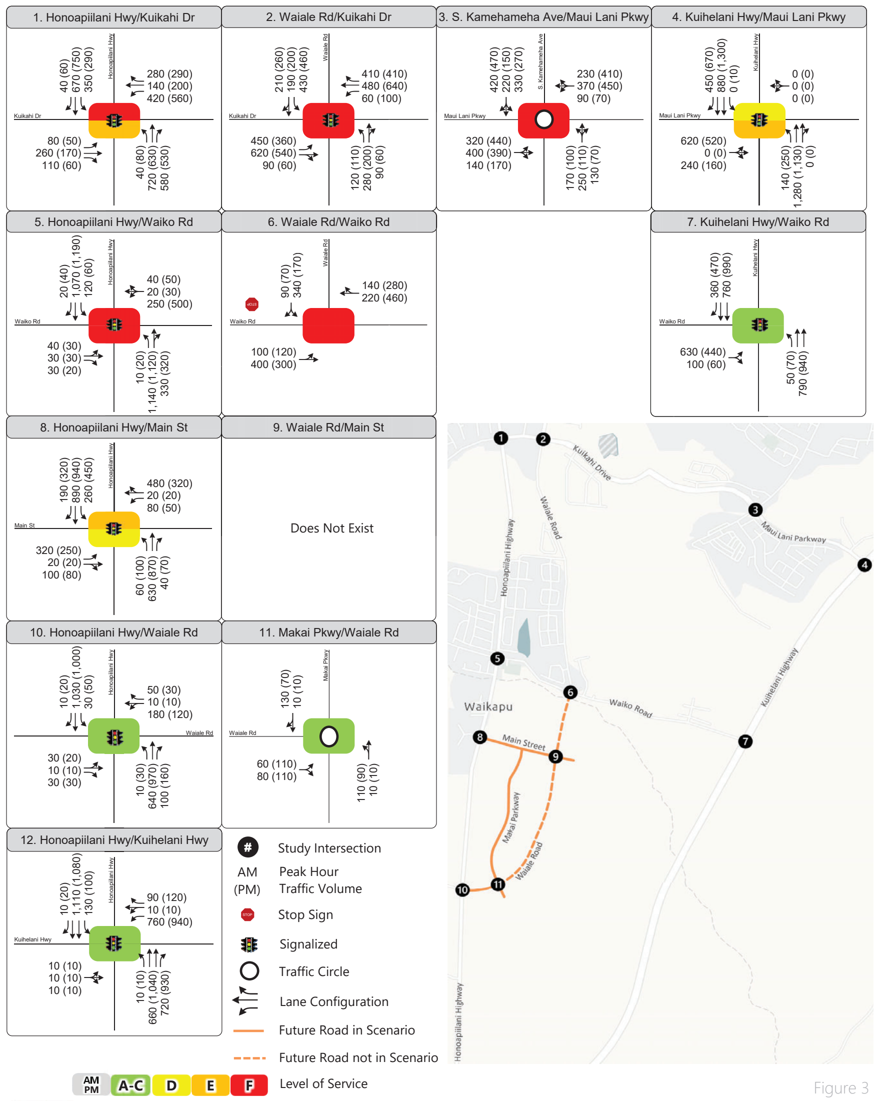


Figure 3

Peak Hour Data and Operations - Future (2045) No Project

4. Future (2045) With Project Conditions

This section describes the analysis conditions in 2045 with the extension of Waiale Road between Waiko Road and Honoapiilani Highway complete as well as how this network addition changes transportation operations compared to Future (2045) No Project conditions. The roadway network is the same network assumed under Future (2045) No Project conditions except for the addition of the Waiale Road Extension (including the Waiale Road/Main Street roundabout intersection), construction of four-leg roundabouts at Waiko Road/Waiale Road and Honoapiilani Highway/Waiale Road and the addition of the fourth leg of the Waiale Road/Makai Parkway intersection. All roundabout intersections were assumed to have one-lane approaches.

4.1 Future (2045) With Project Traffic Projections

Shifts in traffic compared to Future (2045) No Project conditions were forecast using the Maui Travel Demand Model. The forecast land use growth in this scenario includes all of the anticipated land use growth in the area through 2045, similar to the No Project scenario. Traffic volume outputs from the future year model scenarios with and without the project were used to determine shifts in volumes on roadway links and at each intersection.

Figure 4 illustrates the forecasted peak hour traffic volumes and lane configurations for Future (2045) With Project Traffic Conditions.

4.1.1 Vehicle Miles Traveled

The Maui Travel Demand model outputs were used to calculate daily vehicle miles traveled (VMT) on roadways within three (3) miles of the Waiale Road Extension project site under Future (2045) No Project and Future (2045) With Project conditions. VMT decreases by 0.7%, indicating that the Waiale Road Extension provides a more direct route for vehicle trips:

- Future (2045) No Project VMT: 542,500
- Future (2045) With Project VMT: 534,200
- Reduction in VMT associated with Waiale Road Extension: 8,300 (1.5%)

Benefits associated with reductions in VMT included reduced GHG emissions, improved air quality, and shorter travel times.

4.1.2 Average Daily Traffic

Average Daily Traffic (ADT) was forecast along the Waiale Road Extension under Future (2045) With Project Conditions:

- Waiale Road between Waiko Road and Main Street: 13,500 ADT
- Waiale Road between Main Street and Makai Parkway: 3,700 ADT
- Waiale Road between Makai Parkway and Honoapiilani Highway: 4,200 ADT

The northern portion of the extension serves the highest number of trips. It provides the quickest path for much Waikapu Country Town and the adjacent County development towards both Wailuku and Kahului.

The middle portion of the extension has the lowest ADT, indicating that the Waiale Road extension is utilized more by future residents living along the corridor than by pass-through trips.

4.2 Future (2045) With Project Intersection Level of Service

Level of service (LOS) calculations were conducted to evaluate the operating levels of the study intersections under Future (2045) With Project conditions. The results of the LOS analysis for the study intersections under this scenario are presented in **Table 5.** The corresponding LOS calculation sheets are included in **Appendix D**. All roundabout intersections are projected to operate acceptably (LOS D or better) with only a single lane on each approach.

Eight (8) of the 12 study intersections are projected to operate at acceptable levels of service (LOS D or better) following construction of the Waiale Road Extension as proposed. Four (4) intersections are projected to operate at levels of service E or F in the Future (2045) No Project scenario:

- Intersection 1: Honoapiilani Highway/Kuikahi Drive (LOS E in the AM peak hour).
- Intersection 2: Waiale Road/Kuikahi Drive (LOS F in the AM and PM peak hours).
- Intersection 3: South Kamehameha Avenue/Maui Lani Parkway (LOS F in the AM and PM peak hours).
- Intersection 4: Honoapiilani Highway/Kuikahi Drive (LOS E in the PM peak hour).

Large decreases in delay are expected along Honoapiilani Highway due traffic shifting to Waiale Road. Trips to and from Waikapu Country Town and the County parcels along Waiale Road account for the largest changes in intersection volumes. The Waiale Road Extension provides these neighborhoods with additional routes in and out, in particular those trips to/from Kuihelani Highway. Trips to and from these neighborhoods are projected to represent the majority of trips using the Waiale Road Extension. While the project does increase delay at some intersections, the only substantial increase in delay is at Waiale Road/Kuikahi Drive, where delays are projected to increase by nine (9) seconds per vehicle in the AM peak hour and seven (7) seconds per vehicle in the PM peak hour, respectively. Operations at this intersection may be worse than calculated due to queue spillback from the southbound left-turn lane. As part of a separate effort, Maui County is preparing a comprehensive study of transportation projects and programs across the entire Central Maui area for all travel modes, including construction of the Waiale Road Extension. Additional near- and long-term strategies in *I Mua Central Maui (Draft Plan June 2023)* include complete streets and transit-supportive projects (e.g., transit hubs) that will minimize future vehicle demand and help to reduce traffic delays within the Waiale Road corridor and at this affected intersection.

Table 5: Future (2045) With Project Intersection Levels of Service

	Intersection	Control	Peak Hour	Future No Project		Future With Project		Change
				Intersection Delay (sec/veh)[1]	Intersection LOS[1]	Intersection Delay (sec/veh)[1]	Intersection LOS[1]	
1	Honoapiilani Highway/Kuikahi Drive	Signal	AM	**84.7**	**F**	**73.2**	**E**	-11.5
			PM	**70.6**	**E**	50.6	D	-20.0
2	Waiale Road/Kuikahi Drive	Signal	AM	**94.8**	**F**	**104.0**	**F**	9.2
			PM	**83.2**	**F**	**90.0**	**F**	6.8
3	South Kamehameha Avenue/Maui Lani Parkway	Roundabout	AM	**>120**[2]	**F**	**>120**[2]	**F**	<5.0
			PM	**>120**[2]	**F**	**>120**[2]	**F**	<5.0
4	Kuihelani Highway/Maui Lani Parkway	Signal	AM	50.4	D	46.3	D	-4.1
			PM	**64.5**	**E**	**66.6**	**E**	2.1
5	Honoapiilani Highway/Waiko Road	Signal	AM	**118.2**	**F**	21.4	C	-- [4]
			PM	**>120**[2]	**F**	52.4	D	-- [4]
6	Waiale Road/Waiko Road	Roundabout[3]	AM	**>120**[2]	**F**	27.8	D	-- [4]
			PM	**>120**[2]	**F**	22.9	C	-- [4]
7	Kuihelani Highway/Waiko Road	Signal	AM	32.4	C	51.5	D	19.1
			PM	27.1	C	31.8	C	4.7
8	Honoapiilani Highway /Main Street	Signal	AM	62.5	E	25.5	C	-37.0
			PM	52.8	D	28.6	C	-24.2
9	Waiale Road/Main Street	Roundabout	AM	-	-	7.6	A	-
			PM	-	-	7.6	A	-
10	Honoapiilani Highway/Waiale Road	Roundabout[3]	AM	20.6	C	30.9	D	10.3
			PM	18.0	B	29.5	D	11.5
11	Waiale Road/Makai Parkway	Roundabout	AM	3.8	A	4.0	A	0.2
			PM	3.9	A	4.2	A	0.3
12	Honoapiilani Highway/Kuihelani Highway	Signal	AM	23.6	C	22.3	C	-1.3
			PM	29.8	C	25.5	C	-4.3

Source: Fehr & Peers, 2023 using Synchro 11.
Notes: [1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.
[2] Average delay per vehicle exceeds 120 seconds.
[3] Future With Project intersection control differs from Future No Project intersection control.
[4] With the proposed extension of Waiale Road overall delay at this intersection projected to substantially decrease.

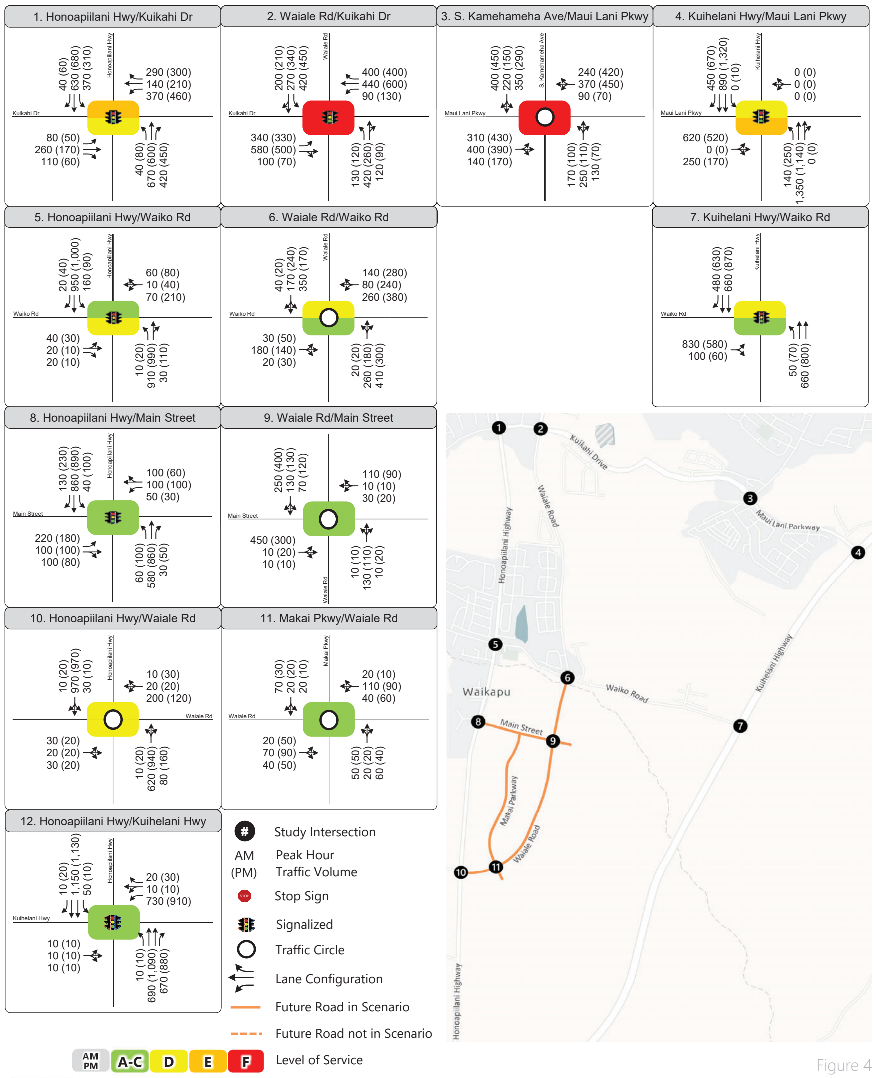


Figure 4

Peak Hour Data and Operations - Future (2045) With Project

4.2.1 Future Considerations

All roundabout intersections are projected to operate acceptably (LOS D or better) with only a single lane on each approach.

Operations beyond 2045 are outside the scope of this project. The following assessment of operations beyond 2045 is provided for information purposes only and may be considered by Maui County and the State of Hawaii as the design of these intersections proceeds. At the Waiale Road/Waiko Road intersection and at the Honoapiilani Highway/Waiale Road intersection, the addition of relatively few additional peak hour trips (e.g. 50 trips on the heaviest approach) beyond 2045 would cause the operations to decline to LOS E.

- To allow for potential future expansion of the roundabout at this location, construction of the second northbound lane at Waiale Road & Waiko Road should be considered as the design of these intersections proceeds.
- To allow for potential future expansion of Honoapiilani Highway, right-of-way to construct a second lane on both the northbound and southbound approaches at Honoapiilani Highway & Waiale Road should be considered as the design of these intersections proceeds.

4.3 Future (2045) With Project Signal Alternative

An alternative Future (2045) With Project scenario assumes the same peak hour traffic volumes and network/lane configurations assumed under Future (2045) With Project conditions except it assumes that the Waiko Road/Waiale Road and Waiale Road/Honoapiilani Highway intersections are signalized.

The results of the LOS analysis for the signal configuration at Waiale Road/Waiko Road and Honoapiilani Highway/Waiale Road are presented in **Table 6.** The LOS calculation sheets are included in **Appendix D**.

To achieve LOS D or better operations at Waiale Road/Waiko Road, the signalized intersection configuration requires a dedicated left-turn lane and shared through-right-turn lane on all approaches. At Honoapiilani Highway/Waiale Road, single-lane approaches are needed on Waiale Road, and a dedicated left turn lane and a shared through-right turn lane are needed on the north and south approaches.

Table 6: Future (2045) With Project Signal Alternative Intersection Levels of Service

Intersection		Control	Peak Hour	Intersection Delay (sec/veh)[1]	Intersection LOS[1]
6	Waiale Road/Waiko Road	Side Street Stop Controlled	AM	43.8	D
			PM	24.7	C
10	Honoapiilani Highway/Waiale Road	Future Intersection	AM	12.2	B
			PM	11.6	B

Source: Fehr & Peers, 2023 using Synchro 11.
Notes:
[1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.

4.4 Future (2045) With Project Multimodal Analysis

Consistent with State of Hawaii and County of Maui policies on Complete Streets, the Waiale Road Extension, as well as new roadways connecting to it as a part of the Waikapu Country Town development, are planned to form a balanced multi-modal network designed to provide mobility choices and to meet the needs of the community and all roadway users.

Approximately eight (8) miles of hiking, biking and walking trails are planned to be incorporated into the Waikapu Country Town project site. A multi-use path is planned along the entire length of the Waiale Road Extension, including on a bridge over Waikapu Stream at the northern end. The entire existing length of Waiale Road is designated as the Waiale Road Complete Street project in the Hele Mai Maui Long-Range Transportation Plan 2040, and these improvements along the Waiale Road Extension will connect to any future improvements to the north to support a more complete multi-modal corridor and network.

The Waiale Road Extension will also emphasize traffic calming and streetscape beautification. The use of roundabouts at intersections, landscape planting strips to buffer pedestrians from traffic, and linear greenways will serve to beautify the corridor while providing motivation for residents to walk and bike more.

Under existing conditions, the Honoapiilani Highway & Waiko Road bus stop is the only bus stop located in the project vicinity. While the Maui Bus has no immediate plans to expand service in this area, the Waiale Road Extension could facilitate additional transit routes as land is developed alongside it. Right-of-way is available for enhancements and amenities (i.e., benches or covered shelter) to be installed at any new bus stops along the extension to support future transit riders in this area.

While no fatal collisions were noted in the immediate vicinity of the project between 2012 and 2021, the reduction in congestion in the study area will reduce the likelihood of severe crashes. This would also benefit transit along Honoapiilani Highway by reducing travel time and increasing reliability.

Roundabouts have the potential to reduce both the number and severity of crashes since they reduce the number of conflict points and act as a traffic calming measure. Roundabouts slow traffic speeds through the intersection, reducing the potential for fatal collisions. For pedestrians and bicyclists, design treatments such as rectangular rapid flashing beacons (RRFBs) or pedestrian hybrid beacons (PHBs) would enhance pedestrian and bicycle safety at the roundabout crossings, particularly if any multi-lane approaches are implemented.

5. Conclusions

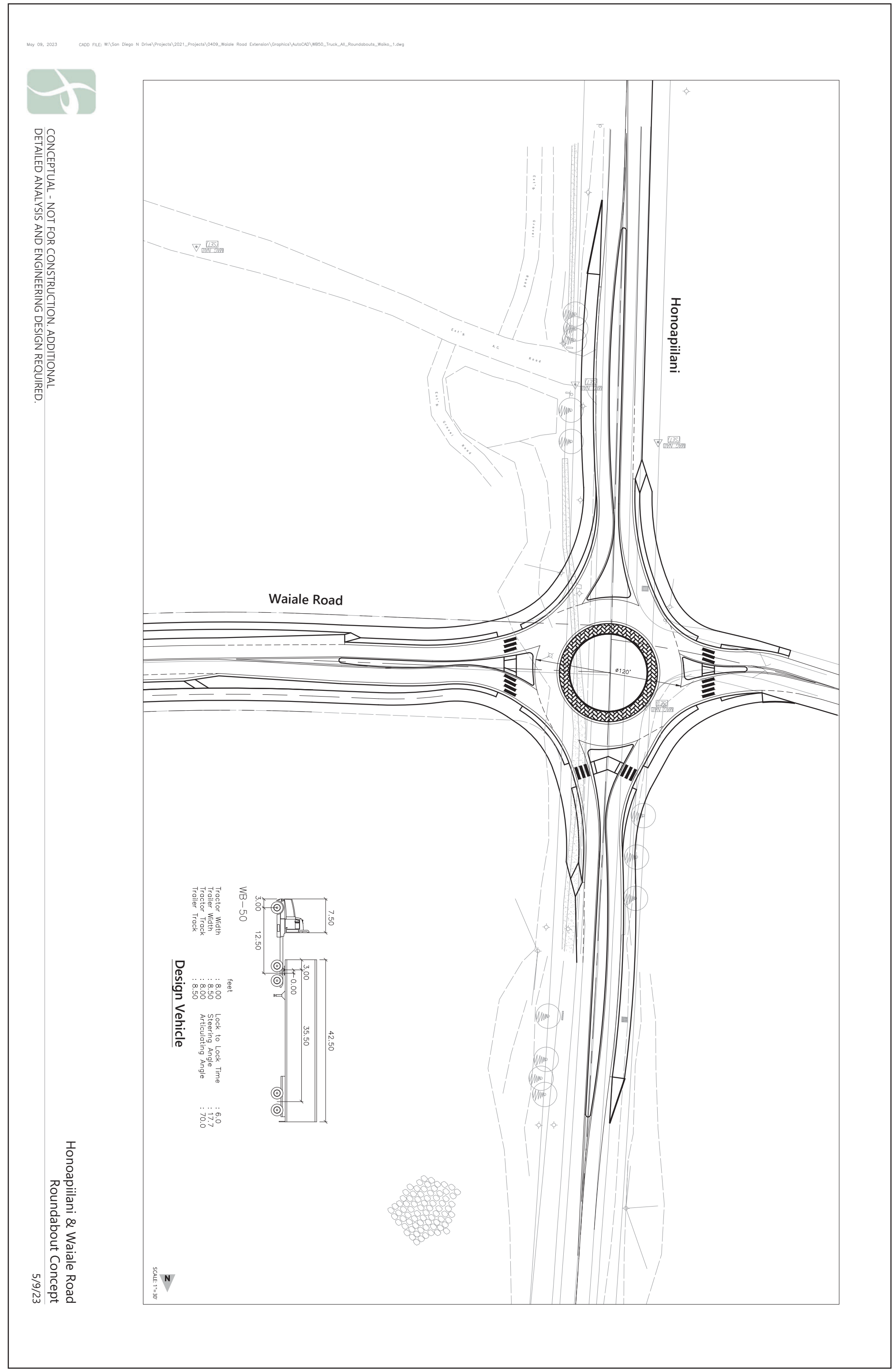
Construction of the proposed Waiale Road Extension would reduce total vehicle miles of travel in Central Maui and reduce delays at intersections along Honoapiilani Highway. Intersection delays would be reduced or only minimally increased most intersections in the project area. An exception is the intersection of Waiale Road/Kuikahi Drive, where the projected shift in traffic volumes would exacerbate projected LOS F conditions.

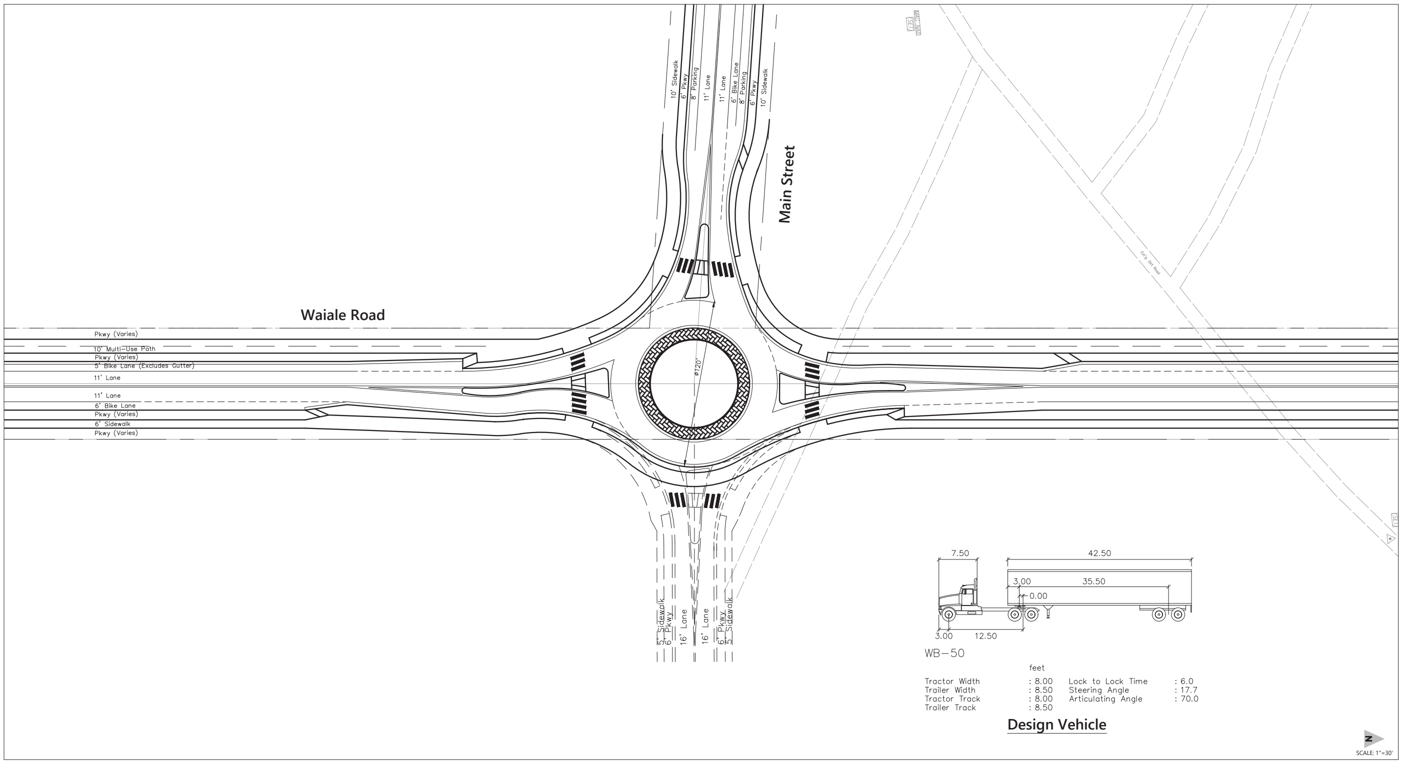
New intersections along the Waiale Road Extension will operate acceptably in 2045 as either roundabouts or signalized intersections. Roundabout configurations would only require one approach lane on all legs and one circulating lane to provide the desired level of service (LOS D). If signalized, the Waiale Road/Waiko Road intersection would need one dedicated left-turn lane and one shared through/right-turn lane on all approaches. At Honoapiilani Highway/Waiale Road, the Waiale Road approaches would provide a single shared lane and the Honoapiilani Highway approaches would provide one left-turn lane and one shared through/right-turn lane.

Fehr & Peers recommends roundabout configurations for Waiale Road/Honoapiilani Highway, Waiale Road/Mauka Parkway, Waiale Road/Main Street and Waiale Road/Waiko Road. Not only are they projected to operate acceptably in 2045 with single-lane approaches but, relative to traditional intersection design, roundabouts have the potential to reduce both the number and severity of crashes since they reduce the number of conflict points and act as a traffic calming measure. Maui County and the State of Hawaii will ultimately determine the type of intersection control and roadway configuration at these intersections.

Appendix A: Conceptual Design of Intersections on the Waiale Road Extension

FEHR PEERS

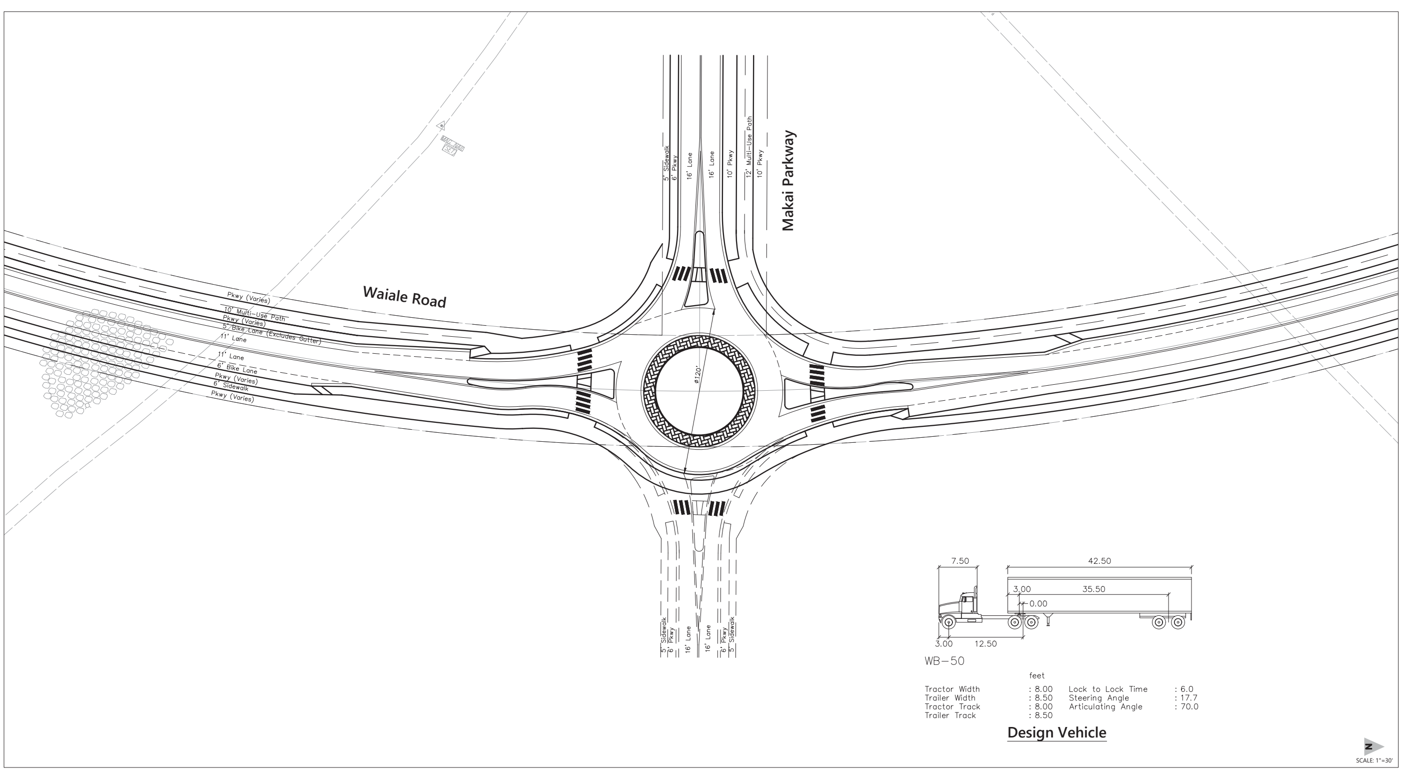




CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Waiale Road & Main Street
Roundabout Concept

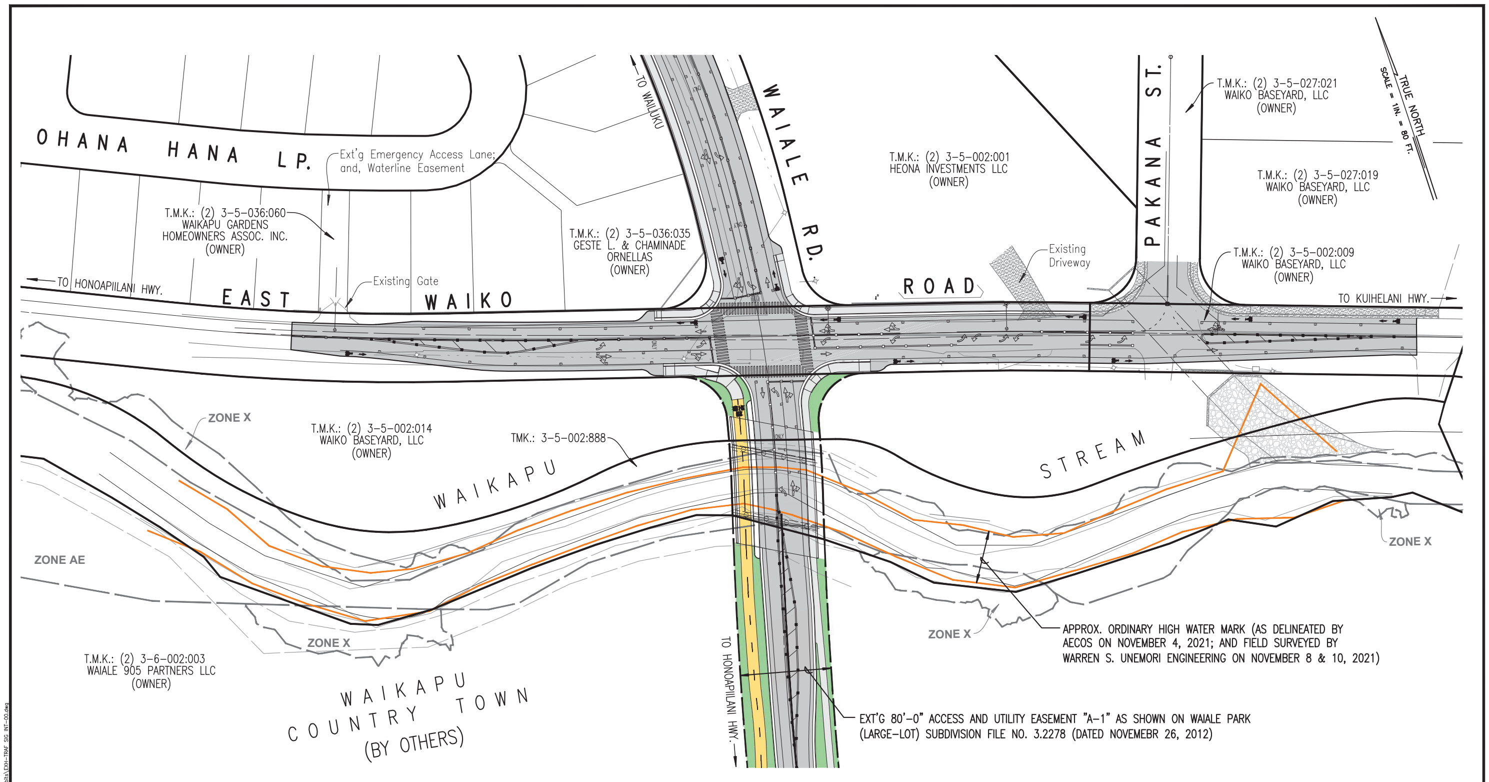
5/9/23



CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Waiale Road & Makai Parkway
Roundabout Concept

5/9/23



DPW WAIALE ROAD EXTENSION

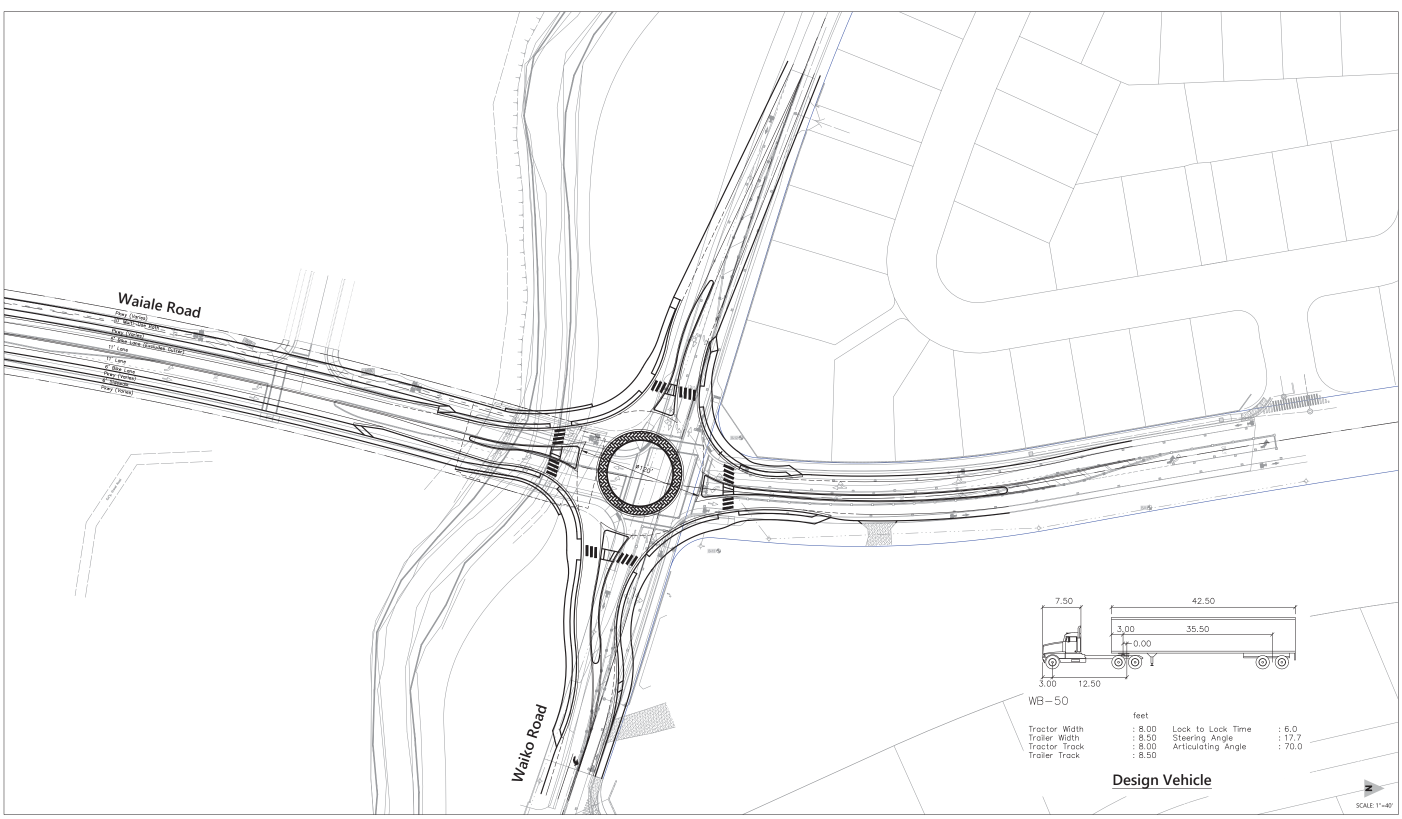
CONCEPTUAL PLAN - TRAFFIC SIGNALIZED INTERSECTION LAYOUT AT WAIALE ROAD

0 80 160 240 320

SCALE: 1 IN. = 80 FT.

WARREN S. UNEMORI ENGINEERING, INC.
CIVIL & STRUCTURAL ENGINEERS / LAND SURVEYORS

SEPTEMBER 19, 2023



CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Waiko Road & Waiale Road
Roundabout Concept
5/9/23

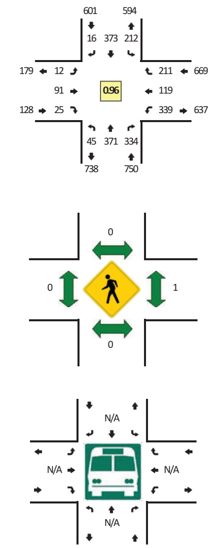
Appendix B: Traffic Count Data

FEHR & PEERS

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuikahi Dr | **QC JOB #:** 15812104

CITY/STATE: Wailuku, HI | **DATE:** Thu, May 12 2022

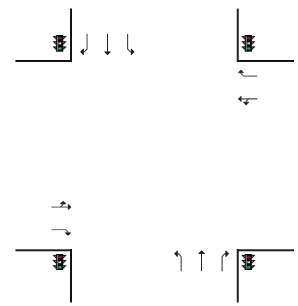


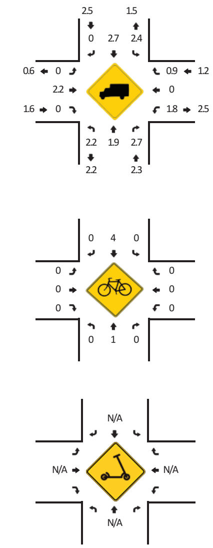
Peak-Hour: 4:00 PM -- 5:00 PM

Peak 15-Min: 4:10 PM -- 4:25 PM

Quality Counts

DATA THAT DRIVES COMMUNITIES





5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Kuikahi Dr (Eastbound)				Kuikahi Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	4	33	27	0	17	31	2	0	1	5	1	0	30	15	13	0	179	
4:05 PM	1	32	32	0	10	40	1	0	0	10	5	0	29	10	14	0	184	
4:10 PM	6	20	28	0	20	29	0	0	4	6	2	0	32	8	24	0	179	
4:15 PM	2	40	29	0	20	33	1	0	1	11	1	0	27	6	21	0	192	
4:20 PM	3	32	28	0	14	38	1	0	0	1	3	0	39	12	19	0	190	
4:25 PM	3	33	26	0	11	29	2	0	0	11	1	0	26	13	22	0	177	
4:30 PM	4	23	26	1	24	29	1	0	2	9	1	0	27	13	15	0	175	
4:35 PM	10	30	28	0	22	34	2	0	0	5	0	0	27	5	18	0	181	
4:40 PM	1	41	29	0	24	29	2	0	1	7	2	0	24	10	17	0	187	
4:45 PM	2	30	27	0	22	21	1	0	0	13	3	0	29	13	19	0	180	
4:50 PM	4	26	31	0	12	28	2	0	2	8	2	0	28	7	13	0	163	
4:55 PM	4	31	23	0	16	32	1	0	1	5	4	0	21	7	16	0	161	2148
5:00 PM	3	32	13	0	12	17	1	0	1	7	1	0	18	12	19	0	136	2105
5:05 PM	4	35	31	0	13	12	3	0	0	9	0	0	21	6	17	0	151	2072
5:10 PM	6	13	11	0	23	31	0	0	0	11	5	0	29	14	13	0	156	2049
5:15 PM	3	30	20	0	14	24	3	0	0	8	3	0	21	13	18	0	157	2014
5:20 PM	2	27	28	0	14	19	2	0	1	13	4	0	23	11	21	0	165	1989
5:25 PM	3	32	16	0	10	25	4	0	0	9	5	0	22	3	16	0	145	1957
5:30 PM	1	16	13	0	11	10	2	0	1	10	0	0	23	12	16	0	115	1897
5:35 PM	4	34	25	0	11	19	3	0	3	6	1	0	18	11	18	0	153	1869
5:40 PM	2	27	10	0	12	25	2	0	0	6	0	0	20	9	15	0	128	1810
5:45 PM	4	36	21	0	12	18	1	0	0	6	1	0	17	11	8	0	135	1765
5:50 PM	4	25	36	0	16	23	1	0	0	6	0	0	19	10	13	0	153	1755
5:55 PM	1	12	11	0	13	11	1	0	0	7	1	0	23	18	14	0	112	1706

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	44	368	340	0	216	400	8	0	20	72	24	0	392	104	256	0	2244
Heavy Trucks	4	8	8		4	16	0		0	4	0		4	0	4		52
Buses																	
Pedestrians		0				0				0				4			4
Bicycles	0	0	0		0	4	0		0	0	0		0	0	0		4
Scooters																	

Comments:

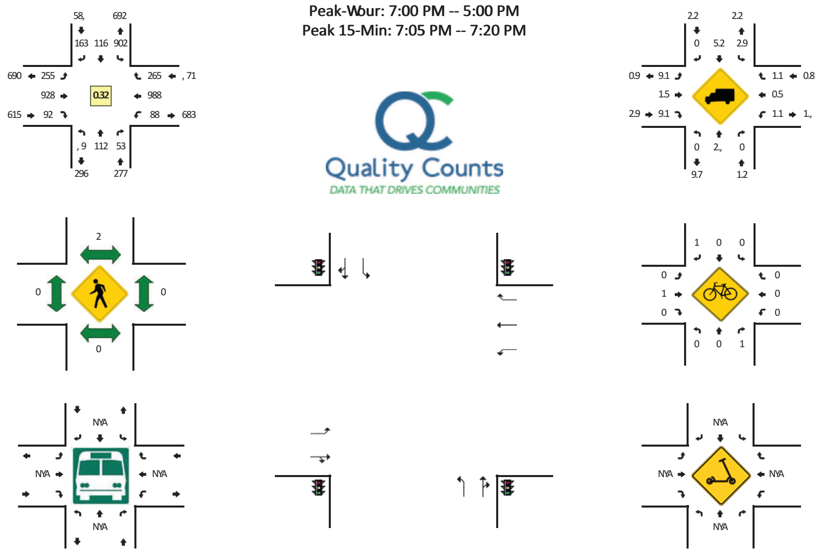
Report generated on 6/15/2022 2:34 PM

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

Type of peak hour being reported: Intersection Peak — Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- Kuikahi Dr — **QC JOB #:** 15812108
CIT4Y/TATE: KahuluiSW — **DATE:** ThuSMay 12 2022

Peak-Wour: 7:00 PM -- 5:00 PM
Peak 15-Min: 7:05 PM -- 7:20 PM



5-Min Count Period Beginning At	H aiale wd (Northbound)				H aiale wd (/outhbound)				Kuikahi Dr (Eastbound)				Kuikahi Dr (H estbound)				Total	Wourly Totals
	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R		
7:00 PM	10	6	9	0	27	8	6	0	22	90	1	0	15	95	1,	0	1, ,	
7:05 PM	,	1,	6	0	18	17	27	0	23	22	2	0	10	27	27	0	13,	
7:10 PM	16	16	10	0	20	10	17	0	20	29	6	0	,	99	16	0	131	
7:15 PM	10	19	8	0	20	3	10	0	26	97	1	0	7	93	97	0	208	
7:20 PM	6	3	5	0	2,	12	18	0	26	90	9	0	8	25	27	0	139	
7:25 PM	8	5	5	0	15	3	19	0	1,	26	0	0	,	75	26	0	1, 6	
7:90 PM	9	8	6	0	28	19	18	0	17	27	6	0	7	98	99	0	135	
7:95 PM	1	3	7	0	20	6	8	0	25	90	9	0	5	98	15	0	167	
7:70 PM	0	8	7	0	92	15	18	0	21	23	7	0	10	2,	16	0	187	
7:75 PM	6	10	9	0	95	3	1,	0	25	92	9	0	7	25	20	0	183	
7:50 PM	1	8	9	0	29	,	16	0	20	29	2	0	5	26	22	0	156	
7:55 PM	5	9	2	0	70	7	,	0	10	25	1	0	3	99	18	0	15,	218,
5:00 PM	1	11	5	0	91	11	17	0	3	16	1	0	,	25	29	0	157	2167
5:05 PM	7	8	,	0	18	10	,	0	22	29	0	0	5	23	16	0	173	2116
5:10 PM	5	3	5	0	23	3	16	0	6	98	9	0	5	26	21	0	1, 2	203,
5:15 PM	2	6	2	0	26	3	10	0	12	90	1	0	8	9,	18	0	161	2050
5:20 PM	2	7	7	0	28	,	11	0	1,	26	,	0	7	95	22	0	16,	2027
5:25 PM	1	,	11	0	27	6	20	0	19	15	2	0	9	96	28	0	166	2017
5:90 PM	7	8	,	0	29	7	11	0	19	20	7	0	9	92	2,	0	156	13, 5
5:95 PM	0	8	7	0	19	,	16	0	19	1,	9	0	8	99	13	0	171	1352
5:70 PM	7	,	6	0	21	10	16	0	11	1,	2	0	7	1,	1,	0	192	1300
5:75 PM	9	7	2	0	29	3	3	0	11	1,	7	0	7	25	20	0	191	1872
5:50 PM	0	10	5	0	17	9	12	0	23	22	7	0	5	99	22	0	153	1875
5:55 PM	9	7	2	0	20	7	11	0	6	1,	2	0	9	2,	19	0	112	1800

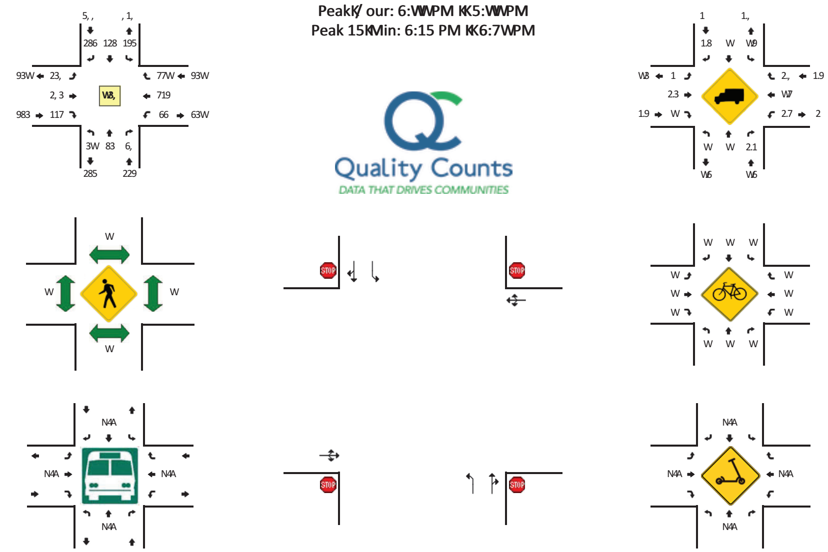
Peak 15-Min UoF rates	Northbound				/outhbound				Eastbound				H estbound				Total
	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	
All Vehicles	192	187	36	0	292	192	132	0	900	916	96	0	87	987	236	0	2987
Weavy Trucks	0	8	0		0	7	0		8	8	0		0	0	7		92
Buses																	
Pedestrians		0				7				0				0			7
Bicycles	0	0	0		0	0	7		0	7	0		0	0	0		8
/cooters																	

Comments:

Type of peak hour being reported: Intersection Peak — Method for determining peak hour: Total Entering Volume

LOCATION: Hwamehameha A- e KKMaui Lani PkDy — **QC JOB #:** 15812112
CIT04HTATE: wahuluiY/ I — **SATE:** ThuYMay 12 2W22

PeakY/ our: 6:WWPM KK5:WWPM
Peak 15KMin: 6:15 PM KK6:7WPM



5KMin Count Period Beginning At	Hwamehameha A- e (Northbound)				Hwamehameha A- e (Houthbound)				Maui Lani PkDy (Eastbound)				Maui Lani PkDy (R estbound)				Total	/ ourly Totals
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F		
6:WWPM	16	11	8	W	11	18	22	W	28	15	18	W	7	2,	26	W	133	
6:W5 PM	19	12	6	W	8	17	22	W	22	2W	6	W	7	26	27	W	1, 1	
6:1WPM	17	5	5	W	1,	16	22	W	26	21	8	W	8	25	26	W	189	
6:15 PM	1	1W	5	W	1,	8	29	W	29	13	8	W	2	77	23	W	186	
6:2WPM	1W	5	1	W	16	11	26	1	28	7W	9	W	W	7W	29	W	189	
6:25 PM	,	6	7	W	12	11	7W	W	26	27	15	W	1	75	2,	W	132	
6:7WPM	6	8	7	W	17	1W	2,	W	2W	13	9	W	5	2,	72	W	1, 6	
6:75 PM	,	9	9	W	15	8	27	W	71	2,	3	W	7	21	25	W	181	
6:6WPM	2	8	2	W	1,	8	28	W	18	26	3	W	11	27	72	W	182	
6:65 PM	9	9	,	W	12	,	1,	W	21	2,	12	W	7	22	71	W	1, 1	
6:5WPM	9	8	2	W	17	3	13	W	76	7W	1W	W	1	22	26	W	1, 8	
6:55 PM	6	9	1	W	15	11	26	W	21	26	8	W	6	2,	77	W	1, 8	2182
5:WWPM	6	11	2	W	17	12	1,	W	25	75	1W	W	9	26	28	W	18,	21, W
5:W5 PM	,	7	7	W	8	9	17	W	22	25	8	W	3	13	21	W	166	2167
5:1WPM	2	6	2	W	15	3	18	W	1,	28	9	W	5	28	13	W	157	211W
5:15 PM	6	6	6	W	,	1W	2W	W	25	27	12	W	8	79	2,	W	18W	21W9
5:2WPM	3	11	7	W	11	9	7W	W	27	77	9	W	1	26	27	W	18W	21WW
5:25 PM	,	9	6	W	16	5	27	W	18	2,	8	W	5	75	1,	W	193	2W,
5:7WPM	12	17	15	W	15	5	28	W	27	13	8	W	,	26	16	W	187	2W89
5:75 PM	11	11	6	W	3	,	19	W	21	13	9	W	1	29	2W	W	151	2W59
5:6WPM	6	12	5	W	17	3	18	W	19	19	5	W	6	12	21	W	175	2WW3
5:65 PM	3	6	5	W	17	9	2W	W	21	17	9	W	6	12	7W	W	167	1381
5:5WPM	6	6	5	W	12	5	16	W	1,	13	1W	W	1	71	13	W	161	1366
5:55 PM	5	2	1	W	16	3	2W	W	18	12	7	W	6	1,	11	W	119	1882

Peak 15KMin vloDrates	Northbound				Houthbound				Eastbound				R estbound				Total
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	
All Vehicles	, 2	, 9	79	W	1, 2	12W	72W	6	712	288	119	W	12	732	728	W	2268
/ ea- y Trucks	W	W	W		W	W	8		6	12	W		W	W	W		26
Buses																	
Pedestrians		W				W				W				W			W
Bicycles	W	W	W		W	W	W		W	W	W		W	W	W		W
Hcooters																	

Comments:

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKMaui Lani Pk- y

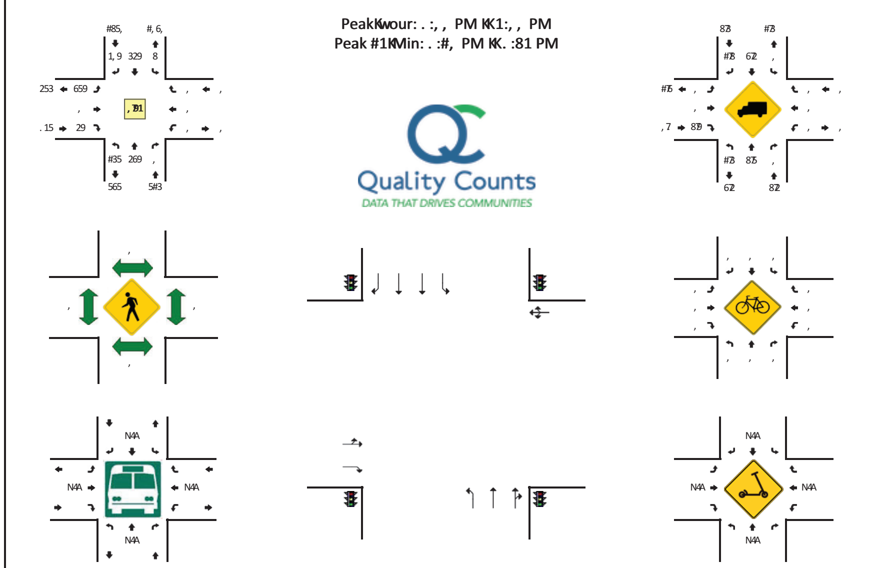
DC QOJ B: #15#8##2

CITO4YTATE: Hahului/wl

SATE: Wed/May 81 8, 88

PeakKwour: . :, , PM KK1:, , PM

Peak #1KMin: . :#, PM KK. :81 PM



1KMin Count Period J eginning At	Huihelani w- y (Northbound) Left	Thru	Right	U	Huihelani w- y (Youthbound) Left	Thru	Right	U	Maui Lani Pk- y (Eastbound) Left	Thru	Right	U	Maui Lani Pk- y (Westbound) Left	Thru	Right	U	Total	wourly Totals
. :, , PM	2	. 8	,	,	,	13	. 8	,	. 6	,	5	,	,	,	,	,	#95	
. :, 1 PM	8#	2,	,	,	,	15	1,	#	6,	,	.	,	,	,	,	,	88.	
. :#, PM	.	1#	,	,	,	52	19	,	6,	,	3	,	,	,	,	,	863	
. :#1 PM	#6	69	,	,	,	18	6,	,	. 2	,	9	,	,	,	,	,	#59	
. :8, PM	#5	2.	,	,	,	9,	. #	,	6,	,	2	,	,	,	,	,	8. 9	
. :81 PM	88	1,	,	,	,	23	62	,	8,	,	1	,	,	,	,	,	8, ,	
. :6, PM	86	2#	,	,	,	13	65	,	68	,	2	,	,	,	,	,	8#3	
. :61 PM	#1	. 8	,	,	,	1#	12	,	81	,	.	,	,	,	,	,	#96	
. :. , PM	#8	2.	,	,	,	18	63	#	68	,	2	,	,	,	,	,	8, .	
. :. 1 PM	#6	. 3	,	,	,	25	. .	,	65	,	3	,	,	,	,	,	8#3	
. :1, PM	#9	1#	,	,	,	3.	. .	,	83	,	6	,	,	,	,	,	8#5	
. :11 PM	#8	25	,	,	,	13	68	,	62	,	.	,	,	,	,	,	8, 9	8111
1:, , PM	2	89	,	,	,	36	. 9	,	6#	,	5	,	,	,	,	,	#92	8116
1:, 1 PM	81	1.	#	,	,	82	. 8	,	. 8	,	9	,	,	,	,	,	#99	8185
1:#, PM	8,	11	,	,	,	25	. 1	,	85	,	.	,	#	,	,	,	88#	81#8
1:#1 PM	##	66	,	,	,	19	. .	,	. 6	,	6	,	,	,	,	,	#96	81#2
1:8, PM	8#	. 2	,	,	,	23	61	,	6,	,	1	,	,	,	,	,	8, .	8. 3#
1:81 PM	#2	. .	,	,	,	81	#9	,	. 6	,	3	,	,	,	,	,	#1.	8. 81
1:6, PM	88	62	,	,	,	13	. 2	,	86	,	1	,	,	,	,	,	#59	8693
1:61 PM	#8	. 2	,	,	#	1,	89	,	82	,	.	,	,	,	#	,	#29	8636
1:. , PM	#2	11	,	,	,	. #	81	,	66	,	##	,	,	,	,	,	#5#	861,
1:. 1 PM	#1	69	,	,	,	62	. 5	,	65	,	3	,	,	,	,	,	#56	86#2
1:1, PM	5	85	,	,	,	15	82	,	6,	,	2	,	,	,	,	,	#12	881.
1:11 PM	#6	69	,	,	,	. 8	89	#	83	,	#	,	,	,	,	,	#18	8#93

Peak #1KMin Flo- rates	Northbound Left	Thru	Right	U	Youthbound Left	Thru	Right	U	Eastbound Left	Thru	Right	U	Westbound Left	Thru	Right	U	Total
All Vehicles	#. ,	2#2	,	,	,	9#8	18,	,	. 8.	,	55	,	,	,	,	,	83, ,
weavy Trucks	.	#8	,		,	85	5		,	,	,		,	,	,		18
J uses																	
Pedestrians		,				,				,				,			,
J icycles	,	,	,		,	,	,		,	,	,		,	,	,		,
Ycooters																	

Comments:

Report generated on 24#148, 88 8:6. PM

YOURCE: Duality Counts/LLC (http:44- - - 7qualitycounts7net) #K533K15, K88#8

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Waiko Rd

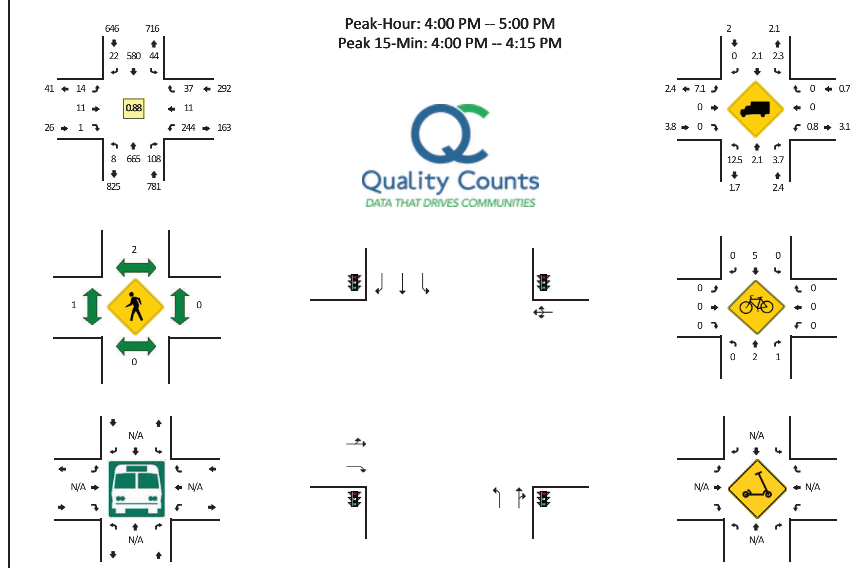
QC JOB #: 15812120

CITY/STATE: Waikapu, HI

DATE: Thu, May 12 2022

Peak-Hour: 4:00 PM -- 5:00 PM

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



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound) Left	Thru	Right	U	Honoapiilani Hwy (Southbound) Left	Thru	Right	U	Waiko Rd (Eastbound) Left	Thru	Right	U	Waiko Rd (Westbound) Left	Thru	Right	U	Total	Hourly Totals
4:00 PM	1	57	9	0	7	62	3	0	1	3	0	0	23	0	2	0	168	
4:05 PM	1	61	17	0	3	52	3	0	0	0	0	0	30	0	1	0	168	
4:10 PM	2	55	9	0	3	50	2	0	3	3	0	0	30	1	2	0	160	
4:15 PM	0	58	5	0	2	48	0	0	1	3	0	0	29	1	2	0	149	
4:20 PM	0	51	14	0	3	48	2	0	3	0	0	0	30	1	2	0	154	
4:25 PM	0	58	13	0	4	59	2	0	0	0	0	0	24	0	1	0	161	
4:30 PM	2	45	7	0	2	40	2	0	3	0	1	0	24	4	10	0	140	
4:35 PM	0	57	5	0	2	56	3	0	1	0	0	0	14	0	6	0	144	
4:40 PM	1	82	7	0	5	43	1	0	0	0	0	0	6	0	1	0	146	
4:45 PM	1	37	9	0	2	44	2	0	1	1	0	0	14	2	4	0	117	
4:50 PM	0	67	4	0	4	33	0	0	1	1	0	0	9	2	2	0	123	
4:55 PM	0	37	9	0	7	45	2	0	0	0	0	0	11	0	4	0	115	1745
5:00 PM	1	60	4	0	5	36	2	0	4	1	0	0	15	1	2	0	131	1708
5:05 PM	0	61	9	0	1	32	0	0	2	0	0	0	20	1	1	0	127	1667
5:10 PM	1	33	9	0	2	33	1	0	0	1	0	0	21	2	5	0	108	1615
5:15 PM	1	58	3	0	4	49	2	0	2	1	0	0	5	0	3	0	128	1594
5:20 PM	2	35	3	0	5	40	1	0	0	1	0	0	8	0	5	0	100	1540
5:25 PM	1	38	8	0	4	40	2	0	1	1	1	0	1	0	2	0	99	1478
5:30 PM	1	52	3	0	2	34	2	0	1	0	0	0	4	1	1	0	101	1439
5:35 PM	0	49	5	0	0	21	1	0	0	0	2	0	4	1	3	0	86	1381
5:40 PM	1	49	2	0	2	33	2	0	1	0	0	0	3	4	3	0	100	1335
5:45 PM	1	52	9	0	0	32	2	0	0	1	1	0	1	0	5	0	104	1322
5:50 PM	1	38	5	0	5	39	1	0	0	0	0	0	5	0	0	0	94	1293
5:55 PM	2	29	6	0	3	25	2	0	1	0	0	0	9	2	4	0	83	1261

Peak 15-Min Flowrates	Northbound Left	Thru	Right	U	Southbound Left	Thru	Right	U	Eastbound Left	Thru	Right	U	Westbound Left	Thru	Right	U	Total
All Vehicles	16	692	140	0	52	656	32	0	16	24	0	0	332	4	20	0	1984
Heavy Trucks	4	24	0		4	28	0		0	0	0		4	0	0		64
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	4	0		0	0	0		0	0	0		4
Scooters																	

Comments:

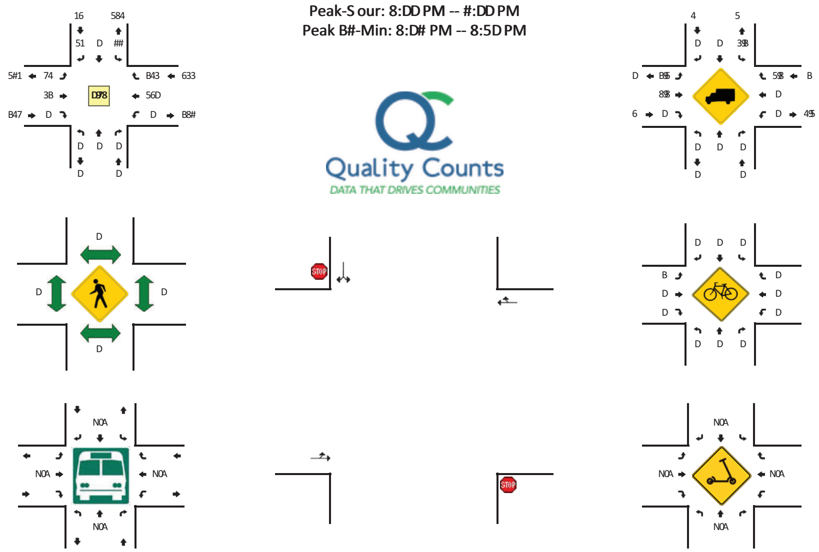
Report generated on 6/15/2022 2:34 PM

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

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- H aiko wd | **WC ROQJ :** B#1B5B58
CIT20YTATE: H aikapu/S I | **, ATE:** Thu/May B5 5D55

Peak-S our: 8:DD PM -- #:DD PM
Peak B#-Min: 8:D# PM -- 8:5D PM



Quality Counts
DATA THAT DRIVES COMMUNITIES

#-Min Count Period Qeginning At	H aiale wd .Northbound(				H aiale wd .Youthbound(				H aiko wd .Eastbound(				H aiko wd .H estbound(				Total	Sourly Totals
	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)		
8:DD PM	D	D	D	D	5	D	5	D	3	7	D	D	D	53	B7	D	44	
8:D# PM	D	D	D	D	6	D	#	D	1	BB	D	D	D	5D	B#	D	45	
8:BD PM	D	D	D	D	8	D	5	D	3	BD	D	D	D	67	54	D	11	
8:B# PM	D	D	D	D	5	D	8	D	4	BD	D	D	D	54	55	D	7D	
8:5D PM	D	D	D	D	8	D	6	D	7	1	D	D	D	55	B4	D	4D	
8:5# PM	D	D	D	D	3	D	B	B	4	7	D	D	D	B6	B5	D	83	
8:6D PM	D	D	D	D	6	D	8	D	1	8	D	D	D	B4	BD	D	8#	
8:6# PM	D	D	D	D	1	D	5	D	8	7	D	D	D	BD	3	D	8D	
8:8D PM	D	D	D	D	7	D	B	D	1	5	D	D	D	BD	B4	D	88	
8:8# PM	D	D	D	D	7	D	B	D	#	7	D	D	D	B8	BB	D	8#	
8:#D PM	D	D	D	D	6	D	B	D	6	7	D	D	D	B8	BD	D	61	
8:## PM	D	D	D	D	5	D	5	D	6	BB	D	D	D	B3	#	D	85	483
#:DD PM	D	D	D	D	7	D	D	D	8	3	D	D	D	B7	BD	D	87	46D
#:D# PM	D	D	D	D	8	D	6	D	4	4	D	D	D	B4	1	D	86	4BB
#:BD PM	D	D	D	D	#	D	6	D	8	#	D	D	D	5D	3	D	84	#43
#:B# PM	D	D	D	D	#	D	D	D	7	#	D	D	D	BD	6	D	6D	#53
#:5D PM	D	D	D	D	6	D	6	D	#	#	D	D	D	3	1	D	66	#D5
#:5# PM	D	D	D	D	8	D	D	D	7	6	D	D	D	3	#	D	51	81B
#:6D PM	D	D	D	D	5	D	6	D	7	#	D	D	D	6	B6	D	66	843
#:6# PM	D	D	D	D	6	D	5	D	6	6	D	D	D	7	3	D	57	8#4
#:8D PM	D	D	D	D	8	D	5	D	5	B	D	D	D	BD	3	D	51	88D
#:8# PM	D	D	D	D	5	D	B	D	5	4	D	D	D	#	8	D	5D	8B#
#:#D PM	D	D	D	D	8	D	6	D	#	8	D	D	D	B	BD	D	57	8D8
#:## PM	D	D	D	D	6	D	8	D	6	4	D	D	D	1	4	D	6D	635

Peak B#-Min UoF rates	Northbound				Youthbound				Eastbound				H estbound				Total
	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	
All Vehicles	D	D	D	D	64	D	88	D	35	B58	D	D	D	665	5#5	D	11D
S eavy Trucks	D	D	D		8	D	D		D	8	D		D	D	1		B4
Quses																	
Pedestrians		D				D				D				D			D
Qicycles	D	D	D		D	D	D		D	D	D		D	D	D		D
Ycooters																	

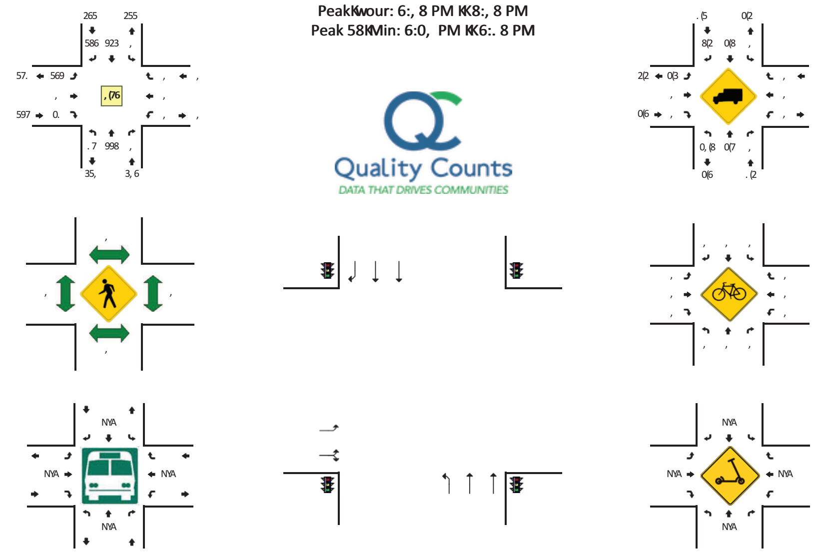
Comments:

weport generated on 40B#05D55 5:68 PM | YO) wCE: Wuality Counts/LLC .http:00F F F 9qualitycounts9net(B-177-#1D-55B5

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKE D aiko Qd | **J C BD# 1:** 58250502
CIT4Y/TATE: HahuluiSwI | **WATE:** D edSMay 08 0, 00

PeakKwour: 6:, 8 PM KK8:, 8 PM
Peak 58KMin: 6:0, PM KK6:. 8 PM



Quality Counts
DATA THAT DRIVES COMMUNITIES

8KMin Count Period #eginning At	Huihelani w- y)NorthboundR				Huihelani w- y)/outhboundR				E D aiko Qd)EastboundR				E D aiko Qd)D estboundR				Total	wourly Totals
	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U		
6:, , PM	5	. 7	,	,	,	80	5.	,	53	,	.	,	,	,	,	,	508	
6:, 8 PM	6	3,	,	,	,	97	55	,	8	,	5	,	,	,	,	,	59,	
6:5, PM	0	8,	,	,	,	86	52	,	58	,	8	,	,	,	,	,	566	
6:58 PM	.	67	,	,	,	88	55	,	56	,	5	,	,	,	,	,	5. .	
6:0, PM	6	86	,	,	,	39	5.	,	55	,	5	,	,	,	,	,	587	
6:08 PM	0	96	,	,	,	82	00	,	56	,	8	,	,	,	,	,	598	
6:. , PM	5	3,	,	,	,	65	7	,	50	,	5	,	,	,	,	,	5. 6	
6:. 8 PM	.	8.	,	,	,	95	56	,	5,	,	,	,	,	,	,	,	565	
6:6, PM	9	86	,	,	,	89	5.	,	58	,	,	,	,	,	,	,	566	
6:68 PM	6	87	,	,	,	65	55	,	55	,	5	,	,	,	,	,	503	
6:8, PM	8	62	,	,	,	99	55	,	56	,	,	,	,	,	,	,	566	
6:88 PM	8	80	,	,	,	85	55	,	58	,	5	,	,	,	,	,	5. 8	5355
8:, , PM	,	60	,	,	,	87	5,	,	5,	,	3	,	,	,	,	,	502	5356
8:, 8 PM	5	93	,	,	,	85	2	,	5,	,	,	,	,	,	,	,	5. 3	5975
8:5, PM	,	95	,	,	,	95	58	,	7	,	5	,	,	,	,	,	563	5976
8:58 PM	0	65	,	,	,	60	50	,	50	,	,	,	,	,	,	,	5, 7	593,
8:0, PM	5	80	,	,	,	60	56	,	2	,	0	,	,	,	,	,	557	59. ,
8:08 PM	5	66	,	,	,	85	8	,	2	,	,	,	,	,	,	,	5, 7	5836
8:. , PM	5	80	,	,	,	6,	9	,	5,	,	5	,	,	,	,	,	55,	588,
8:. 8 PM	5	86	,	,	,	. 9	3	,	2	,	5	,	,	,	,	,	5, 3	5859
8:6, PM	5	63	,	,	,	87	59	,	5,	,	,	,	,	,	,	,	5. .	58, 8
8:68 PM	5	8,	,	,	,	06	5,	,	3	,	.	,	,	,	,	,	78	563.
8:8, PM	5	. ,	,	,	,	60	56	,	5,	,	5	,	,	,	,	,	72	5603
8:88 PM	5	. 7	,	,	,	. 6	5.	,	3	,	0	,	,	,	,	,	79	5. 22

Peak 58KMin Flo- rates	Northbound				/outhbound				Eastbound				D estbound				Total
	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U	
All Vehicles	02	380	,	,	,	3, ,	539	,	562	,	02	,	,	,	,	,	52. 0
weavy Trucks	,	06	,		,	0,	59		,	,	,		,	,	,		9,
#uses																	
Pedestrians		,				,				,				,			,
#icycles	,	,	,		,	,	,		,	,	,		,	,	,		,
/cooters																	

Comments:

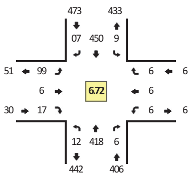
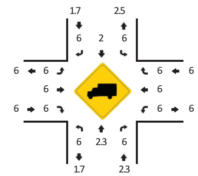
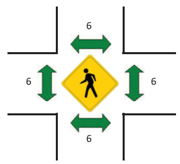
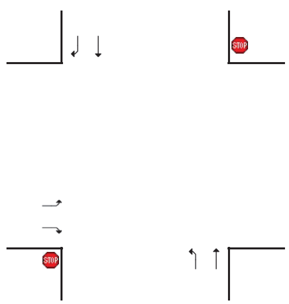
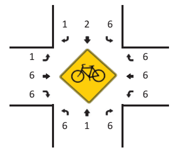
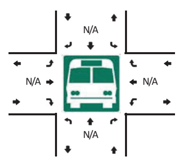
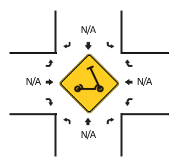
Qeport generated on 9Y58Y0, 00 0:. 6 PM | /OUQCE: J uality CountsSLLC)http:YY- - - (qualitycounts(netR5K233K82, K0050

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Maui Tropical Plantation WiReway | QC JOB #: 15812102

CITY/STATE: , aikapuDHI | WATE: ThuDMay 12 2622

Peak-Hour: 9:66 PM -- 5:66 PM
Peak 15-Min: 9:66 PM -- 9:15 PM

5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Maui Tropical Plantation WiReway (Eastbound)				Maui Tropical Plantation WiReway (, estbound)				Total	Hourly Totals
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F		
9:66 PM	6	36	6	6	6	40	9	6	6	6	2	6	6	6	6	6	107	
9:65 PM	2	35	6	6	6	48	0	6	9	6	6	6	6	6	6	6	152	
9:16 PM	1	35	6	6	6	35	9	6	5	6	2	6	6	6	6	6	192	
9:15 PM	1	51	6	6	6	46	0	1	5	6	6	6	6	6	6	6	101	
9:26 PM	1	55	6	6	6	49	9	6	4	6	2	6	6	6	6	6	190	
9:25 PM	1	58	6	6	6	34	0	1	0	6	1	6	6	6	6	6	109	
9:06 PM	1	33	6	6	6	86	9	6	9	6	1	6	6	6	6	6	153	
9:05 PM	2	33	6	6	6	53	0	1	0	6	2	6	6	6	6	6	100	
9:96 PM	6	39	6	6	6	93	5	1	0	6	9	6	6	6	6	6	120	
9:95 PM	6	54	6	6	6	55	0	6	3	6	1	6	6	6	6	6	122	
9:56 PM	2	56	6	6	6	50	2	6	0	6	2	6	6	6	6	6	112	
9:55 PM	1	31	6	6	6	03	1	6	1	6	2	6	6	6	6	6	162	1587
5:66 PM	6	54	6	6	6	95	5	6	1	6	0	6	6	6	6	6	111	1531
5:65 PM	2	32	6	6	6	93	0	6	0	6	9	6	6	6	6	6	126	1527
5:16 PM	6	97	6	6	6	90	9	6	1	6	0	6	6	6	6	6	166	1984
5:15 PM	1	98	6	6	6	99	0	1	6	6	1	6	6	6	6	6	78	1959
5:26 PM	1	92	6	6	6	98	1	6	6	6	1	6	6	6	6	6	70	1969
5:25 PM	2	98	6	6	6	99	6	6	2	6	1	6	6	6	6	6	74	1034
5:06 PM	6	05	6	6	6	08	2	6	2	6	1	6	6	6	6	6	48	1287
5:05 PM	6	31	6	6	6	03	6	6	3	6	6	6	6	6	6	6	160	1257
5:96 PM	6	93	6	6	6	28	6	6	2	6	1	6	6	6	6	6	44	1210
5:95 PM	2	56	6	1	6	09	1	6	1	6	1	6	6	6	6	6	76	1181
5:56 PM	9	35	6	6	6	01	1	6	2	6	2	6	6	6	6	6	165	1149
5:55 PM	0	21	6	6	6	07	0	6	2	6	6	6	6	6	6	6	38	1196

Peak 15-Min vlowrates	Northbound				Southbound				Eastbound				, estbound				Total
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	
All Vehicles	12	436	6	6	6	839	99	6	03	6	13	6	6	6	6	6	1402
HeaRy Trucks	6	28	6		6	02	6		6	6	6		6	6	6		36
Buses																	
Pedestrians		6				6				6				6			6
Bicycles	6	6	6		6	6	6		6	6	6		6	6	6		6
Scooters																	

Comments:

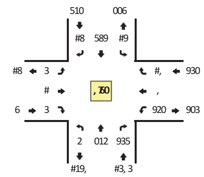
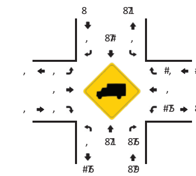
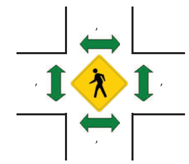
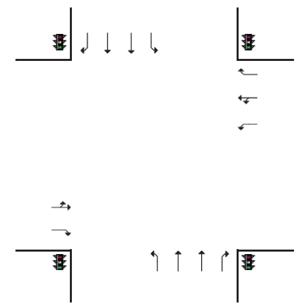
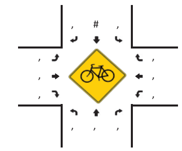
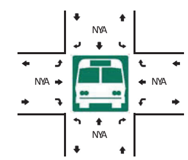
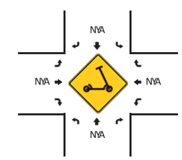
Ueport generated on 3/15/2622 2:09 PM | SOF UCE: Quality CountsDLLC (http://www.qualitycounts.net) 1-844-586-2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuihelani Hwy | DC ꝏJ B: #15#8#20

CIT4Y/TATE: MaalaeaSHI | WATE: ThuSMay #8 8, 88

Peak-Hour: 3:#, PM -- 1:#, PM
Peak #1-Min: 3:81 PM -- 3:3, PM

1-Min Count Period J eginning At	Honoapiilani Hwy .Northbound(				Honoapiilani Hwy ./outhbound(				Kuihelani Hwy .Eastbound(				Kuihelani Hwy .) estbound(				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:, , PM	,	12	0#	,	,	10	#	,	,	,	,	,	98	,	2	,	830	
3:, 1 PM	,	19	00	,	,	0,	,	,	,	,	,	,	9,	#	2	,	819	
3:#, PM	,	1,	13	,	,	59	2	,	,	,	,	,	10	,	8	,	818	
3:#1 PM	,	9,	9#	,	2	06	,	#	,	,	,	,	93	,	,	,	855	
3:8, PM	,	39	0,	,	,	38	2	,	,	,	#	,	11	,	,	,	8, 5	
3:81 PM	,	02	58	#	#	05	,	#	,	,	,	,	11	,	,	,	89#	
3:2, PM	,	91	19	,	,	95	#	,	,	,	,	,	00	,	#	,	895	
3:21 PM	,	36	08	#	8	58	,	,	,	,	,	,	38	,	#	,	826	
3:3, PM	,	30	05	,	#	12	,	,	8	,	,	,	9#	,	#	,	838	
3:31 PM	,	35	16	#	2	1,	#	,	,	,	#	,	08	,	#	,	880	
3:1, PM	,	03	11	,	,	69	,	,	,	,	,	,	21	,	8	,	812	
3:11 PM	,	19	36	,	#	59	#	,	,	,	,	,	11	,	,	,	81,	2, #,
1:, , PM	,	26	00	,	,	18	,	,	,	#	#	,	51	,	#	,	831	2, , 6
1:, 1 PM	,	31	01	,	3	08	2	,	8	,	#	,	5,	,	#	,	802	2, #1
1:#, PM	,	31	18	8	1	03	#	,	#	,	#	,	09	,	,	,	825	2, , #
1:#1 PM	,	30	3,	,	,	30	#	,	,	,	#	,	19	,	#	,	#68	86, 1
1:8, PM	,	25	3#	,	8	36	,	,	,	,	#	,	3,	,	#	,	#98	8506
1:81 PM	,	19	33	,	,	80	,	,	,	,	,	,	16	,	#	,	#59	8951
1:2, PM	,	32	25	#	#	36	,	,	,	,	,	,	35	,	,	,	#5,	8059
1:21 PM	,	12	36	,	#	89	,	,	,	,	,	,	1,	,	,	,	#5,	8085
1:3, PM	,	06	33	,	,	22	#	,	,	,	,	,	39	,	8	,	#60	8158
1:31 PM	,	8,	80	,	2	22	,	,	#	,	,	,	9,	,	#	,	#13	81#,
1:1, PM	,	33	35	,	#	28	,	,	,	,	,	,	38	,	8	,	#06	8380
1:11 PM	,	3#	2#	#	#	86	,	,	,	,	,	,	23	,	,	,	#29	82#2

Peak #1-Min Flowrates	Northbound				/outhbound				Eastbound				) estbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	,	935	5, 3	5	#8	6#8	3	3	,	,	,	,	018	,	5	,	2#18
Heavy Trucks	,	#8	85		,	3,	,		,	,	,		8,	,	,		#, ,
J uses																	
Pedestrians		,				,				,				,			,
J icycles	,	,	,		,	,	,		,	,	,		,	,	,		,
/cooters																	

Comments:

Report generated on 0Y#1Y8, 88 8:23 PM | /OURCE: Duality CountsSLLC .http:YYwww7qualitycounts7net(#-599-15, -88#8

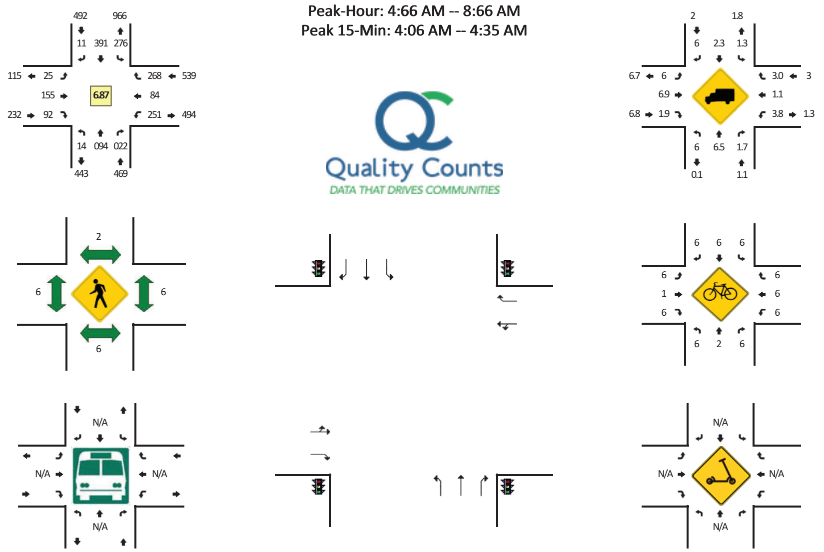
Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuikahi Dr
CITY/STATE: Wailuku, HI

QC JOB #: 15812104
DATE: Thu, May 12 2622

Peak-Hour: 4:66 AM -- 8:66 AM
Peak 15-Min: 4:06 AM -- 4:35 AM



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound) Left	Thru	Right	U	Honoapiilani Hwy (Southbound) Left	Thru	Right	U	Kuikahi Dr (Eastbound) Left	Thru	Right	U	Kuikahi Dr (Westbound) Left	Thru	Right	U	Total	Hourly Totals
4:66 AM	1	25	29	6	14	03	6	6	1	16	4	6	10	5	10	6	152	
4:65 AM	2	29	27	6	14	04	6	6	1	21	4	6	10	8	13	6	145	
4:16 AM	2	06	02	6	03	03	1	6	1	11	4	6	20	4	14	6	177	
4:15 AM	1	28	02	6	24	03	1	6	0	13	7	6	20	7	19	6	174	
4:26 AM	6	04	25	6	23	08	1	6	0	10	0	6	20	4	18	6	172	
4:25 AM	6	26	28	6	18	32	2	6	2	19	9	6	24	3	06	6	175	
4:06 AM	2	04	25	6	21	07	6	6	0	17	5	6	14	16	29	6	263	
4:05 AM	0	03	02	6	27	30	2	6	6	7	3	6	24	8	22	6	210	
4:36 AM	0	04	28	6	21	59	1	6	0	18	0	6	29	9	13	6	219	
4:35 AM	1	09	25	6	27	07	6	6	1	8	5	6	26	5	13	6	180	
4:56 AM	2	00	18	6	24	03	0	6	2	9	0	6	12	9	10	6	157	
4:55 AM	6	23	22	6	29	01	6	6	5	16	0	6	24	12	11	6	141	2259
8:66 AM	1	15	17	6	16	06	6	6	1	11	5	6	27	4	19	6	133	2238
8:65 AM	6	14	26	6	11	23	6	6	2	4	2	6	26	0	10	6	117	2172
8:16 AM	1	03	24	6	19	17	6	6	0	8	5	6	10	4	16	6	130	2109
8:15 AM	0	22	18	6	15	14	1	6	1	8	9	6	26	11	13	6	109	2645
8:26 AM	2	18	14	6	13	21	1	6	3	8	2	6	26	5	11	6	120	2669
8:25 AM	6	23	27	6	15	10	6	6	2	16	3	6	23	3	8	6	100	1733
8:06 AM	1	20	26	6	4	29	6	6	6	16	3	6	12	5	4	6	114	1854
8:05 AM	1	14	27	6	12	14	1	6	6	4	9	6	18	4	4	6	122	1499
8:36 AM	2	14	17	6	7	29	6	6	0	7	3	6	14	2	7	6	114	1994
8:35 AM	0	24	23	6	8	21	6	6	6	11	1	6	11	5	11	6	122	1969
8:56 AM	1	22	29	6	11	14	1	6	6	11	2	6	7	5	9	6	111	1558
8:55 AM	5	20	15	6	16	12	0	6	6	5	2	6	20	4	11	6	119	1560

Peak 15-Min Flowrates	Northbound Left	Thru	Right	U	Southbound Left	Thru	Right	U	Eastbound Left	Thru	Right	U	Westbound Left	Thru	Right	U	Total
All Vehicles	02	302	036	6	283	552	12	6	23	183	38	6	286	79	238	6	2502
Heavy Trucks	6	3	6		3	12	6		6	3	6		12	3	8		38
Buses																	
Pedestrians		6				6				6				6			6
Bicycles	6	3	6		6	6	6		6	6	6		6	6	6		3
Scooters																	

Comments:

Report generated on 9/15/2622 2:03 PM

SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-844-586-2212

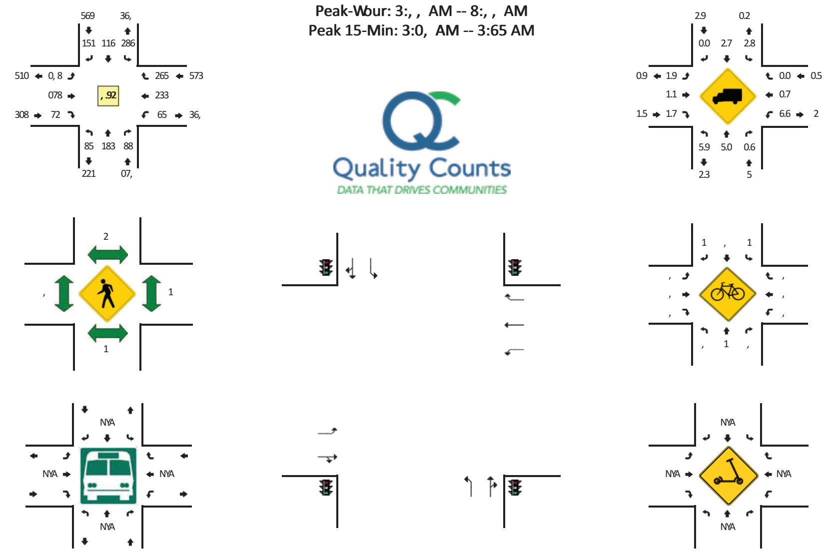
Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- Kuikahi Dr
CIT4Y/TATE: KahuluiSW

QC JOB #: 15812108
DATE: ThuSMay 12 2, 22

Peak-Wour: 3:, , AM -- 8:, , AM
Peak 15-Min: 3:0, AM -- 3:65 AM



5-Min Count Period Beginning At	H aiale wd (Northbound) Left	Thru	wight	R	H aiale wd (/outhbound) Left	Thru	wight	R	Kuikahi Dr (Eastbound) Left	Thru	wight	R	Kuikahi Dr (H estbound) Left	Thru	wight	R	Total	Wourly Totals
3:, , AM	3	2,	11	,	20	8	12	,	21	21	,	,	1	16	18	,	157	
3:, 5 AM	3	11	9	,	27	17	3	,	25	00	0	,	1	17	25	,	139	
3:1, AM	3	18	7	,	17	11	16	,	06	69	0	,	2	28	22	,	21,	
3:15 AM	5	11	3	,	25	3	16	,	06	06	3	,	5	2,	10	,	182	
3:2, AM	11	13	9	,	29	3	13	,	19	21	2	,	0	27	28	,	189	
3:25 AM	1,	22	8	,	2,	7	1,	,	07	23	7	,	6	15	25	,	189	
3:0, AM	17	18	7	,	20	1,	1,	,	26	07	16	,	0	0,	22	,	212	
3:05 AM	9	22	5	,	21	12	13	,	28	19	5	,	5	20	13	,	180	
3:6, AM	6	15	1,	,	22	7	17	,	02	61	7	,	0	26	25	,	2, 6	
3:65 AM	5	8	5	,	29	15	9	,	18	28	8	,	1,	13	2,	,	132	
3:5, AM	2	11	6	,	22	8	11	,	20	26	5	,	5	02	16	,	171	
3:55 AM	2	16	8	,	28	8	16	,	16	05	0	,	0	02	17	,	133	2216
8:, , AM	1	7	2	,	13	5	16	,	2,	27	2	,	6	26	19	,	16,	2198
8:, 5 AM	6	3	0	,	26	9	9	,	10	19	1	,	0	2,	13	,	129	2168
8:1, AM	6	3	0	,	19	3	8	,	23	25	1	,	5	18	15	,	109	2, 33
8:15 AM	0	1,	3	,	13	5	16	,	13	16	1	,	5	28	18	,	109	2, 06
8:2, AM	1	12	5	,	10	1,	5	,	17	22	1	,	2	20	2,	,	10,	1935
8:25 AM	6	7	5	,	21	0	1,	,	2,	18	2	,	0	20	17	,	101	1913
8:0, AM	,	7	7	,	22	6	5	,	20	18	,	,	2	20	11	,	12,	1825
8:05 AM	0	6	0	,	2,	0	12	,	21	15	,	,	1	17	9	,	1, 3	1369
8:6, AM	0	6	1	,	27	5	3	,	20	19	1	,	0	10	17	,	121	1777
8:65 AM	2	5	1	,	22	6	3	,	13	15	2	,	6	15	21	,	115	17, 9
8:5, AM	2	3	0	,	27	5	1,	,	22	2,	1	,	1	18	28	,	160	1591
8:55 AM	1	3	5	,	22	5	3	,	10	18	2	,	2	20	16	,	119	1500

Peak 15-Min UoF rates	Northbound Left	Thru	wight	R	/outhbound Left	Thru	wight	R	Eastbound Left	Thru	wight	R	H estbound Left	Thru	wight	R	Total
All Vehicles	117	22,	86	,	276	112	132	,	007	086	1, ,	,	66	0, 8	257	,	2097
Weavy Trucks	,	12	6		17	8	6		6	,	6		,	17	8		37
Buses																	
Pedestrians		6				8				,				6			17
Bicycles	,	,	,		,	,	6		,	,	,		,	,	,		6
/cooters																	

Comments:

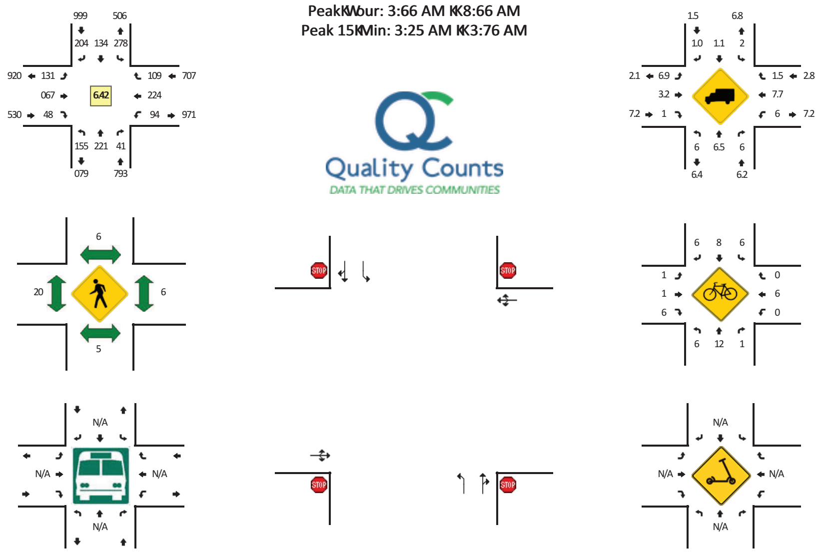
weport generated on 7Y15Y2, 22 2:06 PM

/ORwCE: Quality CountsSLLC (http:YYF F F .qualitycounts.net) 1-833-58, -2212

Type of peak hour being reported: Intersection Peak — Method for determining peak hour: Total Entering Volume

LOCATION: Hwamehameha A- e KKMaui Lani PkDy — QC JOB #: 15812104
CITY/HTATE: wahuluiSW — , ATE: ThuSMay 12 2622

Peak Wour: 3:66 AM KK8:66 AM
Peak 15KMin: 3:25 AM KK3:76 AM



5KMin Count Period Beginning At	Hwamehameha A- e (Northbound) Left	Thru	Uight	F	Hwamehameha A- e (Houthbound) Left	Thru	Uight	F	Maui Lani PkDy (Eastbound) Left	Thru	Uight	F	Maui Lani PkDy (R estbound) Left	Thru	Uight	F	Total	Wourly Totals
3:66 AM	16	10	7	6	27	8	15	6	15	20	9	6	2	20	4	6	152	
3:65 AM	8	22	8	6	06	5	21	6	16	27	11	6	4	18	11	6	133	
3:16 AM	4	3	10	6	25	25	15	6	15	20	4	6	5	14	8	6	130	
3:15 AM	22	8	5	6	23	17	18	6	17	27	0	6	10	11	3	6	199	
3:26 AM	26	14	4	6	17	14	18	1	26	22	4	6	8	22	11	6	142	
3:25 AM	18	28	8	6	21	22	17	6	16	21	18	6	5	13	8	6	146	
3:06 AM	4	21	11	6	14	14	27	1	15	20	10	6	7	18	17	6	141	
3:05 AM	12	14	8	6	13	26	24	6	13	27	11	6	3	14	14	6	262	
3:76 AM	17	27	3	6	10	14	14	6	21	29	3	6	8	13	16	6	185	
3:75 AM	11	25	7	6	21	16	20	6	17	04	7	6	0	13	10	6	187	
3:56 AM	18	29	4	6	19	16	13	6	11	23	7	6	0	21	17	6	139	
3:55 AM	7	4	5	6	14	8	29	6	4	28	0	6	2	23	12	6	152	2176
8:66 AM	0	0	1	6	15	0	27	6	14	29	4	6	0	19	4	6	101	2114
8:65 AM	16	9	2	6	14	6	17	6	12	20	2	6	2	20	11	6	127	2699
8:16 AM	7	7	9	6	19	7	15	6	4	14	7	6	1	11	9	6	44	1442
8:15 AM	8	5	2	6	11	2	13	6	11	21	0	6	7	21	15	6	126	1479
8:26 AM	7	0	7	6	15	0	18	6	4	29	1	6	1	23	3	6	118	1832
8:25 AM	7	2	2	6	4	2	19	6	17	19	0	6	6	17	3	6	84	1331
8:06 AM	0	2	2	6	16	7	13	6	16	27	2	6	0	10	3	6	43	1933
8:05 AM	6	7	1	6	9	2	14	6	8	27	1	6	2	17	3	6	88	1590
8:76 AM	2	1	0	6	4	1	15	6	8	19	6	6	1	21	5	6	82	1796
8:75 AM	7	0	6	6	10	1	18	6	17	25	6	6	1	18	5	6	162	1038
8:56 AM	2	1	7	6	4	1	13	6	12	23	2	6	1	20	11	1	111	1010
8:55 AM	1	2	2	6	2	0	17	6	19	13	5	6	6	26	4	6	41	1252

Peak 15KMin vloDrates	Northbound Left	Thru	Uight	F	Houthbound Left	Thru	Uight	F	Eastbound Left	Thru	Uight	F	R estbound Left	Thru	Uight	F	Total
All Vehicles	159	232	168	6	228	277	298	7	198	232	198	6	97	219	197	6	2002
Wea- y Trucks	6	7	6		7	6	7		6	77	7		6	8	8		39
Buses																	
Pedestrians		8				6				76				6			78
Bicycles	6	12	7		6	6	6		6	7	6		6	6	7		27
Hcooters																	

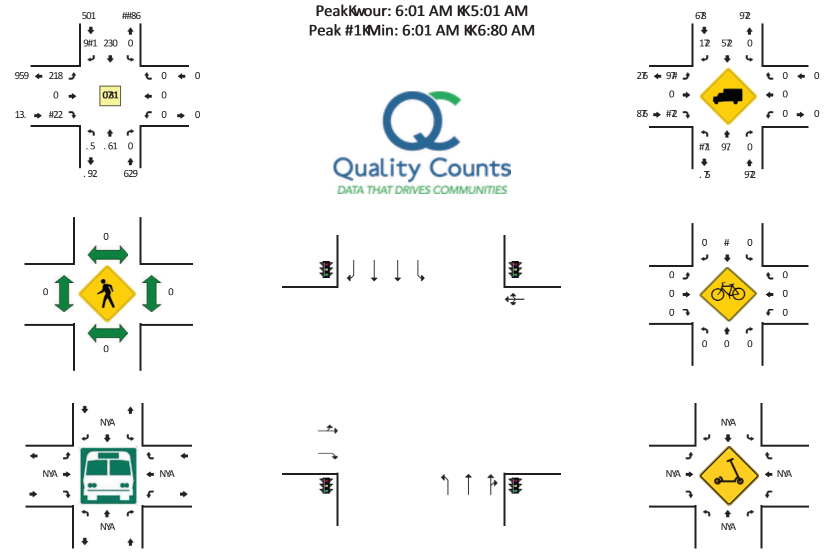
Comments:

Ueport generated on 9/15/2622 2:07 PM — HOF UCE: Quality CountsSLLC (http://DDD.qualitycounts.net) 1K833K586K2212

Type of peak hour being reported: Intersection Peak — Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKMaui Lani Pk- y — DC ODJ B: #15#8#20
CIT4Y/TATE: HahuluiSwl — WATE: , edSMay 81 8088

Peak Kwour: 6:01 AM KK5:01 AM
Peak #1KMin: 6:01 AM KK6:80 AM



1KMin Count Period J eginning At	Huihelani w- y (Northbound) Left	Thru	Right	U	Huihelani w- y (/outhbound) Left	Thru	Right	U	Maui Lani Pk- y (Eastbound) Left	Thru	Right	U	Maui Lani Pk- y (, estbound) Left	Thru	Right	U	Total	wourly Totals
6:00 AM	2	98	0	0	0	99	98	0	19	0	#6	0	0	0	0	0	#6#	
6:01 AM	2	. 2	0	0	0	95	81	0	93	0	#6	0	0	0	0	0	#56	
6:#0 AM	9	12	0	0	0	1.	98	0	95	0	#.	0	0	0	0	0	#33	
6:#1 AM	6	. #	0	0	0	93	8.	0	9.	0	#8	0	0	0	0	0	#5#	
6:80 AM	.	18	0	0	0	20	88	0	95	0	#6	0	0	0	0	0	#61	
6:81 AM	.	16	0	0	0	91	98	0	95	0	#2	0	0	0	0	0	#58	
6:90 AM	2	. 5	0	0	0	10	83	0	20	0	#9	0	0	0	0	0	802	
6:91 AM	6	16	0	0	0	9#	82	0	2#	0	#0	0	0	0	0	0	#60	
6:20 AM	1	19	0	0	0	28	86	0	9#	0	3	0	0	0	0	0	#. 6	
6:21 AM	5	22	0	0	0	29	8#	0	99	0	#0	0	0	0	0	0	#13	
6:10 AM	6	. 6	0	0	0	99	85	0	1#	0	5	0	0	0	0	0	#32	
6:11 AM	.	9.	0	0	0	9.	88	0	92	0	#9	0	0	0	0	0	#26	8#9.
5:00 AM	1	. 8	0	0	0	26	86	0	99	0	1	0	0	0	0	0	#63	8#22
5:01 AM	2	16	0	0	0	25	98	0	81	0	#0	0	0	0	0	0	#6.	8#99
5:#0 AM	2	. 0	0	0	0	99	80	0	83	0	#0	0	0	0	0	0	#1.	8030
5:#1 AM	2	95	0	0	0	99	83	0	10	0	#9	0	0	0	0	0	#. 6	806.
5:80 AM	2	. 2	0	0	0	22	90	0	89	0	#0	0	0	0	0	0	#61	806.
5:81 AM	9	. 8	0	0	0	23	98	0	89	0	.	0	0	0	0	0	#61	80. 3
5:90 AM	8	9.	0	0	0	99	#3	0	81	0	6	0	0	0	0	0	#88	#356
5:91 AM	#	19	0	0	0	8.	#3	0	83	0	5	0	0	0	0	0	#9.	#319
5:20 AM	6	21	0	0	0	86	8#	0	86	0	#0	0	0	0	0	0	#96	#389
5:21 AM	.	2#	0	0	0	93	81	0	83	0	.	0	0	0	0	0	#2.	#3#0
5:10 AM	6	66	0	0	0	9#	83	0	98	0	5	0	0	0	0	0	#52	#300
5:11 AM	9	6#	0	0	0	86	86	0	#3	0	6	0	0	0	0	0	#12	#306

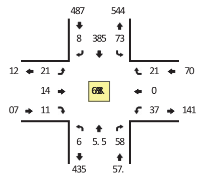
Peak #1KMin Flo- rates	Northbound Left	Thru	Right	U	/outhbound Left	Thru	Right	U	Eastbound Left	Thru	Right	U	, estbound Left	Thru	Right	U	Total
All Vehicles	1.	6#.	0	0	0	198	998	0	218	0	#50	0	0	0	0	0	88. 5
weavy Trucks	0	85	0		0	1.	80		2	0	2		0	0	0		##8
J uses																	
Pedestrians		0				0				0				0			0
J icycles	0	0	0		0	0	0		0	0	0		0	0	0		0
/cooters																	

Comments:

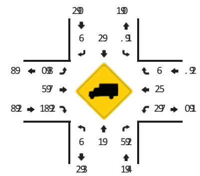
Report generated on . Y#1Y8088 8:92 PM — /OURCE: Duality CountsSLLC (http:YY- - - 7qualitycounts7net) #K566K150K88#8

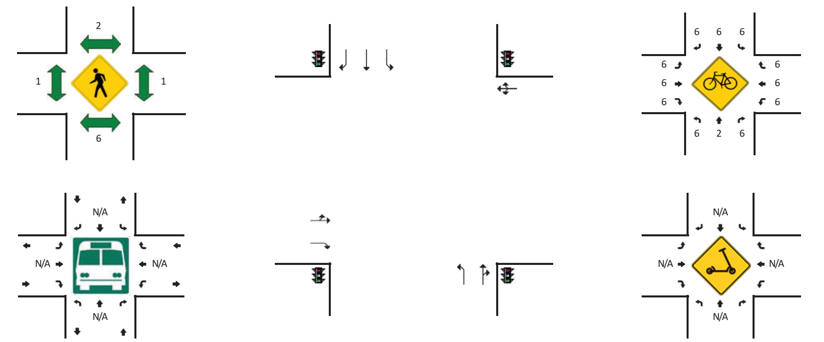
Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Waiko Rd | **QC JOB #:** 15812101
CITY/STATE: Waikapu, HI | **DATE:** Thu, May 12 2622



Peak-Hour: 4:65 AM -- 8:65 AM
Peak 15-Min: 4:. 6 AM -- 4:05 AM





5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Waiko Rd (Eastbound)				Waiko Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:66 AM	6	. 0	1	6	1	32	6	6	2	2	6	6	1	6	2	6	165	
4:65 AM	6	02	2	6	3	54	6	6	1	2	1	6	8	6	.	6	122	
4:16 AM	6	02	1	6	3	52	2	6	5	0	6	6	5	2	1	6	126	
4:15 AM	6	03	5	6	16	55	2	6	2	1	1	6	8	6	6	6	1. 6	
4:26 AM	6	0.	0	6	2	36	1	6	1	1	.	6	2	6	2	6	117	
4:25 AM	6	. 2	4	6	12	. 7	6	6	.	.	6	6	8	6	.	6	164	
4:. 6 AM	6	56	16	6	15	34	1	6	2	2	2	6	5	6	.	6	154	
4:. 5 AM	6	50	2	6	10	50	1	6	1	1	.	6	16	6	2	6	102	
4:06 AM	6	30	4	6	1.	37	6	6	2	6	6	6	0	1	1	6	131	
4:05 AM	6	08	5	6	5	38	6	6	2	1	6	6	.	6	1	6	1. .	
4:56 AM	6	03	4	6	5	08	1	6	6	1	1	6	2	6	1	6	112	
4:55 AM	6	28	0	6	4	02	6	6	6	1	6	6	8	6	.	6	7.	1561
8:66 AM	6	06	0	6	1	40	6	6	2	6	6	6	3	1	1	6	127	1525
8:65 AM	1	. 3	6	6	2	. 3	2	6	2	1	1	6	3	6	6	6	84	1076
8:16 AM	6	54	5	6	2	06	1	6	1	6	6	6	2	1	2	6	111	1081
8:15 AM	6	. .	1	6	6	. .	1	6	1	1	6	6	8	1	1	6	86	10. 1
8:26 AM	6	. 4	.	6	6	02	.	6	6	6	6	6	8	1	6	6	70	1063
8:25 AM	6	. 0	.	6	.	28	1	6	6	1	6	6	7	2	2	6	8.	1. 82
8:. 6 AM	1	02	.	6	0	07	6	6	1	1	6	6	2	6	1	6	160	1. 27
8:. 5 AM	6	. 7	0	6	.	. 1	1	6	2	2	6	6	8	2	2	6	70	1281
8:06 AM	6	00	2	6	0	56	6	6	1	1	6	6	5	6	.	6	116	12. 6
8:05 AM	1	. 3	5	6	3	. 6	6	6	2	1	6	6	2	2	2	6	84	1180
8:56 AM	6	. 0	5	6	1	. 4	6	6	2	1	6	6	.	6	0	6	84	1157
8:55 AM	6	. .	1	6	.	20	6	6	6	1	1	6	3	6	0	6	4.	11. 7

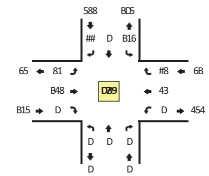
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	6	342	43	6	138	436	8	6	26	12	26	6	43	0	20	6	1806
Heavy Trucks	6	0	6		12	13	6		6	6	0		6	6	6		. 3
Buses																	
Pedestrians		6				0				6				0			8
Bicycles	6	0	6		6	6	6		6	6	6		6	6	6		0
Scooters																	

Comments:

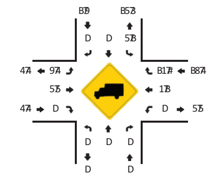
Report generated on 3/15/2622 2:. 0 PM | SOURCE: Quality Counts, LLC (http://www9qualitycounts9net) 1-844-586-2212

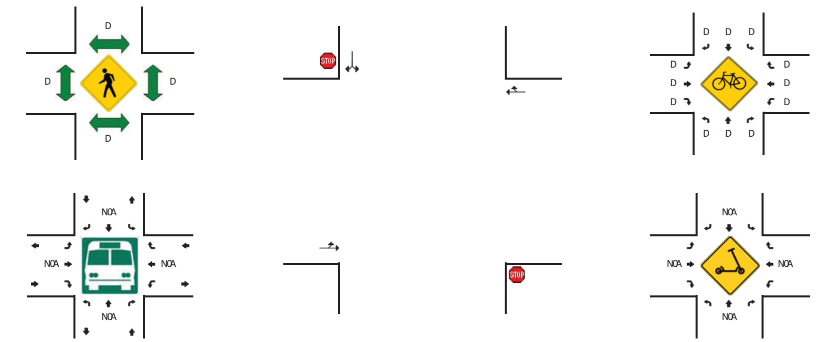
Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- H aiko wd | **WC RQJ :** B#1B5B85
CIT20YTATE: H aikapu/S I | **, ATE:** Thu/May B5 5D55



Peak-S our: 3:DD AM -- 1:DD AM
Peak B#-Min: 3:5# AM -- 3:8D AM





#-Min Count Period Qeginning At	H aiale wd .Northbound(				H aiale wd .Youthbound(				H aiko wd .Eastbound(				H aiko wd .H estbound(				Total	S ourly Totals
	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)		
3:DD AM	D	D	D	D	B5	D	5	D	4	9	D	D	D	B	#	D	56	
3:D# AM	D	D	D	D	6	D	3	D	B	9	D	D	D	5	4	D	51	
3:BD AM	D	D	D	D	B4	D	9	D	B	9	D	D	D	#	8	D	4#	
3:B# AM	D	D	D	D	5D	D	1	D	5	B8	D	D	D	D	4	D	83	
3:5D AM	D	D	D	D	59	D	4	D	3	6	D	D	D	8	6	D	#1	
3:5# AM	D	D	D	D	5#	D	3	D	8	B5	D	D	D	4	5	D	#4	
3:4D AM	D	D	D	D	B3	D	8	D	B4	B8	D	D	D	3	8	D	#6	
3:4# AM	D	D	D	D	B#	D	3	D	4	59	D	D	D	5	9	D	#6	
3:8D AM	D	D	D	D	B9	D	4	D	9	BD	D	D	D	4	4	D	8B	
3:8# AM	D	D	D	D	B8	D	5	D	8	B9	D	D	D	5	9	D	88	
3:#D AM	D	D	D	D	B5	D	B	D	B	8	D	D	D	4	9	D	53	
3:## AM	D	D	D	D	BD	D	#	D	4	BB	D	D	D	#	4	D	43	#B3
1:DD AM	D	D	D	D	#	D	9	D	4	#	D	D	D	8	#	D	51	#B9
1:D# AM	D	D	D	D	3	D	D	D	4	4	D	D	D	8	#	D	55	#BD
1:BD AM	D	D	D	D	#	D	5	D	B	9	D	D	D	#	BD	D	56	#D8
1:B# AM	D	D	D	D	3	D	9	D	5	4	D	D	D	5	8	D	58	81B
1:5D AM	D	D	D	D	8	D	4	D	B	5	D	D	D	5	BD	D	55	88#
1:5# AM	D	D	D	D	9	D	1	D	4	B	D	D	D	B	4	D	55	8B8
1:4D AM	D	D	D	D	9	D	9	D	5	8	D	D	D	#	BD	D	44	411
1:4# AM	D	D	D	D	5	D	9	D	B	1	D	D	D	5	3	D	59	4##
1:8D AM	D	D	D	D	9	D	8	D	4	9	D	D	D	3	8	D	4D	488
1:8# AM	D	D	D	D	3	D	8	D	4	1	D	D	D	5	9	D	4D	44D
1:#D AM	D	D	D	D	#	D	4	D	B	5	D	D	D	B	5	D	B8	4B3
1:## AM	D	D	D	D	8	D	5	D	B	3	D	D	D	9	8	D	58	4D8

Peak B#-Min UoF rates	Northbound				Youthbound				Eastbound				H estbound				Total
	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	
All Vehicles	D	D	D	D	551	D	35	D	1D	5D1	D	D	D	81	81	D	918
S eavy Trucks	D	D	D		8	D	D		B5	1	D		D	D	1		45
Quses																	
Pedestrians		D				D				D				D			D
Qicycles	D	D	D		D	D	D		D	D	D		D	D	D		D
Ycooters																	

Comments:

weport generated on 90B#05D55 5:48 PM | YO) wCE: Wuality Counts/LLC .http:00F F F 7qualitycounts7net(B-133-#1D-55B5

Type of peak hour being reported: Intersection Peak

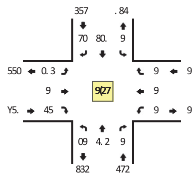
Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKE D aiko Qd

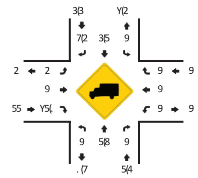
J C BO# 1: 5825054Y

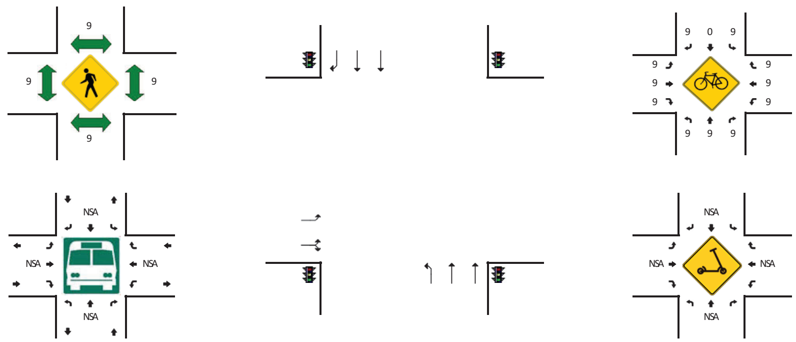
CIT/SWATE: Hahului, wl

6ATE: D ed, May 08 0900



PeakKwour: . :98 AM KK2:98 AM
Peak 58KMin: . :59 AM KK. :08 AM





8KMin Count Period #eginning At	Huihelani w- y)NorthboundR				Huihelani w- y)WouthboundR				E D aiko Qd)EastboundR				E D aiko Qd)D estboundR				Total	wourly Totals
	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U		
. :99 AM	0	Y9	9	9	9	4.	59	9	05	9	4	9	9	9	9	9	554	
. :98 AM	5	Y.	9	9	9	Y8	2	9	58	9	3	9	9	9	9	9	590	
. :59 AM	4	Y2	9	9	9	8Y	.	9	08	9	8	9	9	9	9	9	5Y0	
. :58 AM	0	Y.	9	9	9	8.	54	9	Y4	9	5	9	9	9	9	9	548	
. :09 AM	0	Y8	9	9	9	47	7	9	08	9	8	9	9	9	9	9	508	
. :08 AM	5	5.	9	9	9	Y8	0	9	Y0	9	0	9	9	9	9	9	27	
. :Y9 AM	5	42	9	9	9	85	59	9	04	9	4	9	9	9	9	9	5Y2	
. :Y8 AM	Y	4.	9	9	9	4Y	8	9	08	9	8	9	9	9	9	9	502	
. :49 AM	9	40	9	9	9	89	.	9	05	9	0	9	9	9	9	9	500	
. :48 AM	0	03	9	9	9	Y0	3	9	09	9	8	9	9	9	9	9	75	
. :89 AM	9	42	9	9	9	44	3	9	Y5	9	Y	9	9	9	9	9	5Y0	
. :88 AM	0	49	9	9	9	Y3	2	9	2	9	5	9	9	9	9	9	78	545Y
2:99 AM	0	3Y	9	9	9	40	59	9	53	9	0	9	9	9	9	9	5Y8	54Y4
2:98 AM	0	Y2	9	9	9	Y3	55	9	59	9	8	9	9	9	9	9	590	54Y4
2:59 AM	5	80	9	9	9	42	7	9	.	9	8	9	9	9	9	9	500	5404
2:58 AM	9	80	9	9	9	49	2	9	7	9	Y	9	9	9	9	9	550	5Y75
2:09 AM	0	45	9	9	9	49	50	9	.	9	8	9	9	9	9	9	59.	5Y. Y
2:08 AM	9	84	9	9	9	YY	54	9	2	9	9	9	9	9	9	9	597	5Y7Y
2:Y9 AM	0	0.	9	9	9	4Y	7	9	55	9	3	9	9	9	9	9	72	5Y8Y
2:Y8 AM	Y	43	9	9	9	Y9	4	9	7	9	5	9	9	9	9	9	7Y	5Y52
2:49 AM	5	80	9	9	9	07	3	9	3	9	0	9	9	9	9	9	73	5070
2:48 AM	Y	4Y	9	9	9	YY	55	9	2	9	5	9	9	9	9	9	77	5Y99
2:89 AM	3	. 4	9	9	9	04	55	9	59	9	Y	9	9	9	9	9	502	5073
2:88 AM	0	8Y	9	9	9	Y9	2	9	55	9	5	9	9	9	9	9	598	5Y93

Peak 58KMin Flo- rates	Northbound				Wouthbound				Eastbound				D estbound				Total
	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U	Left	Thru	Qight	U	
All Vehicles	Y0	449	9	9	9	3Y3	509	9	YY3	9	44	9	9	9	9	9	5392
weavy Trucks	9	4	9		9	Y3	4		04	9	53		9	9	9		24
#uses																	
Pedestrians		9				9				9				9			9
#icycles	9	9	9		9	9	9		9	9	9		9	9	9		9
Wcooters																	

Comments:

Qeport generated on 3S58S0900 0:Y4 PM

WOUQCE: J uality Counts, LLC)http:SS- - - (qualitycounts(netR5K2. . K829K0050

Type of peak hour being reported: Intersection Peak

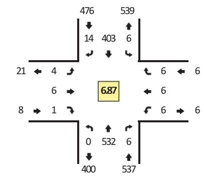
Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Maui Tropical Plantation WiReway

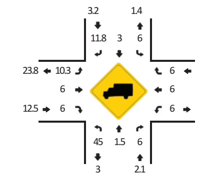
QC JOB #: 15812100

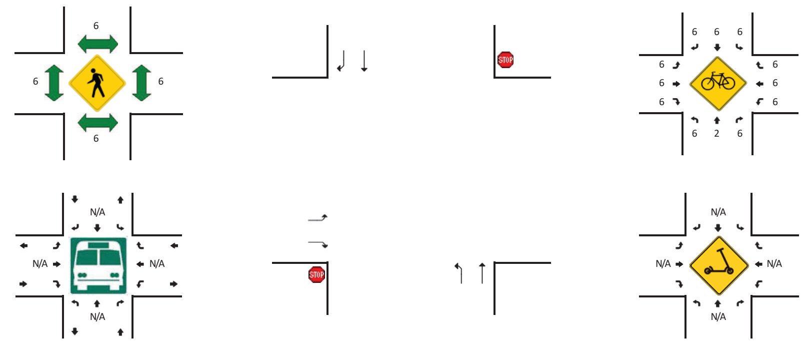
CITY/STATE: , aikapuDHI

WATE: ThuDMay 12 2622



Peak-Hour: 4:66 AM -- 8:66 AM
Peak 15-Min: 4:35 AM -- 4:56 AM





5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Maui Tropical Plantation WiReway (Eastbound)				Maui Tropical Plantation WiReway (, estbound)				Total	Hourly Totals
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F		
4:66 AM	6	03	6	6	6	73	1	6	1	6	6	6	6	6	6	6	168	
4:65 AM	1	35	6	6	6	74	6	6	6	6	6	6	6	6	6	6	163	
4:16 AM	6	30	6	6	6	74	6	6	6	6	6	6	6	6	6	6	161	
4:15 AM	6	30	6	6	6	58	6	6	6	6	6	6	6	6	6	6	92	
4:26 AM	2	07	6	6	6	59	3	6	6	6	6	6	6	6	6	6	116	
4:25 AM	6	31	6	6	6	75	2	6	2	6	6	6	6	6	6	6	166	
4:36 AM	6	55	6	6	6	05	3	6	1	6	6	6	6	6	6	6	160	
4:35 AM	6	07	6	6	6	46	3	6	1	6	6	6	6	6	6	6	126	
4:06 AM	1	76	6	6	6	71	2	6	6	6	6	6	6	6	6	6	120	
4:05 AM	6	58	6	6	6	43	1	6	1	6	1	6	6	6	6	6	130	
4:56 AM	6	02	6	6	6	58	2	6	1	6	6	6	6	6	6	6	163	
4:55 AM	6	08	6	6	6	54	6	6	6	6	6	6	6	6	6	6	165	1360
8:66 AM	6	27	6	6	6	04	2	6	1	6	6	6	6	6	6	6	47	1242
8:65 AM	1	06	6	6	6	43	1	6	1	6	6	6	6	6	6	6	117	1285
8:16 AM	6	03	6	6	6	38	2	6	1	6	6	6	6	6	6	6	80	1278
8:15 AM	1	56	6	6	6	06	6	6	6	6	6	6	6	6	6	6	91	1274
8:26 AM	6	31	6	6	6	39	6	6	6	6	6	6	6	6	6	6	46	1224
8:25 AM	2	05	6	6	6	04	3	6	6	6	1	6	6	6	6	6	98	1225
8:36 AM	1	38	6	6	6	31	5	6	2	6	6	6	6	6	6	6	44	1198
8:35 AM	2	35	6	6	6	05	5	6	2	6	6	6	6	6	6	6	89	1174
8:06 AM	1	02	6	6	6	33	3	6	1	6	6	6	6	6	6	6	86	1123
8:05 AM	1	03	6	6	6	53	1	6	1	6	3	6	6	6	6	6	162	1691
8:56 AM	3	39	6	6	6	32	1	6	2	6	6	6	6	6	6	6	44	1675
8:55 AM	1	35	6	6	6	39	2	6	6	6	6	6	6	6	6	6	44	1634

Peak 15-Min vlowrates	Northbound				Southbound				Eastbound				, estbound				Total
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	
All Vehicles	0	757	6	6	6	817	20	6	8	6	0	6	6	6	6	6	1512
HeaRy Trucks	0	12	6		6	20	6		6	6	6		6	6	6		06
Buses																	
Pedestrians		6				6				6				6			6
Bicycles	6	0	6		6	6	6		6	6	6		6	6	6		0
Scooters																	

Comments:

Ueport generated on 7/15/2622 2:30 PM

SOF UCE: Quality CountsDLLC (http://www.qualitycounts.net) 1-844-586-2212

Type of peak hour being reported: Intersection Peak

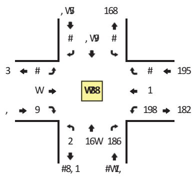
Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuihelani Hwy

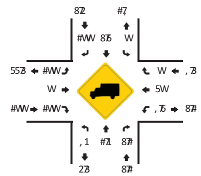
DC QQJ B: #15#8#21

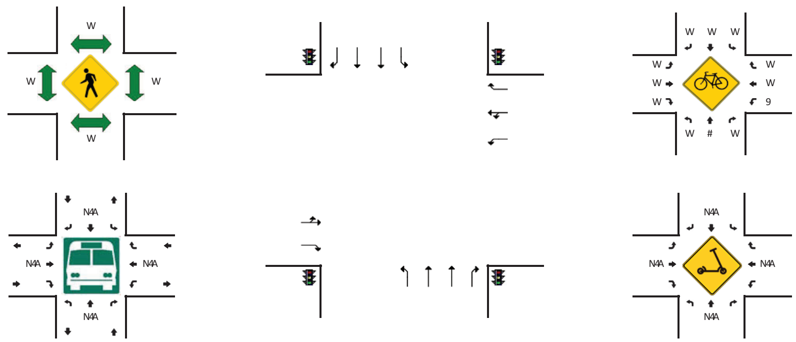
CIT04YTATE: Maalaea/HI

S ATE: Thu/May #8 8W88



Peak-Hour: , :W1 AM -- 5:W1 AM
Peak #1-Min: , :61 AM -- , :1WAM





1-Min Count Period J eginning At	Honoapiilani Hwy .Northbound(				Honoapiilani Hwy .Youthbound(				Kuihelani Hwy .Eastbound(				Kuihelani Hwy .) estbound(				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
, :WWAM	W	62	89	8	W	, W	W	W	W	W	W	W	2#	W	W	W	#, 6	
, :W1 AM	W	6,	69	W	W	96	W	W	W	W	W	W	15	#	W	W	#31	
, :#WAM	W	29	26	W	W	12	W	W	W	W	W	W	6,	W	W	W	#5W	
, :#1 AM	W	63	23	#	W	1,	W	W	#	W	W	W	15	8	W	W	8W	
, :8WAM	W	26	29	W	W	9#	W	W	W	W	W	W	11	W	#	W	8W9	
, :81 AM	#	2,	6W	W	W	16	W	W	W	W	W	W	12	W	W	W	#51	
, :6WAM	W	9,	63	W	W	98	#	W	W	W	#	W	62	W	W	W	8W2	
, :61 AM	#	13	12	W	W	91	W	W	W	W	#	W	18	W	W	W	868	
, :2WAM	W	26	2#	W	#	19	W	W	W	W	W	W	21	W	W	W	#59	
, :21 AM	#	25	23	W	W	95	W	W	W	W	#	W	25	#	W	W	8#9	
, :1WAM	W	8#	63	W	W	9#	W	W	W	W	8	W	21	#	W	W	#93	
, :11 AM	W	65	15	W	W	2#	W	W	W	W	#	W	25	W	W	W	#59	8663
5:WWAM	W	28	63	W	W	91	W	W	W	W	W	W	85	W	W	W	#, 2	862W
5:W1 AM	W	23	23	W	W	65	#	W	W	W	#	W	1#	#	W	W	#3W	8661
5:#WAM	#	69	29	W	#	25	W	W	W	W	W	W	63	W	W	W	#, #	8689
5:#1 AM	W	2,	2,	W	#	2#	W	W	W	W	W	W	65	#	#	W	#, 9	8831
5:8WAM	#	2W	65	W	8	2W	W	W	W	#	W	W	2#	W	W	W	#96	8818
5:81 AM	W	6,	19	W	#	66	W	W	W	6	W	W	6W	8	#	W	#96	886W
5:6WAM	W	28	62	W	8	63	W	W	W	#	#	W	62	W	#	W	#12	8#5W
5:61 AM	8	1W	16	W	W	69	W	W	W	W	W	W	81	#	W	W	#9,	8##1
5:2WAM	#	2W	19	W	W	1W	W	W	W	W	W	W	61	W	W	W	#58	8###
5:21 AM	W	6#	2#	W	8	63	W	W	#	W	#	W	61	W	W	W	#1W	8W21
5:1WAM	W	82	96	W	#	6W	W	W	W	W	#	W	62	W	W	W	#16	8W83
5:11 AM	W	26	65	W	W	83	W	W	W	W	W	W	61	#	W	W	#29	#353

Peak #1-Min Flowrates	Northbound				Youthbound				Eastbound				) estbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	5	9WW	1, 9	W	2	, 19	W	W	W	W	5	W	15W	2	W	W	8169
Heavy Trucks	5	2	5		W	#9	W		W	W	5		18	W	W		39
J uses																	
Pedestrians		W				W				W				W			W
J icycles	W	W	W		W	W	W		W	W	W		8W	W	W		8W
Ycooters																	

Comments:

Report generated on 94#148W88 8:62 PM

YOURCE: Duality Counts/LLC .http:44www7qualitycounts7net(#-5, , -15W88#8

Appendix C: Land Use Projects included in 2045 Forecasts

Appendix B: Land Use Projects Assumed Complete by 2045

Portal ProjNum[1]	ProjName	DevStage	TMKS	Developer	Multi-Family Units	Single-Family Units	Other Units	Acres	Land Use Description	Est Emp Floor Area Ratio	Est KSF	Est Sq Ft per Emp	Est Emp	Students
592	Maui Lani	1: Conceptual or Proposed	38007159	DR Horton; Schuler homes		120		21.7	Mostly residential					
638	Maui Lani	1: Conceptual or Proposed	38007109	D.R.Horton Schuler Homes	238			16.7	Mostly residential					
677	Waikapu Mauka Rural Lots	1: Conceptual or Proposed	236004004	THP Assoc., Waikapu Mauka Partners		304		281.5	Mostly residential					
723	Maui Lani	1: Conceptual or Proposed	38007159	Maui Lani 100				1.5	Low employment					
724	Maui Lani	1: Conceptual or Proposed	38007159	Maui Lani 100	68			5.1	Mostly residential					
725	Maui Lani	1: Conceptual or Proposed	38007159	Maui Lani 100				2.4	Other Retail Trade and Strip Commercial	0.35	37	450	82	
726	Maui Lani	1: Conceptual or Proposed	38007130	Maui Lani 100		240		46.0	Mostly residential					
501	Kehalani	2: Pending Approvals (Discretionary)	35001113	RCFC Kehalani LLC		138		38.6	Mostly residential					
585	Pu`unani Homestead	2: Pending Approvals (Discretionary)	35002002	Endurance Investors LLC		161		60.3	Mostly residential					
688	Waikapu Light Industrial Park	2: Pending Approvals (Discretionary)	38007105	ABC Development Comp LLC, Munekiyo & Hiraga, Weinberg				8.3	Industrial Park	0.35	126	600	210	
721	Wai`ale Affordable Homes	2: Pending Approvals (Discretionary)	38007101	A & B Properties	300			34.1	Mostly residential					
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	141	231			Mixed Use		58	400	146	
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	37	188			Mostly residential					
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	243	216			Mixed Use		111	450	247	
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	108	415			Mostly residential					
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC					School					1200
888	Kuikahi	2: Pending Approvals (Discretionary)	35002003	Alaula Builders Lawrence Carnicelli		204		0.0	Mostly residential					
492	Wai`olu	3: Approved (Discretionary)	35001075	Kehalani Mauka LLC		60		24.9	Mostly residential					
587	Maui Lani	3: Approved (Discretionary)	38096001	Maui Lani Homes, LLC; DR Horton/Schuller Homes		50		12.7	Mostly residential					
651	Valley Isle Fellowship	3: Approved (Discretionary)	35002012	Wayne Arakaki Eng, LLC				14.7	Mostly residential					
655	Emmanuel Lutheran Campus	3: Approved (Discretionary)	35002011	CHP				25.2	School					450
660	Maui Lani Gentry	3: Approved (Discretionary)	38007151	GENTRY MAUI DEVELOPMENT LLC	200	185		46.7	Mostly residential					
775	Waiko Baseyard	3: Approved (Discretionary)	238007102	Vincent Bagoyo				30.5	Industrial Park	0.35	465	600	774	
825	Wailuku Rental Housing	3: Approved (Discretionary)	35001064	Legacy Wailuku LLC	324			14.4	Mostly residential					
854	Waikapu Affordable Housing	3: Approved (Discretionary)	35002011	Waikapu Development Venture	12	68		12.5	Mostly residential					
500	Kehalani[2]	4: Under Construction	35001108	HBT Of Anuhea LLC		131		39.2	Mostly residential					
503	Kehalani	4: Under Construction	35040001	RCFC Kehalani LLC	25			14.2	Mostly residential					
815	Maui Lani Village[2]	4: Under Construction	38097001	Maui Lani 100 LLC		40	40	58.1	Industrial Park	0.35	443	600	738	
787	County Facilities	99: Need More Info	36002004	County of Maui		250		100.5	No info provided					
787	County Facilities	99: Need More Info	36002004	County of Maui		250		100.5	No info provided					
810	County Facilities	99: Need More Info	38005023	County of Maui				212.0	No info provided					

[1] Project number in Maui County Planning Department Project Status Viewer https://mauicounty.maps.arcgis.com/apps/webappviewer/index.html?id=0a7b91b1265045608c91e48902dced18

[2] Development partially complete. Land uses in table are estimated remaining land use to be developed

Appendix D: LOS Worksheets

FEHR PEERS

HCM 6th Signalized Intersection Summary

1: Honoapiilani Hwy & Kuikahi Dr

Existing (2022)
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	155	62	251	87	208	17	367	322	290	461	11
Future Volume (veh/h)	25	155	62	251	87	208	17	367	322	290	461	11
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		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	1826	1870	1841	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	28	174	0	282	98	0	19	412	0	326	518	0
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	2	2	2	5	2	4	2	2	2	2	2	2
Cap, veh/h	308	235		431	497		321	552		463	790	
Arrive On Green	0.02	0.13	0.00	0.16	0.27	0.00	0.02	0.29	0.00	0.15	0.42	0.00
Sat Flow, veh/h	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	28	174	0	282	98	0	19	412	0	326	518	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	0.9	6.2	0.0	9.2	2.8	0.0	0.5	13.9	0.0	8.2	15.4	0.0
Cycle Q Clear(g_c), s	0.9	6.2	0.0	9.2	2.8	0.0	0.5	13.9	0.0	8.2	15.4	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	308	235		431	497		321	552		463	790	
V/C Ratio(X)	0.09	0.74		0.65	0.20		0.06	0.75		0.70	0.66	
Avail Cap(c_a), veh/h	636	537		508	537		665	1128		580	1128	
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	25.6	29.3	0.0	19.9	19.8	0.0	16.7	22.2	0.0	14.5	16.1	0.0
Incr Delay (d2), s/veh	0.1	3.4	0.0	2.3	0.1	0.0	0.0	4.3	0.0	1.8	2.0	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	0.4	2.9	0.0	3.7	1.2	0.0	0.2	6.0	0.0	2.9	5.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	25.7	32.7	0.0	22.3	20.0	0.0	16.8	26.5	0.0	16.3	18.0	0.0
LnGrp LOS	C	C		C	B		B	C		B	B	
Approach Vol, veh/h		202	A		380	A		431	A		844	A
Approach Delay, s/veh		31.8			21.7			26.1			17.4	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	14.4	25.5	15.9	13.8	5.5	34.4	6.2	23.5
Change Period (Y+Rc), s	4.0	5.0	4.5	5.0	4.0	5.0	4.5	5.0
Max Green Setting (Gmax), s	15.0	42.0	14.5	20.0	15.0	42.0	14.5	20.0
Max Q Clear Time (g_c+I1), s	10.2	15.9	11.2	8.2	2.5	17.4	2.9	4.8
Green Ext Time (p_c), s	0.2	4.7	0.3	0.5	0.0	6.1	0.0	0.3

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.

HCM 6th Signalized Intersection Summary

2: Waiale Rd & Kuikahi Dr

Existing (2022)
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	308	368	62	45	277	245	85	187	88	284	114	151
Future Volume (veh/h)	308	368	62	45	277	245	85	187	88	284	114	151
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		0.98	1.00		0.98
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	1841	1841	1856	1811	1826	1856	1856	1856	1856
Adj Flow Rate, veh/h	335	400	64	49	301	67	92	203	83	309	124	129
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	4	4	3	6	5	3	3	3	3
Cap, veh/h	449	530	85	266	386	328	394	255	104	424	253	263
Arrive On Green	0.17	0.34	0.34	0.04	0.21	0.21	0.06	0.21	0.21	0.16	0.31	0.31
Sat Flow, veh/h	1781	1573	252	1753	1841	1565	1725	1222	500	1767	823	856
Grp Volume(v), veh/h	335	0	464	49	301	67	92	0	286	309	0	253
Grp Sat Flow(s),veh/h/ln	1781	0	1825	1753	1841	1565	1725	0	1721	1767	0	1680
Q Serve(g_s), s	10.8	0.0	17.7	1.7	12.1	2.8	3.2	0.0	12.3	10.1	0.0	9.6
Cycle Q Clear(g_c), s	10.8	0.0	17.7	1.7	12.1	2.8	3.2	0.0	12.3	10.1	0.0	9.6
Prop In Lane	1.00		0.14	1.00		1.00	1.00		0.29	1.00		0.51
Lane Grp Cap(c), veh/h	449	0	614	266	386	328	394	0	360	424	0	516
V/C Ratio(X)	0.75	0.00	0.76	0.18	0.78	0.20	0.23	0.00	0.80	0.73	0.00	0.49
Avail Cap(c_a), veh/h	718	0	1144	440	824	701	580	0	881	487	0	902
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.9	0.0	23.1	22.9	29.2	25.5	22.2	0.0	29.3	19.4	0.0	22.1
Incr Delay (d2), s/veh	0.9	0.0	1.9	0.1	3.5	0.3	0.1	0.0	4.0	3.6	0.0	0.7
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	4.3	0.0	7.6	0.7	5.6	1.0	1.3	0.0	5.4	4.4	0.0	3.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	19.8	0.0	25.0	23.1	32.6	25.8	22.3	0.0	33.3	23.0	0.0	22.8
LnGrp LOS	B	A	C	C	C	C	C	A	C	C	A	C
Approach Vol, veh/h		799			417			378			562	
Approach Delay, s/veh		22.8			30.4			30.7			22.9	
Approach LOS		C			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.2	21.3	8.3	31.3	9.6	29.0	18.2	21.4
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	15.0	40.0	11.0	49.0	13.0	42.0	25.0	35.0
Max Q Clear Time (g_c+I1), s	12.1	14.3	3.7	19.7	5.2	11.6	12.8	14.1
Green Ext Time (p_c), s	0.2	1.9	0.0	3.4	0.1	1.8	0.4	2.1

Intersection Summary	
HCM 6th Ctrl Delay	25.7
HCM 6th LOS	C

Intersection	
Intersection Delay, s/veh	30.0
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	623	472	507	725
Demand Flow Rate, veh/h	652	486	517	739
Vehicles Circulating, veh/h	550	606	818	506
Vehicles Exiting, veh/h	695	729	384	586
Ped Vol Crossing Leg, #/h	28	5	28	23
Ped Cap Adj	0.996	0.999	0.996	0.997
Approach Delay, s/veh	27.9	17.2	37.9	34.6
Approach LOS	D	C	E	D

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	652	486	517	739
Cap Entry Lane, veh/h	787	744	599	824
Entry HV Adj Factor	0.955	0.971	0.981	0.981
Flow Entry, veh/h	623	472	507	725
Cap Entry, veh/h	749	722	586	806
V/C Ratio	0.831	0.654	0.866	0.900
Control Delay, s/veh	27.9	17.2	37.9	34.6
LOS	D	C	E	D
95th %tile Queue, veh	9	5	10	12

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	452	0	144	0	0	0	68	675	0	0	490	315
Future Volume (veh/h)	452	0	144	0	0	0	68	675	0	0	490	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		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	1870	1870	1870	1870	1870	1870	1841	1870	1870	1781	1826
Adj Flow Rate, veh/h	476	0	0	0	0	0	72	711	0	0	516	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, %	3	2	2	2	2	2	2	4	2	2	8	5
Cap, veh/h	642	0		0	704	0	92	1497	0	3	1018	
Arrive On Green	0.38	0.00	0.00	0.00	0.00	0.00	0.05	0.43	0.00	0.00	0.30	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3589	0	1781	3385	1547
Grp Volume(v), veh/h	476	0	0	0	0	0	72	711	0	0	516	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1749	0	1781	1692	1547
Q Serve(g_s), s	21.0	0.0	0.0	0.0	0.0	0.0	2.7	9.7	0.0	0.0	8.4	0.0
Cycle Q Clear(g_c), s	21.0	0.0	0.0	0.0	0.0	0.0	2.7	9.7	0.0	0.0	8.4	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	642	0		0	704	0	92	1497	0	3	1018	
V/C Ratio(X)	0.74	0.00		0.00	0.00	0.00	0.78	0.47	0.00	0.00	0.51	
Avail Cap(c_a), veh/h	1047	0		0	1294	0	348	2368	0	80	1782	
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	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	19.5	0.0	0.0	0.0	0.0	0.0	31.1	13.6	0.0	0.0	19.2	0.0
Incr Delay (d2), s/veh	0.6	0.0	0.0	0.0	0.0	0.0	5.2	0.5	0.0	0.0	0.8	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	6.5	0.0	0.0	0.0	0.0	0.0	1.1	3.0	0.0	0.0	2.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.1	0.0	0.0	0.0	0.0	0.0	36.4	14.1	0.0	0.0	20.0	0.0
LnGrp LOS	C	A		A	A	A	D	B	A	A	C	
Approach Vol, veh/h		476	A		0			783			516	A
Approach Delay, s/veh		20.1			0.0			16.2			20.0	
Approach LOS		C						B			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	0.0	35.4	31.0	8.4	27.0	31.0
Change Period (Y+Rc), s	5.0	7.0	6.0	5.0	7.0	* 6
Max Green Setting (Gmax), s	3.0	45.0	44.0	13.0	35.0	* 46
Max Q Clear Time (g_c+I1), s	0.0	11.7	23.0	4.7	10.4	0.0
Green Ext Time (p_c), s	0.0	9.2	2.1	0.0	5.7	0.0

Intersection Summary	
HCM 6th Ctrl Delay	18.3
HCM 6th LOS	B

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Existing (2022)
5: Honoapiilani Hwy & Waiko Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	21	17	11	69	4	21	0	535	58	96	685	8
Future Volume (veh/h)	21	17	11	69	4	21	0	535	58	96	685	8
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.99	0.99		0.99	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	1826	1811	1633	1870	1530	1870	1870	1870	1826	1856	1870	1870
Adj Flow Rate, veh/h	25	20	1	83	5	14	0	645	68	116	825	0
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Percent Heavy Veh, %	5	6	18	2	25	2	2	2	5	3	2	2
Cap, veh/h	192	125	181	213	16	19	382	894	94	393	1232	
Arrive On Green	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.54	0.54	0.05	0.66	0.00
Sat Flow, veh/h	748	953	1374	788	123	145	1781	1659	175	1767	1870	1585
Grp Volume(v), veh/h	45	0	1	102	0	0	0	0	713	116	825	0
Grp Sat Flow(s),veh/h/ln	1700	0	1374	1055	0	0	1781	0	1834	1767	1870	1585
Q Serve(g_s), s	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	17.4	1.6	16.0	0.0
Cycle Q Clear(g_c), s	1.3	0.0	0.0	5.8	0.0	0.0	0.0	0.0	17.4	1.6	16.0	0.0
Prop In Lane	0.56		1.00	0.81		0.14	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	318	0	181	249	0	0	382	0	989	393	1232	
V/C Ratio(X)	0.14	0.00	0.01	0.41	0.00	0.00	0.00	0.00	0.72	0.30	0.67	
Avail Cap(c_a), veh/h	666	0	496	526	0	0	559	0	1911	598	2074	
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	1.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	23.0	0.0	22.5	25.2	0.0	0.0	0.0	0.0	10.3	8.3	6.2	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.0	2.1	0.2	1.4	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	0.5	0.0	0.0	1.4	0.0	0.0	0.0	0.0	6.1	0.4	4.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.1	0.0	22.5	25.6	0.0	0.0	0.0	0.0	12.5	8.4	7.6	0.0
LnGrp LOS	C	A	C	C	A	A	A	A	B	A	A	
Approach Vol, veh/h		46			102			713			941	A
Approach Delay, s/veh		23.1			25.6			12.5			7.7	
Approach LOS		C			C			B			A	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.1	38.1		14.3	0.0	45.2		14.3
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5
Max Green Setting (Gmax), s	10.0	62.0		21.5	6.0	66.0		* 22
Max Q Clear Time (g_c+I1), s	3.6	19.4		3.3	0.0	18.0		7.8
Green Ext Time (p_c), s	0.1	12.6		0.1	0.0	16.5		0.3

Intersection Summary		
HCM 6th Ctrl Delay		11.0
HCM 6th LOS		B

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th TWSC — Existing (2022)
6: Waiko Rd & Waiale Rd — AM Peak Hour

Intersection	
Int Delay, s/veh	8.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	48	134	37	54	189	55
Future Vol, veh/h	48	134	37	54	189	55
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	76	76	76	76	76	76
Heavy Vehicles, %	6	2	8	19	2	2
Mvmt Flow	63	176	49	71	249	72

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	120	0	-	0	387	85
Stage 1	-	-	-	-	85	-
Stage 2	-	-	-	-	302	-
Critical Hdwy	4.16	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.254	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1443	-	-	-	616	974
Stage 1	-	-	-	-	938	-
Stage 2	-	-	-	-	750	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1443	-	-	-	586	974
Mov Cap-2 Maneuver	-	-	-	-	586	-
Stage 1	-	-	-	-	893	-
Stage 2	-	-	-	-	750	-

Approach	EB		WB		SB
HCM Control Delay, s	2		0		16
HCM LOS					C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1443	-	-	-	644
HCM Lane V/C Ratio	0.044	-	-	-	0.499
HCM Control Delay (s)	7.6	0	-	-	16
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0.1	-	-	-	2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	276	41	20	478	527	92
Future Volume (veh/h)	276	41	20	478	527	92
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	1767	1455	1870	1870	1811	1752
Adj Flow Rate, veh/h	310	42	22	537	592	0
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	9	30	2	2	6	10
Cap, veh/h	362	49	46	1745	1280	
Arrive On Green	0.25	0.25	0.03	0.49	0.37	0.00
Sat Flow, veh/h	1456	197	1781	3647	3532	1485
Grp Volume(v), veh/h	353	0	22	537	592	0
Grp Sat Flow(s),veh/h/ln	1658	0	1781	1777	1721	1485
Q Serve(g_s), s	10.9	0.0	0.7	4.9	7.0	0.0
Cycle Q Clear(g_c), s	10.9	0.0	0.7	4.9	7.0	0.0
Prop In Lane	0.88	0.12	1.00			1.00
Lane Grp Cap(c), veh/h	412	0	46	1745	1280	
V/C Ratio(X)	0.86	0.00	0.47	0.31	0.46	
Avail Cap(c_a), veh/h	864	0	497	2843	1472	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	19.3	0.0	25.8	8.2	12.8	0.0
Incr Delay (d2), s/veh	2.0	0.0	2.8	0.1	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.0	0.0	0.3	1.3	2.1	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	21.3	0.0	28.6	8.3	13.1	0.0
LnGrp LOS	C	A	C	A	B	
Approach Vol, veh/h	353			559	592	A
Approach Delay, s/veh	21.3			9.1	13.1	
Approach LOS	C			A	B	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		33.4		20.4	6.4	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		43.0		28.0	15.0	23.0
Max Q Clear Time (g_c+I1), s		6.9		12.9	2.7	9.0
Green Ext Time (p_c), s		3.5		0.5	0.0	3.1

Intersection Summary			
HCM 6th Ctrl Delay			13.5
HCM 6th LOS			B

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	7	1	4	532	743	17
Future Vol, veh/h	7	1	4	532	743	17
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	250	-	-	250
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	86	86	86	86	86	86
Heavy Vehicles, %	14	2	75	2	3	12
Mvmt Flow	8	1	5	619	864	20

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1493	864	884	0	-	0
Stage 1	864	-	-	-	-	-
Stage 2	629	-	-	-	-	-
Critical Hdwy	6.54	6.22	4.85	-	-	-
Critical Hdwy Stg 1	5.54	-	-	-	-	-
Critical Hdwy Stg 2	5.54	-	-	-	-	-
Follow-up Hdwy	3.626	3.318	2.875	-	-	-
Pot Cap-1 Maneuver	127	354	531	-	-	-
Stage 1	393	-	-	-	-	-
Stage 2	509	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	126	354	531	-	-	-
Mov Cap-2 Maneuver	126	-	-	-	-	-
Stage 1	389	-	-	-	-	-
Stage 2	509	-	-	-	-	-

Approach	EB		NB		SB	
HCM Control Delay, s	33.2		0.1		0	
HCM LOS	D					

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	531	-	137	-	-
HCM Lane V/C Ratio	0.009	-	0.068	-	-
HCM Control Delay (s)	11.8	-	33.2	-	-
HCM Lane LOS	B	-	D	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	0	6	562	5	1	4	530	523	1	706	1
Future Volume (veh/h)	1	0	6	562	5	1	4	530	523	1	706	1
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	418	1870	418	1796	714	1870	788	1870	1870	1870	1870	418
Adj Flow Rate, veh/h	1	0	0	615	0	0	4	576	0	1	767	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	100	2	100	7	80	2	75	2	2	2	2	100
Cap, veh/h	3	0		853	0		4	1366		3	1352	
Arrive On Green	0.00	0.00	0.00	0.25	0.00	0.00	0.01	0.38	0.00	0.00	0.38	0.00
Sat Flow, veh/h	1781	0	0	3421	0	1585	751	3554	1585	1781	3554	354
Grp Volume(v), veh/h	1	0	0	615	0	0	4	576	0	1	767	0
Grp Sat Flow(s),veh/h/ln	1781	0	0	1711	0	1585	751	1777	1585	1781	1777	354
Q Serve(g_s), s	0.0	0.0	0.0	8.6	0.0	0.0	0.3	6.2	0.0	0.0	8.9	0.0
Cycle Q Clear(g_c), s	0.0	0.0	0.0	8.6	0.0	0.0	0.3	6.2	0.0	0.0	8.9	0.0
Prop In Lane	1.00		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	3	0		853	0		4	1366		3	1352	
V/C Ratio(X)	0.29	0.00		0.72	0.00		0.99	0.42		0.29	0.57	
Avail Cap(c_a), veh/h	170	0		2946	0		86	3740		204	3740	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	26.1	0.0	0.0	18.0	0.0	0.0	26.0	11.8	0.0	26.1	12.8	0.0
Incr Delay (d2), s/veh	41.9	0.0	0.0	1.2	0.0	0.0	122.9	0.3	0.0	16.7	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	0.1	0.0	0.0	3.1	0.0	0.0	0.2	2.1	0.0	0.0	3.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	67.9	0.0	0.0	19.1	0.0	0.0	148.9	12.1	0.0	42.8	13.3	0.0
LnGrp LOS	E	A		B	A		F	B		D	B	
Approach Vol, veh/h		1	A		615	A		580	A		768	A
Approach Delay, s/veh		67.9			19.1			13.1			13.4	
Approach LOS		E			B			B			B	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	4.1	25.1		18.0	4.3	24.9		5.1				
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0				
Max Green Setting (Gmax), s	6.0	55.0		45.0	6.0	55.0		5.0				
Max Q Clear Time (g_c+I1), s	2.0	8.2		10.6	2.3	10.9		2.0				
Green Ext Time (p_c), s	0.0	6.3		2.4	0.0	9.0		0.0				

Intersection Summary		
HCM 6th Ctrl Delay		15.1
HCM 6th LOS		B

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
1: Honoapiilani Hwy & Kuikahi Dr

Existing (2022)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	12	91	25	339	119	211	45	371	334	212	373	16
Future Volume (veh/h)	12	91	25	339	119	211	45	371	334	212	373	16
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	1870	1870	1870	1870	1870	1856	1870	1856	1870
Adj Flow Rate, veh/h	12	95	0	353	124	0	47	386	0	221	389	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, %	2	2	2	2	2	2	2	2	3	2	3	2
Cap, veh/h	240	156		519	513		405	587		443	703	
Arrive On Green	0.01	0.08	0.00	0.20	0.27	0.00	0.04	0.31	0.00	0.11	0.38	0.00
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Grp Volume(v), veh/h	12	95	0	353	124	0	47	386	0	221	389	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Q Serve(g_s), s	0.4	3.1	0.0	10.7	3.3	0.0	1.1	11.4	0.0	4.9	10.5	0.0
Cycle Q Clear(g_c), s	0.4	3.1	0.0	10.7	3.3	0.0	1.1	11.4	0.0	4.9	10.5	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	240	156		519	513		405	587		443	703	
V/C Ratio(X)	0.05	0.61		0.68	0.24		0.12	0.66		0.50	0.55	
Avail Cap(c_a), veh/h	624	587		563	587		745	1233		668	1223	
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	26.3	28.2	0.0	18.8	18.0	0.0	13.8	18.9	0.0	12.6	15.5	0.0
Incr Delay (d2), s/veh	0.1	2.8	0.0	3.0	0.2	0.0	0.0	2.7	0.0	0.3	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	0.2	1.5	0.0	4.5	1.3	0.0	0.4	4.6	0.0	1.6	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	26.3	31.1	0.0	21.8	18.2	0.0	13.9	21.6	0.0	12.9	17.0	0.0
LnGrp LOS	C	C		C	B		B	C		B	B	
Approach Vol, veh/h		107	A		477	A		433	A		610	A
Approach Delay, s/veh		30.5			20.8			20.7			15.5	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	11.0	25.0	17.4	10.3	6.8	29.2	5.3	22.5
Change Period (Y+Rc), s	4.0	5.0	4.5	5.0	4.0	5.0	4.5	5.0
Max Green Setting (Gmax), s	15.0	42.0	14.5	20.0	15.0	42.0	14.5	20.0
Max Q Clear Time (g_c+I1), s	6.9	13.4	12.7	5.1	3.1	12.5	2.4	5.3
Green Ext Time (p_c), s	0.2	4.4	0.2	0.3	0.0	4.5	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	19.5
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
2: Waiale Rd & Kuikahi Dr

Existing (2022)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	255	328	32	88	388	265	73	112	59	302	116	169
Future Volume (veh/h)	255	328	32	88	388	265	73	112	59	302	116	169
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		0.98	1.00		0.98
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	1870	1856	1841	1841	1856	1870	1856	1870	1870	1826	1870
Adj Flow Rate, veh/h	277	357	34	96	422	92	79	122	49	328	126	143
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	3	2	3	4	4	3	2	3	2	2	5	2
Cap, veh/h	395	600	57	380	517	440	321	169	68	465	199	226
Arrive On Green	0.14	0.36	0.36	0.06	0.28	0.28	0.05	0.14	0.14	0.18	0.26	0.26
Sat Flow, veh/h	1767	1678	160	1753	1841	1567	1781	1250	502	1781	771	875
Grp Volume(v), veh/h	277	0	391	96	422	92	79	0	171	328	0	269
Grp Sat Flow(s),veh/h/ln	1767	0	1838	1753	1841	1567	1781	0	1751	1781	0	1646
Q Serve(g_s), s	7.6	0.0	12.8	2.8	15.8	3.3	2.8	0.0	6.9	11.0	0.0	10.7
Cycle Q Clear(g_c), s	7.6	0.0	12.8	2.8	15.8	3.3	2.8	0.0	6.9	11.0	0.0	10.7
Prop In Lane	1.00		0.09	1.00		1.00	1.00		0.29	1.00		0.53
Lane Grp Cap(c), veh/h	395	0	657	380	517	440	321	0	237	465	0	426
V/C Ratio(X)	0.70	0.00	0.59	0.25	0.82	0.21	0.25	0.00	0.72	0.71	0.00	0.63
Avail Cap(c_a), veh/h	755	0	1220	539	873	743	538	0	949	510	0	937
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.5	0.0	19.3	17.4	24.8	20.3	25.4	0.0	30.6	20.4	0.0	24.2
Incr Delay (d2), s/veh	0.9	0.0	0.9	0.1	3.2	0.2	0.1	0.0	4.1	3.1	0.0	1.6
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	5.4	1.1	7.1	1.2	1.2	0.0	3.1	4.8	0.0	4.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	17.4	0.0	20.2	17.6	28.0	20.5	25.5	0.0	34.7	23.5	0.0	25.8
LnGrp LOS	B	A	C	B	C	C	C	A	C	C	A	C
Approach Vol, veh/h		668			610			250			597	
Approach Delay, s/veh		19.0			25.2			31.8			24.6	
Approach LOS		B			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	18.1	15.0	9.3	31.4	9.0	24.1	15.0	25.7
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	15.0	40.0	11.0	49.0	13.0	42.0	25.0	35.0
Max Q Clear Time (g_c+I1), s	13.0	8.9	4.8	14.8	4.8	12.7	9.6	17.8
Green Ext Time (p_c), s	0.1	1.1	0.1	2.8	0.0	1.9	0.4	2.9

Intersection Summary	
HCM 6th Ctrl Delay	23.9
HCM 6th LOS	C

Intersection				
Intersection Delay, s/veh	21.8			
Intersection LOS	C			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	710	711	233	595
Demand Flow Rate, veh/h	727	729	238	607
Vehicles Circulating, veh/h	354	501	782	474
Vehicles Exiting, veh/h	727	519	299	756
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	18.4	31.9	11.4	17.8
Approach LOS	C	D	B	C

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	727	729	238	607
Cap Entry Lane, veh/h	962	828	622	851
Entry HV Adj Factor	0.977	0.976	0.980	0.981
Flow Entry, veh/h	710	711	233	595
Cap Entry, veh/h	940	808	609	835
V/C Ratio	0.756	0.881	0.383	0.713
Control Delay, s/veh	18.4	31.9	11.4	17.8
LOS	C	D	B	C
95th %tile Queue, veh	7	11	2	6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	389	0	69	0	0	0	178	639	0	2	769	509
Future Volume (veh/h)	389	0	69	0	0	0	178	639	0	2	769	509
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	1856	1870	1870	1870	1870	1856	1870	1870	1841	1870
Adj Flow Rate, veh/h	409	0	0	0	0	0	187	673	0	2	809	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, %	2	2	3	2	2	2	2	3	2	2	4	2
Cap, veh/h	546	0		0	601	0	227	1590	0	3	1137	
Arrive On Green	0.32	0.00	0.00	0.00	0.00	0.00	0.13	0.45	0.00	0.00	0.33	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3618	0	1781	3497	1585
Grp Volume(v), veh/h	409	0	0	0	0	0	187	673	0	2	809	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1763	0	1781	1749	1585
Q Serve(g_s), s	21.9	0.0	0.0	0.0	0.0	0.0	8.2	10.3	0.0	0.1	16.2	0.0
Cycle Q Clear(g_c), s	21.9	0.0	0.0	0.0	0.0	0.0	8.2	10.3	0.0	0.1	16.2	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	546	0		0	601	0	227	1590	0	3	1137	
V/C Ratio(X)	0.75	0.00		0.00	0.00	0.00	0.82	0.42	0.00	0.69	0.71	
Avail Cap(c_a), veh/h	873	0		0	1080	0	514	2433	0	67	1536	
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	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	25.8	0.0	0.0	0.0	0.0	0.0	33.9	14.8	0.0	39.8	23.6	0.0
Incr Delay (d2), s/veh	0.8	0.0	0.0	0.0	0.0	0.0	2.9	0.4	0.0	72.5	1.9	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	7.2	0.0	0.0	0.0	0.0	0.0	3.4	3.5	0.0	0.1	6.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	26.6	0.0	0.0	0.0	0.0	0.0	36.7	15.2	0.0	112.3	25.5	0.0
LnGrp LOS	C	A		A	A	A	D	B	A	F	C	
Approach Vol, veh/h		409	A		0			860			811	A
Approach Delay, s/veh		26.6			0.0			19.9			25.7	
Approach LOS		C						B			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	5.1	42.9		31.6	15.2	32.9		31.6
Change Period (Y+Rc), s	5.0	7.0		6.0	5.0	7.0		* 6
Max Green Setting (Gmax), s	3.0	55.0		44.0	23.0	35.0		* 46
Max Q Clear Time (g_c+I1), s	2.1	12.3		23.9	10.2	18.2		0.0
Green Ext Time (p_c), s	0.0	9.2		1.7	0.2	7.7		0.0

Intersection Summary		
HCM 6th Ctrl Delay		23.5
HCM 6th LOS		C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

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)	14	11	1	244	11	37	8	665	108	44	580	22
Future Volume (veh/h)	14	11	1	244	11	37	8	665	108	44	580	22
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		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	1796	1870	1870	1870	1870	1870	1722	1870	1841	1870	1870	1870
Adj Flow Rate, veh/h	16	12	-10	277	12	32	9	756	121	50	659	0
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	7	2	2	2	2	2	12	2	4	2	2	2
Cap, veh/h	274	190	375	369	13	34	339	881	141	218	1084	
Arrive On Green	0.24	0.24	0.00	0.24	0.24	0.24	0.01	0.56	0.56	0.02	0.58	0.00
Sat Flow, veh/h	903	805	1585	1255	54	145	1640	1567	251	1781	1870	1585
Grp Volume(v), veh/h	28	0	-10	321	0	0	9	0	877	50	659	0
Grp Sat Flow(s),veh/h/ln	1708	0	1585	1455	0	0	1640	0	1818	1781	1870	1585
Q Serve(g_s), s	0.0	0.0	0.0	19.0	0.0	0.0	0.2	0.0	38.0	1.1	21.3	0.0
Cycle Q Clear(g_c), s	1.1	0.0	0.0	20.1	0.0	0.0	0.2	0.0	38.0	1.1	21.3	0.0
Prop In Lane	0.57		1.00	0.86		0.10	1.00		0.14	1.00		1.00
Lane Grp Cap(c), veh/h	465	0	375	416	0	0	339	0	1022	218	1084	
V/C Ratio(X)	0.06	0.00	-0.03	0.77	0.00	0.00	0.03	0.00	0.86	0.23	0.61	
Avail Cap(c_a), veh/h	465	0	375	416	0	0	434	0	1211	366	1326	
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	27.6	0.0	0.0	34.7	0.0	0.0	10.8	0.0	17.2	16.6	12.7	0.0
Incr Delay (d2), s/veh	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	6.8	0.2	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	0.5	0.0	0.0	7.9	0.0	0.0	0.1	0.0	16.2	0.4	8.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.6	0.0	0.0	42.6	0.0	0.0	10.8	0.0	24.0	16.8	13.9	0.0
LnGrp LOS	C	A	A	D	A	A	B	A	C	B	B	
Approach Vol, veh/h		18			321			886			709	A
Approach Delay, s/veh		42.9			42.6			23.9			14.1	
Approach LOS		D			D			C			B	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	6.3	58.3	28.5	4.6	60.0	28.5
Change Period (Y+Rc), s	4.0	6.0	6.5	4.0	6.0	* 6.5
Max Green Setting (Gmax), s	10.0	62.0	21.5	6.0	66.0	* 22
Max Q Clear Time (g_c+I1), s	3.1	40.0	3.1	2.2	23.3	22.1
Green Ext Time (p_c), s	0.0	12.3	0.0	0.0	11.1	0.0

Intersection Summary	
HCM 6th Ctrl Delay	23.6
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	76	91	230	169	55	28
Future Vol, veh/h	76	91	230	169	55	28
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	2	4	2	2	9	2
Mvmt Flow	103	123	311	228	74	38

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	539	0	-	0	754	425
Stage 1	-	-	-	-	425	-
Stage 2	-	-	-	-	329	-
Critical Hdwy	4.12	-	-	-	6.49	6.22
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	2.218	-	-	-	3.581	3.318
Pot Cap-1 Maneuver	1029	-	-	-	367	629
Stage 1	-	-	-	-	645	-
Stage 2	-	-	-	-	714	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1029	-	-	-	328	629
Mov Cap-2 Maneuver	-	-	-	-	328	-
Stage 1	-	-	-	-	576	-
Stage 2	-	-	-	-	714	-

Approach	EB	WB	SB
HCM Control Delay, s	4	0	17.9
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1029	-	-	-	391
HCM Lane V/C Ratio	0.1	-	-	-	0.287
HCM Control Delay (s)	8.9	0	-	-	17.9
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0.3	-	-	-	1.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	146	23	39	665	687	154
Future Volume (veh/h)	146	23	39	665	687	154
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	1856	1870	1604	1856	1856	1811
Adj Flow Rate, veh/h	155	17	41	707	731	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	3	2	20	3	3	6
Cap, veh/h	283	31	66	1906	1402	
Arrive On Green	0.18	0.18	0.04	0.54	0.40	0.00
Sat Flow, veh/h	1565	172	1527	3618	3618	1535
Grp Volume(v), veh/h	173	0	41	707	731	0
Grp Sat Flow(s),veh/h/ln	1746	0	1527	1763	1763	1535
Q Serve(g_s), s	4.5	0.0	1.3	5.8	7.9	0.0
Cycle Q Clear(g_c), s	4.5	0.0	1.3	5.8	7.9	0.0
Prop In Lane	0.90	0.10	1.00			1.00
Lane Grp Cap(c), veh/h	316	0	66	1906	1402	
V/C Ratio(X)	0.55	0.00	0.62	0.37	0.52	
Avail Cap(c_a), veh/h	972	0	456	3015	1612	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	18.7	0.0	23.6	6.6	11.5	0.0
Incr Delay (d2), s/veh	0.5	0.0	3.5	0.1	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	0.0	0.5	1.3	2.3	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	19.3	0.0	27.1	6.8	11.8	0.0
LnGrp LOS	B	A	C	A	B	
Approach Vol, veh/h	173			748	731	A
Approach Delay, s/veh	19.3			7.9	11.8	
Approach LOS	B			A	B	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		34.2		16.1	7.2	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		43.0		28.0	15.0	23.0
Max Q Clear Time (g_c+I1), s		7.8		6.5	3.3	9.9
Green Ext Time (p_c), s		4.9		0.2	0.0	3.8

Intersection Summary			
HCM 6th Ctrl Delay			10.8
HCM 6th LOS			B

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	44	19	12	718	753	39
Future Vol, veh/h	44	19	12	718	753	39
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	250	-	-	250
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	3	2	2
Mvmt Flow	48	21	13	780	818	42

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1624	818	860	0	-	0
Stage 1	818	-	-	-	-	-
Stage 2	806	-	-	-	-	-
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	113	376	781	-	-	-
Stage 1	434	-	-	-	-	-
Stage 2	439	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	111	376	781	-	-	-
Mov Cap-2 Maneuver	111	-	-	-	-	-
Stage 1	427	-	-	-	-	-
Stage 2	439	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	52.5	0.2	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	781	-	141	-	-
HCM Lane V/C Ratio	0.017	-	0.486	-	-
HCM Control Delay (s)	9.7	-	52.5	-	-
HCM Lane LOS	A	-	F	-	-
HCM 95th %tile Q(veh)	0.1	-	2.3	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	4	1	4	736	0	10	3	653	748	17	827	12
Future Volume (veh/h)	4	1	4	736	0	10	3	653	748	17	827	12
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	1870	1870	1752	1870	1856	1856	1870	1870	418
Adj Flow Rate, veh/h	4	1	0	767	0	0	3	680	0	18	861	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, %	2	2	2	2	2	10	2	3	3	2	2	100
Cap, veh/h	10	2		1002	0		7	1334		38	1406	
Arrive On Green	0.01	0.01	0.00	0.28	0.00	0.00	0.00	0.38	0.00	0.02	0.40	0.00
Sat Flow, veh/h	1439	360	0	3563	0	1485	1781	3526	1572	1781	3554	354
Grp Volume(v), veh/h	5	0	0	767	0	0	3	680	0	18	861	0
Grp Sat Flow(s),veh/h/ln	1798	0	0	1781	0	1485	1781	1763	1572	1781	1777	354
Q Serve(g_s), s	0.2	0.0	0.0	12.0	0.0	0.0	0.1	9.0	0.0	0.6	11.8	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0	12.0	0.0	0.0	0.1	9.0	0.0	0.6	11.8	0.0
Prop In Lane	0.80		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	12	0		1002	0		7	1334		38	1406	
V/C Ratio(X)	0.42	0.00		0.77	0.00		0.41	0.51		0.47	0.61	
Avail Cap(c_a), veh/h	148	0		2635	0		176	3187		176	3212	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	30.1	0.0	0.0	20.0	0.0	0.0	30.2	14.6	0.0	29.4	14.7	0.0
Incr Delay (d2), s/veh	21.5	0.0	0.0	1.3	0.0	0.0	13.4	0.4	0.0	3.3	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	0.1	0.0	0.0	4.7	0.0	0.0	0.1	3.2	0.0	0.3	4.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.6	0.0	0.0	21.3	0.0	0.0	43.7	15.0	0.0	32.7	15.3	0.0
LnGrp LOS	D	A		C	A		D	B		C	B	
Approach Vol, veh/h		5	A		767	A		683	A		879	A
Approach Delay, s/veh		51.6			21.3			15.1			15.6	
Approach LOS		D			C			B			B	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	5.3	28.0		22.1	4.2	29.1		5.4				
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0				
Max Green Setting (Gmax), s	6.0	55.0		45.0	6.0	55.0		5.0				
Max Q Clear Time (g_c+I1), s	2.6	11.0		14.0	2.1	13.8		2.2				
Green Ext Time (p_c), s	0.0	7.7		3.1	0.0	10.3		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			17.4
HCM 6th LOS			B

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
1: Honoapiilani Hwy & Kuikahi Dr

Future (2045) No Project
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	80	260	110	420	140	280	40	720	580	350	670	40
Future Volume (veh/h)	80	260	110	420	140	280	40	720	580	350	670	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		1.00	0.99		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	1826	1870	1841	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	84	274	0	442	147	0	42	758	0	368	705	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, %	2	2	2	5	2	4	2	2	2	2	2	2
Cap, veh/h	319	238		382	477		264	714		325	925	
Arrive On Green	0.05	0.13	0.00	0.18	0.25	0.00	0.03	0.38	0.00	0.15	0.49	0.00
Sat Flow, veh/h	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	84	274	0	442	147	0	42	758	0	368	705	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	4.5	14.0	0.0	20.0	7.0	0.0	1.6	42.0	0.0	16.0	33.6	0.0
Cycle Q Clear(g_c), s	4.5	14.0	0.0	20.0	7.0	0.0	1.6	42.0	0.0	16.0	33.6	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	319	238		382	477		264	714		325	925	
V/C Ratio(X)	0.26	1.15		1.16	0.31		0.16	1.06		1.13	0.76	
Avail Cap(c_a), veh/h	320	238		382	477		286	714		325	925	
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	48.0	0.0	33.5	33.1	0.0	21.5	34.0	0.0	35.3	22.6	0.0
Incr Delay (d2), s/veh	0.4	105.2	0.0	96.6	0.3	0.0	0.1	51.2	0.0	91.3	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	2.0	13.4	0.0	18.9	3.2	0.0	0.6	27.8	0.0	12.3	14.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.1	153.2	0.0	130.1	33.4	0.0	21.6	85.2	0.0	126.6	27.0	0.0
LnGrp LOS	D	F		F	C		C	F		F	C	
Approach Vol, veh/h		358	A		589	A		800	A		1073	A
Approach Delay, s/veh		126.4			106.0			81.8			61.2	
Approach LOS		F			F			F			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	47.0	24.0	19.0	7.6	59.4	10.0	33.0
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	16.0	42.0	20.0	14.0	5.0	53.0	6.0	28.0
Max Q Clear Time (g_c+I1), s	18.0	44.0	22.0	16.0	3.6	35.6	6.5	9.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	84.7
HCM 6th LOS	F

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
2: Waiale Rd & Kuikahi Dr

Future (2045) No Project
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	450	620	90	60	480	410	120	280	90	430	190	210
Future Volume (veh/h)	450	620	90	60	480	410	120	280	90	430	190	210
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.97	1.00		0.97
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	1856	1856	1856	1856	1856	1856	1856	1856
Adj Flow Rate, veh/h	474	653	93	63	505	127	126	295	88	453	200	195
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, %	2	2	2	3	3	3	3	3	3	3	3	3
Cap, veh/h	418	671	96	124	461	378	296	281	84	403	299	291
Arrive On Green	0.21	0.42	0.42	0.03	0.25	0.25	0.06	0.21	0.21	0.20	0.35	0.35
Sat Flow, veh/h	1781	1595	227	1767	1856	1523	1767	1360	406	1767	850	828
Grp Volume(v), veh/h	474	0	746	63	505	127	126	0	383	453	0	395
Grp Sat Flow(s),veh/h/ln	1781	0	1822	1767	1856	1523	1767	0	1766	1767	0	1678
Q Serve(g_s), s	30.0	0.0	58.2	3.8	36.0	9.9	8.0	0.0	30.0	29.0	0.0	28.9
Cycle Q Clear(g_c), s	30.0	0.0	58.2	3.8	36.0	9.9	8.0	0.0	30.0	29.0	0.0	28.9
Prop In Lane	1.00		0.12	1.00		1.00	1.00		0.23	1.00		0.49
Lane Grp Cap(c), veh/h	418	0	767	124	461	378	296	0	365	403	0	590
V/C Ratio(X)	1.13	0.00	0.97	0.51	1.10	0.34	0.43	0.00	1.05	1.12	0.00	0.67
Avail Cap(c_a), veh/h	418	0	767	124	461	378	296	0	365	403	0	590
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	46.6	0.0	41.2	42.8	54.5	44.7	42.9	0.0	57.5	45.9	0.0	39.8
Incr Delay (d2), s/veh	85.7	0.0	25.9	1.4	70.6	0.5	0.4	0.0	60.3	82.9	0.0	2.9
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	20.7	0.0	31.6	1.8	26.0	3.9	3.7	0.0	19.6	20.0	0.0	12.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	132.2	0.0	67.1	44.2	125.1	45.2	43.3	0.0	117.8	128.8	0.0	42.8
LnGrp LOS	F	A	E	D	F	D	D	A	F	F	A	D
Approach Vol, veh/h		1220			695			509			848	
Approach Delay, s/veh		92.4			103.2			99.3			88.7	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	34.0	35.0	10.0	66.0	13.0	56.0	35.0	41.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	29.0	30.0	5.0	61.0	8.0	51.0	30.0	36.0
Max Q Clear Time (g_c+I1), s	31.0	32.0	5.8	60.2	10.0	30.9	32.0	38.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.4	0.0	2.7	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	94.8
HCM 6th LOS	F

Intersection	
Intersection Delay, s/veh	203.1
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	905	726	579	1021
Demand Flow Rate, veh/h	928	749	591	1042
Vehicles Circulating, veh/h	688	795	1132	685
Vehicles Exiting, veh/h	1039	928	484	859
Ped Vol Crossing Leg, #/h	28	5	28	23
Ped Cap Adj	0.996	0.999	1.000	0.997
Approach Delay, s/veh	191.6	137.3	202.3	260.6
Approach LOS	F	F	F	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	928	749	591	1042
Cap Entry Lane, veh/h	684	613	435	686
Entry HV Adj Factor	0.976	0.970	0.979	0.980
Flow Entry, veh/h	905	726	579	1021
Cap Entry, veh/h	665	594	426	670
V/C Ratio	1.362	1.222	1.359	1.523
Control Delay, s/veh	191.6	137.3	202.3	260.6
LOS	F	F	F	F
95th %tile Queue, veh	39	27	27	51

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	620	0	240	0	0	0	140	1280	0	0	880	450
Future Volume (veh/h)	620	0	240	0	0	0	140	1280	0	0	880	450
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	1870	1870	1870	1870	1870	1870	1841	1870	1870	1841	1856
Adj Flow Rate, veh/h	653	0	0	0	0	0	147	1347	0	0	926	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, %	3	2	2	2	2	2	2	4	2	2	4	3
Cap, veh/h	729	0		0	890	0	160	1492	0	1	1045	
Arrive On Green	0.48	0.00	0.00	0.00	0.00	0.00	0.09	0.43	0.00	0.00	0.30	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3589	0	1781	3497	1572
Grp Volume(v), veh/h	653	0	0	0	0	0	147	1347	0	0	926	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1749	0	1781	1749	1572
Q Serve(g_s), s	59.6	0.0	0.0	0.0	0.0	0.0	10.9	47.9	0.0	0.0	33.6	0.0
Cycle Q Clear(g_c), s	59.6	0.0	0.0	0.0	0.0	0.0	10.9	47.9	0.0	0.0	33.6	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	729	0		0	890	0	160	1492	0	1	1045	
V/C Ratio(X)	0.90	0.00		0.00	0.00	0.00	0.92	0.90	0.00	0.00	0.89	
Avail Cap(c_a), veh/h	778	0		0	983	0	160	1492	0	40	1103	
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	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	33.9	0.0	0.0	0.0	0.0	0.0	60.1	35.6	0.0	0.0	44.5	0.0
Incr Delay (d2), s/veh	12.0	0.0	0.0	0.0	0.0	0.0	46.4	8.4	0.0	0.0	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	22.7	0.0	0.0	0.0	0.0	0.0	6.8	20.6	0.0	0.0	15.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	45.9	0.0	0.0	0.0	0.0	0.0	106.5	44.1	0.0	0.0	53.9	0.0
LnGrp LOS	D	A		A	A	A	F	D	A	A	D	
Approach Vol, veh/h		653	A		0			1494			926	A
Approach Delay, s/veh		45.9			0.0			50.2			53.9	
Approach LOS		D						D			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	0.0	63.8		69.4	17.0	46.8		69.4
Change Period (Y+Rc), s	5.0	7.0		6.0	5.0	7.0		* 6
Max Green Setting (Gmax), s	3.0	51.0		68.0	12.0	42.0		* 70
Max Q Clear Time (g_c+I1), s	0.0	49.9		61.6	12.9	35.6		0.0
Green Ext Time (p_c), s	0.0	1.0		1.8	0.0	4.2		0.0

Intersection Summary	
HCM 6th Ctrl Delay	50.4
HCM 6th LOS	D

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

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)	40	30	30	250	20	40	10	1140	330	120	1070	20
Future Volume (veh/h)	40	30	30	250	20	40	10	1140	330	120	1070	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	0.99		0.97	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	1856	1856	1856	1870	1856	1870	1870	1870	1856	1856	1870	1870
Adj Flow Rate, veh/h	42	32	7	263	21	40	11	1200	341	126	1126	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, %	3	3	3	2	3	2	2	2	3	3	2	2
Cap, veh/h	207	148	293	219	14	27	172	925	263	107	1291	
Arrive On Green	0.19	0.19	0.19	0.19	0.19	0.19	0.01	0.66	0.66	0.03	0.69	0.00
Sat Flow, veh/h	882	769	1518	911	73	139	1781	1392	396	1767	1870	1585
Grp Volume(v), veh/h	74	0	7	324	0	0	11	0	1541	126	1126	0
Grp Sat Flow(s),veh/h/ln	1651	0	1518	1123	0	0	1781	0	1787	1767	1870	1585
Q Serve(g_s), s	0.0	0.0	0.6	23.5	0.0	0.0	0.3	0.0	100.0	5.0	70.5	0.0
Cycle Q Clear(g_c), s	5.5	0.0	0.6	29.0	0.0	0.0	0.3	0.0	100.0	5.0	70.5	0.0
Prop In Lane	0.57		1.00	0.81		0.12	1.00		0.22	1.00		1.00
Lane Grp Cap(c), veh/h	356	0	293	260	0	0	172	0	1188	107	1291	
V/C Ratio(X)	0.21	0.00	0.02	1.25	0.00	0.00	0.06	0.00	1.30	1.18	0.87	
Avail Cap(c_a), veh/h	356	0	293	260	0	0	194	0	1188	107	1291	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	51.2	0.0	49.3	65.5	0.0	0.0	23.2	0.0	25.3	52.0	18.1	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	139.5	0.0	0.0	0.1	0.0	140.2	144.4	7.3	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	2.4	0.0	0.2	20.2	0.0	0.0	0.2	0.0	85.7	8.4	31.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.3	0.0	49.3	204.9	0.0	0.0	23.3	0.0	165.5	196.4	25.4	0.0
LnGrp LOS	D	A	D	F	A	A	C	A	F	F	C	
Approach Vol, veh/h		81			324			1552			1252	A
Approach Delay, s/veh		51.1			204.9			164.5			42.6	
Approach LOS		D			F			F			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	9.0	106.0		35.5	5.1	109.9		35.5
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5
Max Green Setting (Gmax), s	5.0	100.0		28.5	3.0	102.0		* 29
Max Q Clear Time (g_c+I1), s	7.0	102.0		7.5	2.3	72.5		31.0
Green Ext Time (p_c), s	0.0	0.0		0.2	0.0	20.6		0.0

Intersection Summary	
HCM 6th Ctrl Delay	118.2
HCM 6th LOS	F

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	97.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	100	400	220	140	340	90
Future Vol, veh/h	100	400	220	140	340	90
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	3	2	3	4	2	2
Mvmt Flow	105	421	232	147	358	95

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	384	0	-	0	947	316
Stage 1	-	-	-	-	311	-
Stage 2	-	-	-	-	636	-
Critical Hdwy	4.13	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.227	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1169	-	-	-	~ 290	724
Stage 1	-	-	-	-	743	-
Stage 2	-	-	-	-	527	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1164	-	-	-	~ 254	718
Mov Cap-2 Maneuver	-	-	-	-	~ 254	-
Stage 1	-	-	-	-	652	-
Stage 2	-	-	-	-	525	-

Approach	EB	WB	SB
HCM Control Delay, s	1.7	0	291
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1164	-	-	-	294
HCM Lane V/C Ratio	0.09	-	-	-	1.54
HCM Control Delay (s)	8.4	0	-	-	291
HCM Lane LOS	A	A	-	-	F
HCM 95th %tile Q(veh)	0.3	-	-	-	26.3

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	630	100	50	790	760	360
Future Volume (veh/h)	630	100	50	790	760	360
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	1856	1841	1870	1870	1841	1841
Adj Flow Rate, veh/h	663	99	53	832	800	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	4	2	2	4	4
Cap, veh/h	693	103	76	1314	929	
Arrive On Green	0.46	0.46	0.04	0.37	0.27	0.00
Sat Flow, veh/h	1511	226	1781	3647	3589	1560
Grp Volume(v), veh/h	763	0	53	832	800	0
Grp Sat Flow(s),veh/h/ln	1739	0	1781	1777	1749	1560
Q Serve(g_s), s	34.5	0.0	2.4	15.7	17.8	0.0
Cycle Q Clear(g_c), s	34.5	0.0	2.4	15.7	17.8	0.0
Prop In Lane	0.87	0.13	1.00			1.00
Lane Grp Cap(c), veh/h	798	0	76	1314	929	
V/C Ratio(X)	0.96	0.00	0.69	0.63	0.86	
Avail Cap(c_a), veh/h	895	0	109	1481	1029	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.3	0.0	38.5	21.2	28.5	0.0
Incr Delay (d2), s/veh	18.6	0.0	4.2	0.7	7.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	16.9	0.0	1.1	6.0	7.7	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	39.9	0.0	42.7	21.9	35.6	0.0
LnGrp LOS	D	A	D	C	D	
Approach Vol, veh/h	763			885	800	A
Approach Delay, s/veh	39.9			23.1	35.6	
Approach LOS	D			C	D	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		37.2		44.4	8.5	28.7
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		34.0		42.0	5.0	24.0
Max Q Clear Time (g_c+I1), s		17.7		36.5	4.4	19.8
Green Ext Time (p_c), s		4.8		0.9	0.0	1.9

Intersection Summary			
HCM 6th Ctrl Delay			32.4
HCM 6th LOS			C

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [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	20	100	80	20	480	60	630	40	260	890	190
Future Volume (veh/h)	320	20	100	80	20	480	60	630	40	260	890	190
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	0.99		0.96	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1870	1856	1870	1870	1870	1856	1856
Adj Flow Rate, veh/h	337	21	32	84	21	298	63	663	19	274	937	141
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, %	3	2	2	2	2	2	3	2	2	2	3	3
Cap, veh/h	317	202	307	373	20	279	111	833	687	331	953	787
Arrive On Green	0.15	0.31	0.31	0.04	0.19	0.19	0.03	0.45	0.45	0.10	0.51	0.51
Sat Flow, veh/h	1767	655	998	1781	102	1444	1767	1870	1542	1781	1856	1531
Grp Volume(v), veh/h	337	0	53	84	0	319	63	663	19	274	937	141
Grp Sat Flow(s),veh/h/ln	1767	0	1654	1781	0	1546	1767	1870	1542	1781	1856	1531
Q Serve(g_s), s	21.0	0.0	3.2	5.0	0.0	27.0	2.7	42.6	1.0	11.3	69.4	6.9
Cycle Q Clear(g_c), s	21.0	0.0	3.2	5.0	0.0	27.0	2.7	42.6	1.0	11.3	69.4	6.9
Prop In Lane	1.00		0.60	1.00		0.93	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	317	0	509	373	0	299	111	833	687	331	953	787
V/C Ratio(X)	1.06	0.00	0.10	0.23	0.00	1.07	0.57	0.80	0.03	0.83	0.98	0.18
Avail Cap(c_a), veh/h	317	0	509	373	0	299	111	833	687	375	956	789
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.1	0.0	34.6	43.6	0.0	56.4	33.7	33.3	21.8	27.2	33.4	18.2
Incr Delay (d2), s/veh	68.3	0.0	0.1	0.3	0.0	71.4	6.6	5.4	0.0	13.0	24.9	0.1
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	15.2	0.0	1.3	2.4	0.0	16.5	1.3	20.4	0.4	5.8	36.9	2.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	111.4	0.0	34.7	43.9	0.0	127.8	40.3	38.8	21.8	40.1	58.3	18.3
LnGrp LOS	F	A	C	D	A	F	D	D	C	D	E	B
Approach Vol, veh/h		390			403			745			1352	
Approach Delay, s/veh		101.0			110.4			38.5			50.5	
Approach LOS		F			F			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.6	66.3	9.0	47.0	8.0	75.8	25.0	31.0
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	17.0	59.0	5.0	43.0	4.0	72.0	21.0	27.0
Max Q Clear Time (g_c+I1), s	13.3	44.6	7.0	5.2	4.7	71.4	23.0	29.0
Green Ext Time (p_c), s	0.3	4.0	0.0	0.3	0.0	0.4	0.0	0.0

Intersection Summary			
HCM 6th Ctrl Delay			62.5
HCM 6th LOS			E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	10	30	180	10	50	10	640	100	30	1030	10
Future Volume (veh/h)	30	10	30	180	10	50	10	640	100	30	1030	10
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		0.96	1.00		0.97	1.00		0.98
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	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	32	11	0	189	11	8	11	674	69	32	1084	8
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, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	58	20	69	238	14	214	166	1169	966	414	1194	986
Arrive On Green	0.04	0.04	0.00	0.14	0.14	0.14	0.01	0.62	0.62	0.02	0.64	0.64
Sat Flow, veh/h	1342	461	1585	1688	98	1518	1781	1870	1545	1781	1870	1545
Grp Volume(v), veh/h	43	0	0	200	0	8	11	674	69	32	1084	8
Grp Sat Flow(s),veh/h/ln	1803	0	1585	1786	0	1518	1781	1870	1545	1781	1870	1545
Q Serve(g_s), s	2.2	0.0	0.0	10.4	0.0	0.4	0.2	20.3	1.7	0.6	47.9	0.2
Cycle Q Clear(g_c), s	2.2	0.0	0.0	10.4	0.0	0.4	0.2	20.3	1.7	0.6	47.9	0.2
Prop In Lane	0.74		1.00	0.94		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	78	0	69	252	0	214	166	1169	966	414	1194	986
V/C Ratio(X)	0.55	0.00	0.00	0.79	0.00	0.04	0.07	0.58	0.07	0.08	0.91	0.01
Avail Cap(c_a), veh/h	395	0	347	391	0	332	221	1520	1256	446	1520	1256
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	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	45.0	0.0	0.0	39.9	0.0	35.6	18.0	10.6	7.1	8.3	14.9	6.3
Incr Delay (d2), s/veh	5.9	0.0	0.0	6.0	0.0	0.1	0.2	0.5	0.0	0.1	7.0	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	1.1	0.0	0.0	4.9	0.0	0.2	0.1	7.7	0.5	0.2	19.8	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	50.9	0.0	0.0	45.9	0.0	35.7	18.1	11.0	7.1	8.4	22.0	6.3
LnGrp LOS	D	A	A	D	A	D	B	B	A	A	C	A
Approach Vol, veh/h		43			208			754			1124	
Approach Delay, s/veh		50.9			45.5			10.8			21.5	
Approach LOS		D			D			B			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	6.3	64.0		8.2	5.0	65.3		17.6
Change Period (Y+Rc), s	4.0	4.0		4.0	4.0	4.0		4.0
Max Green Setting (Gmax), s	4.0	78.0		21.0	4.0	78.0		21.0
Max Q Clear Time (g_c+I1), s	2.6	22.3		4.2	2.2	49.9		12.4
Green Ext Time (p_c), s	0.0	5.9		0.1	0.0	11.4		0.7

Intersection Summary	
HCM 6th Ctrl Delay	20.6
HCM 6th LOS	C

Intersection	
Intersection Delay, s/veh	3.8
Intersection LOS	A

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	147	127	148
Demand Flow Rate, veh/h	150	129	151
Vehicles Circulating, veh/h	11	64	118
Vehicles Exiting, veh/h	258	97	75
Ped Vol Crossing Leg, #/h	5	5	5
Ped Cap Adj	0.999	0.999	0.999
Approach Delay, s/veh	3.6	3.6	4.0
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	LR	LT	TR
Assumed Moves	LR	LT	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	150	129	151
Cap Entry Lane, veh/h	1364	1293	1223
Entry HV Adj Factor	0.980	0.983	0.979
Flow Entry, veh/h	147	127	148
Cap Entry, veh/h	1336	1270	1197
V/C Ratio	0.110	0.100	0.124
Control Delay, s/veh	3.6	3.6	4.0
LOS	A	A	A
95th %tile Queue, veh	0	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	760	10	90	10	660	720	130	1110	10
Future Volume (veh/h)	10	10	10	760	10	90	10	660	720	130	1110	10
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	1870	1856	1856	1856	1870	1856	1870	1870	1870	1870	1856
Adj Flow Rate, veh/h	11	11	0	808	0	0	11	695	0	137	1168	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, %	3	2	3	3	3	2	3	2	2	2	2	3
Cap, veh/h	23	23		961	0		24	1134		173	1431	
Arrive On Green	0.03	0.03	0.00	0.27	0.00	0.00	0.01	0.32	0.00	0.10	0.40	0.00
Sat Flow, veh/h	912	912	0	3534	0	1585	1767	3554	1585	1781	3554	1572
Grp Volume(v), veh/h	22	0	0	808	0	0	11	695	0	137	1168	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1767	0	1585	1767	1777	1585	1781	1777	1572
Q Serve(g_s), s	0.8	0.0	0.0	14.3	0.0	0.0	0.4	11.0	0.0	5.0	19.4	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0	14.3	0.0	0.0	0.4	11.0	0.0	5.0	19.4	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	46	0		961	0		24	1134		173	1431	
V/C Ratio(X)	0.48	0.00		0.84	0.00		0.45	0.61		0.79	0.82	
Avail Cap(c_a), veh/h	138	0		1172	0		133	1339		242	1553	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	31.9	0.0	0.0	22.8	0.0	0.0	32.5	19.1	0.0	29.3	17.6	0.0
Incr Delay (d2), s/veh	7.6	0.0	0.0	4.7	0.0	0.0	4.7	0.8	0.0	7.4	3.5	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	0.4	0.0	0.0	6.1	0.0	0.0	0.2	4.2	0.0	2.4	7.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.5	0.0	0.0	27.5	0.0	0.0	37.2	20.0	0.0	36.6	21.2	0.0
LnGrp LOS	D	A		C	A		D	B		D	C	
Approach Vol, veh/h		22	A		808	A		706	A		1305	A
Approach Delay, s/veh		39.5			27.5			20.2			22.8	
Approach LOS		D			C			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.5	26.2		23.0	4.9	31.7		6.7
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0
Max Green Setting (Gmax), s	9.0	25.0		22.0	5.0	29.0		5.0
Max Q Clear Time (g_c+I1), s	7.0	13.0		16.3	2.4	21.4		2.8
Green Ext Time (p_c), s	0.0	4.7		1.7	0.0	5.3		0.0

Intersection Summary	
HCM 6th Ctrl Delay	23.6
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) No Project
1: Honoapiilani Hwy & Kuikahi Dr — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	50	170	60	560	200	290	80	630	530	290	750	60
Future Volume (veh/h)	50	170	60	560	200	290	80	630	530	290	750	60
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		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	1870	1870	1870	1870	1870	1856	1870	1856	1870
Adj Flow Rate, veh/h	52	177	0	583	208	0	83	656	0	302	781	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, %	2	2	2	2	2	2	2	2	3	2	3	2
Cap, veh/h	225	174		552	628		160	684		294	837	
Arrive On Green	0.04	0.09	0.00	0.28	0.34	0.00	0.04	0.37	0.00	0.12	0.45	0.00
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Grp Volume(v), veh/h	52	177	0	583	208	0	83	656	0	302	781	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Q Serve(g_s), s	3.4	12.0	0.0	36.0	10.7	0.0	3.8	44.3	0.0	16.0	51.6	0.0
Cycle Q Clear(g_c), s	3.4	12.0	0.0	36.0	10.7	0.0	3.8	44.3	0.0	16.0	51.6	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	225	174		552	628		160	684		294	837	
V/C Ratio(X)	0.23	1.02		1.06	0.33		0.52	0.96		1.03	0.93	
Avail Cap(c_a), veh/h	231	174		552	628		160	694		294	847	
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	50.6	58.7	0.0	36.8	32.1	0.0	31.3	40.0	0.0	38.5	33.7	0.0
Incr Delay (d2), s/veh	0.5	73.6	0.0	54.2	0.2	0.0	1.3	24.7	0.0	59.5	17.5	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	1.6	9.2	0.0	23.8	4.9	0.0	1.6	24.1	0.0	14.2	25.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.2	132.2	0.0	91.1	32.3	0.0	32.6	64.7	0.0	98.0	51.1	0.0
LnGrp LOS	D	F		F	C		C	E		F	D	
Approach Vol, veh/h		229	A		791	A		739	A		1083	A
Approach Delay, s/veh		113.8			75.6			61.1			64.2	
Approach LOS		F			E			E			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	52.3	40.0	17.0	9.0	63.3	8.6	48.4
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	16.0	48.0	36.0	12.0	5.0	59.0	5.0	43.0
Max Q Clear Time (g_c+I1), s	18.0	46.3	38.0	14.0	5.8	53.6	5.4	12.7
Green Ext Time (p_c), s	0.0	1.0	0.0	0.0	0.0	3.4	0.0	1.0

Intersection Summary	
HCM 6th Ctrl Delay	70.6
HCM 6th LOS	E

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) No Project
2: Waiale Rd & Kuikahi Dr — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	360	540	60	100	640	410	110	200	60	460	200	260
Future Volume (veh/h)	360	540	60	100	640	410	110	200	60	460	200	260
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.96	0.99		0.97
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	1870	1856	1856	1856	1856	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	379	568	60	105	674	179	116	211	57	484	211	242
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, %	3	2	3	3	3	3	2	3	2	2	3	2
Cap, veh/h	331	763	81	257	627	516	189	241	65	413	240	275
Arrive On Green	0.16	0.46	0.46	0.04	0.34	0.34	0.05	0.17	0.17	0.19	0.31	0.31
Sat Flow, veh/h	1767	1658	175	1767	1856	1526	1781	1394	376	1781	775	888
Grp Volume(v), veh/h	379	0	628	105	674	179	116	0	268	484	0	453
Grp Sat Flow(s),veh/h/ln	1767	0	1833	1767	1856	1526	1781	0	1770	1781	0	1663
Q Serve(g_s), s	22.0	0.0	39.1	5.0	47.0	12.2	7.0	0.0	20.5	26.0	0.0	35.9
Cycle Q Clear(g_c), s	22.0	0.0	39.1	5.0	47.0	12.2	7.0	0.0	20.5	26.0	0.0	35.9
Prop In Lane	1.00		0.10	1.00		1.00	1.00		0.21	1.00		0.53
Lane Grp Cap(c), veh/h	331	0	844	257	627	516	189	0	306	413	0	515
V/C Ratio(X)	1.14	0.00	0.74	0.41	1.07	0.35	0.61	0.00	0.87	1.17	0.00	0.88
Avail Cap(c_a), veh/h	331	0	844	257	627	516	189	0	382	413	0	586
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	46.2	0.0	30.8	32.5	46.0	34.5	47.1	0.0	56.0	37.9	0.0	45.5
Incr Delay (d2), s/veh	94.4	0.0	3.6	0.4	57.7	0.4	4.2	0.0	16.8	100.2	0.0	13.2
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	15.9	0.0	18.2	2.4	31.8	4.7	3.6	0.0	10.7	23.1	0.0	16.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	140.6	0.0	34.4	32.9	103.8	34.9	51.3	0.0	72.8	138.1	0.0	58.8
LnGrp LOS	F	A	C	C	F	C	D	A	E	F	A	E
Approach Vol, veh/h		1007			958			384			937	
Approach Delay, s/veh		74.4			83.1			66.3			99.7	
Approach LOS		E			F			E			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	31.0	29.1	10.0	69.0	12.0	48.1	27.0	52.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	26.0	30.0	5.0	64.0	7.0	49.0	22.0	47.0
Max Q Clear Time (g_c+I1), s	28.0	22.5	7.0	41.1	9.0	37.9	24.0	49.0
Green Ext Time (p_c), s	0.0	0.9	0.0	4.8	0.0	2.4	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	83.2
HCM 6th LOS	F

Intersection				
Intersection Delay, s/veh	169.7			
Intersection LOS	F			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1031	959	288	918
Demand Flow Rate, veh/h	1055	982	293	937
Vehicles Circulating, veh/h	515	683	1161	651
Vehicles Exiting, veh/h	1073	771	409	1014
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	1.000	0.999
Approach Delay, s/veh	159.2	220.0	29.6	173.0
Approach LOS	F	F	D	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1055	982	293	937
Cap Entry Lane, veh/h	816	688	422	710
Entry HV Adj Factor	0.977	0.976	0.982	0.980
Flow Entry, veh/h	1031	959	288	918
Cap Entry, veh/h	797	671	415	695
V/C Ratio	1.294	1.429	0.694	1.320
Control Delay, s/veh	159.2	220.0	29.6	173.0
LOS	F	F	D	F
95th %tile Queue, veh	39	44	5	37

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥		↰	↑↱		↰	↑↑	↱
Traffic Volume (veh/h)	520	0	160	0	0	0	250	1130	0	10	1300	670
Future Volume (veh/h)	520	0	160	0	0	0	250	1130	0	10	1300	670
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	1856	1870	1870	1870	1870	1856	1870	1870	1841	1870
Adj Flow Rate, veh/h	547	0	0	0	0	0	263	1189	0	11	1368	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, %	2	2	3	2	2	2	2	3	2	2	4	2
Cap, veh/h	556	0		0	655	0	223	1736	0	14	1312	
Arrive On Green	0.35	0.00	0.00	0.00	0.00	0.00	0.13	0.49	0.00	0.01	0.38	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3618	0	1781	3497	1585
Grp Volume(v), veh/h	547	0	0	0	0	0	263	1189	0	11	1368	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1763	0	1781	1749	1585
Q Serve(g_s), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.0	0.0	0.7	45.0	0.0
Cycle Q Clear(g_c), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.0	0.0	0.7	45.0	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	556	0		0	655	0	223	1736	0	14	1312	
V/C Ratio(X)	0.98	0.00		0.00	0.00	0.00	1.18	0.69	0.00	0.80	1.04	
Avail Cap(c_a), veh/h	556	0		0	686	0	223	1736	0	45	1312	
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	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	41.0	0.0	0.0	0.0	0.0	0.0	52.5	23.3	0.0	59.4	37.5	0.0
Incr Delay (d2), s/veh	33.8	0.0	0.0	0.0	0.0	0.0	118.0	1.5	0.0	31.9	36.9	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	22.0	0.0	0.0	0.0	0.0	0.0	13.7	11.9	0.0	0.4	24.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	74.7	0.0	0.0	0.0	0.0	0.0	170.5	24.8	0.0	91.4	74.4	0.0
LnGrp LOS	E	A		A	A	A	F	C	A	F	F	
Approach Vol, veh/h		547	A		0			1452			1379	A
Approach Delay, s/veh		74.7			0.0			51.2			74.5	
Approach LOS		E						D			E	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	5.9	66.1		48.0	20.0	52.0		48.0
Change Period (Y+Rc), s	5.0	7.0		6.0	5.0	7.0		* 6
Max Green Setting (Gmax), s	3.0	57.0		42.0	15.0	45.0		* 44
Max Q Clear Time (g_c+I1), s	2.7	33.0		44.0	17.0	47.0		0.0
Green Ext Time (p_c), s	0.0	14.3		0.0	0.0	0.0		0.0

Intersection Summary			
HCM 6th Ctrl Delay			64.5
HCM 6th LOS			E

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

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)	30	30	20	500	30	50	20	1120	320	60	1190	40
Future Volume (veh/h)	30	30	20	500	30	50	20	1120	320	60	1190	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.97	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	1870	1870	1870	1870	1870	1856	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	32	32	6	526	32	52	21	1179	331	63	1253	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, %	3	2	2	2	2	2	3	2	3	2	2	2
Cap, veh/h	295	284	484	392	21	34	68	779	219	83	1059	
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.01	0.56	0.56	0.02	0.57	0.00
Sat Flow, veh/h	829	909	1550	1111	68	110	1767	1396	392	1781	1870	1585
Grp Volume(v), veh/h	64	0	6	610	0	0	21	0	1510	63	1253	0
Grp Sat Flow(s),veh/h/ln	1738	0	1550	1289	0	0	1767	0	1787	1781	1870	1585
Q Serve(g_s), s	0.0	0.0	0.4	43.2	0.0	0.0	0.8	0.0	84.0	2.3	85.2	0.0
Cycle Q Clear(g_c), s	3.8	0.0	0.4	47.0	0.0	0.0	0.8	0.0	84.0	2.3	85.2	0.0
Prop In Lane	0.50		1.00	0.86		0.09	1.00		0.22	1.00		1.00
Lane Grp Cap(c), veh/h	579	0	484	447	0	0	68	0	998	83	1059	
V/C Ratio(X)	0.11	0.00	0.01	1.36	0.00	0.00	0.31	0.00	1.51	0.76	1.18	
Avail Cap(c_a), veh/h	579	0	484	447	0	0	83	0	998	83	1059	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	36.9	0.0	35.7	55.8	0.0	0.0	37.5	0.0	33.3	37.3	32.6	0.0
Incr Delay (d2), s/veh	0.0	0.0	0.0	177.9	0.0	0.0	0.9	0.0	236.4	29.1	92.0	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	1.7	0.0	0.2	39.6	0.0	0.0	0.4	0.0	100.7	2.0	64.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.9	0.0	35.7	233.7	0.0	0.0	38.5	0.0	269.6	66.4	124.7	0.0
LnGrp LOS	D	A	D	F	A	A	D	A	F	E	F	
Approach Vol, veh/h		70			610			1531			1316	A
Approach Delay, s/veh		36.8			233.7			266.4			121.9	
Approach LOS		D			F			F			F	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	7.0	90.0		53.5	5.8	91.2		53.5				
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5				
Max Green Setting (Gmax), s	3.0	84.0		46.5	3.0	84.0		* 47				
Max Q Clear Time (g_c+I1), s	4.3	86.0		5.8	2.8	87.2		49.0				
Green Ext Time (p_c), s	0.0	0.0		0.2	0.0	0.0		0.0				

Intersection Summary		
HCM 6th Ctrl Delay		202.3
HCM 6th LOS		F

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	34.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	120	300	460	280	170	70
Future Vol, veh/h	120	300	460	280	170	70
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	3	2	2	3	2
Mvmt Flow	126	316	484	295	179	74

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	784	0	-	0	1210	642
Stage 1	-	-	-	-	637	-
Stage 2	-	-	-	-	573	-
Critical Hdwy	4.12	-	-	-	6.43	6.22
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	2.218	-	-	-	3.527	3.318
Pot Cap-1 Maneuver	834	-	-	-	201	474
Stage 1	-	-	-	-	525	-
Stage 2	-	-	-	-	562	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	831	-	-	-	~ 163	470
Mov Cap-2 Maneuver	-	-	-	-	~ 163	-
Stage 1	-	-	-	-	427	-
Stage 2	-	-	-	-	560	-

Approach	EB	WB	SB
HCM Control Delay, s	2.9	0	196.8
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	831	-	-	-	201
HCM Lane V/C Ratio	0.152	-	-	-	1.257
HCM Control Delay (s)	10.1	0	-	-	196.8
HCM Lane LOS	B	A	-	-	F
HCM 95th %tile Q(veh)	0.5	-	-	-	13.5

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

HCM 6th Signalized Intersection Summary
7: Kuihelani Hwy & Waiko Rd

Future (2045) No Project
PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	440	60	70	940	990	470
Future Volume (veh/h)	440	60	70	940	990	470
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	0.98	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	1856	1870	1841	1856	1856	1856
Adj Flow Rate, veh/h	463	57	74	989	1042	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	2	4	3	3	3
Cap, veh/h	510	63	100	1587	1108	
Arrive On Green	0.33	0.33	0.06	0.45	0.31	0.00
Sat Flow, veh/h	1546	190	1753	3618	3618	1572
Grp Volume(v), veh/h	521	0	74	989	1042	0
Grp Sat Flow(s),veh/h/ln	1740	0	1753	1763	1763	1572
Q Serve(g_s), s	18.2	0.0	2.6	13.6	18.3	0.0
Cycle Q Clear(g_c), s	18.2	0.0	2.6	13.6	18.3	0.0
Prop In Lane	0.89	0.11	1.00			1.00
Lane Grp Cap(c), veh/h	574	0	100	1587	1108	
V/C Ratio(X)	0.91	0.00	0.74	0.62	0.94	
Avail Cap(c_a), veh/h	711	0	138	1662	1108	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	20.4	0.0	29.5	13.4	21.2	0.0
Incr Delay (d2), s/veh	12.1	0.0	7.0	0.7	15.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.6	0.0	1.2	4.4	8.6	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	32.5	0.0	36.6	14.1	36.2	0.0
LnGrp LOS	C	A	D	B	D	
Approach Vol, veh/h	521			1063	1042	A
Approach Delay, s/veh	32.5			15.6	36.2	
Approach LOS	C			B	D	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		35.6		28.0	8.6	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		30.0		26.0	5.0	20.0
Max Q Clear Time (g_c+I1), s		15.6		20.2	4.6	20.3
Green Ext Time (p_c), s		5.5		0.5	0.0	0.0

Intersection Summary		
HCM 6th Ctrl Delay		27.1
HCM 6th LOS		C

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
8: Honoapiilani Hwy & Main Street

Future (2045) No Project
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	250	20	80	50	20	320	100	870	70	450	940	320
Future Volume (veh/h)	250	20	80	50	20	320	100	870	70	450	940	320
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		0.96	0.96		0.93	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1856	1870	1870	1870	1870
Adj Flow Rate, veh/h	263	21	12	53	21	32	105	916	36	474	989	255
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, %	2	2	2	2	2	2	2	3	2	2	2	2
Cap, veh/h	287	150	85	201	41	63	262	908	755	449	1252	1034
Arrive On Green	0.11	0.14	0.14	0.04	0.06	0.06	0.04	0.49	0.49	0.22	0.67	0.67
Sat Flow, veh/h	1781	1097	627	1781	638	972	1781	1856	1543	1781	1870	1545
Grp Volume(v), veh/h	263	0	33	53	0	53	105	916	36	474	989	255
Grp Sat Flow(s),veh/h/ln	1781	0	1724	1781	0	1610	1781	1856	1543	1781	1870	1545
Q Serve(g_s), s	15.0	0.0	2.3	3.8	0.0	4.4	4.1	68.0	1.7	31.0	51.5	9.1
Cycle Q Clear(g_c), s	15.0	0.0	2.3	3.8	0.0	4.4	4.1	68.0	1.7	31.0	51.5	9.1
Prop In Lane	1.00		0.36	1.00		0.60	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	287	0	235	201	0	104	262	908	755	449	1252	1034
V/C Ratio(X)	0.92	0.00	0.14	0.26	0.00	0.51	0.40	1.01	0.05	1.06	0.79	0.25
Avail Cap(c_a), veh/h	287	0	372	201	0	232	262	908	755	449	1252	1034
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	55.6	0.0	52.8	58.0	0.0	62.9	19.4	35.5	18.5	47.8	16.1	9.1
Incr Delay (d2), s/veh	32.0	0.0	0.3	0.7	0.0	3.9	1.0	32.0	0.0	57.8	3.5	0.1
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	1.0	1.8	0.0	1.9	1.8	38.0	0.6	22.1	22.0	3.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	87.7	0.0	53.1	58.6	0.0	66.7	20.4	67.5	18.6	105.6	19.6	9.2
LnGrp LOS	F	A	D	E	A	E	C	F	B	F	B	A
Approach Vol, veh/h		296			106			1057			1718	
Approach Delay, s/veh		83.8			62.7			61.2			41.8	
Approach LOS		F			E			E			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	35.0	72.0	9.0	22.9	10.0	97.0	19.0	12.9
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	31.0	68.0	5.0	30.0	6.0	93.0	15.0	20.0
Max Q Clear Time (g_c+I1), s	33.0	70.0	5.8	4.3	6.1	53.5	17.0	6.4
Green Ext Time (p_c), s	0.0	0.0	0.0	0.1	0.0	12.1	0.0	0.2

Intersection Summary			
HCM 6th Ctrl Delay			52.8
HCM 6th LOS			D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	10	30	120	10	30	30	970	160	50	1000	20
Future Volume (veh/h)	20	10	30	120	10	30	30	970	160	50	1000	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.91	1.00		0.95	1.00		0.97	1.00		0.98
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	1870	1870	1870	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	21	11	3	126	11	5	32	1021	133	53	1053	16
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, %	2	2	2	2	2	2	2	3	2	2	3	2
Cap, veh/h	47	25	57	179	16	164	216	1168	973	231	1184	986
Arrive On Green	0.04	0.04	0.04	0.11	0.11	0.11	0.02	0.63	0.63	0.03	0.64	0.64
Sat Flow, veh/h	1188	623	1448	1645	144	1507	1781	1856	1545	1781	1856	1545
Grp Volume(v), veh/h	32	0	3	137	0	5	32	1021	133	53	1053	16
Grp Sat Flow(s),veh/h/ln	1811	0	1448	1788	0	1507	1781	1856	1545	1781	1856	1545
Q Serve(g_s), s	1.5	0.0	0.2	6.3	0.0	0.3	0.5	38.4	3.0	0.9	40.2	0.3
Cycle Q Clear(g_c), s	1.5	0.0	0.2	6.3	0.0	0.3	0.5	38.4	3.0	0.9	40.2	0.3
Prop In Lane	0.66		1.00	0.92		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	71	0	57	194	0	164	216	1168	973	231	1184	986
V/C Ratio(X)	0.45	0.00	0.05	0.70	0.00	0.03	0.15	0.87	0.14	0.23	0.89	0.02
Avail Cap(c_a), veh/h	449	0	359	443	0	373	255	1708	1422	255	1708	1422
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	39.8	0.0	39.2	36.5	0.0	33.8	15.0	12.9	6.4	14.7	12.8	5.6
Incr Delay (d2), s/veh	4.4	0.0	0.4	4.6	0.0	0.1	0.3	3.7	0.1	0.5	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	0.7	0.0	0.1	2.9	0.0	0.1	0.3	14.5	0.9	0.5	15.2	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.2	0.0	39.6	41.1	0.0	33.9	15.3	16.7	6.4	15.2	17.3	5.6
LnGrp LOS	D	A	D	D	A	C	B	B	A	B	B	A
Approach Vol, veh/h		35			142			1186			1122	
Approach Delay, s/veh		43.8			40.8			15.5			17.0	
Approach LOS		D			D			B			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	6.9	57.4		7.3	6.1	58.1		13.2
Change Period (Y+Rc), s	4.0	4.0		4.0	4.0	4.0		4.0
Max Green Setting (Gmax), s	4.0	78.0		21.0	4.0	78.0		21.0
Max Q Clear Time (g_c+I1), s	2.9	40.4		3.5	2.5	42.2		8.3
Green Ext Time (p_c), s	0.0	11.9		0.1	0.0	11.8		0.5

Intersection Summary			
HCM 6th Ctrl Delay			18.0
HCM 6th LOS			B

Intersection	
Intersection Delay, s/veh	3.9
Intersection LOS	A

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	232	106	85
Demand Flow Rate, veh/h	236	108	86
Vehicles Circulating, veh/h	11	118	97
Vehicles Exiting, veh/h	172	129	129
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.1	3.7	3.5
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	LR	LT	TR
Assumed Moves	LR	LT	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	236	108	86
Cap Entry Lane, veh/h	1364	1223	1250
Entry HV Adj Factor	0.983	0.979	0.986
Flow Entry, veh/h	232	106	85
Cap Entry, veh/h	1341	1198	1232
V/C Ratio	0.173	0.088	0.069
Control Delay, s/veh	4.1	3.7	3.5
LOS	A	A	A
95th %tile Queue, veh	1	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	940	10	120	10	1040	930	100	1080	20
Future Volume (veh/h)	10	10	10	940	10	120	10	1040	930	100	1080	20
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	1870	1870	1841	1870	1856	1856	1870	1870	1841
Adj Flow Rate, veh/h	10	10	0	986	0	0	10	1083	0	104	1125	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, %	2	2	2	2	2	4	2	3	3	2	2	4
Cap, veh/h	20	20		1116	0		22	1262		131	1489	
Arrive On Green	0.02	0.02	0.00	0.31	0.00	0.00	0.01	0.36	0.00	0.07	0.42	0.00
Sat Flow, veh/h	912	912	0	3563	0	1560	1781	3526	1572	1781	3554	1560
Grp Volume(v), veh/h	20	0	0	986	0	0	10	1083	0	104	1125	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1781	0	1560	1781	1763	1572	1781	1777	1560
Q Serve(g_s), s	0.9	0.0	0.0	21.4	0.0	0.0	0.5	23.2	0.0	4.7	22.0	0.0
Cycle Q Clear(g_c), s	0.9	0.0	0.0	21.4	0.0	0.0	0.5	23.2	0.0	4.7	22.0	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	41	0		1116	0		22	1262		131	1489	
V/C Ratio(X)	0.49	0.00		0.88	0.00		0.45	0.86		0.79	0.76	
Avail Cap(c_a), veh/h	112	0		1266	0		109	1340		131	1489	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.4	0.0	0.0	26.6	0.0	0.0	40.0	24.3	0.0	37.2	20.1	0.0
Incr Delay (d2), s/veh	8.9	0.0	0.0	7.0	0.0	0.0	5.3	5.8	0.0	25.7	2.4	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	0.5	0.0	0.0	9.7	0.0	0.0	0.2	10.0	0.0	2.9	8.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	48.3	0.0	0.0	33.6	0.0	0.0	45.3	30.1	0.0	62.9	22.6	0.0
LnGrp LOS	D	A		C	A		D	C		E	C	
Approach Vol, veh/h		20	A		986	A		1093	A		1229	A
Approach Delay, s/veh		48.3			33.6			30.2			26.0	
Approach LOS		D			C			C			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	10.0	34.2	30.6	5.0	39.2	6.8
Change Period (Y+Rc), s	4.0	5.0	5.0	4.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	31.0	29.0	5.0	32.0	5.0
Max Q Clear Time (g_c+I1), s	6.7	25.2	23.4	2.5	24.0	2.9
Green Ext Time (p_c), s	0.0	4.0	2.1	0.0	5.4	0.0

Intersection Summary	
HCM 6th Ctrl Delay	29.8
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) With Project
1: Honoapiilani Hwy & Kuikahi Dr — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↑	↱	↰	↑	↱	↰	↑	↱
Traffic Volume (veh/h)	80	260	110	370	140	290	40	670	420	370	630	40
Future Volume (veh/h)	80	260	110	370	140	290	40	670	420	370	630	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		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	1826	1870	1841	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	84	274	0	389	147	0	42	705	0	389	663	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, %	2	2	2	5	2	4	2	2	2	2	2	2
Cap, veh/h	315	255		350	476		302	697		357	942	
Arrive On Green	0.05	0.14	0.00	0.16	0.25	0.00	0.03	0.37	0.00	0.16	0.50	0.00
Sat Flow, veh/h	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	84	274	0	389	147	0	42	705	0	389	663	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	4.5	15.0	0.0	18.0	7.0	0.0	1.6	41.0	0.0	18.0	30.0	0.0
Cycle Q Clear(g_c), s	4.5	15.0	0.0	18.0	7.0	0.0	1.6	41.0	0.0	18.0	30.0	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	315	255		350	476		302	697		357	942	
V/C Ratio(X)	0.27	1.07		1.11	0.31		0.14	1.01		1.09	0.70	
Avail Cap(c_a), veh/h	315	255		350	476		325	697		357	942	
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	38.6	47.5	0.0	33.9	33.2	0.0	21.1	34.5	0.0	35.4	21.0	0.0
Incr Delay (d2), s/veh	0.4	77.5	0.0	81.6	0.3	0.0	0.1	36.9	0.0	73.9	3.0	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	2.0	12.4	0.0	15.8	3.2	0.0	0.6	24.5	0.0	12.1	12.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.1	125.0	0.0	115.5	33.4	0.0	21.2	71.4	0.0	109.3	24.0	0.0
LnGrp LOS	D	F		F	C		C	F		F	C	
Approach Vol, veh/h		358	A		536	A		747	A		1052	A
Approach Delay, s/veh		104.8			93.0			68.6			55.5	
Approach LOS		F			F			E			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.0	46.0	22.0	20.0	7.6	60.4	9.0	33.0
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	18.0	41.0	18.0	15.0	5.0	54.0	5.0	28.0
Max Q Clear Time (g_c+I1), s	20.0	43.0	20.0	17.0	3.6	32.0	6.5	9.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	73.2
HCM 6th LOS	E

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) With Project
2: Waiale Rd & Kuikahi Dr — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑	↱	↰	↑↱		↰	↑↱	
Traffic Volume (veh/h)	340	580	100	90	440	400	130	420	120	420	270	200
Future Volume (veh/h)	340	580	100	90	440	400	130	420	120	420	270	200
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.97	1.00		0.97
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	1856	1856	1856	1856	1856	1856	1856	1856
Adj Flow Rate, veh/h	358	611	101	95	463	138	137	442	118	442	284	190
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, %	2	2	2	3	3	3	3	3	3	3	3	3
Cap, veh/h	314	536	89	128	445	365	307	403	108	354	418	280
Arrive On Green	0.14	0.34	0.34	0.04	0.24	0.24	0.05	0.29	0.29	0.17	0.41	0.41
Sat Flow, veh/h	1781	1558	257	1767	1856	1523	1767	1401	374	1767	1024	685
Grp Volume(v), veh/h	358	0	712	95	463	138	137	0	560	442	0	474
Grp Sat Flow(s),veh/h/ln	1781	0	1815	1767	1856	1523	1767	0	1775	1767	0	1710
Q Serve(g_s), s	18.0	0.0	43.0	5.0	30.0	9.5	6.0	0.0	36.0	21.0	0.0	28.4
Cycle Q Clear(g_c), s	18.0	0.0	43.0	5.0	30.0	9.5	6.0	0.0	36.0	21.0	0.0	28.4
Prop In Lane	1.00		0.14	1.00		1.00	1.00		0.21	1.00		0.40
Lane Grp Cap(c), veh/h	314	0	624	128	445	365	307	0	511	354	0	698
V/C Ratio(X)	1.14	0.00	1.14	0.74	1.04	0.38	0.45	0.00	1.10	1.25	0.00	0.68
Avail Cap(c_a), veh/h	314	0	624	128	445	365	307	0	511	354	0	698
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	38.1	0.0	41.0	38.3	47.5	39.7	32.2	0.0	44.5	39.6	0.0	30.3
Incr Delay (d2), s/veh	94.1	0.0	81.3	18.1	53.3	0.6	0.4	0.0	68.4	132.6	0.0	2.7
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	15.1	0.0	33.2	2.9	20.5	3.7	0.7	0.0	25.5	20.0	0.0	12.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	132.2	0.0	122.3	56.4	100.8	40.3	32.6	0.0	112.9	172.2	0.0	33.0
LnGrp LOS	F	A	F	E	F	D	C	A	F	F	A	C
Approach Vol, veh/h		1070			696			697			916	
Approach Delay, s/veh		125.6			82.8			97.1			100.1	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	26.0	41.0	10.0	48.0	11.0	56.0	23.0	35.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	21.0	36.0	5.0	43.0	6.0	51.0	18.0	30.0
Max Q Clear Time (g_c+I1), s	23.0	38.0	7.0	45.0	8.0	30.4	20.0	32.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	104.0
HCM 6th LOS	F

Intersection				
Intersection Delay, s/veh	205.7			
Intersection LOS	F			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	894	737	579	1021
Demand Flow Rate, veh/h	917	760	591	1041
Vehicles Circulating, veh/h	709	784	1142	685
Vehicles Exiting, veh/h	1017	949	484	859
Ped Vol Crossing Leg, #/h	28	5	28	23
Ped Cap Adj	0.996	0.999	1.000	0.997
Approach Delay, s/veh	197.5	138.6	208.3	260.0
Approach LOS	F	F	F	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	917	760	591	1041
Cap Entry Lane, veh/h	670	620	431	686
Entry HV Adj Factor	0.975	0.970	0.979	0.981
Flow Entry, veh/h	894	737	579	1021
Cap Entry, veh/h	651	601	422	671
V/C Ratio	1.375	1.226	1.373	1.522
Control Delay, s/veh	197.5	138.6	208.3	260.0
LOS	F	F	F	F
95th %tile Queue, veh	39	27	28	51

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣		↰	↑↱		↰	↑↑	↱
Traffic Volume (veh/h)	620	0	250	0	0	0	140	1350	0	0	890	450
Future Volume (veh/h)	620	0	250	0	0	0	140	1350	0	0	890	450
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	1870	1870	1870	1870	1870	1870	1841	1870	1870	1841	1856
Adj Flow Rate, veh/h	653	0	0	0	0	0	147	1421	0	0	937	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, %	3	2	2	2	2	2	2	4	2	2	4	3
Cap, veh/h	692	0		0	826	0	164	1535	0	2	1053	
Arrive On Green	0.44	0.00	0.00	0.00	0.00	0.00	0.09	0.44	0.00	0.00	0.30	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3589	0	1781	3497	1572
Grp Volume(v), veh/h	653	0	0	0	0	0	147	1421	0	0	937	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1749	0	1781	1749	1572
Q Serve(g_s), s	48.0	0.0	0.0	0.0	0.0	0.0	8.9	41.7	0.0	0.0	27.8	0.0
Cycle Q Clear(g_c), s	48.0	0.0	0.0	0.0	0.0	0.0	8.9	41.7	0.0	0.0	27.8	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	692	0		0	826	0	164	1535	0	2	1053	
V/C Ratio(X)	0.94	0.00		0.00	0.00	0.00	0.90	0.93	0.00	0.00	0.89	
Avail Cap(c_a), veh/h	692	0		0	860	0	164	1535	0	49	1094	
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	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	31.4	0.0	0.0	0.0	0.0	0.0	48.9	28.8	0.0	0.0	36.3	0.0
Incr Delay (d2), s/veh	21.2	0.0	0.0	0.0	0.0	0.0	41.2	10.3	0.0	0.0	9.8	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	21.3	0.0	0.0	0.0	0.0	0.0	5.6	17.6	0.0	0.0	12.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	52.6	0.0	0.0	0.0	0.0	0.0	90.0	39.1	0.0	0.0	46.1	0.0
LnGrp LOS	D	A		A	A	A	F	D	A	A	D	
Approach Vol, veh/h		653	A		0			1568			937	A
Approach Delay, s/veh		52.6			0.0			43.9			46.1	
Approach LOS		D						D			D	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	0.0	54.7	54.0	15.0	39.7	54.0
Change Period (Y+Rc), s	5.0	7.0	6.0	5.0	7.0	* 6
Max Green Setting (Gmax), s	3.0	41.0	48.0	10.0	34.0	* 50
Max Q Clear Time (g_c+I1), s	0.0	43.7	50.0	10.9	29.8	0.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	2.9	0.0

Intersection Summary	
HCM 6th Ctrl Delay	46.3
HCM 6th LOS	D

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

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)	40	20	20	70	10	60	10	910	30	160	950	20
Future Volume (veh/h)	40	20	20	70	10	60	10	910	30	160	950	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.98		0.96	1.00		0.97	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	1856	1870	1856	1870	1870	1870	1856	1856	1870	1870
Adj Flow Rate, veh/h	42	21	3	74	11	28	11	958	31	168	1000	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, %	3	3	3	2	3	2	2	2	3	3	2	2
Cap, veh/h	205	87	207	175	33	43	235	1057	34	266	1194	
Arrive On Green	0.14	0.14	0.14	0.14	0.14	0.14	0.01	0.59	0.59	0.06	0.64	0.00
Sat Flow, veh/h	922	638	1509	705	238	310	1781	1800	58	1767	1870	1585
Grp Volume(v), veh/h	63	0	3	113	0	0	11	0	989	168	1000	0
Grp Sat Flow(s),veh/h/ln	1561	0	1509	1253	0	0	1781	0	1858	1767	1870	1585
Q Serve(g_s), s	0.0	0.0	0.1	4.5	0.0	0.0	0.2	0.0	35.8	2.6	31.7	0.0
Cycle Q Clear(g_c), s	2.6	0.0	0.1	7.0	0.0	0.0	0.2	0.0	35.8	2.6	31.7	0.0
Prop In Lane	0.67		1.00	0.65		0.25	1.00		0.03	1.00		1.00
Lane Grp Cap(c), veh/h	293	0	207	250	0	0	235	0	1091	266	1194	
V/C Ratio(X)	0.22	0.00	0.01	0.45	0.00	0.00	0.05	0.00	0.91	0.63	0.84	
Avail Cap(c_a), veh/h	507	0	425	466	0	0	290	0	1146	277	1202	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	29.5	0.0	28.4	31.7	0.0	0.0	11.4	0.0	13.9	17.1	10.7	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	10.8	3.2	5.9	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	1.0	0.0	0.0	2.0	0.0	0.0	0.1	0.0	15.7	1.9	12.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	29.6	0.0	28.5	32.2	0.0	0.0	11.5	0.0	24.7	20.2	16.6	0.0
LnGrp LOS	C	A	C	C	A	A	B	A	C	C	B	
Approach Vol, veh/h		66			113			1000			1168	A
Approach Delay, s/veh		29.5			32.2			24.5			17.1	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	8.5	50.8		16.9	4.6	54.7		16.9
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5
Max Green Setting (Gmax), s	5.0	47.0		21.5	3.0	49.0		* 22
Max Q Clear Time (g_c+I1), s	4.6	37.8		4.6	2.2	33.7		9.0
Green Ext Time (p_c), s	0.0	7.0		0.2	0.0	10.8		0.3

Intersection Summary	
HCM 6th Ctrl Delay	21.4
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Intersection Delay, s/veh	27.8
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	242	505	727	589
Demand Flow Rate, veh/h	247	515	744	602
Vehicles Circulating, veh/h	838	336	601	386
Vehicles Exiting, veh/h	150	1009	484	465
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	12.8	10.5	56.0	14.1
Approach LOS	B	B	F	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	247	515	744	602
Cap Entry Lane, veh/h	587	980	748	931
Entry HV Adj Factor	0.981	0.981	0.977	0.978
Flow Entry, veh/h	242	505	727	589
Cap Entry, veh/h	575	960	730	910
V/C Ratio	0.421	0.526	0.996	0.647
Control Delay, s/veh	12.8	10.5	56.0	14.1
LOS	B	B	F	B
95th %tile Queue, veh	2	3	16	5

HCM 6th Signalized Intersection Summary
7: Kuihelani Hwy & Waiko Rd

Future (2045) With Project
AM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	830	100	50	660	660	480
Future Volume (veh/h)	830	100	50	660	660	480
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	1856	1841	1870	1870	1841	1841
Adj Flow Rate, veh/h	874	101	53	695	695	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	4	2	2	4	4
Cap, veh/h	811	94	73	1148	789	
Arrive On Green	0.52	0.52	0.04	0.32	0.23	0.00
Sat Flow, veh/h	1562	181	1781	3647	3589	1560
Grp Volume(v), veh/h	976	0	53	695	695	0
Grp Sat Flow(s),veh/h/ln	1744	0	1781	1777	1749	1560
Q Serve(g_s), s	46.0	0.0	2.6	14.6	17.0	0.0
Cycle Q Clear(g_c), s	46.0	0.0	2.6	14.6	17.0	0.0
Prop In Lane	0.90	0.10	1.00			1.00
Lane Grp Cap(c), veh/h	905	0	73	1148	789	
V/C Ratio(X)	1.08	0.00	0.72	0.61	0.88	
Avail Cap(c_a), veh/h	905	0	100	1203	789	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.3	0.0	42.0	25.2	33.2	0.0
Incr Delay (d2), s/veh	53.3	0.0	7.9	0.8	11.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	30.3	0.0	1.3	5.8	8.0	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	74.6	0.0	49.9	26.1	44.5	0.0
LnGrp LOS	F	A	D	C	D	
Approach Vol, veh/h	976			748	695	A
Approach Delay, s/veh	74.6			27.7	44.5	
Approach LOS	E			C	D	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		35.6		53.0	8.6	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		30.0		46.0	5.0	20.0
Max Q Clear Time (g_c+I1), s		16.6		48.0	4.6	19.0
Green Ext Time (p_c), s		3.6		0.0	0.0	0.4

Intersection Summary		
HCM 6th Ctrl Delay		51.5
HCM 6th LOS		D

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
8: Honoapiilani Hwy & Main Street

Future (2045) With Project
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	220	100	100	50	100	100	60	580	30	40	860	130
Future Volume (veh/h)	220	100	100	50	100	100	60	580	30	40	860	130
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.96	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1870	1856	1870	1870	1870	1856	1856
Adj Flow Rate, veh/h	232	105	63	53	105	63	63	611	18	42	905	77
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, %	3	2	2	2	2	2	3	2	2	2	3	3
Cap, veh/h	310	211	127	287	151	91	200	993	819	390	971	801
Arrive On Green	0.09	0.20	0.20	0.04	0.14	0.14	0.04	0.53	0.53	0.03	0.52	0.52
Sat Flow, veh/h	1767	1078	647	1781	1075	645	1767	1870	1544	1781	1856	1531
Grp Volume(v), veh/h	232	0	168	53	0	168	63	611	18	42	905	77
Grp Sat Flow(s),veh/h/ln	1767	0	1725	1781	0	1720	1767	1870	1544	1781	1856	1531
Q Serve(g_s), s	7.0	0.0	6.7	2.0	0.0	7.2	1.3	17.6	0.4	0.8	35.1	1.9
Cycle Q Clear(g_c), s	7.0	0.0	6.7	2.0	0.0	7.2	1.3	17.6	0.4	0.8	35.1	1.9
Prop In Lane	1.00		0.38	1.00		0.38	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	310	0	338	287	0	242	200	993	819	390	971	801
V/C Ratio(X)	0.75	0.00	0.50	0.18	0.00	0.69	0.31	0.62	0.02	0.11	0.93	0.10
Avail Cap(c_a), veh/h	310	0	514	317	0	445	224	1041	860	427	1033	853
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.9	0.0	27.6	27.1	0.0	31.6	16.6	12.6	8.6	9.8	17.1	9.2
Incr Delay (d2), s/veh	9.5	0.0	1.1	0.3	0.0	3.6	0.9	1.0	0.0	0.1	14.1	0.1
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	1.6	0.0	2.8	0.8	0.0	3.1	0.5	6.8	0.1	0.3	16.8	0.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.4	0.0	28.8	27.4	0.0	35.2	17.5	13.6	8.6	10.0	31.2	9.3
LnGrp LOS	D	A	C	C	A	D	B	B	A	A	C	A
Approach Vol, veh/h		400			221			692			1024	
Approach Delay, s/veh		33.2			33.3			13.9			28.7	
Approach LOS		C			C			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.4	45.0	6.7	19.1	7.0	44.4	11.0	14.9
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	4.0	43.0	4.0	23.0	4.0	43.0	7.0	20.0
Max Q Clear Time (g_c+I1), s	2.8	19.6	4.0	8.7	3.3	37.1	9.0	9.2
Green Ext Time (p_c), s	0.0	4.4	0.0	0.7	0.0	3.3	0.0	0.6

Intersection Summary			
HCM 6th Ctrl Delay			25.5
HCM 6th LOS			C

Intersection				
Intersection Delay, s/veh	7.6			
Intersection LOS	A			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	496	159	159	474
Demand Flow Rate, veh/h	505	162	163	484
Vehicles Circulating, veh/h	249	635	569	55
Vehicles Exiting, veh/h	290	97	185	742
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	8.8	7.7	7.1	6.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	505	162	163	484
Cap Entry Lane, veh/h	1070	722	772	1305
Entry HV Adj Factor	0.982	0.980	0.975	0.979
Flow Entry, veh/h	496	159	159	474
Cap Entry, veh/h	1050	707	752	1276
V/C Ratio	0.472	0.225	0.211	0.371
Control Delay, s/veh	8.8	7.7	7.1	6.3
LOS	A	A	A	A
95th %tile Queue, veh	3	1	1	2

Intersection				
Intersection Delay, s/veh	30.9			
Intersection LOS	D			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	85	243	748	1064
Demand Flow Rate, veh/h	87	249	764	1085
Vehicles Circulating, veh/h	1291	710	87	249
Vehicles Exiting, veh/h	43	141	1291	710
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	1.000	0.999	0.999	0.999
Approach Delay, s/veh	14.2	10.6	10.3	51.4
Approach LOS	B	B	B	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	87	249	764	1085
Cap Entry Lane, veh/h	370	669	1263	1070
Entry HV Adj Factor	0.972	0.974	0.979	0.980
Flow Entry, veh/h	85	243	748	1064
Cap Entry, veh/h	360	651	1235	1049
V/C Ratio	0.235	0.373	0.605	1.014
Control Delay, s/veh	14.2	10.6	10.3	51.4
LOS	B	B	B	F
95th %tile Queue, veh	1	2	4	21

Intersection				
Intersection Delay, s/veh	4.0			
Intersection LOS	A			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	137	179	137	116
Demand Flow Rate, veh/h	140	183	139	117
Vehicles Circulating, veh/h	85	96	118	216
Vehicles Exiting, veh/h	248	161	107	63
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	3.8	4.2	3.9	4.2
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	140	183	139	117
Cap Entry Lane, veh/h	1265	1251	1223	1107
Entry HV Adj Factor	0.977	0.976	0.983	0.988
Flow Entry, veh/h	137	179	137	116
Cap Entry, veh/h	1235	1220	1201	1093
V/C Ratio	0.111	0.146	0.114	0.106
Control Delay, s/veh	3.8	4.2	3.9	4.2
LOS	A	A	A	A
95th %tile Queue, veh	0	1	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	730	10	20	10	690	670	50	1150	10
Future Volume (veh/h)	10	10	10	730	10	20	10	690	670	50	1150	10
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	1870	1856	1856	1856	1870	1856	1870	1870	1870	1870	1856
Adj Flow Rate, veh/h	11	11	0	776	0	0	11	726	0	53	1211	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, %	3	2	3	3	3	2	3	2	2	2	2	3
Cap, veh/h	23	23		922	0		24	1360		83	1477	
Arrive On Green	0.03	0.03	0.00	0.26	0.00	0.00	0.01	0.38	0.00	0.05	0.42	0.00
Sat Flow, veh/h	912	912	0	3534	0	1585	1767	3554	1585	1781	3554	1572
Grp Volume(v), veh/h	22	0	0	776	0	0	11	726	0	53	1211	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1767	0	1585	1767	1777	1585	1781	1777	1572
Q Serve(g_s), s	0.8	0.0	0.0	13.9	0.0	0.0	0.4	10.6	0.0	2.0	20.2	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0	13.9	0.0	0.0	0.4	10.6	0.0	2.0	20.2	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	46	0		922	0		24	1360		83	1477	
V/C Ratio(X)	0.48	0.00		0.84	0.00		0.45	0.53		0.63	0.82	
Avail Cap(c_a), veh/h	137	0		1111	0		132	1543		160	1596	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	32.1	0.0	0.0	23.4	0.0	0.0	32.7	16.0	0.0	31.3	17.3	0.0
Incr Delay (d2), s/veh	7.6	0.0	0.0	5.1	0.0	0.0	4.8	0.5	0.0	3.0	3.5	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	0.4	0.0	0.0	6.0	0.0	0.0	0.2	3.9	0.0	0.9	7.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.7	0.0	0.0	28.5	0.0	0.0	37.4	16.5	0.0	34.2	20.8	0.0
LnGrp LOS	D	A		C	A		D	B		C	C	
Approach Vol, veh/h		22	A		776	A		737	A		1264	A
Approach Delay, s/veh		39.7			28.5			16.8			21.4	
Approach LOS		D			C			B			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.1	30.6		22.4	4.9	32.8		6.7
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0
Max Green Setting (Gmax), s	6.0	29.0		21.0	5.0	30.0		5.0
Max Q Clear Time (g_c+I1), s	4.0	12.6		15.9	2.4	22.2		2.8
Green Ext Time (p_c), s	0.0	5.9		1.5	0.0	5.6		0.0

Intersection Summary	
HCM 6th Ctrl Delay	22.3
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

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)	50	170	60	460	210	300	80	600	450	310	680	60
Future Volume (veh/h)	50	170	60	460	210	300	80	600	450	310	680	60
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		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	1870	1870	1870	1870	1870	1856	1870	1856	1870
Adj Flow Rate, veh/h	52	177	0	479	219	0	83	625	0	323	708	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, %	2	2	2	2	2	2	2	2	3	2	3	2
Cap, veh/h	259	189		470	523		231	672		331	805	
Arrive On Green	0.04	0.10	0.00	0.21	0.28	0.00	0.05	0.36	0.00	0.12	0.43	0.00
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Grp Volume(v), veh/h	52	177	0	479	219	0	83	625	0	323	708	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Q Serve(g_s), s	2.3	8.4	0.0	19.0	8.5	0.0	2.6	28.6	0.0	10.5	31.1	0.0
Cycle Q Clear(g_c), s	2.3	8.4	0.0	19.0	8.5	0.0	2.6	28.6	0.0	10.5	31.1	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	259	189		470	523		231	672		331	805	
V/C Ratio(X)	0.20	0.94		1.02	0.42		0.36	0.93		0.98	0.88	
Avail Cap(c_a), veh/h	297	189		470	523		244	694		331	814	
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	34.2	39.7	0.0	27.9	26.1	0.0	20.1	27.4	0.0	21.7	23.1	0.0
Incr Delay (d2), s/veh	0.4	46.9	0.0	46.3	0.4	0.0	0.4	19.7	0.0	42.4	11.6	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	1.0	6.2	0.0	14.7	3.8	0.0	1.0	15.2	0.0	7.7	14.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.5	86.6	0.0	74.2	26.5	0.0	20.5	47.1	0.0	64.1	34.6	0.0
LnGrp LOS	C	F		F	C		C	D		E	C	
Approach Vol, veh/h		229	A		698	A		708	A		1031	A
Approach Delay, s/veh		74.8			59.2			44.0			43.9	
Approach LOS		E			E			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	36.9	23.0	14.0	8.4	43.6	7.1	29.9
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	11.0	33.0	19.0	9.0	5.0	39.0	5.0	23.0
Max Q Clear Time (g_c+I1), s	12.5	30.6	21.0	10.4	4.6	33.1	4.3	10.5
Green Ext Time (p_c), s	0.0	1.3	0.0	0.0	0.0	3.4	0.0	0.8

Intersection Summary	
HCM 6th Ctrl Delay	50.6
HCM 6th LOS	D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

2: Waiale Rd & Kuikahi Dr

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	330	500	70	130	600	400	120	260	90	450	340	210
Future Volume (veh/h)	330	500	70	130	600	400	120	260	90	450	340	210
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.96	1.00		0.97
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	1870	1856	1856	1856	1856	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	347	526	71	137	632	153	126	274	87	474	358	205
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, %	3	2	3	3	3	3	2	3	2	2	3	2
Cap, veh/h	306	654	88	231	576	473	172	267	85	418	400	229
Arrive On Green	0.14	0.41	0.41	0.05	0.31	0.31	0.04	0.20	0.20	0.21	0.37	0.37
Sat Flow, veh/h	1767	1607	217	1767	1856	1525	1781	1336	424	1781	1094	627
Grp Volume(v), veh/h	347	0	597	137	632	153	126	0	361	474	0	563
Grp Sat Flow(s),veh/h/ln	1767	0	1824	1767	1856	1525	1781	0	1761	1781	0	1721
Q Serve(g_s), s	21.0	0.0	41.8	7.0	45.0	11.2	6.0	0.0	29.0	30.0	0.0	44.7
Cycle Q Clear(g_c), s	21.0	0.0	41.8	7.0	45.0	11.2	6.0	0.0	29.0	30.0	0.0	44.7
Prop In Lane	1.00		0.12	1.00		1.00	1.00		0.24	1.00		0.36
Lane Grp Cap(c), veh/h	306	0	742	231	576	473	172	0	352	418	0	629
V/C Ratio(X)	1.14	0.00	0.80	0.59	1.10	0.32	0.73	0.00	1.03	1.13	0.00	0.90
Avail Cap(c_a), veh/h	306	0	742	231	576	473	172	0	352	418	0	629
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	47.8	0.0	37.9	37.8	50.0	38.3	52.2	0.0	58.0	45.7	0.0	43.4
Incr Delay (d2), s/veh	93.3	0.0	6.4	2.8	66.9	0.4	13.3	0.0	54.6	85.7	0.0	15.4
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	14.8	0.0	20.2	3.6	31.7	4.3	2.4	0.0	18.3	25.3	0.0	21.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	141.0	0.0	44.4	40.6	116.9	38.7	65.5	0.0	112.6	131.4	0.0	58.8
LnGrp LOS	F	A	D	D	F	D	E	A	F	F	A	E
Approach Vol, veh/h		944			922			487			1037	
Approach Delay, s/veh		79.9			92.6			100.4			92.0	
Approach LOS		E			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	35.0	34.0	12.0	64.0	11.0	58.0	26.0	50.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	30.0	29.0	7.0	59.0	6.0	53.0	21.0	45.0
Max Q Clear Time (g_c+I1), s	32.0	31.0	9.0	43.8	8.0	46.7	23.0	47.0
Green Ext Time (p_c), s	0.0	0.0	0.0	3.8	0.0	2.1	0.0	0.0

Intersection Summary		
HCM 6th Ctrl Delay		90.0
HCM 6th LOS		F

3: S. Kamehameha Ave & Maui Lani Pkwy

Intersection	
Intersection Delay, s/veh	171.6
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1020	969	288	918
Demand Flow Rate, veh/h	1044	992	293	936
Vehicles Circulating, veh/h	536	672	1171	651
Vehicles Exiting, veh/h	1051	792	409	1013
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	1.000	0.999
Approach Delay, s/veh	165.6	219.1	30.4	172.4
Approach LOS	F	F	D	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1044	992	293	936
Cap Entry Lane, veh/h	799	695	418	710
Entry HV Adj Factor	0.977	0.977	0.982	0.981
Flow Entry, veh/h	1020	969	288	918
Cap Entry, veh/h	780	679	410	696
V/C Ratio	1.308	1.428	0.701	1.319
Control Delay, s/veh	165.6	219.1	30.4	172.4
LOS	F	F	D	F
95th %tile Queue, veh	40	44	5	37

HCM 6th Signalized Intersection Summary
4: Kuihelani Hwy & Maui Lani Pkwy

Future (2045) WIth Project
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	520	0	170	0	0	0	250	1140	0	10	1320	670
Future Volume (veh/h)	520	0	170	0	0	0	250	1140	0	10	1320	670
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	1856	1870	1870	1870	1870	1856	1870	1870	1841	1870
Adj Flow Rate, veh/h	547	0	0	0	0	0	263	1200	0	11	1389	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, %	2	2	3	2	2	2	2	3	2	2	4	2
Cap, veh/h	556	0		0	655	0	223	1736	0	14	1312	
Arrive On Green	0.35	0.00	0.00	0.00	0.00	0.00	0.13	0.49	0.00	0.01	0.38	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3618	0	1781	3497	1585
Grp Volume(v), veh/h	547	0	0	0	0	0	263	1200	0	11	1389	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1763	0	1781	1749	1585
Q Serve(g_s), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.4	0.0	0.7	45.0	0.0
Cycle Q Clear(g_c), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.4	0.0	0.7	45.0	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	556	0		0	655	0	223	1736	0	14	1312	
V/C Ratio(X)	0.98	0.00		0.00	0.00	0.00	1.18	0.69	0.00	0.80	1.06	
Avail Cap(c_a), veh/h	556	0		0	686	0	223	1736	0	45	1312	
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	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	41.0	0.0	0.0	0.0	0.0	0.0	52.5	23.4	0.0	59.4	37.5	0.0
Incr Delay (d2), s/veh	33.8	0.0	0.0	0.0	0.0	0.0	118.0	1.5	0.0	31.9	42.1	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	22.0	0.0	0.0	0.0	0.0	0.0	13.7	12.1	0.0	0.4	25.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	74.7	0.0	0.0	0.0	0.0	0.0	170.5	25.0	0.0	91.4	79.6	0.0
LnGrp LOS	E	A		A	A	A	F	C	A	F	F	
Approach Vol, veh/h		547	A		0			1463			1400	A
Approach Delay, s/veh		74.7			0.0			51.1			79.7	
Approach LOS		E						D			E	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	5.9	66.1	48.0	20.0	52.0	48.0
Change Period (Y+Rc), s	5.0	7.0	6.0	5.0	7.0	* 6
Max Green Setting (Gmax), s	3.0	57.0	42.0	15.0	45.0	* 44
Max Q Clear Time (g_c+I1), s	2.7	33.4	44.0	17.0	47.0	0.0
Green Ext Time (p_c), s	0.0	14.2	0.0	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	66.6
HCM 6th LOS	E

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
5: Honoapiilani Hwy & Waiko Rd

Future (2045) WIth Project
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	10	10	210	40	80	20	990	110	90	1000	40
Future Volume (veh/h)	30	10	10	210	40	80	20	990	110	90	1000	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.97	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	1870	1870	1870	1870	1870	1856	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	32	11	3	221	42	77	21	1042	114	95	1053	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, %	3	2	2	2	2	2	3	2	3	2	2	2
Cap, veh/h	271	87	356	243	38	69	160	1012	111	110	1181	
Arrive On Green	0.23	0.23	0.23	0.23	0.23	0.23	0.01	0.61	0.61	0.03	0.63	0.00
Sat Flow, veh/h	971	377	1548	861	164	300	1767	1652	181	1781	1870	1585
Grp Volume(v), veh/h	43	0	3	340	0	0	21	0	1156	95	1053	0
Grp Sat Flow(s),veh/h/ln	1348	0	1548	1324	0	0	1767	0	1832	1781	1870	1585
Q Serve(g_s), s	0.0	0.0	0.2	26.9	0.0	0.0	0.6	0.0	80.0	2.9	62.0	0.0
Cycle Q Clear(g_c), s	3.1	0.0	0.2	30.0	0.0	0.0	0.6	0.0	80.0	2.9	62.0	0.0
Prop In Lane	0.74		1.00	0.65		0.23	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	358	0	356	350	0	0	160	0	1123	110	1181	
V/C Ratio(X)	0.12	0.00	0.01	0.97	0.00	0.00	0.13	0.00	1.03	0.87	0.89	
Avail Cap(c_a), veh/h	358	0	356	350	0	0	179	0	1123	110	1181	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.8	0.0	38.8	53.2	0.0	0.0	23.4	0.0	25.3	35.1	20.3	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	40.3	0.0	0.0	0.1	0.0	34.6	45.4	9.3	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	1.1	0.0	0.1	15.3	0.0	0.0	0.3	0.0	43.1	3.2	28.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.9	0.0	38.8	93.5	0.0	0.0	23.6	0.0	59.9	80.5	29.6	0.0
LnGrp LOS	D	A	D	F	A	A	C	A	F	F	C	
Approach Vol, veh/h		46			340			1177			1148	A
Approach Delay, s/veh		39.8			93.5			59.2			33.8	
Approach LOS		D			F			E			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	8.0	86.0	36.5	5.6	88.4	36.5
Change Period (Y+Rc), s	4.0	6.0	6.5	4.0	6.0	* 6.5
Max Green Setting (Gmax), s	4.0	80.0	29.5	3.0	81.0	* 30
Max Q Clear Time (g_c+I1), s	4.9	82.0	5.1	2.6	64.0	32.0
Green Ext Time (p_c), s	0.0	0.0	0.1	0.0	12.4	0.0

Intersection Summary	
HCM 6th Ctrl Delay	52.4
HCM 6th LOS	D

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Intersection Delay, s/veh	22.9
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	232	948	526	453
Demand Flow Rate, veh/h	238	967	538	466
Vehicles Circulating, veh/h	853	270	389	687
Vehicles Exiting, veh/h	300	657	702	550
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	12.9	32.8	12.2	19.6
Approach LOS	B	D	B	C

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	238	967	538	466
Cap Entry Lane, veh/h	578	1048	928	685
Entry HV Adj Factor	0.973	0.980	0.978	0.973
Flow Entry, veh/h	232	948	526	453
Cap Entry, veh/h	562	1026	907	666
V/C Ratio	0.412	0.924	0.580	0.681
Control Delay, s/veh	12.9	32.8	12.2	19.6
LOS	B	D	B	C
95th %tile Queue, veh	2	15	4	5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	580	60	70	800	870	630
Future Volume (veh/h)	580	60	70	800	870	630
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	0.98	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	1856	1870	1841	1856	1856	1856
Adj Flow Rate, veh/h	611	59	74	842	916	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	2	4	3	3	3
Cap, veh/h	640	62	94	1460	1040	
Arrive On Green	0.40	0.40	0.05	0.41	0.30	0.00
Sat Flow, veh/h	1589	153	1753	3618	3618	1572
Grp Volume(v), veh/h	671	0	74	842	916	0
Grp Sat Flow(s),veh/h/ln	1745	0	1753	1763	1763	1572
Q Serve(g_s), s	28.5	0.0	3.2	14.1	18.9	0.0
Cycle Q Clear(g_c), s	28.5	0.0	3.2	14.1	18.9	0.0
Prop In Lane	0.91	0.09	1.00			1.00
Lane Grp Cap(c), veh/h	703	0	94	1460	1040	
V/C Ratio(X)	0.95	0.00	0.79	0.58	0.88	
Avail Cap(c_a), veh/h	730	0	115	1567	1106	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.2	0.0	35.8	17.2	25.7	0.0
Incr Delay (d2), s/veh	22.0	0.0	20.1	0.5	8.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.0	0.0	1.8	5.0	8.2	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	44.2	0.0	55.9	17.7	33.8	0.0
LnGrp LOS	D	A	E	B	C	
Approach Vol, veh/h	671			916	916	A
Approach Delay, s/veh	44.2			20.8	33.8	
Approach LOS	D			C	C	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		38.7		37.8	9.1	29.6
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		34.0		32.0	5.0	24.0
Max Q Clear Time (g_c+I1), s		16.1		30.5	5.2	20.9
Green Ext Time (p_c), s		5.1		0.3	0.0	1.6

Intersection Summary	
HCM 6th Ctrl Delay	31.8
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [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)	180	100	80	30	100	60	100	860	50	100	890	230
Future Volume (veh/h)	180	100	80	30	100	60	100	860	50	100	890	230
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.98		0.95	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1856	1870	1870	1870	1870
Adj Flow Rate, veh/h	189	105	51	32	105	38	105	905	29	105	937	138
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, %	2	2	2	2	2	2	2	3	2	2	2	2
Cap, veh/h	312	222	108	272	162	59	208	987	821	228	995	821
Arrive On Green	0.09	0.19	0.19	0.03	0.13	0.13	0.05	0.53	0.53	0.05	0.53	0.53
Sat Flow, veh/h	1781	1173	570	1781	1292	468	1781	1856	1544	1781	1870	1543
Grp Volume(v), veh/h	189	0	156	32	0	143	105	905	29	105	937	138
Grp Sat Flow(s),veh/h/ln	1781	0	1742	1781	0	1760	1781	1856	1544	1781	1870	1543
Q Serve(g_s), s	7.0	0.0	6.2	1.2	0.0	6.0	2.0	34.6	0.7	2.0	36.5	3.6
Cycle Q Clear(g_c), s	7.0	0.0	6.2	1.2	0.0	6.0	2.0	34.6	0.7	2.0	36.5	3.6
Prop In Lane	1.00		0.33	1.00		0.27	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	312	0	330	272	0	220	208	987	821	228	995	821
V/C Ratio(X)	0.61	0.00	0.47	0.12	0.00	0.65	0.50	0.92	0.04	0.46	0.94	0.17
Avail Cap(c_a), veh/h	312	0	516	318	0	453	217	1027	855	236	1035	854
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	25.5	0.0	28.0	28.5	0.0	32.3	17.6	16.6	8.7	16.7	17.1	9.3
Incr Delay (d2), s/veh	3.3	0.0	1.0	0.2	0.0	3.2	1.9	12.3	0.0	1.5	15.6	0.1
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	2.6	0.5	0.0	2.7	1.0	16.1	0.2	0.9	17.9	1.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	28.8	0.0	29.1	28.7	0.0	35.5	19.4	28.9	8.7	18.1	32.7	9.4
LnGrp LOS	C	A	C	C	A	D	B	C	A	B	C	A
Approach Vol, veh/h		345			175			1039			1180	
Approach Delay, s/veh		28.9			34.3			27.4			28.7	
Approach LOS		C			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	7.6	45.3	6.0	18.7	7.6	45.3	11.0	13.7
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	4.0	43.0	4.0	23.0	4.0	43.0	7.0	20.0
Max Q Clear Time (g_c+I1), s	4.0	36.6	3.2	8.2	4.0	38.5	9.0	8.0
Green Ext Time (p_c), s	0.0	3.5	0.0	0.7	0.0	2.8	0.0	0.5

Intersection Summary	
HCM 6th Ctrl Delay	28.6
HCM 6th LOS	C

Intersection	
Intersection Delay, s/veh	7.6
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	348	127	148	684
Demand Flow Rate, veh/h	354	129	151	699
Vehicles Circulating, veh/h	291	452	472	43
Vehicles Exiting, veh/h	451	171	173	538
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	7.2	5.7	6.1	8.5
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	354	129	151	699
Cap Entry Lane, veh/h	1026	870	853	1321
Entry HV Adj Factor	0.982	0.983	0.977	0.978
Flow Entry, veh/h	348	127	148	684
Cap Entry, veh/h	1006	855	833	1291
V/C Ratio	0.345	0.148	0.177	0.530
Control Delay, s/veh	7.2	5.7	6.1	8.5
LOS	A	A	A	A
95th %tile Queue, veh	2	1	1	3

Intersection				
Intersection Delay, s/veh	29.5			
Intersection LOS	D			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	63	179	1178	1053
Demand Flow Rate, veh/h	63	184	1213	1084
Vehicles Circulating, veh/h	1193	1061	53	172
Vehicles Exiting, veh/h	63	205	1203	1073
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	1.000	1.000	0.999	0.999
Approach Delay, s/veh	11.2	15.0	29.4	33.1
Approach LOS	B	B	D	D

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	63	184	1213	1084
Cap Entry Lane, veh/h	409	468	1307	1158
Entry HV Adj Factor	0.993	0.971	0.971	0.972
Flow Entry, veh/h	63	179	1178	1053
Cap Entry, veh/h	406	454	1269	1124
V/C Ratio	0.154	0.393	0.929	0.937
Control Delay, s/veh	11.2	15.0	29.4	33.1
LOS	B	B	D	D
95th %tile Queue, veh	1	2	16	16

Intersection				
Intersection Delay, s/veh	4.2			
Intersection LOS	A			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	201	169	116	64
Demand Flow Rate, veh/h	206	173	118	65
Vehicles Circulating, veh/h	96	129	163	216
Vehicles Exiting, veh/h	185	152	139	86
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	4.4	4.3	4.0	3.8
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	206	173	118	65
Cap Entry Lane, veh/h	1251	1210	1169	1107
Entry HV Adj Factor	0.976	0.978	0.980	0.978
Flow Entry, veh/h	201	169	116	64
Cap Entry, veh/h	1221	1182	1144	1082
V/C Ratio	0.165	0.143	0.101	0.059
Control Delay, s/veh	4.4	4.3	4.0	3.8
LOS	A	A	A	A
95th %tile Queue, veh	1	0	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	910	10	30	10	1090	880	10	1130	20
Future Volume (veh/h)	10	10	10	910	10	30	10	1090	880	10	1130	20
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	1870	1870	1841	1870	1856	1856	1870	1870	1841
Adj Flow Rate, veh/h	10	10	0	955	0	0	10	1135	0	10	1177	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, %	2	2	2	2	2	4	2	3	3	2	2	4
Cap, veh/h	21	21		1107	0		22	1417		22	1428	
Arrive On Green	0.02	0.02	0.00	0.31	0.00	0.00	0.01	0.40	0.00	0.01	0.40	0.00
Sat Flow, veh/h	912	912	0	3563	0	1560	1781	3526	1572	1781	3554	1560
Grp Volume(v), veh/h	20	0	0	955	0	0	10	1135	0	10	1177	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1781	0	1560	1781	1763	1572	1781	1777	1560
Q Serve(g_s), s	0.8	0.0	0.0	19.0	0.0	0.0	0.4	21.4	0.0	0.4	22.3	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0	19.0	0.0	0.0	0.4	21.4	0.0	0.4	22.3	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	41	0		1107	0		22	1417		22	1428	
V/C Ratio(X)	0.48	0.00		0.86	0.00		0.45	0.80		0.45	0.82	
Avail Cap(c_a), veh/h	121	0		1324	0		118	1544		118	1556	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	36.4	0.0	0.0	24.5	0.0	0.0	36.9	19.9	0.0	36.9	20.1	0.0
Incr Delay (d2), s/veh	8.5	0.0	0.0	5.3	0.0	0.0	5.1	3.1	0.0	5.1	3.7	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	0.5	0.0	0.0	8.3	0.0	0.0	0.2	8.5	0.0	0.2	9.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.8	0.0	0.0	29.8	0.0	0.0	42.1	23.0	0.0	42.1	23.9	0.0
LnGrp LOS	D	A		C	A		D	C		D	C	
Approach Vol, veh/h		20	A		955	A		1145	A		1187	A
Approach Delay, s/veh		44.8			29.8			23.2			24.0	
Approach LOS		D			C			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	4.9	35.3		28.4	4.9	35.3		6.7
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0
Max Green Setting (Gmax), s	5.0	33.0		28.0	5.0	33.0		5.0
Max Q Clear Time (g_c+I1), s	2.4	23.4		21.0	2.4	24.3		2.8
Green Ext Time (p_c), s	0.0	6.3		2.4	0.0	6.0		0.0

Intersection Summary	
HCM 6th Ctrl Delay	25.5
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

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)	30	180	20	260	80	140	20	260	410	350	170	40
Future Volume (veh/h)	30	180	20	260	80	140	20	260	410	350	170	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.97	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	32	189	18	274	84	79	21	274	371	368	179	35
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, %	2	2	2	2	2	2	2	3	2	2	3	2
Cap, veh/h	284	240	23	293	185	174	591	286	387	404	834	163
Arrive On Green	0.02	0.14	0.14	0.09	0.21	0.21	0.02	0.41	0.41	0.17	0.56	0.56
Sat Flow, veh/h	1781	1674	159	1781	870	818	1781	702	950	1781	1500	293
Grp Volume(v), veh/h	32	0	207	274	0	163	21	0	645	368	0	214
Grp Sat Flow(s),veh/h/ln	1781	0	1833	1781	0	1688	1781	0	1652	1781	0	1794
Q Serve(g_s), s	1.3	0.0	9.3	8.0	0.0	7.1	0.6	0.0	32.2	12.0	0.0	5.1
Cycle Q Clear(g_c), s	1.3	0.0	9.3	8.0	0.0	7.1	0.6	0.0	32.2	12.0	0.0	5.1
Prop In Lane	1.00		0.09	1.00		0.48	1.00		0.58	1.00		0.16
Lane Grp Cap(c), veh/h	284	0	263	293	0	359	591	0	673	404	0	997
V/C Ratio(X)	0.11	0.00	0.79	0.94	0.00	0.45	0.04	0.00	0.96	0.91	0.00	0.21
Avail Cap(c_a), veh/h	324	0	345	293	0	398	642	0	681	421	0	997
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	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	29.9	0.0	35.1	31.1	0.0	29.1	14.2	0.0	24.5	22.8	0.0	9.5
Incr Delay (d2), s/veh	0.2	0.0	8.6	36.0	0.0	0.9	0.0	0.0	24.5	23.3	0.0	0.1
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	0.6	0.0	4.7	4.6	0.0	2.9	0.2	0.0	16.3	9.7	0.0	1.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	30.1	0.0	43.8	67.1	0.0	30.0	14.2	0.0	48.9	46.1	0.0	9.6
LnGrp LOS	C	A	D	E	A	C	B	A	D	D	A	A
Approach Vol, veh/h		239			437			666			582	
Approach Delay, s/veh		41.9			53.3			47.8			32.7	
Approach LOS		D			D			D			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	18.2	38.6	12.0	16.2	5.6	51.2	6.1	22.1
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	15.0	35.0	8.0	16.0	4.0	46.0	4.0	20.0
Max Q Clear Time (g_c+I1), s	14.0	34.2	10.0	11.3	2.6	7.1	3.3	9.1
Green Ext Time (p_c), s	0.1	0.4	0.0	0.4	0.0	1.4	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	43.8
HCM 6th LOS	D

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	32	210	274	231	21	706	368	221
v/c Ratio	0.13	0.72	1.00	0.50	0.04	0.98	0.96	0.21
Control Delay	23.6	49.2	86.2	22.3	8.7	54.2	63.6	9.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.6	49.2	86.2	22.3	8.7	54.2	63.6	9.9
Queue Length 50th (ft)	13	109	126	68	4	345	159	46
Queue Length 95th (ft)	33	184	#290	142	13	#602	#343	103
Internal Link Dist (ft)		1982		4578		1623		6781
Turn Bay Length (ft)	100		290		50		350	
Base Capacity (vph)	249	337	273	466	536	719	382	1041
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.13	0.62	1.00	0.50	0.04	0.98	0.96	0.21

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	20	30	200	20	10	10	620	80	30	970	10
Future Volume (veh/h)	30	20	30	200	20	10	10	620	80	30	970	10
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.97	0.99		0.97	1.00		0.97	1.00		0.97
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	1856	1870	1870	1870
Adj Flow Rate, veh/h	32	21	9	211	21	9	11	653	78	32	1021	10
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, %	2	2	2	3	2	2	2	2	3	2	2	2
Cap, veh/h	263	158	53	406	27	12	235	1023	122	418	1158	11
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.63	0.63	0.63	0.63	0.63	0.63
Sat Flow, veh/h	721	742	248	1272	127	54	547	1634	195	725	1848	18
Grp Volume(v), veh/h	62	0	0	241	0	0	11	0	731	32	0	1031
Grp Sat Flow(s),veh/h/ln	1711	0	0	1452	0	0	547	0	1829	725	0	1867
Q Serve(g_s), s	0.0	0.0	0.0	6.3	0.0	0.0	0.9	0.0	12.4	1.4	0.0	22.9
Cycle Q Clear(g_c), s	1.4	0.0	0.0	7.7	0.0	0.0	23.8	0.0	12.4	13.8	0.0	22.9
Prop In Lane	0.52		0.15	0.88		0.04	1.00		0.11	1.00		0.01
Lane Grp Cap(c), veh/h	474	0	0	445	0	0	235	0	1146	418	0	1169
V/C Ratio(X)	0.13	0.00	0.00	0.54	0.00	0.00	0.05	0.00	0.64	0.08	0.00	0.88
Avail Cap(c_a), veh/h	641	0	0	598	0	0	288	0	1324	489	0	1351
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	0.00	1.00
Uniform Delay (d), s/veh	16.0	0.0	0.0	18.3	0.0	0.0	17.7	0.0	5.8	10.1	0.0	7.8
Incr Delay (d2), s/veh	0.1	0.0	0.0	1.0	0.0	0.0	0.1	0.0	0.8	0.1	0.0	6.5
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	0.5	0.0	0.0	2.4	0.0	0.0	0.1	0.0	3.0	0.2	0.0	7.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.1	0.0	0.0	19.3	0.0	0.0	17.8	0.0	6.6	10.2	0.0	14.2
LnGrp LOS	B	A	A	B	A	A	B	A	A	B	A	B
Approach Vol, veh/h		62			241			742			1063	
Approach Delay, s/veh		16.1			19.3			6.8			14.1	
Approach LOS		B			B			A			B	

Timer - Assigned Phs	2	4	6	8
Phs Duration (G+Y+Rc), s	35.1	14.6	35.1	14.6
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	36.0	16.0	36.0	16.0
Max Q Clear Time (g_c+I1), s	25.8	3.4	24.9	9.7
Green Ext Time (p_c), s	3.8	0.2	6.2	0.7

Intersection Summary	
HCM 6th Ctrl Delay	12.2
HCM 6th LOS	B

Lane Group	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	85	243	11	737	32	1032
v/c Ratio	0.22	0.73	0.09	0.64	0.10	0.89
Control Delay	13.6	34.6	7.1	10.5	6.1	22.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	34.6	7.1	10.5	6.1	22.4
Queue Length 50th (ft)	15	76	1	147	4	285
Queue Length 95th (ft)	44	#164	8	256	14	#580
Internal Link Dist (ft)	447	967		6714		4002
Turn Bay Length (ft)			50		50	
Base Capacity (vph)	438	381	126	1150	313	1166
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.64	0.09	0.64	0.10	0.89

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	50	140	30	380	240	280	20	180	300	170	240	20
Future Volume (veh/h)	50	140	30	380	240	280	20	180	300	170	240	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.96	0.99		0.97	0.99		0.97	1.00		0.97
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	1856	1870	1870	1870	1870	1870	1856	1870	1856	1856	1870
Adj Flow Rate, veh/h	53	147	20	400	253	236	21	189	231	179	253	18
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, %	2	3	2	2	2	2	2	3	2	3	3	2
Cap, veh/h	234	296	40	561	286	267	420	219	267	312	606	43
Arrive On Green	0.04	0.19	0.19	0.18	0.33	0.33	0.02	0.29	0.29	0.08	0.35	0.35
Sat Flow, veh/h	1781	1590	216	1781	876	817	1781	746	911	1767	1708	122
Grp Volume(v), veh/h	53	0	167	400	0	489	21	0	420	179	0	271
Grp Sat Flow(s),veh/h/ln	1781	0	1807	1781	0	1694	1781	0	1657	1767	0	1829
Q Serve(g_s), s	1.5	0.0	5.1	10.7	0.0	16.8	0.5	0.0	14.7	4.1	0.0	6.9
Cycle Q Clear(g_c), s	1.5	0.0	5.1	10.7	0.0	16.8	0.5	0.0	14.7	4.1	0.0	6.9
Prop In Lane	1.00		0.12	1.00		0.48	1.00		0.55	1.00		0.07
Lane Grp Cap(c), veh/h	234	0	336	561	0	553	420	0	486	312	0	649
V/C Ratio(X)	0.23	0.00	0.50	0.71	0.00	0.88	0.05	0.00	0.86	0.57	0.00	0.42
Avail Cap(c_a), veh/h	281	0	471	561	0	634	501	0	593	312	0	685
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	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.6	0.0	22.4	15.0	0.0	19.6	14.8	0.0	20.6	14.9	0.0	15.0
Incr Delay (d2), s/veh	0.5	0.0	1.1	4.2	0.0	12.8	0.0	0.0	10.9	2.5	0.0	0.4
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	0.6	0.0	2.1	4.4	0.0	7.9	0.2	0.0	6.6	1.7	0.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.1	0.0	23.6	19.2	0.0	32.4	14.8	0.0	31.5	17.4	0.0	15.4
LnGrp LOS	C	A	C	B	A	C	B	A	C	B	A	B
Approach Vol, veh/h		220			889			441			450	
Approach Delay, s/veh		22.7			26.5			30.7			16.2	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.0	22.0	15.0	15.4	5.2	25.8	6.4	24.1
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	5.0	22.0	11.0	16.0	4.0	23.0	4.0	23.0
Max Q Clear Time (g_c+I1), s	6.1	16.7	12.7	7.1	2.5	8.9	3.5	18.8
Green Ext Time (p_c), s	0.0	1.3	0.0	0.5	0.0	1.3	0.0	1.3

Intersection Summary	
HCM 6th Ctrl Delay	24.7
HCM 6th LOS	C

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	53	179	400	548	21	505	179	274
v/c Ratio	0.25	0.50	0.78	0.83	0.05	0.87	0.75	0.38
Control Delay	15.2	26.5	27.3	30.9	11.5	34.6	36.6	17.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.2	26.5	27.3	30.9	11.5	34.6	36.6	17.3
Queue Length 50th (ft)	13	60	118	189	5	152	46	72
Queue Length 95th (ft)	31	115	#233	#376	16	#320	#133	154
Internal Link Dist (ft)		1982		4578		1623		6781
Turn Bay Length (ft)	100		290		50		350	
Base Capacity (vph)	214	467	516	675	437	659	239	736
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.25	0.38	0.78	0.81	0.05	0.77	0.75	0.37

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	20	20	120	20	30	20	940	160	10	970	20
Future Volume (veh/h)	20	20	20	120	20	30	20	940	160	10	970	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.96	1.00		0.98	1.00		0.98
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	1856	1856	1870	1856	1870
Adj Flow Rate, veh/h	21	21	5	126	21	23	21	989	162	11	1021	20
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, %	2	2	2	3	2	2	2	3	3	2	3	2
Cap, veh/h	171	149	28	261	36	31	308	1113	182	223	1303	26
Arrive On Green	0.15	0.15	0.15	0.15	0.15	0.15	0.72	0.72	0.72	0.72	0.72	0.72
Sat Flow, veh/h	575	971	184	1052	232	201	542	1549	254	488	1813	36
Grp Volume(v), veh/h	47	0	0	170	0	0	21	0	1151	11	0	1041
Grp Sat Flow(s),veh/h/ln	1730	0	0	1485	0	0	542	0	1802	488	0	1848
Q Serve(g_s), s	0.0	0.0	0.0	5.3	0.0	0.0	1.6	0.0	31.1	1.1	0.0	22.7
Cycle Q Clear(g_c), s	1.4	0.0	0.0	6.7	0.0	0.0	24.3	0.0	31.1	32.2	0.0	22.7
Prop In Lane	0.45		0.11	0.74		0.14	1.00		0.14	1.00		0.02
Lane Grp Cap(c), veh/h	349	0	0	328	0	0	308	0	1296	223	0	1328
V/C Ratio(X)	0.13	0.00	0.00	0.52	0.00	0.00	0.07	0.00	0.89	0.05	0.00	0.78
Avail Cap(c_a), veh/h	509	0	0	475	0	0	404	0	1613	310	0	1654
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	0.00	1.00
Uniform Delay (d), s/veh	23.0	0.0	0.0	25.1	0.0	0.0	13.5	0.0	6.8	19.4	0.0	5.7
Incr Delay (d2), s/veh	0.2	0.0	0.0	1.3	0.0	0.0	0.1	0.0	5.5	0.1	0.0	2.0
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	0.6	0.0	0.0	2.4	0.0	0.0	0.2	0.0	8.3	0.1	0.0	5.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.2	0.0	0.0	26.4	0.0	0.0	13.6	0.0	12.3	19.5	0.0	7.7
LnGrp LOS	C	A	A	C	A	A	B	A	B	B	A	A
Approach Vol, veh/h		47			170			1172			1052	
Approach Delay, s/veh		23.2			26.4			12.4			7.8	
Approach LOS		C			C			B			A	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		49.0		13.6		49.0		13.6				
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0				
Max Green Setting (Gmax), s		56.0		16.0		56.0		16.0				
Max Q Clear Time (g_c+I1), s		33.1		3.4		34.2		8.7				
Green Ext Time (p_c), s		11.9		0.1		9.6		0.5				

Intersection Summary		
HCM 6th Ctrl Delay		11.6
HCM 6th LOS		B

Lane Group	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	63	179	21	1157	11	1042
v/c Ratio	0.21	0.69	0.10	0.90	0.09	0.79
Control Delay	21.6	41.6	5.2	20.6	5.7	13.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	21.6	41.6	5.2	20.6	5.7	13.4
Queue Length 50th (ft)	17	76	3	363	1	276
Queue Length 95th (ft)	50	142	11	#788	7	499
Internal Link Dist (ft)	447	967		6714		4002
Turn Bay Length (ft)			50		50	
Base Capacity (vph)	359	321	216	1372	133	1399
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.18	0.56	0.10	0.84	0.08	0.74

Intersection Summary

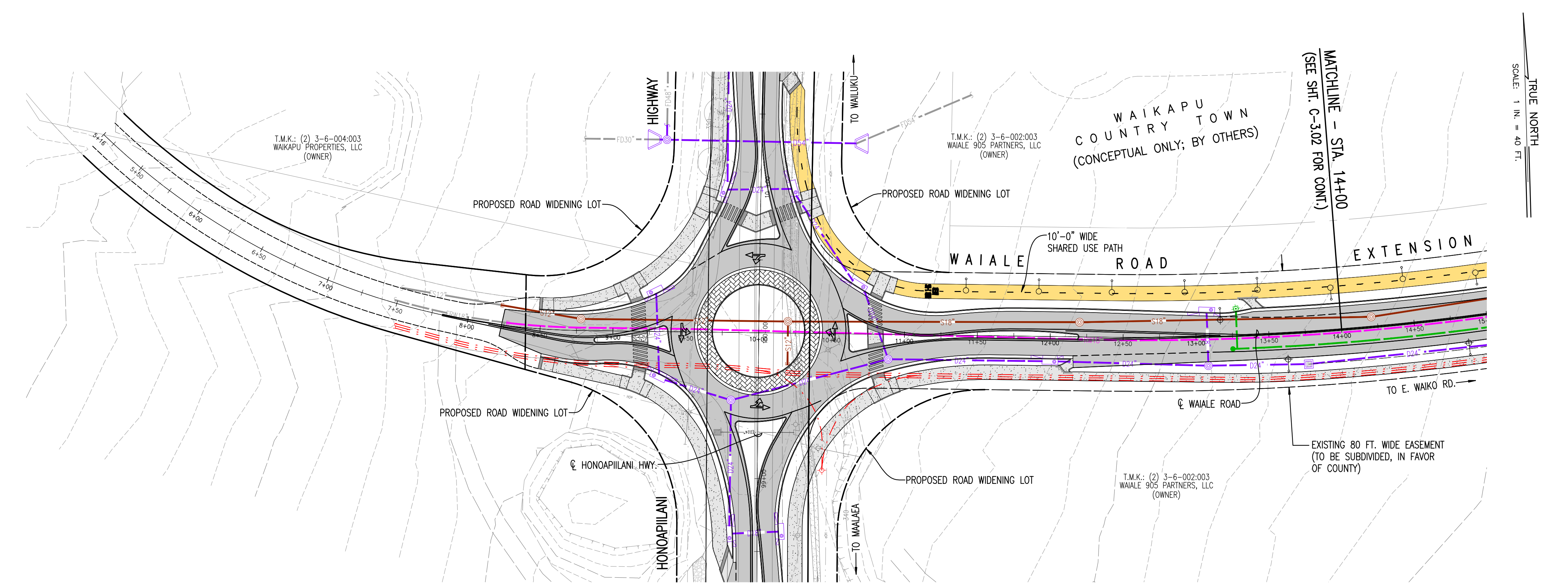
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

APPENDIX B

PRELIMINARY PROJECT PLANS

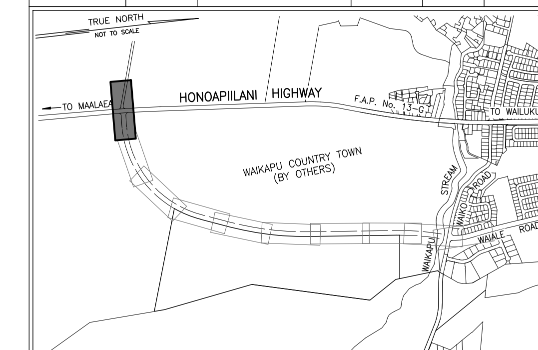
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



PLAN

SCALE: 1 IN. = 40 FT.

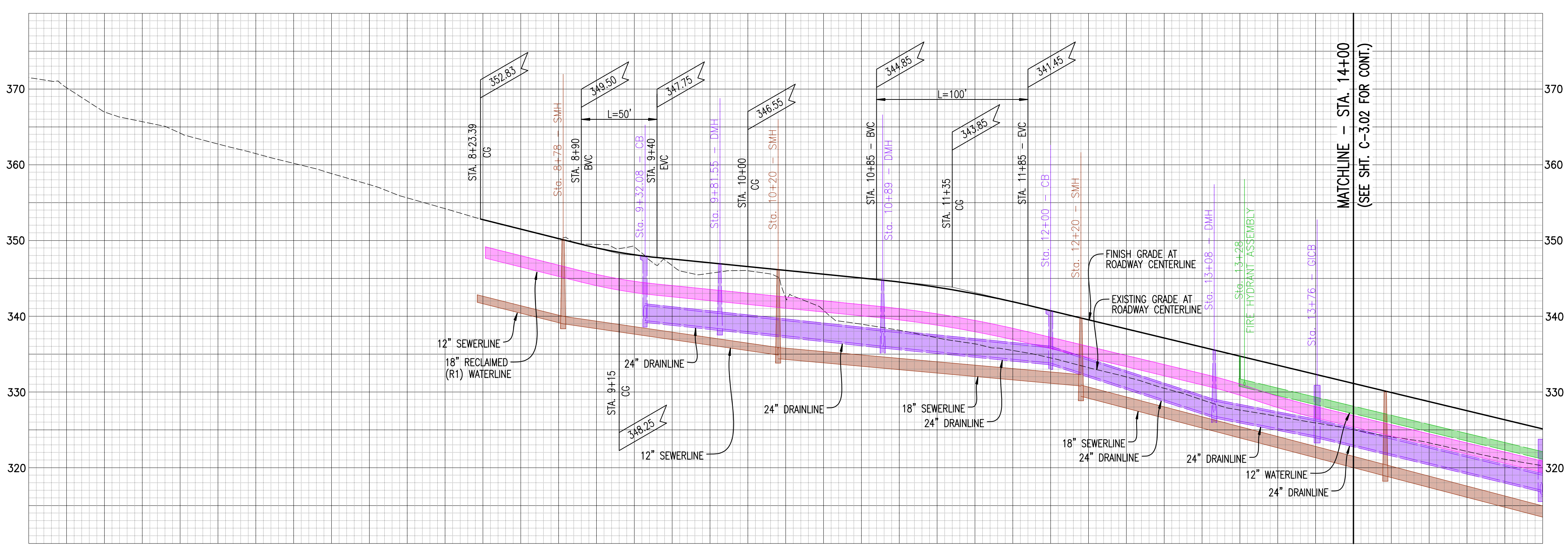


LOCATION MAP

NOT TO SCALE

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SFM18" SEWER FORCE MAIN W/ SIZE
- RW12" RECLAIMED (R1) WATERLINE W/ SIZE
- D24" DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- S8" SEWERLINE W/ SIZE
- FS12" FUTURE SEWERLINE W/ SIZE
- FW12" FUTURE WATERLINE W/ SIZE
- FRW18" FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FRW18" FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DC DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- W4" WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- ED24" EXISTING DRAINLINE W/ SIZE
- EFM4" EXISTING FORCE MAIN W/ SIZE
- EW8" EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.

SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.01

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILTIY
PLAN & PROFILE;
WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

APPROVED ____ DATE

SUBMITTED BY ____ FIRM MEMBER ____ DATE

JOB NO.

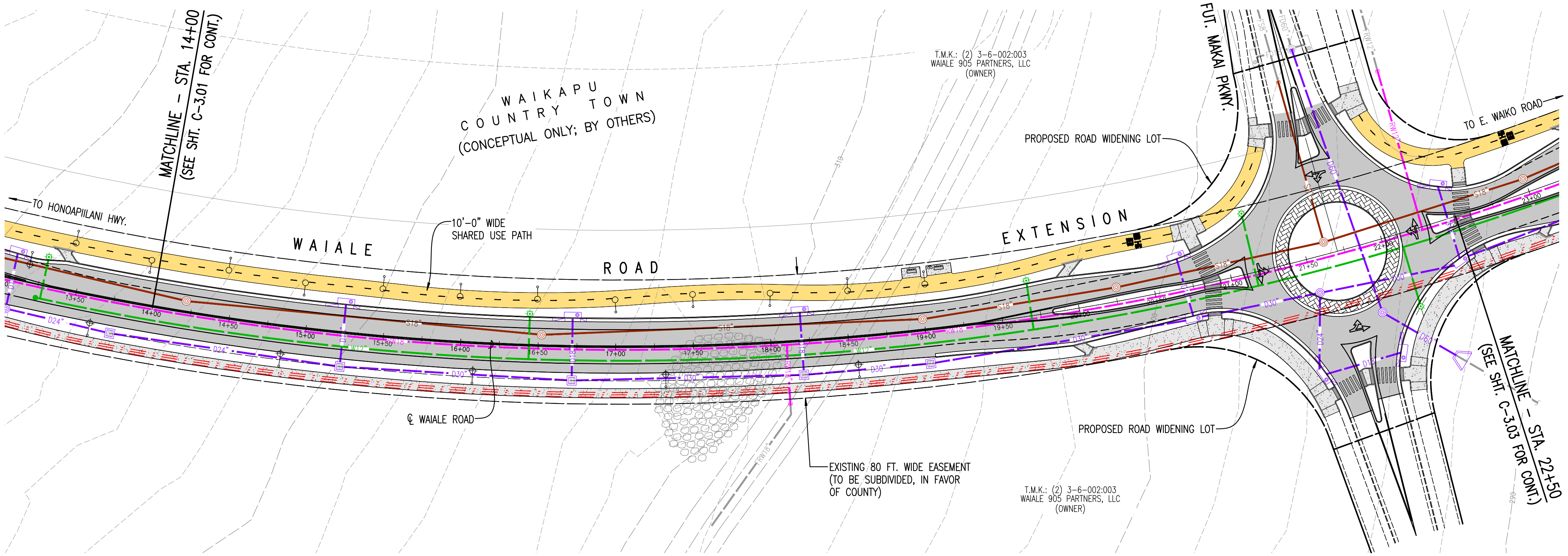
SHEET OF

FILE	POCKET	FOLDER	NO.

Y:\Projdata\21PROJ\21011 - B+K_CoM Waiale Rd Ext\dwg\complans\Conceptual\PL-WAIALE-00.dwg

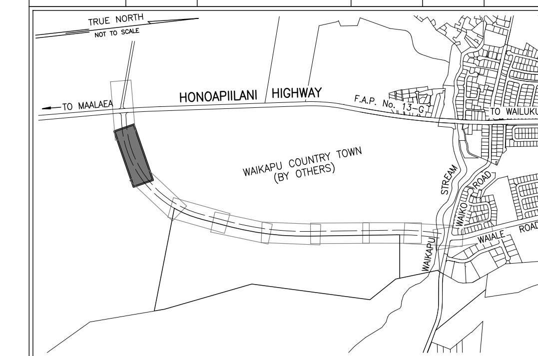
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



PLAN

SCALE: 1 IN. = 40 FT.

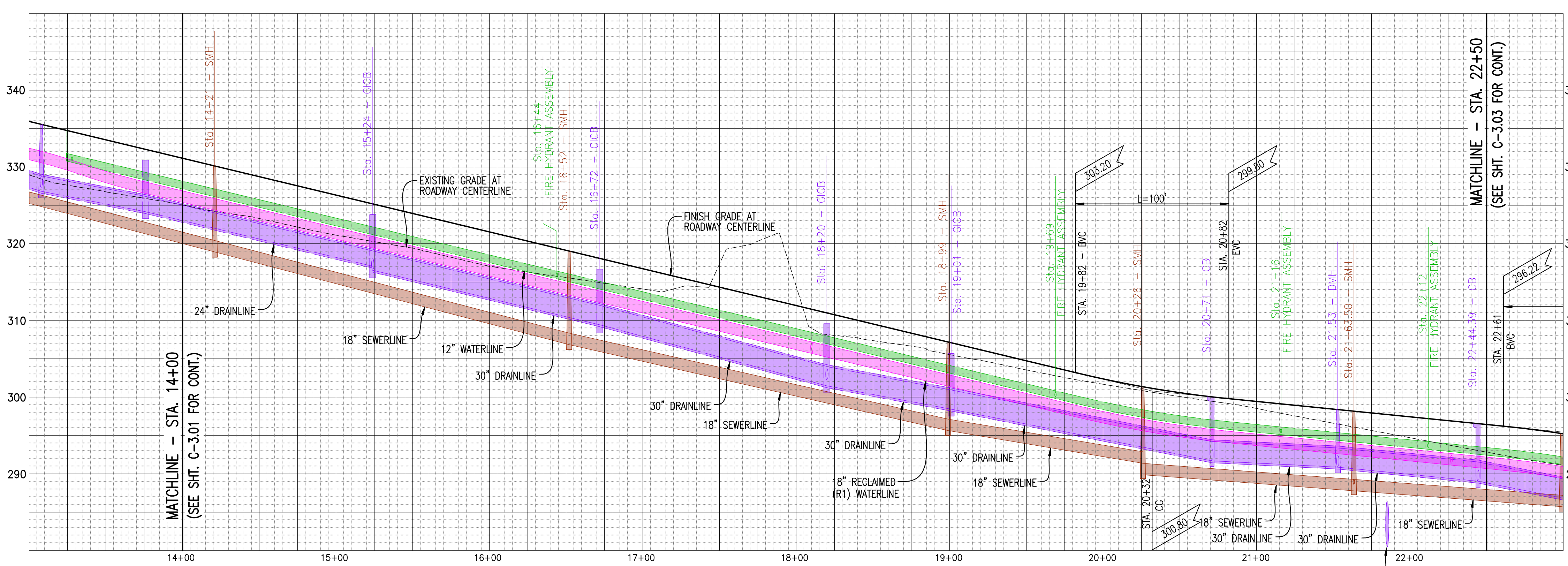


LOCATION MAP

NOT TO SCALE

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.

SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.02

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE; WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM DRAWN BY DPT CHECKED BY CNM

APPROVED SUBMITTED BY

DATE FIRM MEMBER DATE

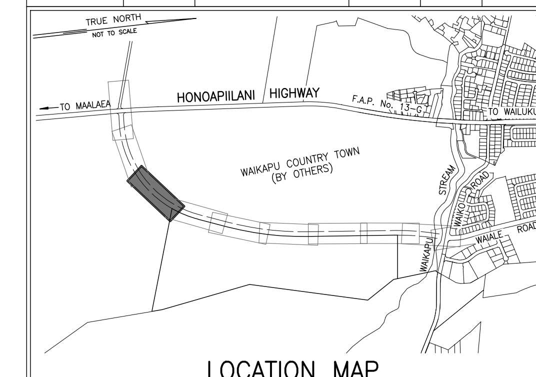
JOB NO.

SHEET OF

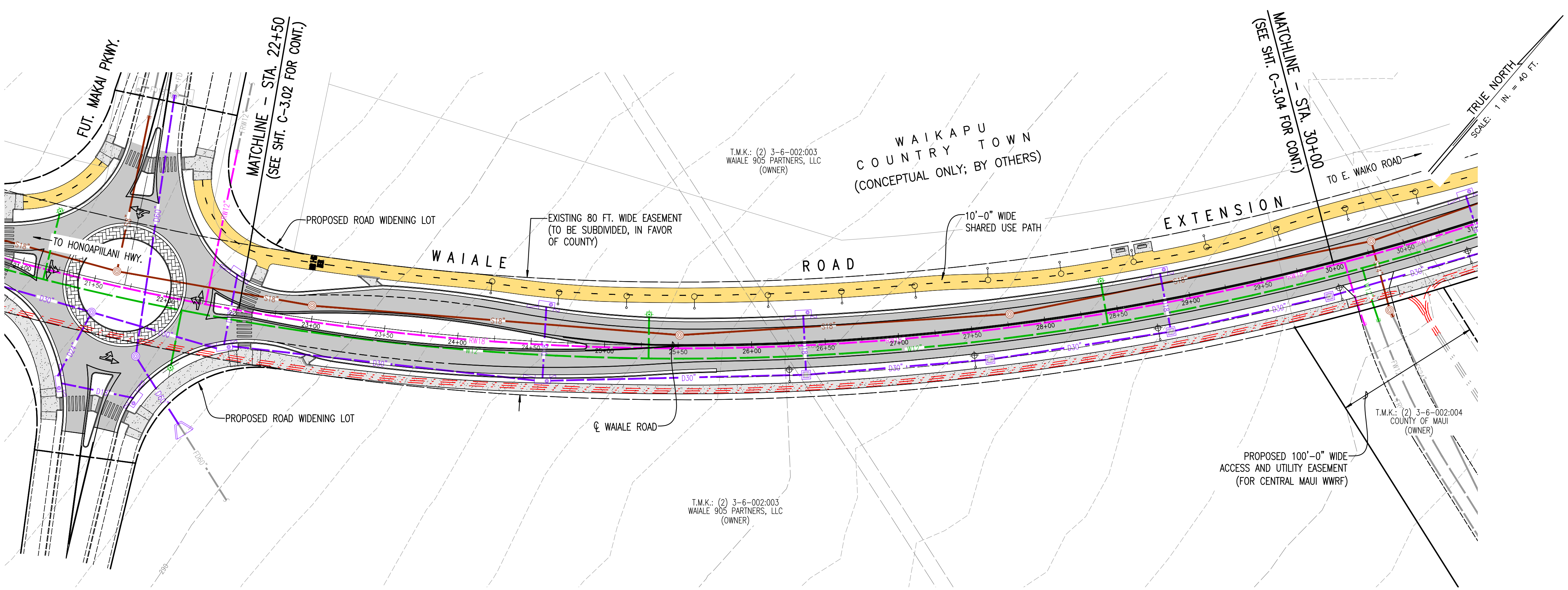
FILE	POCKET	FOLDER	NO.

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



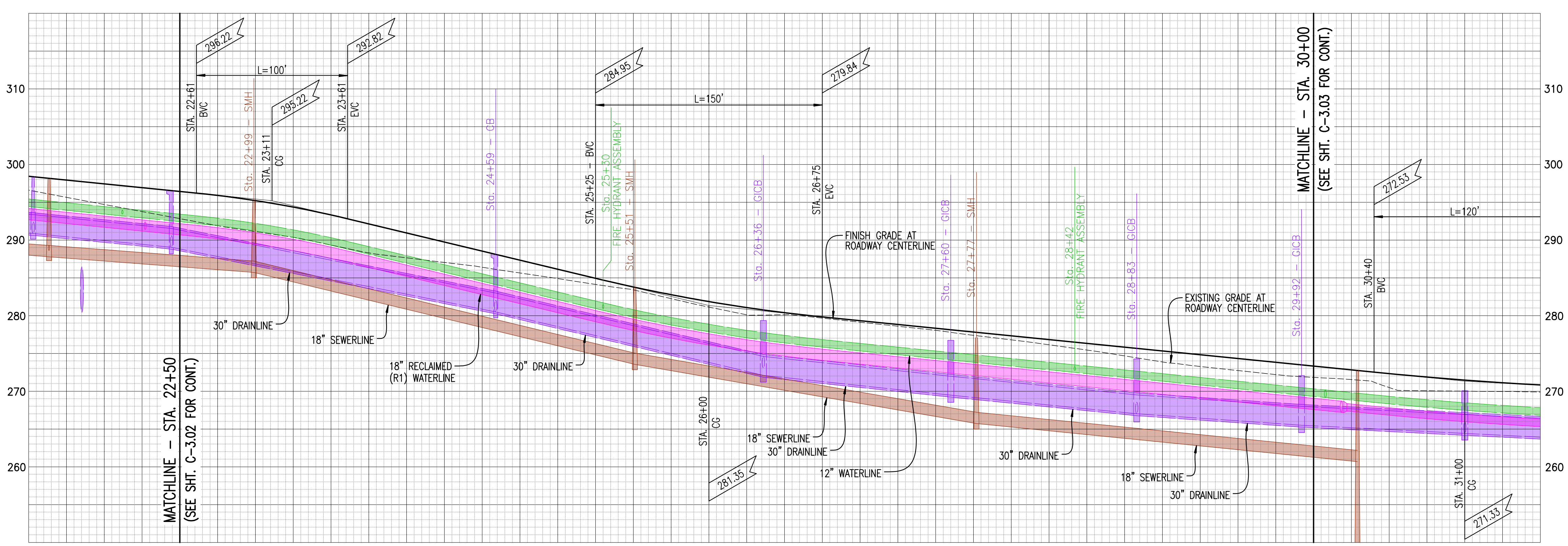
LOCATION MAP
NOT TO SCALE



PLAN
SCALE: 1 IN. = 40 FT.

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE; WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

APPROVED | SUBMITTED BY

DATE | FIRM MEMBER | DATE

C-3.03

JOB NO.

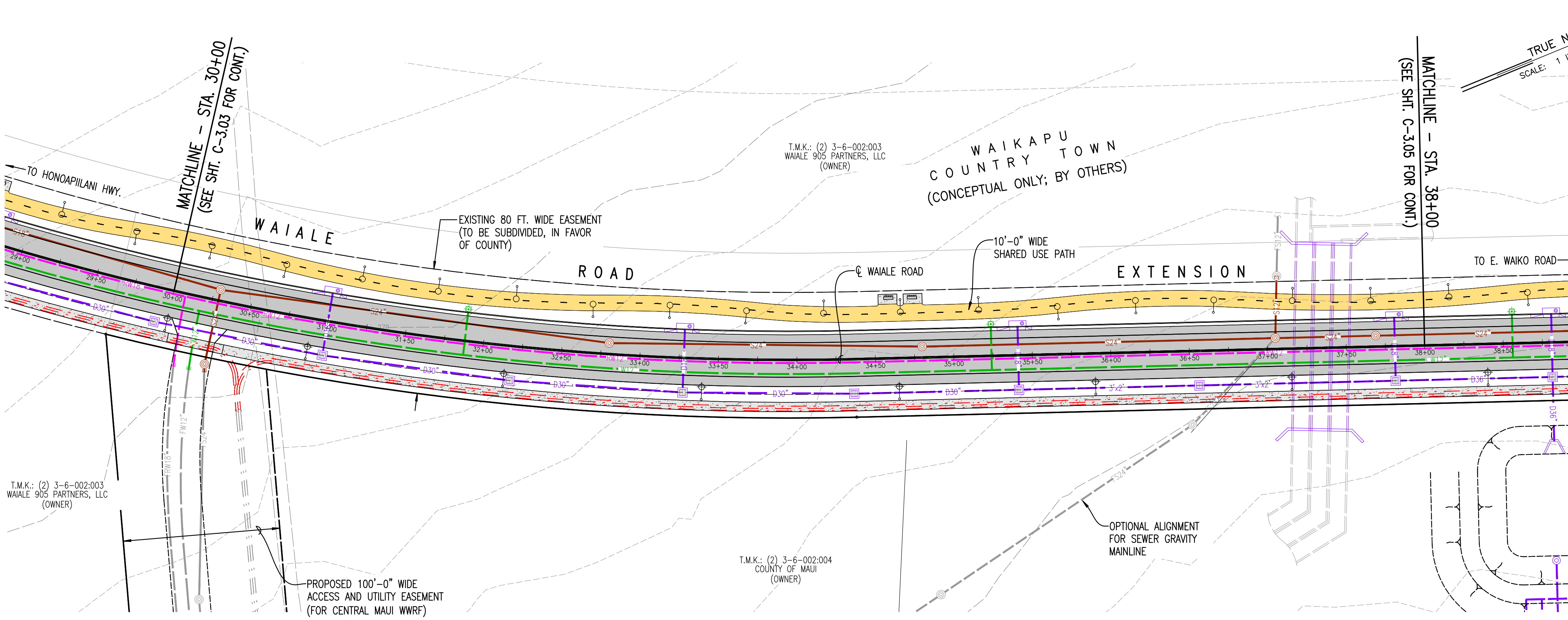
SHEET OF

FILE	POCKET	FOLDER	NO.

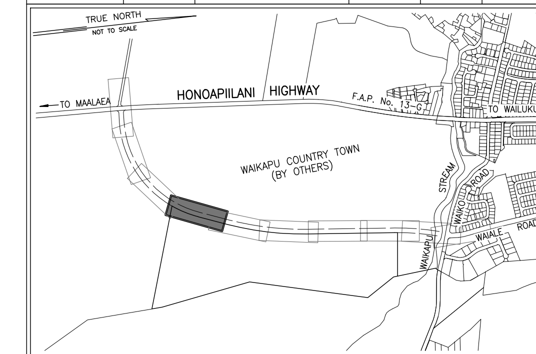
Y:\Projects\21PROJ\21011 - B+K_CoM Waiale Rd Ext\dwg\complans\Conceptual\PL-WAIALE-00.dwg

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



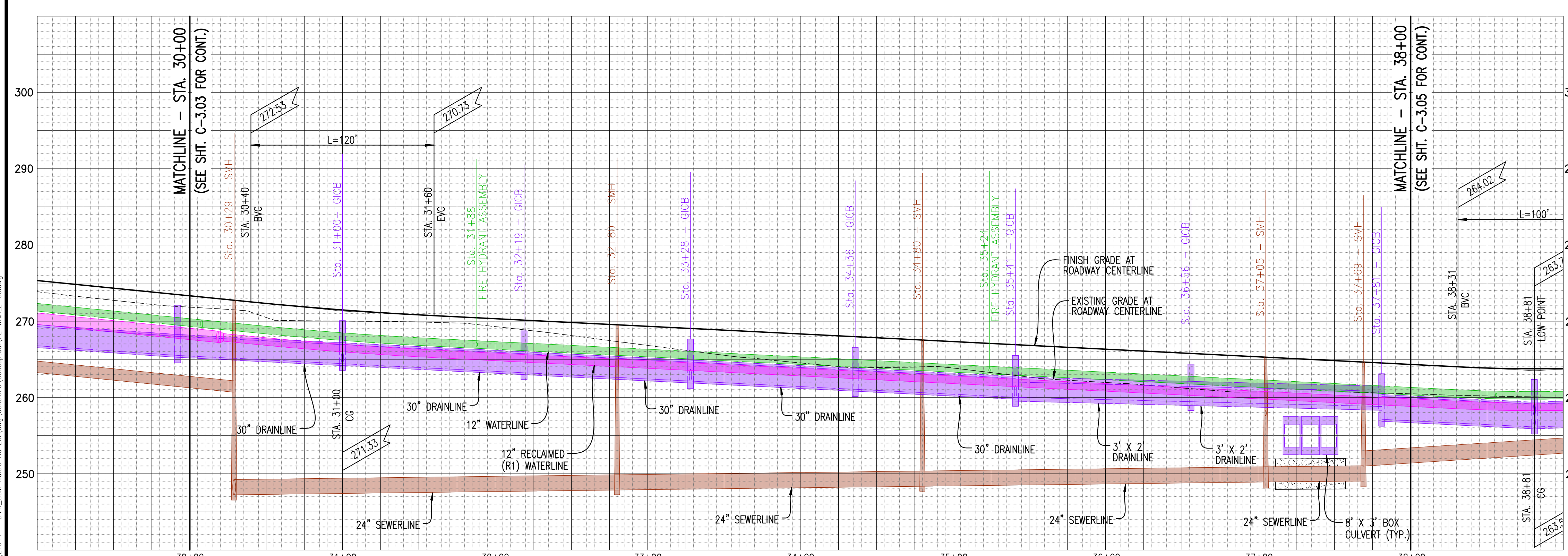
PLAN
SCALE: 1 IN. = 40 FT.



LOCATION MAP
NOT TO SCALE

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.04

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

REVISION	DATE	BRIEF	MADE BY	APPROVED

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE: WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM DRAWN BY DPT CHECKED BY CNM

APPROVED ____ DATE

SUBMITTED BY ____ FIRM MEMBER DATE

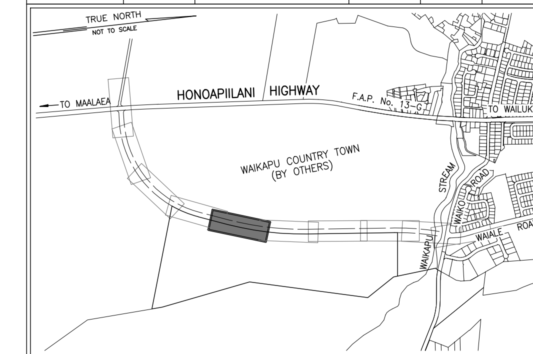
JOB NO.

SHEET OF

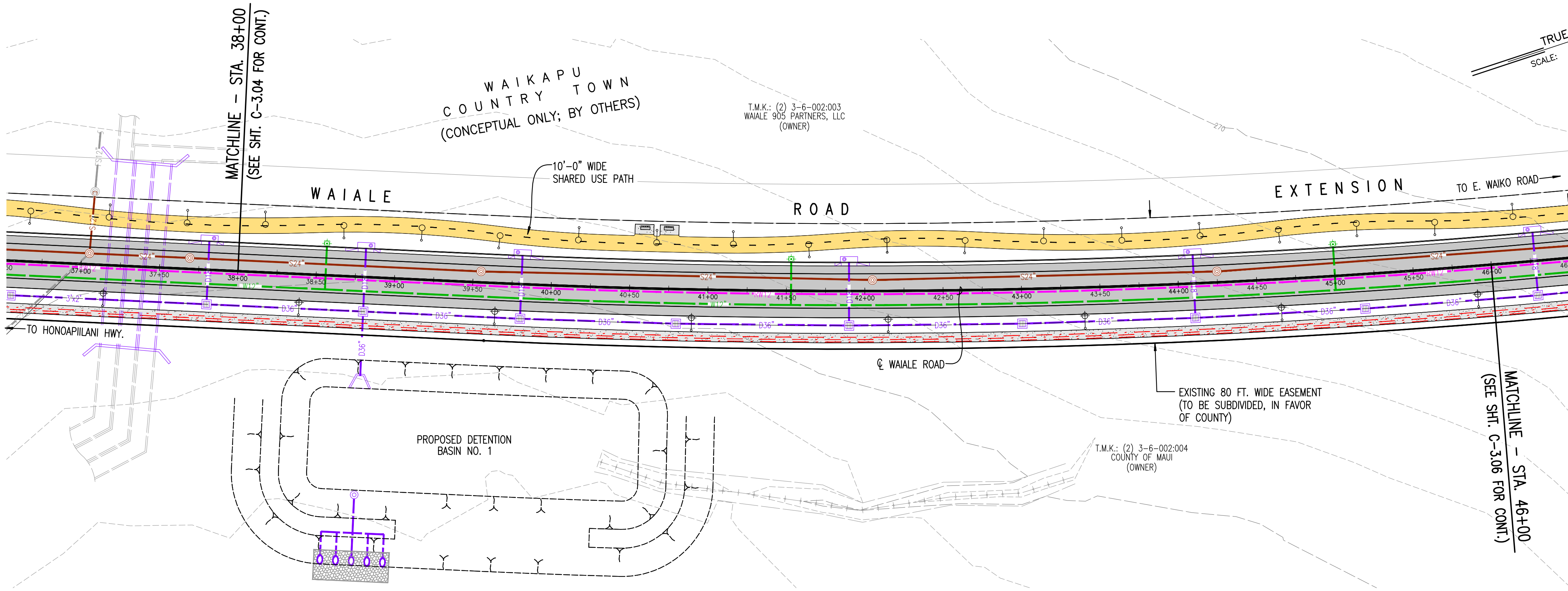
FILE	POCKET	FOLDER	NO.

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



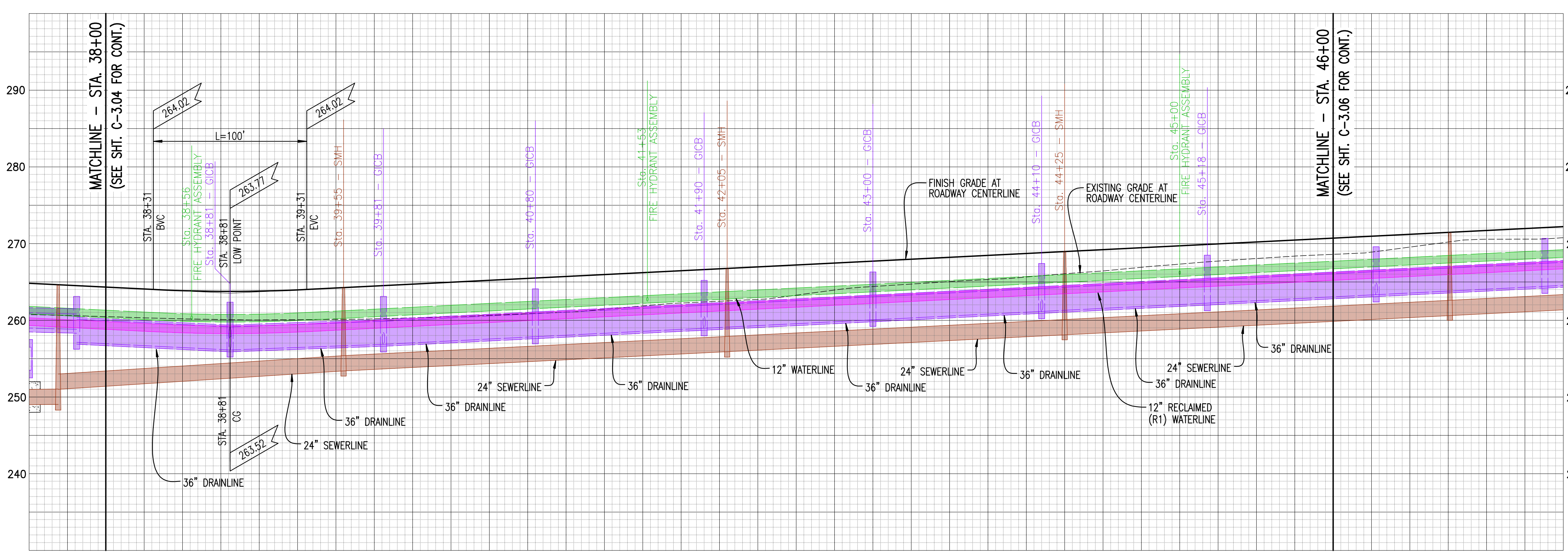
LOCATION MAP
NOT TO SCALE



PLAN
SCALE: 1 IN. = 40 FT.

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.05

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION
License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

REVISION	DATE	BRIEF	MADE BY	APPROVED

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE; WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

APPROVED ______ DATE
SUBMITTED BY ______ FIRM MEMBER ______ DATE

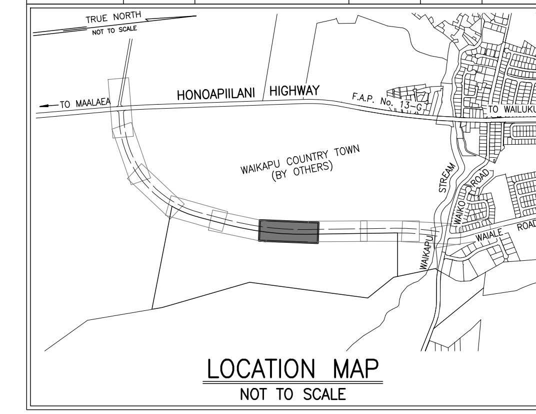
JOB NO.

SHEET OF

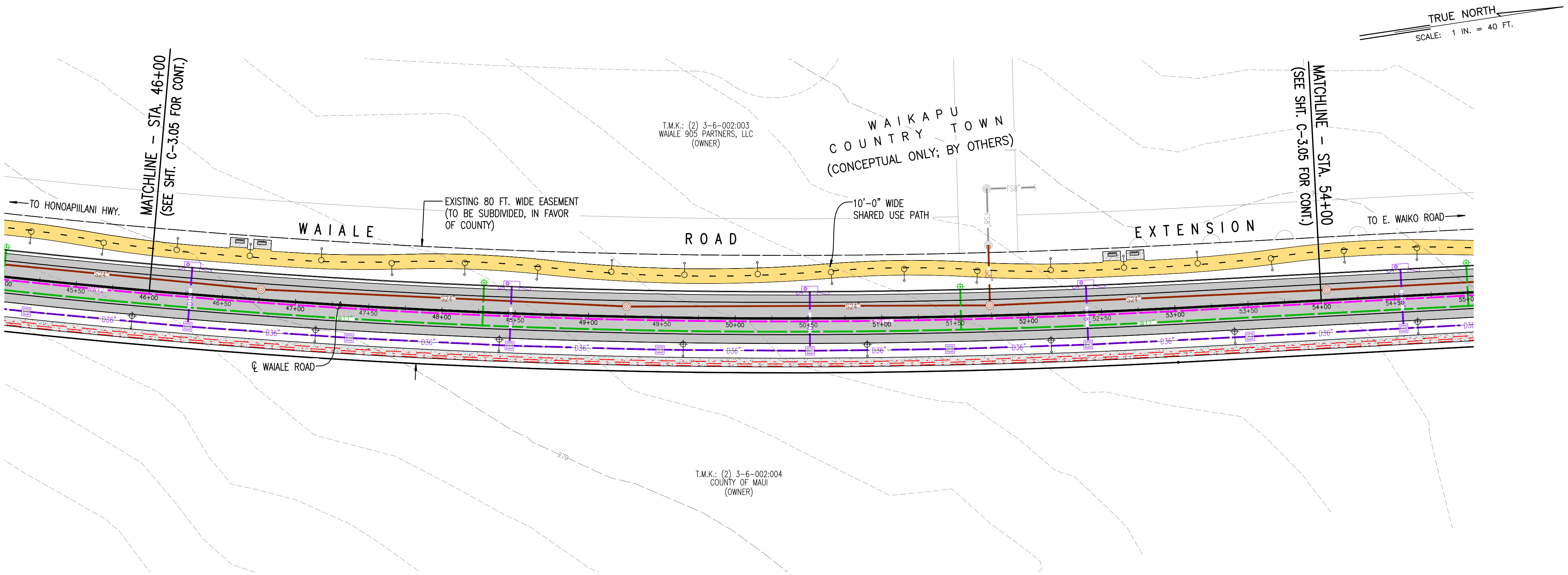
FILE	POCKET	FOLDER	NO.

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

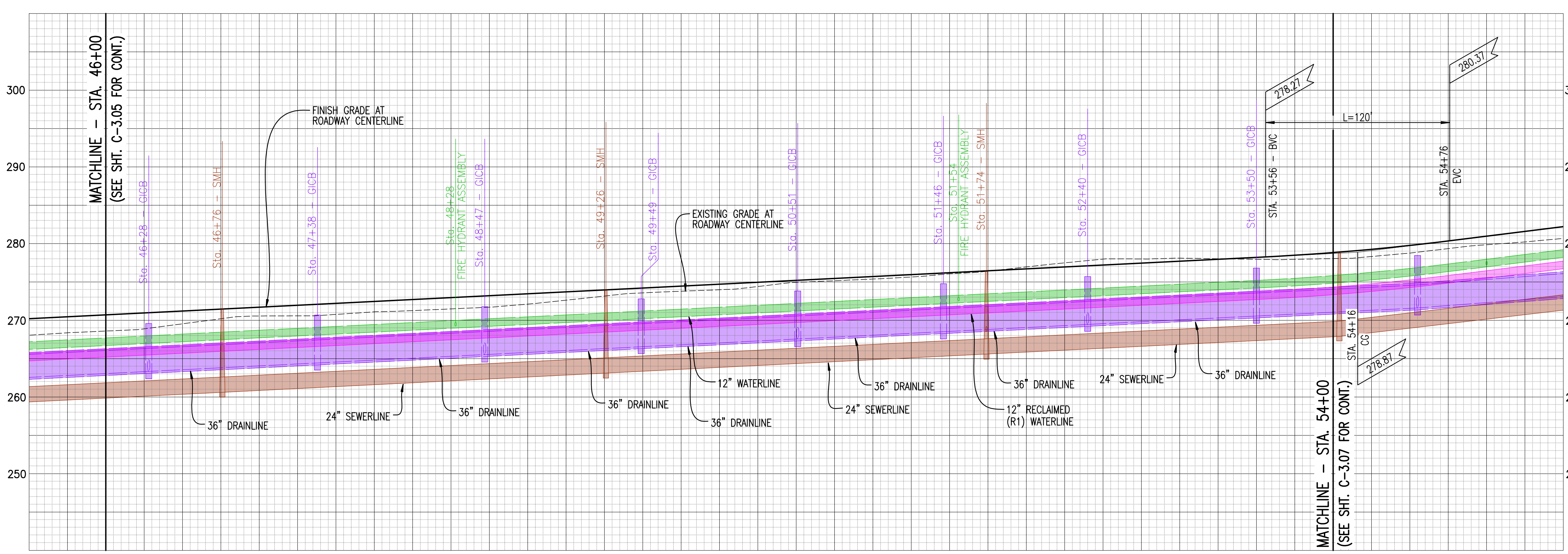
04-15-2024 (Conceptual Plans)



LOCATION MAP
NOT TO SCALE



PLAN
SCALE: 1 IN. = 40 FT.



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILTIY
PLAN & PROFILE;
WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM DRAWN BY DPT CHECKED BY CNM

APPROVED DATE SUBMITTED BY FIRM MEMBER DATE

C-3.06

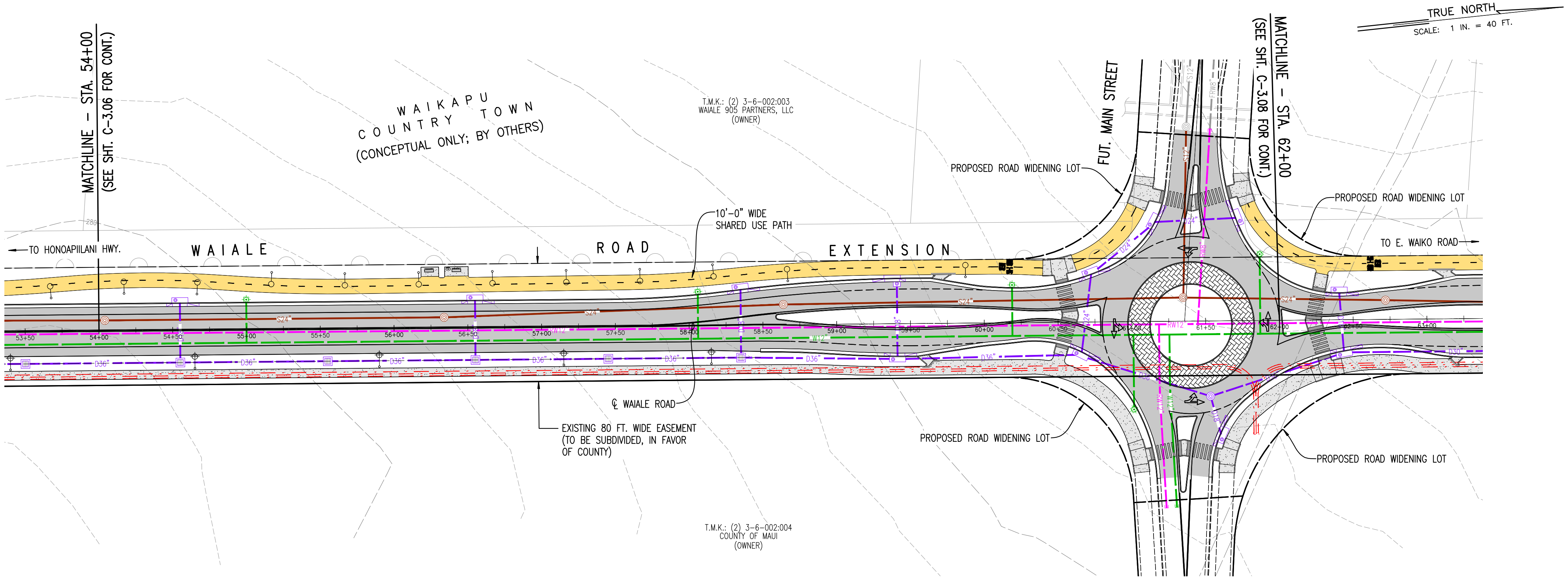
JOB NO.

SHEET OF

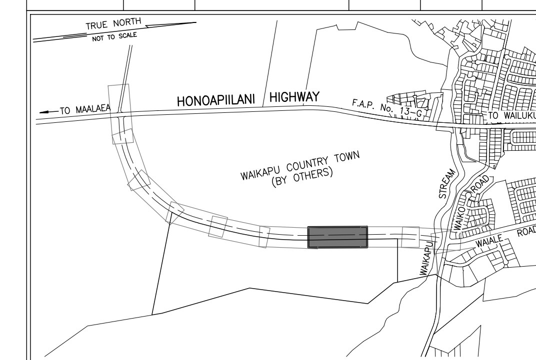
FILE	POCKET	FOLDER	NO.

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



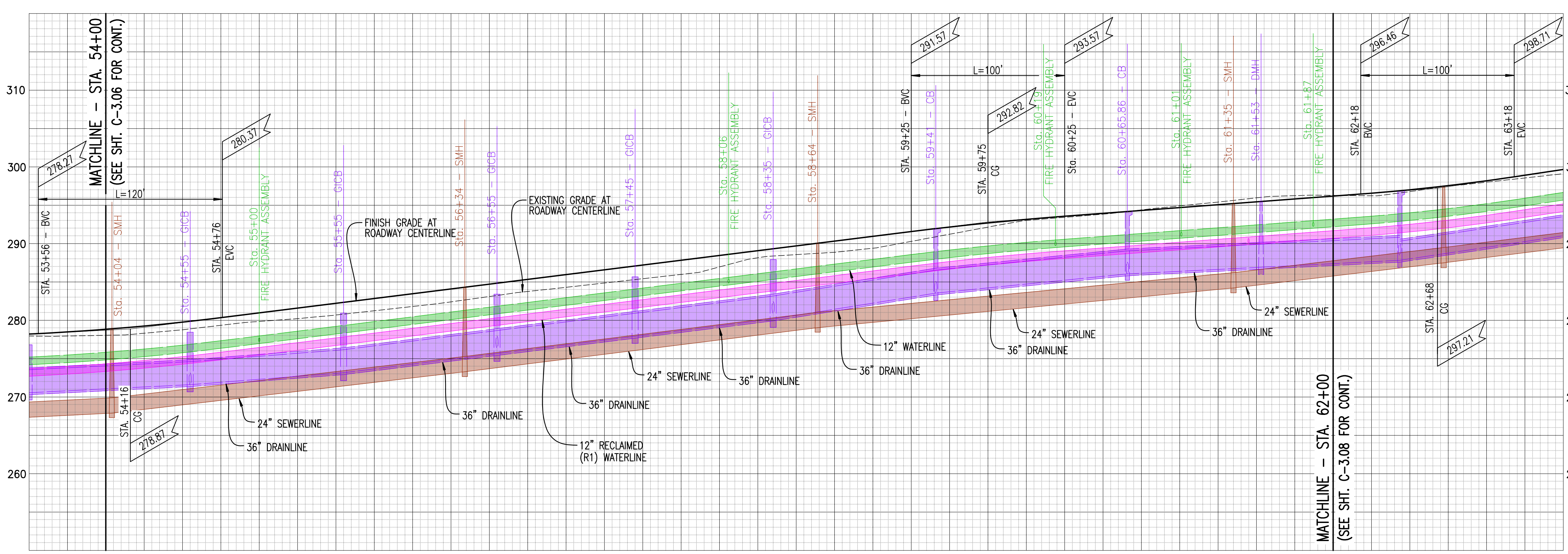
PLAN
SCALE: 1 IN. = 40 FT.



LOCATION MAP
NOT TO SCALE

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SFM18" SEWER FORCE MAIN W/ SIZE
- RW12" RECLAIMED (R1) WATERLINE W/ SIZE
- D24" DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- S8" SEWERLINE W/ SIZE
- FS12" FUTURE SEWERLINE W/ SIZE
- FW12" FUTURE WATERLINE W/ SIZE
- FRW18" FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FRW18" FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- W4" WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- ED24" EXISTING DRAINLINE W/ SIZE
- EFM4" EXISTING FORCE MAIN W/ SIZE
- EW8" EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.07

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION
License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE; WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

APPROVED ____ DATE

SUBMITTED BY ____ FIRM MEMBER ____ DATE

JOB NO.

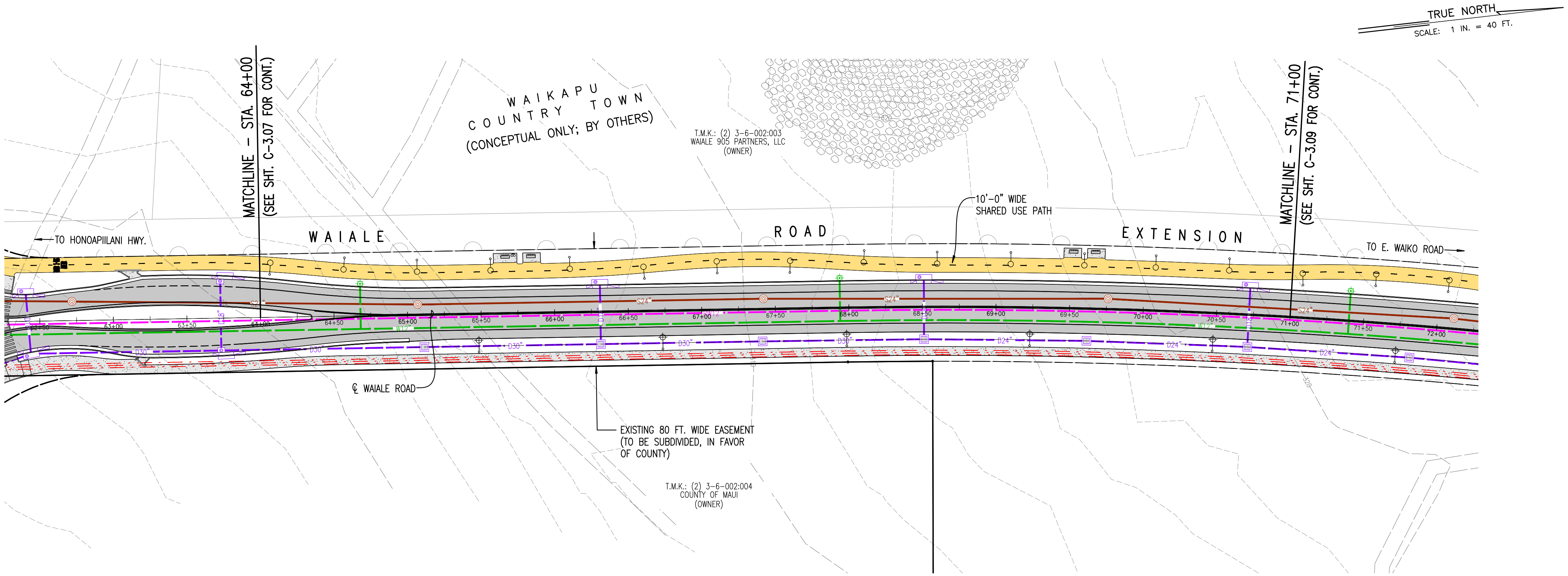
SHEET OF

FILE	POCKET	FOLDER	NO.

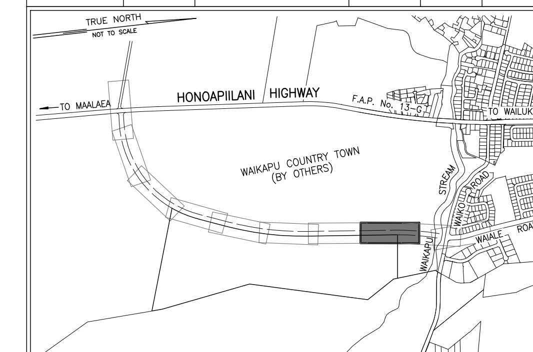
Y:\Projdata\21PROJ\21011 - B+K_CoM Waiale Rd Ext\dwg\complans\Conceptual\PL-WAIALE-00.dwg

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



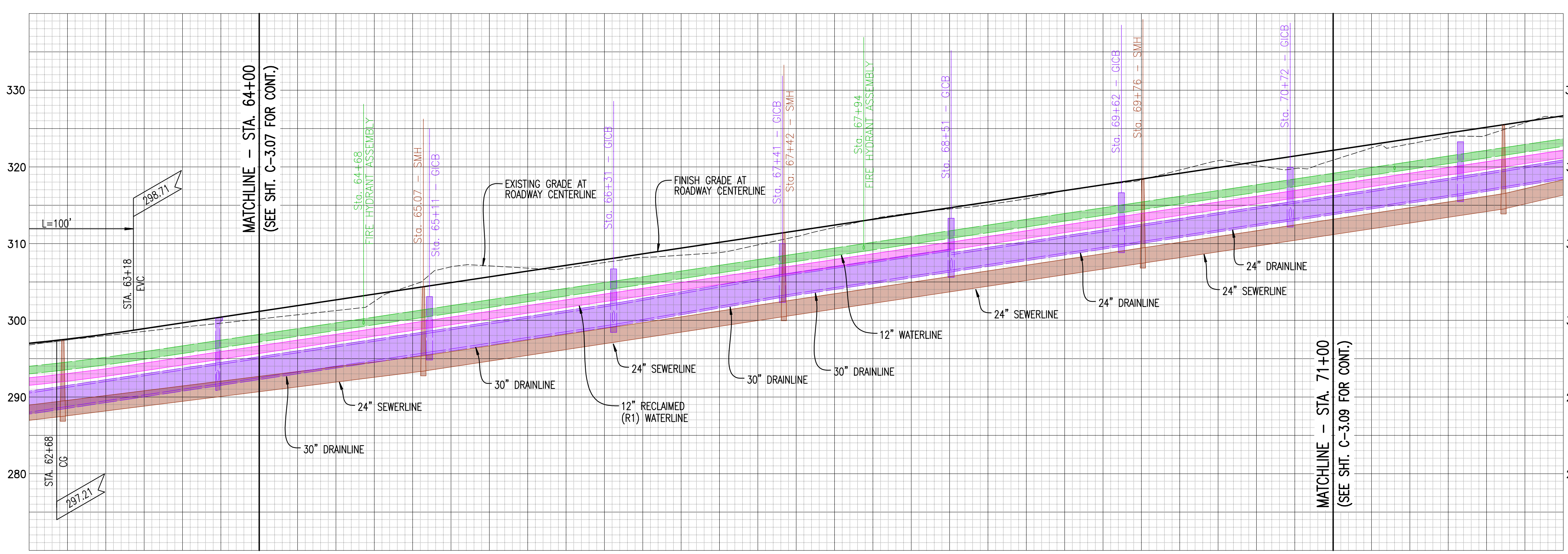
PLAN
SCALE: 1 IN. = 40 FT.



LOCATION MAP
NOT TO SCALE

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.08

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE;
WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)
FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM DRAWN BY DPT CHECKED BY CNM

APPROVED DATE SUBMITTED BY FIRM MEMBER DATE

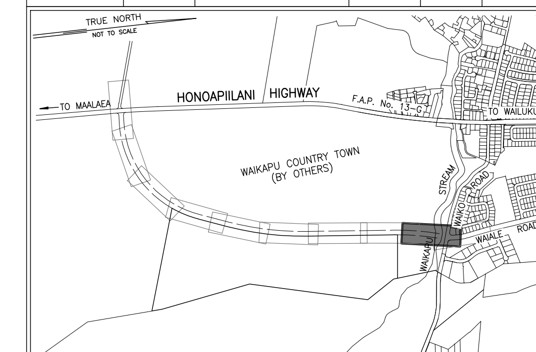
JOB NO.

SHEET OF

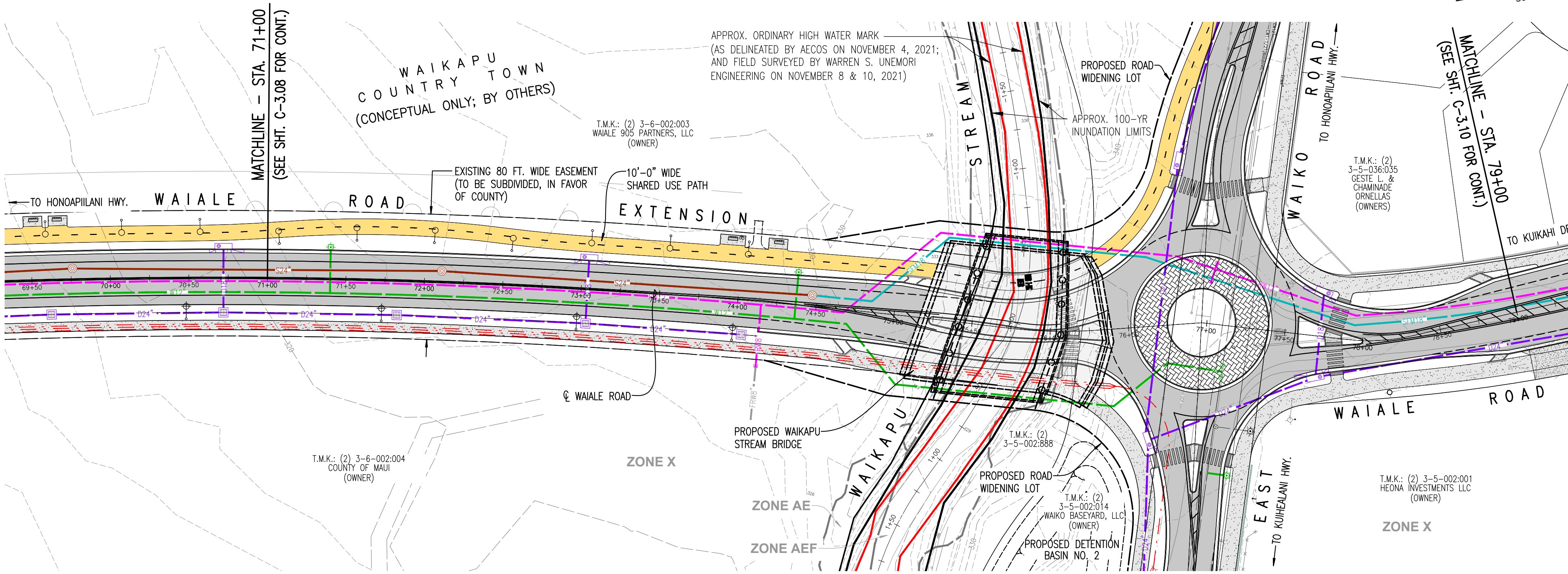
FILE	POCKET	FOLDER	NO.

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

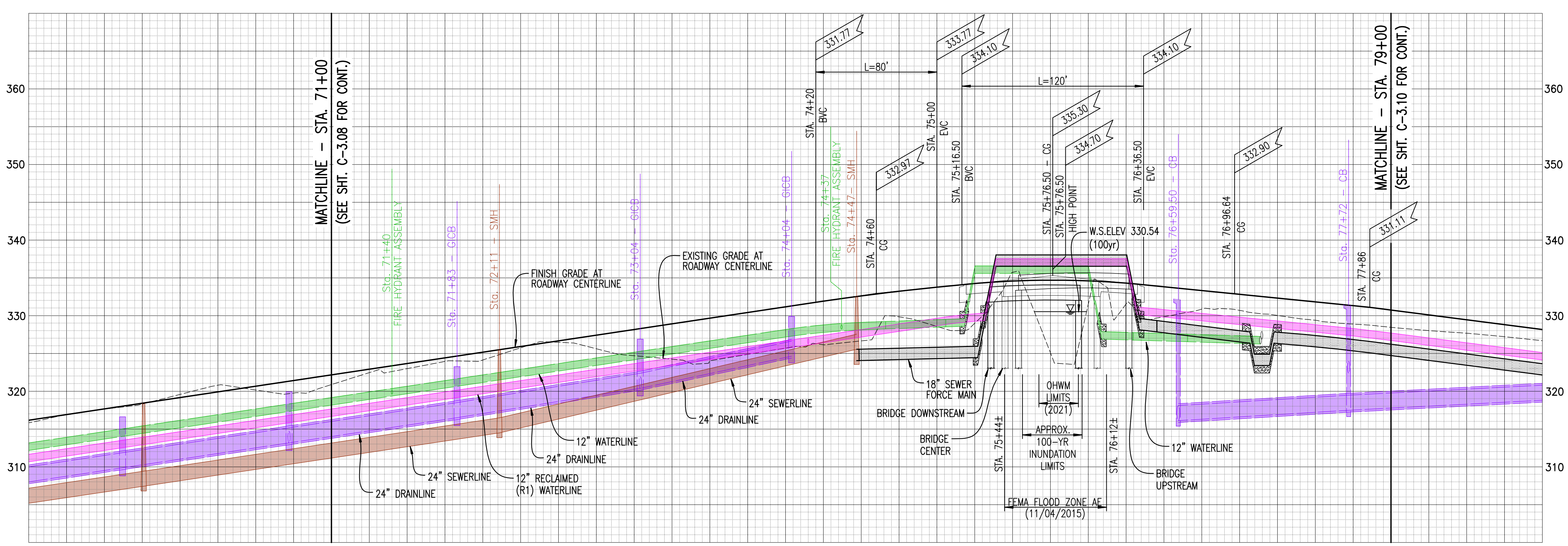
04-15-2024 (Conceptual Plans)



LOCATION MAP
NOT TO SCALE



PLAN
SCALE: 1 IN. = 40 FT.



PROFILE - WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SFM18" — SEWER FORCE MAIN W/ SIZE
- RW12" — RECLAIMED (R1) WATERLINE W/ SIZE
- D24" — DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- S8" — SEWERLINE W/ SIZE
- FS12" — FUTURE SEWERLINE W/ SIZE
- FW12" — FUTURE WATERLINE W/ SIZE
- FRW18" — FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FRW18" — FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- W4" — WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- ED24" — EXISTING DRAINLINE W/ SIZE
- EFM4" — EXISTING FORCE MAIN W/ SIZE
- EW8" — EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION
License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE;
WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)
FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

APPROVED | DATE
SUBMITTED BY | FIRM MEMBER | DATE

C-3.09

JOB NO.

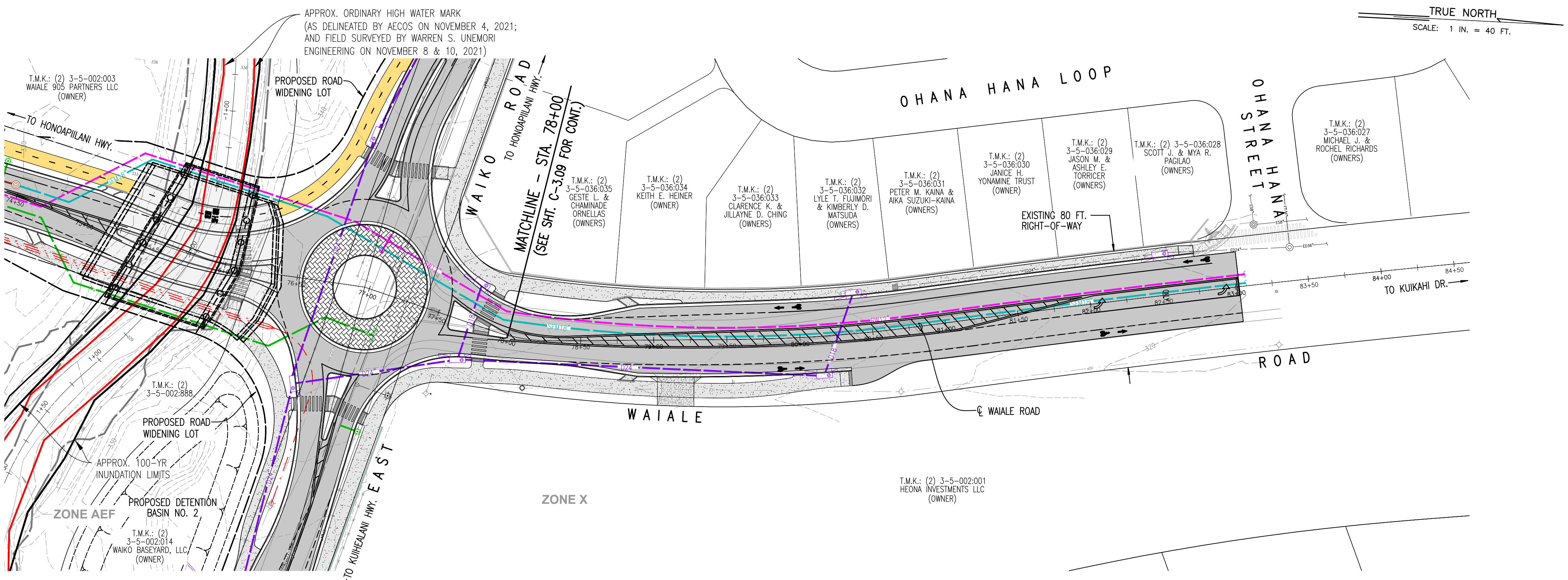
SHEET OF

FILE	POCKET	FOLDER	NO.

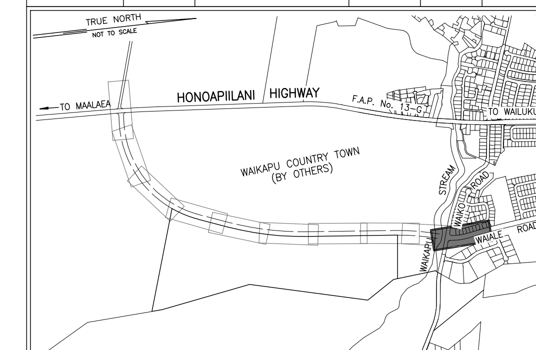
Y:\Projects\21PROJ\21011 - B+K_CoM Waiale Rd Ext\dwg\complans\Conceptual\PL-WAIALE-00.dwg

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--

04-15-2024 (Conceptual Plans)



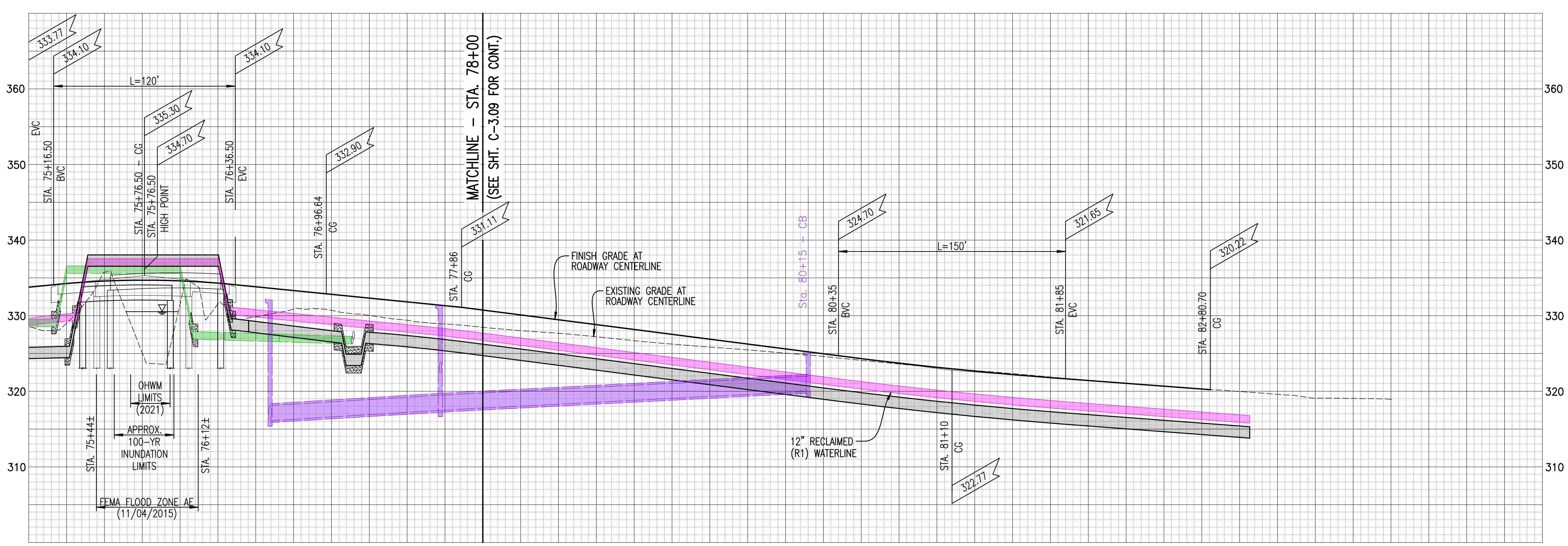
PLAN
SCALE: 1 IN. = 40 FT.



LOCATION MAP
NOT TO SCALE

LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SFM18" SEWER FORCE MAIN W/ SIZE
- RW12" RECLAIMED (R1) WATERLINE W/ SIZE
- D24" DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- S8" SEWERLINE W/ SIZE
- FS12" FUTURE SEWERLINE W/ SIZE
- FW12" FUTURE WATERLINE W/ SIZE
- FRW18" FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FRW18" FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- W4" WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- ED24" EXISTING DRAINLINE W/ SIZE
- EFM4" EXISTING FORCE MAIN W/ SIZE
- EW8" EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT



PROFILE – WAIALE ROAD EXT.
SCALE: HORIZ. 1" = 40'
VERT. 1" = 8'

C-3.10

REVISION	DATE	BRIEF	MADE BY	APPROVED

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION
License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY
PLAN & PROFILE;
WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM DRAWN BY DPT CHECKED BY CNM

APPROVED DATE SUBMITTED BY FIRM MEMBER DATE

JOB NO.

SHEET OF

FILE	POCKET	FOLDER	NO.

V:\Projdata\21PROJ\21011 – B+K_CoM Waiale Rd Ext\dwg\complans\Conceptual\PL-WAIALE-00.dwg

APPENDIX

C

AIR QUALITY STUDY

Draft

AIR QUALITY STUDY
FOR THE PROPOSED
WAIALE ROAD EXTENSION PROJECT

WAIKAPU, MAUI, HAWAII

Prepared for:

Bowers & Kubota

December 7, 2023

B.D. NEAL & ASSOCIATES
Applied Meteorology • Air Quality • Computer Science
73-4610 KALOKO LOA PLACE • KAILUA-KONA, HAWAII 96740 • TELPHONE (808) 329-1627
EMAIL: bdneal@bdneal.com

CONTENTS

FIGURES

TABLES

1.0 SUMMARY

The County of Maui, Department of Public Works is proposing the Waiale Road Extension Project in the Waikapu area on the island of Maui. Construction is currently expected to start in 2025 and the proposed roadway is expected to be open for use in 2027. The proposed action is intended to reduce future traffic congestion and improve traffic flow in the Waikapu and Wailuku areas. It will involve the construction of 8,600 feet of roadway and the construction or improvement of four roadway intersections. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed new roadway and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

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

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its elevation near sea level and by nearby mountains. The predominant trade winds tend to be channeled through the area by the mountains to the east and west. Temperatures in the project area are generally very consistent and warm with average daily

temperatures ranging from about 67°F to 82°F. Rainfall in the project area is minimal with an average of about 16 inches per year.

Except for periodic impacts from volcanic emissions (vog), occasional wild fires and possibly occasional localized impacts from traffic congestion and local agricultural sources, the present air quality of the project area is believed to be relatively good. There is very little air quality monitoring data from the Department of Health for the project area, but the limited data that are available suggest that concentrations are generally within state and national air quality standards. The recent cessation of sugarcane cultivation in the project area likely has resulted in improved air quality.

If the proposed project is given the necessary approvals to proceed, there may be some short- and/or long-term impacts on air quality that may occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust could occur during the project construction phases. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the minor disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures to consider include limiting the area that is disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

To assess the potential long-term impact of emissions from project-related motor vehicle traffic operating on roadways in the project area after construction is completed, a computerized air quality modeling study was undertaken. The air quality modeling study estimated current worst-case concentrations of carbon monoxide at intersections in the project vicinity and predicted future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour worst-case carbon monoxide concentrations are well within both the state and the national ambient air quality standards. In the year 2045 without the project, worst-case carbon monoxide concentrations were predicted to decrease (improve) slightly or remain unchanged despite an increase in traffic, and concentrations would remain well within standards. This is because emissions from the increase in traffic will be more than offset by the retirement of older, more-polluting vehicles over time. With the project in the year 2045, estimated worst-case carbon monoxide concentrations indicated no measurable impact compared to the without project case. Concentrations would remain well within standards. Due to the negligible impact the project is expected to have, implementing mitigation measures for long-term traffic-related air quality impacts is probably unnecessary and unwarranted.

Greenhouse gases will be emitted from construction equipment and motor vehicles during the approximately two-year period of construction. After that and for the long-term, the project is expected to result in improved traffic flow and reduced intersection delay in the project area, and thereby provide for a reduction in greenhouse gas emissions.

2.0 INTRODUCTION

The County of Maui, Department of Public Works is proposing the Waiale Road Extension Project in the Waikapu area on the island of Maui (see Figure 1 for project location). The project is currently expected to begin construction in 2025 and be completed during 2027. The purpose of this project is to relieve the increased traffic congestion on Honoapiilani Highway in the vicinity of Waikapu and Wailuku that is expected to occur in the future with additional development in the area. This project would extend the existing portion of Waiale Road, which currently terminates at East Waiko Road, approximately 8,600 feet south to Honoapiilani Highway. Four intersections along the Waiale Road extension would be constructed as roundabouts. These would include the intersections of Waiale Road extension at Honoapiilani Highway, at Makai Parkway, at Main Street and at Waiko Road. The project traffic study [1] examined the intersections at the northern and southern termini both as roundabouts and as signalized intersections.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate project impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit.

The national AAQS are reviewed periodically, and multiple revisions have occurred over the past 30 years. In general, the national AAQS have become more stringent with the passage of time and as more information and evidence become available concerning the detrimental effects of air pollution. Changes to the Hawaii AAQS over the past several years have tended to follow revisions to the national AAQS, making several of the Hawaii AAQS the same as the national AAQS.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The topography of Maui is dominated by the great volcanic masses of Haleakala (10,023 feet) and the West Maui Mountains (5,788 feet). The island consists entirely of the slopes of these mountains and of a connecting isthmus. Haleakala is still considered to be an active volcano and last erupted about 1790. The project site is located in central Maui in the valley between Haleakala and the West Maui Mountains at an elevation of about 400 feet.

Maui lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high-pressure cell to the north and east. Because the project site is located within the valley between Haleakala and the West Maui Mountains, the predominant trade wind flow tends to be channeled through the area from north to south by the terrain to the east and west. Local winds such as land/sea breezes and/or upslope/downslope winds also influence the wind pattern for the area when the trade winds are weak or absent. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Warmer temperatures tend to result in higher emissions of carbon monoxide from automobiles and higher concentrations of photochemical smog. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's lower elevation results in relatively even temperatures. Average daily minimum and maximum temperatures at nearby Kahului Airport are 67°F and 82°F, respectively [2]. Temperatures at the project site can be expected to be similar to this.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Kahului area, stability classes 5 or 6 typically occur during the nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the nearby mountains. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the prevailing wind conditions.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3,000 feet (1,000 meters).

Rainfall can have a beneficial effect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is moderately dry due to the low elevation. Historical records from Kahului show that this area of Maui averages about 16 inches of precipitation per year with the summer months being the driest [2].

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Most of the manmade particulate and sulfur oxides emissions on Maui originate from point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions occur from both point sources and area sources (mostly motor vehicle traffic). The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic and agriculture), while hydrocarbons are emitted mainly from point sources. Emissions today from agriculture, primarily particulate and carbon monoxide, are probably lower than a few years ago because of the cessation of sugarcane cultivation on Maui. Area source emissions of particulate occur from rock quarry and landfill operations. Occasional wildfires can result in significant but short-term emissions of carbon monoxide and particulate.

The largest sources of air pollution in the immediate project area are most likely automobile traffic using local roadways. Emissions from these sources consist primarily of particulate, hydrocarbons, carbon monoxide and nitrogen oxides. Kahului Power Plant, which is located about 3 miles to the northeast, emits mostly sulfur dioxide, nitrogen oxides and particulate, and operations at Kahului Airport, located about 5 miles to the northeast, result in emissions of particulate, carbon monoxide, nitrogen oxides and hydrocarbons. Particulate emissions occur from a large cement plant/quarry and from a county landfill located about 5 miles to the east. Large wildfires occurred in August 2023 at Lahaina and Kula resulting in significant emissions of carbon monoxide, particulate and other contaminants. Volcanic emissions from distant natural sources on the Big Island also affect the air quality at times during kona wind conditions. By the time the volcanic emissions reach the project area, they consist mostly of fine particulate sulfate.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state, but only very limited data are available for Maui Island. The only recent air quality data for the island of Maui consists of particulate measurements collected at Kihei, which is about 8 miles to the south, and at Kahului. Table 3 summarizes the data from these two monitoring stations for the years 2018 to 2022. At Kihei, the annual 24-hour 98th percentile PM-2.5 particulate concentrations (which are most relevant to the air quality standards) ranged from 6 to 17 $\mu g/m^3$ between 2018 and 2022. Average annual concentrations ranged from 2 to 4 $\mu g/m^3$. Three values above 35 $\mu g/m^3$ (which relates to the national standard) were recorded during 2019. These were likely caused by wildfires. Concentrations at Kahului for the period 2018 to 2022 were similar.

Given the limited air pollution sources in the area, it is likely that air pollution concentrations are near natural background levels most of the time, except possibly for locations adjacent to agricultural operations or near traffic-congested intersections or when wild fires occur nearby. With the cessation of sugarcane cultivation in 2017, it is likely that air quality has improved in the past five years. Present concentrations of carbon monoxide in the project area are

estimated later in this study based on computer modeling of motor vehicle emissions.

6.0 SHORT-TERM IMPACTS OF PROJECT

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

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [3] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site could be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [4] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually 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. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could become airborne. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the annual standard for nitrogen dioxide is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for

nitrogen dioxide is based on a three-year average; thus, it is unlikely that relatively short-term construction emissions would exceed the standard. Carbon monoxide emissions from diesel engines are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities could obstruct the normal flow of traffic for short periods of times such that overall vehicular emissions in the project area could temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

After construction is completed, use of the proposed facilities may result in increased motor vehicle traffic at some locations in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation required further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, and these began to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways.

To evaluate the potential long-term ambient air quality impact of motor vehicle traffic using the proposed new roadway facilities, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways within the project area. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single project.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2022 with present conditions, (2) year 2045 without the project, and (3) year 2045 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, six of the key intersections identified in the traffic study [1] were selected for air quality analysis. These included the following intersections:

- Honoapiilani Highway at Kuikahi Drive
- Waiale Road at Kuikahi Drive
- South Kamehameha Avenue at Maui Lani Parkway
- Kuihelani Highway at Maui Lani Parkway
- Honoapiilani Highway at Waiko Road
- Waiale Road at Waiko Road.

The traffic study indicated that the selected intersections generally had higher traffic volumes and/or more congestion. The traffic study describes the existing and projected future traffic conditions and laneage configurations of the study intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. The air quality study evaluated these same periods.

Vehicular carbon monoxide emissions for each year studied were calculated using the latest version of EPA's Motor Vehicle Emission Simulator (MOVES4) computer model [5]. MOVES4 was configured for a project-level analysis specifically for Hawaii. Assumptions included an urban, unrestricted road type, national average vehicle mix, default fuel supply and fuel formulation, default vehicle age distribution and morning and afternoon ambient temperatures of 70°F and 90°F, respectively. MOVES4 emission factors were generated both for idling and for moving traffic.

After computing vehicular carbon monoxide emissions through the use of MOVES4, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Some years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model had become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings. All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOVES based on assumed free-flow vehicle speeds corresponding to the posted or design speed limits.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This acknowledges that pedestrian sidewalks already exist or may exist in the future in these locations. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second (2 miles per hour) with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2022. Although increased traffic is expected to occur within the project area within the next few years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 3 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2022 with existing traffic, year 2045 without the project and year 2045 with the project. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2022) case was 1.5 ppm. This was projected to occur during the morning peak traffic hour at the intersection of South Kamehameha Avenue and Maui Lani Parkway. Predicted worst-case 1-hour concentrations at all locations studied for the 2022 scenario were well within both the national AAQS of 35 ppm and the state standard of 9 ppm.

In the year 2045 without the proposed project, the highest worst-case 1-hour carbon monoxide concentration in the project area was predicted to reach 0.9 ppm during both the morning and the afternoon peak traffic hours at the intersection of South Kamehameha Avenue and Maui Lani Parkway. Compared to the existing case, predicted concentrations for the year 2045 without the project either decreased (improved) or remained unchanged at all locations, and worst-case concentrations remained well within the state and national standards. This suggests that emissions from higher traffic volumes and increased traffic congestion in the future will be more than offset by the retirement of older, more-polluting vehicles over time.

Predicted 1-hour worst-case concentrations for the 2045 with project scenario remained nearly unchanged at the study intersections compared to the without project case. Forecast worst-case concentrations at all locations studied remained well within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 4. For the 2022 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the six locations studied ranged from 0.4 to 0.8 ppm. The estimated worst-case concentrations for the existing case were well within both the state standard of 4.4 ppm and the national limit of 9 ppm.

For the year 2045 without project scenario, predicted worst-case concentrations were 0.4 ppm at all locations studied, generally decreasing (improving) slightly or remaining unchanged compared to the existing scenario. All predicted concentrations were within the standards.

For the 2045 with project scenario, worst-case concentrations remained unchanged compared to the without project case, indicating no measurable project impact. All predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second (4 miles per hour), for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

8.0 GREENHOUSE GAS EMISSIONS

Gases that trap heat in the atmosphere, greenhouse gases (GHGs), regulate the earth's temperature. This phenomenon, known as the greenhouse effect, is responsible for maintaining a habitable climate. The most common GHGs are carbon dioxide (CO_2) and water vapor but there are also several others, most importantly methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). These are released into the earth's atmosphere through a variety of natural processes and human activities. Sources of GHGs are generally as follows:

- CO_2 and N_2O are byproducts of fossil fuel combustion.
- N_2O is associated with agricultural operations such as fertilization of crops.
- CH_4 is commonly created by off-gassing from agricultural practices (e.g., keeping livestock) and landfill operations.
- Chlorofluorocarbons (CFCs) were widely used as refrigerants, propellants, and cleaning solvents but their production has been stopped by international treaty.
- HFCs are now used as a substitute for CFCs in refrigeration and cooling.
- PFCs and sulfur hexafluoride emissions are commonly created by industries such as aluminum production and semi-conductor manufacturing.

Each GHG has its own potency and effect upon the earth's energy balance. This is expressed in terms of a global warming potential (GWP), with CO_2 being assigned a value of 1 and sulfur hexafluoride being several orders of magnitude stronger. In GHG

emission inventories, the weight of each gas is multiplied by its GWP and is measured in units of CO_2 equivalents (CO_2e). An expanding body of scientific research and evidence supports the theory that global warming is occurring due to manmade activities and that it will increasingly do so in the future. Several natural resources and processes worldwide have and will continue to be adversely affected by the global warming trend, including: increased precipitation; sea level rise; increased coastal flooding; saltwater intrusion; degradation of wetlands; and adverse impacts on plant and animal species. The effects of global climate change that could adversely affect human health include: increases in extreme heat events and heat-related stress; increases in climate sensitive diseases; more frequent and intense natural disasters such as flooding, hurricanes and drought; and increased levels of air pollution.

During construction phases of the proposed project, fossil-fueled equipment and motor vehicles will be used to support project construction, and use of this equipment and motor vehicles will result in the emission of GHGs. The present start date for the project is planned for the summer of 2025. The overall construction duration is expected to be about 18 to 24 months and to occur in five stages:

- Stage 1: Installation of Best Management Practices (BMPs)for water drainage and dust control; installation of signage for traffic control and routing; performance of clearing/grubbing and general grading. This stage is anticipated to have a duration of about three months and involve heavy equipment, such as backhoes, excavators, loaders, graders, dozers, dump trucks and water trucks.

- Stage 2.1: Installation of underground civil utilities, including sewerlines, potable waterlines, reclaimed waterlines, and drainlines. This stage may overlap with Stage 1 and is anticipated to have a duration of 12 months and involve heavy equipment, such as backhoes, excavators, hoe rams, dump trucks, boom trucks, water trucks and portable compaction equipment.

- Stage 2.2: Bridge construction activities will occur, including drilled shafts and cap beams, precast prestressed planks, decks, railings, etc. This stage may overlap with earlier construction stages and is anticipated to have a duration of 15 months and involve heavy equipment, such as drill rigs, cranes, backhoes, excavators, dozers, loaders, graders, dump trucks, boom trucks, rollers, water trucks, portable compaction equipment, air compressors, generators, concrete saws, forklifts, concrete trucks and pump trucks.

- Stage 2.3: Removal/relocation/installation of electric utilities. This stage is expected to have a duration of three months and involve heavy equipment, such as backhoes, excavators, dump trucks, electrical utility trucks, compaction equipment, concrete trucks and cranes.

- Stage 2.4: Installation of underground electrical utilities, street lights, electrical ducts, handholes, manholes and associated appurtenances. This stage is expected to have a duration of six months and may overlap with earlier construction stages and involve heavy equipment such as backhoes, excavators, dump trucks, electric utility trucks, portable compaction equipment, concrete trucks and cranes.

- Stage 3.1: Installation of roundabout at Honoapiilani Highway. This stage is expected to have a duration of 15 months, overlapping with other construction stages, and involve heavy equipment such as backhoes, excavators, loaders, graders, dump trucks, dozers, pavers, rollers, concrete trucks and water trucks.

- Stage 3.2: Installation of roundabout at East Waiko Road. This stage is expected to have a duration of 12 months, overlapping with other construction stages, and involve heavy equipment such as backhoes, excavators, loaders, graders, dump trucks, dozers, pavers, rollers, concrete trucks and water trucks.

- Stage 3.3: Installation of roadway section and share use path. This stage is expected to have a duration of 12 months, overlapping with other construction stages, and involve heavy equipment such as backhoes, excavators, loaders, graders, dump trucks, dozers, pavers, rollers, concrete trucks and water trucks.

- Stage 4.1: Installation of landscaping and irrigation. This stage is expected to have a duration of six months, overlapping with other construction stages, and involve heavy equipment such as backhoes, boom trucks, bobcats, dump trucks, water trucks and forklifts.

- Stage 4.2: Installation of striping and signage. This stage is expected to have a duration of one month and involve utility trucks and concrete trucks.

- Stage 5: Cleanup and inspections. This stage is expected to have a duration of one month and involve backhoes, bobcats and dump trucks.

During all stages of construction, construction workers will travel to and from the site in personal vehicles and there will be deliveries using semi-trucks and trailers to bring equipment and material to the site.

The purpose of this project is to relieve traffic congestion and improve traffic flow in the project area. After project construction is completed, it is expected that average travel speeds will increase and average traffic delay times at intersections will generally decrease. As reported in the project traffic study, eight of the 12 study intersections are projected to operate in the future (year 2045) at acceptable levels-of-service (LOS D or better) following construction of the Waiale Road Extension as proposed. Four intersections are projected to operate at levels-of-service E or F in the future (2045) no-project scenario. The reduction in congestion and improvement of traffic flow in the long-term can be expected to result in a long-term reduction in GHGs.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Although very little ambient air quality data are available to characterize existing conditions, it is likely that state and federal ambient air quality standards are currently being met in the project area. The air quality has likely improved in recent years with the cessation of sugarcane cultivation, which was frequently the source of significant smoke and dust. Occasional

air quality degradation in the project area may occur due to dust and smoke emissions from nearby wild fires. Air quality analysis of roadway intersections in the project area indicate that carbon monoxide concentrations are currently within state and federal air quality standards.

Project-related short-term impacts on air quality may occur from the emission of fugitive dust during construction phases. Uncontrolled fugitive dust emissions from construction activities could amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Establishment of landscaping early in the construction schedule will also help to control dust.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After the proposed project is completed, any long-term impacts on air quality in the project area due to emissions from project-related motor vehicle traffic should be negligible. Worst-case concentrations of carbon monoxide should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

During the period of construction, which is expected to last about 18 to 24 months, greenhouse gases will occur from construction equipment, trucks and worker vehicles. After construction is complete, the improved roadways in the project area are expected to result in better traffic flow and reduced intersection congestion, which can be expected to result in the long-term reduction in greenhouse gas emissions. Thus, it can be expected that the project will result in a net positive impact on greenhouse gases.

REFERENCES

1. Fehr & Peers, Transportation Impact Analysis Report, Waiale Road Extension, October 2023.

2. "Climatic Summary of the United States, Supplement for 1951 through 1960, Hawaii and Pacific", U.S. Department of Commerce, Weather Bureau, Washington, D.C., 1965.

3. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1995.

4. State of Hawaii. Hawaii Administrative Rules, Chapter 11-60, Air Pollution Control.

5. User Guide for Motor Vehicle Emission Simulator (MOVES), U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Assessment and Standards Division, Ann Arbor, Michigan, July 2014, EPA-420-B-14-055.

6. Guideline on Air Quality Models (Revised), Including Supplements A and B, EPA-450/2-78-027R, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1986.

7. User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections, U.S. Environmental Protection Agency, November 1992.

8. CALINE4 - A Dispersion Model for Predicting Air Pollutant Concentrations Near Roadways, FHWA/CA/TL-84/15, California State Department of Transportation, November 1984 with June 1989 Revisions.

9. "Persistence Factors for Mobile Source (Roadway) Carbon Monoxide Modeling", C. David Cooper, Journal of the Air & Waste Management Association, Volume 39, Number 5, May 1989.

10. Guideline for Modeling Carbon Monoxide from Roadway Intersections, U.S. Environmental Protection Agency, EPA-454/R-92-005, November 1992.

11. Annual Summaries, Hawaii Air Quality Data, 2018-2022, State of Hawaii Department of Health.

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	µg/m³	Annual	–	–	50
		24 Hours	150[a]	150[a]	150[b]
Particulate Matter (<2.5 microns)	µg/m³	Annual	15[c]	15[c]	–
		24 Hours	35[d]	35[d]	–
Sulfur Dioxide	ppm	Annual	–	–	0.03
		24 Hours	–	–	0.14[b]
		3 Hours	–	0.5[b]	0.5[b]
		1 Hour	0.075[e]	–	–
Nitrogen Dioxide	ppm	Annual	0.053	0.053	0.04
		1 Hour	0.100[f]	–	–
Carbon Monoxide	ppm	8 Hours	9[b]	–	4.4[b]
		1 Hour	35[b]	–	9[b]
Ozone	ppm	8 Hours	0.075[g]	0.075[g]	0.08[g]
Lead	µg/m³	3 Months	0.15[h]	0.15[h]	–
		Quarter	1.5[i]	1.5[i]	1.5[i]
Hydrogen Sulfide	ppm	1 Hour	–	–	0.025[b]

[a] Not to be exceeded more than once per year on average over three years.
[b] Not to be exceeded more than once per year.
[c] Three-year average of the weighted annual arithmetic mean.
[d] 98th percentile value of the 24-hour concentrations averaged over three years.
[e] Three-year average of annual fourth-highest daily 1-hour maximum.
[f] 98th percentile value of the daily 1-hour maximum averaged over three years.
[g] Three-year average of annual fourth-highest daily 8-hour maximum.
[h] Rolling 3-month average.
[i] Quarterly average.

Table 2

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST WAIALE ROAD EXTENSION PROJECT

Parameter / Location	Year				
	2018	2019	2020	2021	2022
Particulate (PM-2.5) / Kahului					
24-Hour Averaging Period:					
No. of Samples	295	323	331	336	358
Highest Concentration (µg/m³)	15	13	9	9	13
98th Percentile Concentration (µg/m³)	8	8	7	7	8
No. of values greater than 35 µg/m³	0	0	0	0	0
Annual Average Concentration (µg/m³)	3	3	4	4	4
Particulate (PM-2.5) / Kihei					
24-Hour Averaging Period:					
No. of Samples	339	357	332	355	86
Highest Concentration (µg/m³)	13	84	14	15	8
98th Percentile Concentration (µg/m³)	11	17	7	6	7
No. of values greater than 35 µg/m³	0	3	0	0	0
Annual Average Concentration (µg/m³)	4	4	3	2	2

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2018 – 2022"

Table 3

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR WAIALE ROAD EXTENSION PROJECT (parts per million)

Roadway Intersection	Year/Scenario					
	2022/Present		2045/Without Project		2045/With Project	
	AM	PM	AM	PM	AM	PM
Honapiilani Highway at Kuikahi Drive	1.2	1.0	0.7	0.8	0.7	0.7
Waiale Road at Kuikahi Drive	1.3	1.2	0.8	0.8	0.9	0.8
S. Kamehameha Ave at Maui Lani Parkway	1.5	1.4	0.9	0.9	0.9	0.9
Kuihelani Highway at Maui Lani Parkway	1.1	1.1	0.8	0.8	0.8	0.8
Honapiilani Highway at Waiko Road	1.1	1.0	0.8	0.8	0.7	0.8
Waiale Road at Waiko Road	0.7	0.7	0.7	0.7	0.9*	0.8*

Hawaii State AAQS: 9
National AAQS: 35

*Assumes roundabout

Table 4

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR WAIALE ROAD EXTENSION PROJECT (parts per million)

Roadway Intersection	Year/Scenario		
	2022/Present	2045/Without Project	2045/With Project
Honapiilani Highway at Kuikahi Drive	0.6	0.4	0.4
Waiale Road at Kuikahi Drive	0.6	0.4	0.4
S. Kamehameha Ave at Maui Lani Parkway	0.8	0.4	0.4
Kuihelani Highway at Maui Lani Parkway	0.6	0.4	0.4
Honapiilani Highway at Waiko Road	0.6	0.4	0.4
Waiale Road at Waiko Road	0.4	0.4	0.4*

Hawaii State AAQS: 4.4
National AAQS: 9

*Assumes roundabout

PRELIMINARY ENGINEERING REPORT

APPENDIX

D

Established 1969

[DRAFT]

Preliminary Engineering Synopsis

WAIALE ROAD EXTENSION (Vicinity of Honoapiilani Highway to Vicinity of East Waiko Road)

County Project No. 21-33
Federal Aid Project No. STP-3180 (001)

Wailuku, Maui, Hawaii

TMK (2) 3-6-004: 003, 3-6-002:003 & 004, 3-5-002:001, 009, 014 & 888, 3-5-036:035

Prepared For:

Engineering Division
Department of Public Works

CLIFFORD N. MUKAI
LICENSED PROFESSIONAL ENGINEER
NO. 6667-C
HAWAII, U.S.A.

License Expires April 30, 2026

Warren S. Unemori Engineering, Inc.
Civil and Structural Engineers - Land Surveyors
Wells Street Professional Center
2145 Wells Street, Suite 403
Wailuku, Maui, Hawaii

Date: August 2024

TABLE OF CONTENTS

LIST OF FIGURES:

LIST OF EXHIBITS:

APPENDICES:

Preliminary Engineering Synopsis for
Waiale Road Extension
(Vicinity of Honoapiilani Highway to Vicinity of East Waiko Road)

I. INTRODUCTION

A. OBJECTIVE:

This treatise has been prepared as a summary and preliminary engineering evaluation of the County of Maui – Department of Public Works (DPW) proposed Waiale Road Extension (WRE) project (hereafter, "Project"), from the existing terminus of Waiale Road and its intersection of East Waiko Road towards the south to the vicinity of Honoapiilani Highway [at the existing intersection of Old Quarry Road near Mile marker (MM) 3.4], which includes improvements within East Waiko Road and Honoapiilani Highway to accommodate the new intersection configurations, including two (2) new intersections for the Waikapu Country Town (WCT) development. See FIGURE 1 for a recent aerial photo of the Project site and immediate vicinity.

Additional relevant engineering documents include the following:

- A Preliminary Drainage Report has been prepared ["Preliminary Drainage Report for Waiale Road Extension (Vicinity of Honoapiilani Highway to Vicinity of East Waiko Road)" (dated April 15, 2024, prepared by Warren S. Unemori Engineering, Inc.)] and is contained in APPENDIX "A".
- A Geotechnical (Soils) Engineering Exploration Report has been prepared ["Geotechnical Engineering Exploration – Waiale Road Extension, Waikapu, Maui, Hawaii" (dated June 24, 2024, prepared by Geolabs, Inc.)] and is contained in APPENDIX "B-1".
- A Preliminary Pavement Justification Report has been prepared ["Pavement Justification Report, County of Maui – Department of Public Works, Waiale Road Extension" (dated March 21, 2024, prepared by Geolabs, Inc.)] and is contained in APPENDIX "B-2".
- A Traffic Impact and Analysis Report has been prepared ["Waiale Road Extension, Transportation Impact Analysis Report" (dated October 2023, prepared by Fehr & Peers)] and is contained in APPENDIX "C" (TIAR appendices are not included herein).
- A Natural Resources Assessment was prepared ["A Natural Resource Assessment for the County of Maui, Waiale Road Extension Project, Waikapu, Maui" (dated July 5, 2022, prepared by AECOS Inc.)] and is contained in APPENDIX "D".

A more comprehensive, detailed evaluation of existing conditions, potential impacts and mitigative measures are addressed through an Environmental Assessment (prepared by others as a separate, compiled document).

Date of Photo: May 12, 2022

LEGEND:
Project Limits

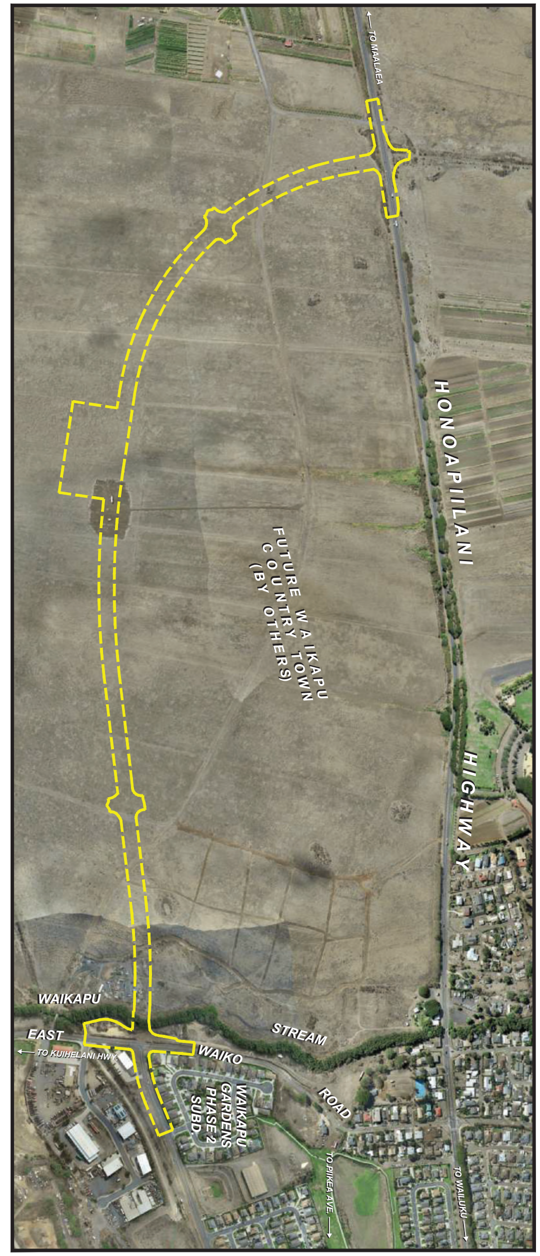


FIGURE 1 - Aerial Photo of Project Site & Immediate Vicinity

WARREN S. UNEMORI ENGINEERING, INC.

B. SITE LOCATION:

1. GENERAL

Waikapu, on the island of Maui, is located on the eastern slope, along the windward side, of West Maui Mountains (also known as Mauna Kahalawai), an eroded shield volcano rising up to approximately 6,000 ft. above mean sea level (M.S.L.).

The Project (see EXHIBIT "A" – Project Location Map) is located in Waikapu, and is proposed to consist of an approximately 8,600± ft. long segment of a new two-lane roadway and shared use path aligned generally in a north-south direction, parallel to and between Honoapiilani Highway and Kuihelani Highway.

The Project site is situated (at its northly terminus and connection at its intersection of East Waiko Road) approximately (see EXHIBIT "B" – General Plan):

- 2000± ft. east of Honoapiilani Highway;
- 3,000± to 5,000± ft. west of Kuihelani Highway; and,
- 3.25± miles north of the nearest downslope shoreline.

FIGURE 2 – Northerly Terminus of Waiale Road Extension [looking in a northerly direction from intersection of existing Waiale Road and East Waiko Road]

The Project extends the existing Waiale Road, and it generally follows the existing 80-ft. wide Easement "A-1", which will be subdivided and will include the creation of a dedicable roadway lot for the Waiale Road Extension between the following:

- Its existing northerly terminus in the vicinity of the existing intersection of Waiale Road and East Waiko Road (see FIGURE 2); and
- Its future southerly terminus in the vicinity of its proposed intersection with Honoapiilani Highway (see FIGURE 3), in the vicinity of its existing intersection with Old Quarry Road, near MM 3.4.

A portion of the Project is located within the Waikapu County Town (WCT) District (Conditional Zoning), as designated by Ordinance No. 4998 (see APPENDIX "E-1"); and, First Amendment to Unilateral Agreement and Declaration for Conditional Zoning, under Ordinance No. 5556 (see APPENDIX "E-2").

FIGURE 3 – Southerly Terminus of Waiale Road Extension [looking in a westerly direction from intersection of Honoapiilani Highway and Old Quarry Road, at Old Quarry Road]

Heading in an easterly direction from its southern terminus at Honoapiilani Highway, near Old Quarry Road (see EXHIBIT "B" – General Plan):

- WRE follows its master-planned alignment along existing Easement "A-1" between the proposed WCT development (by others) on the west (mauka) side and undeveloped parcel TMK (2) 3-6-003:004 on the east (makai) side; to its intersection with Makai Parkway (as shown on the Master Plan of WCT)
- WRE then continues in a northeasterly to northerly direction along the existing Easement "A-1" to its master-planned intersection with Main Street (WCT);
- WRE then continues northward and crosses Waikapu Stream;
- WRE then continues to its intersection with East Waiko Road (see FIGURE 4);
- Improvements for WRE will extend to Ohana Hana Street between Waikapu Gardens Phase II Subdivision on the west (mauka) side and Waikapu East Subdivision No. 3 on the east (makai) in order to transition to existing roadway conditions (see FIGURE 5).

FIGURE 4 – Southerly terminus of existing Waiale Road and East Waiko Road [looking in a southerly direction]

FIGURE 5 – Northerly Terminus of Waiale Road Extension [looking in a southwesterly direction from the vicinity of Ohana Hana Street]

2. COUNTY OF MAUI SPECIAL MANAGEMENT AREA (SMA)

The entire project site is located outside of the County of Maui Special Management Area (SMA; see EXHIBIT "L" – Special Management Areas).

C. GENERAL PROJECT BACKGROUND AND DESCRIPTION

Several long-range plans have included their support and mentions the anticipated construction for the extension of Waiale Road to Honoapiilani Highway, generally following 80-ft. wide Easement "A-1", as currently shown on Waiale Park (Large Lot) Subdivision (File Plan No. 3.2278). These plans include the 2002 Wailuku-Kahului Community Plan, the Hele MAI Maui Long-Range Transportation Plan 2040 (completed in 2019), and the ongoing *I Mua Central Maui* long-range plan (Draft Plan June 2023). The Final Environmental Assessment (EA) for the Proposed Waiale Road Extension and East Waiko Road Improvements was published on August 8, 2014 with a FONSI determination.

In addition to enhancing local vehicular circulation throughout the Wailuku-Waikapu area, the Project will also incorporate a landscaped shared use path, providing opportunities for a pedestrian-friendly linear pathway along WRE as well as attractive pedestrian-friendly connectivity and continuity to the adjacent residential subdivisions and future community development (i.e., Waikapu Country Town) in the area. Accordingly, WRE is expected to enhance access for residential communities in this area to destinations such as schools, medical offices, park and recreation facilities, etc. The construction of the roadway, improved shoulders, underground electrical systems, fire hydrants, and paved bikeway could also serve to reduce the potential for uncontrolled brush fires.

The proposed alignment, scope, and connections between WRE and the adjacent roadways, as well as its relation to the existing and proposed regional projects in the vicinity (e.g., Waikapu Country Town, Waikapu Gardens Phase II Subdivision, etc.) are shown on EXHIBIT "B" - General Plan.

The typical roadway section to be implemented along the proposed WRE and the anticipated Waikapu Stream bridge section are depicted on EXHIBIT "C" - Typical Sections.

Wherever practicable, to minimize the disruption to the community and traffic, underground utilities for basic services (e.g., drainage, wastewater, non-potable and potable water, electrical, irrigation, etc.) are expected to be installed in conjunction with the construction of the Project.

Typical anticipated infrastructure improvements are expected to generally consist of:

- Clearing, grubbing, and grading the existing and proposed roadway corridor;
- Implementation of single-lane roundabouts at the four (4) major intersections along Waiale Road Ext.:
  - Honoapiilani Highway;
  - Main Street (as shown on WCT Master Plan);
  - Makai Parkway (as shown on WCT Master Plan);
  - East Waiko Road.

- Implementation of a modern, concrete free-span bridge at Waikapu Stream, accommodating the proposed electric, water, sewer force main, drain, and reclaimed water lines to be mounted to the exterior on both upstream and downstream sides, as required;
- Roadway improvements consisting of: asphalt concrete and/or Portland cement concrete pavement, concrete curb and gutters, concrete sidewalks and ADA-accessible curb ramps, signage and striping;
- Asphalt concrete paved multi-use pathway;
- Retaining walls, bridge railing, fencing and sound walls (where required);
- Overhead and underground electrical, telephone, cable and internet systems (including streetlights, pathway lights, pole mounted lighting, underground ducts, transformers, handholes, manholes, ground mounted cabinets, and appurtenances, where required);
  - Existing overhead electrical power transmission lines are expected to remain overhead along Honoapiilani Highway and East Waiko Road; and,
  - Relocation and/or replacement of existing utility poles (e.g., 69kV, telcom, cable, etc.) will be required to accommodate proposed roundabout configurations.
- Drainage improvements consisting, but not limited to: concrete headwalls, inlet and outlet structures, drain inlets, manholes, underground drainage piping (including box culverts, etc.), at-grade landscaped detention basins, and appurtenances;
- Underground water transmission and distribution mains (for potable water and fire protection) and appurtenances, where applicable, including fire hydrants along entire length of corridor to enhance fire protection for adjoining properties;
- Sewer improvements consisting of, but not limited to underground force mains and gravity sewer piping, manholes and appurtenances;
- Recycled (R1) Water improvements consisting of, but not limited to underground recycled (R1) water transmission mains and appurtenances; and,
- Landscaping and irrigation [expected to be supplied initially from domestic potable water system and transfer to the new reclaimed (R1) waterline, when available].

Temporary construction-phase measures are expected to be implemented from the inception of any ground disturbing activities, and maintained as required for erosion and sedimentation mitigation (e.g., dust fences, silt fences, filtration berms, temporary sedimentation basins, etc.), pursuant to applicable provisions of:

- Storm Water Permanent Best Management Practices Manual (State of Hawaii Department of Transportation (dated April 2015);
- Chapter 20.08 of the Maui County Code, “Soil Erosion and Sedimentation Control”;
- Construction Best Management Practices (BMPs) for the County of Maui (dated May 2001);
- Title MC-15, Subtitle 01, Chapter 111, “Rules for the Design of Storm Water Treatment Best Management Practices” (adopted November 9, 2012); and,
- Any applicable conditions and requirements of the project-specific National Pollutant Discharge Elimination System (NPDES) Permit, including Hawaii Administrative Rules (HAR) Chapter 11-55, Appendix K.

All sitework construction is expected to conform to the requirements and recommendations of the Project Geotechnical (Soils) Engineer of Record (who shall be a professional engineer licensed to practice in the State of Hawaii) and the applicable requirements of the Maui County Code. The Owner is expected to retain the Project Geotechnical Engineer of Record, to provide all construction phase monitoring and testing in accordance with the recommendations of the Soils Report and requirements of the County of Maui.

D. EXISTING SITE CONDITIONS

1. GENERAL

The majority of the Project is currently undeveloped, and traverses through open grassland covering fallow sugarcane fields south of East Waiko Road, with scattered rock piles. Several existing farm roads (i.e., unpaved roads) transverse through WRE on the west (mauka) and east (makai) side. Waikapu Stream is contoured by earthen berms and large boulders lining the top banks of the stream to protect the fields from flooding. Natural vegetation includes, but is not limited to guinea grass, ruderal herbs, and java plum.

2. SOIL CLASSIFICATIONS

According to the Soil Survey of the Island of Maui, prepared by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS), the predominant soil classifications underlying the proposed WRE project (see EXHIBIT “E” – Soils Classification Report) consist of:

- Iao Clay (IcB);
  - The Iao Clay, which mainly occurs in the central area of the Project, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 3 to 7 percent slopes.
- Jaucas Sand (JaC):
  - Jaucas sand, which only occurs along existing East Waiko Road and Waiale Road, is characterized as being excessively-drained soil, with low runoff.
  - Slopes: 0 to 15 percent slopes.
- Pulehu Silt Loam (PpA);
  - Pulehu silt loam, which occurs throughout the Project area, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 0 to 3 percent slopes.
- Pulehu Silt Loam (PpB);
  - Pulehu silt loam, which only occurs on the mauka side of East Waiko Road, is characterized as being well-drained soil, with low runoff.
  - Slopes: 3 to 7 percent slopes.

- Pulehu Cobbly Silt Loam (PrB);
  - The predominant Pulehu cobbly silt loam, which occurs at the northernmost portion of the Project, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 3 to 7 percent slopes.
- Pulehu Clay Loam (PsA);
  - Pulehu clay loam, which only occurs at Honoapiilani Highway, is characterized as being well-drained soil, with low runoff.
  - Slopes: 0 to 3 percent slopes.
- Pulehu Cobbly Clay Loam (PtA);
  - Pulehu cobbly clay loam, which occurs at the central portion of Project, is characterized as being well-drained soil, with low runoff.
  - Slopes: 0 to 3 percent slopes.
- Pulehu Cobbly Clay Loam (PtB);
  - Pulehu cobbly clay loam, which only occurs at the southernmost portion of Project, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 3 to 7 percent slopes.
- Puuone Sand (PZUE);
  - Puuone sand, which only occurs at the northermost region of the project limits (at Waiale Road), is characterized as being somewhat excessively-drained soil, with medium runoff.
  - Slopes: 7 to 30 percent slopes.

3. TOPOGRAPHY

The existing ground (see EXHIBIT “F” – Topographic Survey Map of Existing Grades) is characterized by a gently sloping topography with longitudinal slopes generally ranging from 2% to 7%, generally in a westerly (mauka) to easterly (makai) direction; and, cross slopes of approximately 0% to 5% along existing roadways (i.e., Honoapiilani Highway, East Waiko Road, existing Waiale Road, Old Quarry Road). Several rock piles are scattered through the fallow fields the Project transverses, while Waikapu Stream is contoured by earthen berms and large boulders lining the top banks of the stream to protect the fields from flooding. The existing grades along the Project varies in elevation from approximately 250 feet to approximately 355 feet M.S.L.

4. FLOOD AND TSUNAMI ZONES

According to Panel Number 150003 0393F of the Flood Insurance Rate Map, dated November 4, 2015, prepared by the United States Federal Emergency Management Agency (see EXHIBIT “G” – Flood Insurance Rate Map):

- The majority of the project site is situated within Zone “X”, which is designated as an area outside the 0.2% chance flood plain and of minimal flood hazard. At the crossing with Waikapu Stream, a portion of the project site is within Zones “AE” and “AEF”, ranging in base flood elevations from Elev. 318 to Elev.

342. Zone “AE” indicates it is within a special flood hazard area subject to inundation by the 1% (i.e, 100-year) annual chance flood where the base flood elevation is determined. Zone “AEF” is a floodway area, or channel of stream plus any adjacent floodplain areas, within Zone “AE” that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the base flood elevation (BFE).

Based on the National Oceanic and Atmospheric Administration (NOAA) delineation:

- The entire project site is located approximately 11,000± to 12,000± ft. inland of the Maui County Tsunami Evacuation and Extreme Tsunami Evacuation Zones from the north (Kahului) and south (Maalaea) side of Maui.
- The entire project site is located inside the Maui County Safe Zone (see EXHIBIT “J” – Tsunami Evacuation Map).

5. WETLAND

According to the National Wetlands Inventory, U.S. Fish and Wildlife Service, the following general categories of wetlands exist at least approximately 700± ft. (or more) beyond the Project (see EXHIBIT “K” – Existing Wetlands):

- Freshwater Emergent Wetland; and,
- Freshwater Pond.

Although a narrow, curvilinear delineation of the general category Freshwater Forested / Shrub Wetland (PFO3C) is depicted (see Insets on EXHIBIT “K” – Existing Wetlands) to extend downstream in an easterly direction along Waikapu Stream; across the Project; and, continuing further downstream across Kuihelani Highway, it is our understanding that a detailed, on-ground biological survey and jurisdictional waters delineation (conducted by AECOS, Inc. in 2022) confirmed that:

- Despite the java plum fruit and accumulated organic matter in some sections, the water appeared exceptionally clear throughout the stream, with no visible turbidity and no evidence of wetlands.
- Banks of the stream (consisting of earthen berms and large boulders lining the top-of-banks) are steep throughout the Project area, with no room for a floodplain or adjacent wetland to develop.
- The climate in the Project area is dry to mesic.
  - The Project is in the lee of both East and West Maui mountains, and typically blocked from precipitation carried by prevalent trade winds.
  - The Hawaii Department of Health (HDOH) listing indicates that the Waikapu Stream is “impaired” for turbidity in the dry season.
  - Waikapu Stream has been assigned a total maximum daily load (TMDL) priority of “low.”

E. DETAILED PROJECT DESCRIPTION:

As mentioned previously, the existing overall Project corridor extends in a northerly to southerly direction, from its northerly terminus in the vicinity of East Waiko Road to the vicinity of Honoapiilani Highway (see EXHIBIT “B”).

The proposed improvements generally include the following scope of improvements (where applicable):

- Single-lane roundabouts at the intersections of Honoapiilani Highway (with provisions for future implementation of a double-lane roundabout), Makai Parkway (WCT), Main Street (WCT) and East Waiko Road;
- Ten (10) to twelve (12) feet wide vehicular lanes, slightly widening at transitional areas at the roundabouts to accommodate large vehicle turning movements (e.g., WB-50 Design Vehicle), including a five (5) to six (6) feet asphalt shoulder bikeways on the west (mauka) side of the roadway;
- Curbs, gutters, grass swales, and six (6) feet wide sidewalks for pedestrian use only (fully ADA compliant) on the east (makai) side of roadway;
- Ten (10) feet wide asphalt concrete paved shared use path on the west (mauka) side of roadway with adjoining landscaping and irrigation, appurtenances, and ornamental light poles and fixture;
- Modern, concrete free-span bridge at Waikapu Stream; and,
- ADA-compliant curb cut ramps at intersections.

The connecting roadways are typically encumbered by the following existing utilities:

- Utility Poles, accommodating overhead 69kV main electrical transmission lines, secondary distributions lines, communications, etc.
- Drainage structures and appurtenances, etc.

In addition, at East Waiko Road, the following existing utilities are to be accounted for:

- Drainage structures and appurtenances, including headwalls, culverts, and a 7’x28’ Conspan culvert;
- 4” Sewer Force Main; and,
- 12” Waterline.

The following is a more detailed description of the existing conditions and constraints along the progression of the corridor segments:

- Beginning at its northerly terminus in the vicinity of existing Waiale Road (south of its intersection with Ohana Hana Street), the Project;
  - Integrates and extends southward approximately 600± ft. of existing improvements located immediately south of the intersection of Ohana Hana Street and existing Waiale Road, between Waikapu Gardens Phase II Subdivision and Waikapu East Subdivision No. 3, towards East Waiko Road.

  Anticipated improvements will include the transition of the new roadway to the existing roadway vehicle travel lanes, extension of sidewalk and revisions to the drainage system;
- Incorporates a single-lane roundabout at its intersection of East Waiko Road;
  - Improvements will extend westerly (mauka) and easterly (makai) along the existing East Waiko Road, to transition the existing roadway (e.g., vehicles lanes, sidewalk, curb and gutters, utilities, etc.) to accommodate the roundabout.
- Immediately south of its intersection with E. Waiko Road, at Waikapu Stream, a concrete bridge (constructed with precast prestressed planks and concrete topping) crossing will be implemented to traverse the stream (which spans approximately 90 ft. in length) and accommodates the roundabout, approximately 2,000 ft. from Honoapiilani Highway.
  - The bridge will be designed to accommodate the 100-year flow, providing 2-feet (minimum) of freeboard between the water surface elevation and bridge soffit, as required by HDOT; and
  - Construction of the bridge being completed outside of the designated Ordinary High Water Mark (OHWM), as provided by AECOS (see Appendix “D”).
- The Project continues southerly approximately 1,400 ft., along the Easement “A-1” between the proposed WCT development and undeveloped parcel TMK (2) 3-6-003:004, to its intersection with Main Street (WCT).
  - Incorporates a single-lane roundabout at its intersection with future Main Street to the west (mauka) and provisions for a future roadway within the undeveloped parcel (makai).
- WRE continues south and easterly approximately 4,000 ft. along “Easement “A-1” between the proposed WCT and undeveloped parcel TMK (2) 3-6-003:004 towards the southwest corner of parcel TMK (2) 3-6-003:004 to its intersection with Makai Parkway (WCT);
  - Incorporates a single-lane roundabout at its intersection with future Makai Parkway to the west (mauka) and provisions for an access to the undeveloped agricultural lot to the south.
- WRE continues southwesterly approximately 1,200 ft. along “Easement “A-1” adjacent to the eastern edge of proposed WCT; and, within TMK (2) 3-6-002:003 to its south terminus in the vicinity of Honoapiilani Highway where a new single-lane roundabout will be incorporated, and the project will end.
  - Improvements will extend southerly and northerly along the existing Honoapiilani Highway, to transition the existing roadway (e.g., vehicles lanes, sidewalk, curb and gutters, utilities, etc.) to accommodate the roundabout.
  - Improvement will also extend westerly (mauka) to transition to the existing asphalt pavement, and make provisions for future roadway connectivity to WCT development.

II. ROADWAY IMPROVEMENTS AND TRAFFIC ASSESSMENT:

A. EXISTING CONDITIONS

1. HONOAPIILANI HIGHWAY:

Honoapiilani Highway (also known as Hawaii Route 30), which provides access between West Maui and Central Maui, is a two-lane, undivided, State arterial highway (between its northeasterly terminus at Keanu Street / S. High St., and its northwesterly terminus near Honokohau Bay, where it becomes Kahekili Highway), generally traverses Maui along the base of the West Maui Mountains in a north-south direction from downtown Wailuku towards Maalaea, then runs along to the coastline on the west side of West Maui Mountains, through Lahaina and Kapalua, towards Honokohau Bay. In the Project Vicinity, Honoapiilani Highway is currently classified as a Principal Arterial from its northeasterly terminus at Keanu Street/S. High Street through south Waikapu and Maalaea. The shoulder areas of Honoapiilani Highway are designated as bicycle lanes. A bus stop is located near the intersection of Honoapiilani Highway and East Waiko Road. The posted speed limit is generally 30 to 45 miles per hour (mph).

2. WAIALE ROAD:

The existing Waiale Road (also known as Route 3180) is oriented in a northerly (Wailuku) to southerly (Waikapu) alignment, between its current northerly (Wailuku end) terminus at Lower Main Street in the vicinity of the Wailuku Japanese Cemetery (where it acts as an extension of Lower Main Street) and its southerly terminus at East Waiko Road. Waiale Road provides circulation between Lower Main Street and East Waiko Road, and access to the adjoining commercial and residential developments.

From Ohana Hana Street to East Waiko Road, Waiale Road is a partially improved roadway with two travel lanes, a striped median allowing for designated left-turn lanes at its intersection with local streets, and asphalt shoulders on both sides of the roadway.

3. EAST WAIKO ROAD:

The existing East Waiko Road is oriented in a westerly to easterly alignment, between its existing intersection with Honoapiilani (and West Waiko Road) and Kuihelani Highway, providing access between these major highways; and, adjoining commercial and residential developments (West Waiko Road extends mauka from the westerly end of East Waiko Road/Honoapiilani intersection).

In the project vicinity (from the vicinity of Lot 60 of Waikapu Gardens Phase II Subdivision to the vicinity of Pakana Street), East Waiko Road is a partially improved roadway with two travel lanes. The posted speed limit is generally 20 to 30 miles per hour (mph).

B. PRELIMINARY TRAFFIC ASSESSMENT:

A preliminary Traffic Impact Assessment Report has been undertaken for the proposed project by a traffic engineering consultant (Fehr & Peers) retained by Bowers & Kubota [see "Waiale Road Extension, Traffic Impact Analysis Report" (dated October 2023); prepared by Fehr & Peers] (see APPENDIX "C").
Existing conditions, alternatives considered, and recommended roadway and traffic improvements (both project-specific and regional) are identified and discussed in more detail therein.

C. PROPOSED ROADWAY IMPROVEMENTS:

The Project is proposed to be a community oriented, pedestrian friendly, two-lane road that will enhance local access and provide an alternate route through and around the urban areas of Kahului and Wailuku. It will include pedestrian-friendly access and connectivity to nearby residential subdivisions, future community developments (i.e., Waiakpu Country Town, etc.), County's future Central Maui Wastewater Treatment Facility, recreational facilities, shopping, eating attractions, schools, parks, and other community-oriented destinations.

WRE is proposed to be a two-lane road (one in each direction with single-lane roundabouts at the main intersections) incorporating a community oriented, pedestrian-friendly, landscaped multi-use path along its entire length on the west (makai) side and concrete sidewalk on the east (makai) side (see EXHIBIT "C" - Typical Sections and EXHIBIT "D" - Conceptual Road & Utility Plan & Profile).

The proposed roadway extension will cross the existing Waikapu Stream. A bridge will, therefore, be constructed to span the stream. To minimize the impacts (e.g., physical, cultural, etc.) to the existing stream, DPW proposes to construct a modern, concrete single-span bridge with drilled shafts being located outside of the Ordinary High Water Mark (OHWM; as designated by the Project Biologist). This will allow the existing stream to remain as-is, and not require improvements within the stream itself. For this bridge, it is preliminarily anticipated to include twelve (12) 4'-0" diameter drilled shafts at estimated depths of 45 ft. (contingent on the findings and recommendations from the Project Geotechnical Engineer). It is anticipated that the major utilities [e.g., waterlines, sewer force main, reclaimed (R1) waterline, etc.] will be mounted on the upstream and/or downstream edge of the proposed bridge, as necessary. Electrical ducts are anticipated to be installed within the bridge railings (both the upstream and downstream sides) and the cast-in-place portion of the bridge deck, as necessary.

DPW has also evaluated several alternative designs for the bridge crossing, considering criteria such as Federal and State requirements, permitting, and input from the community. DPW has thus considered an alternative to incorporate a single-span bridge with Stream Bed and Bank Alterations (e.g., Reinforced Concrete Invert Lining, Grouted Rubble Pavement Bank Protection, etc.). However, this alternative would require extensive work within the stream channel [including excavation (estimated depths of 3-

ft.)]; potential horizontal and vertical realignment of the stream channel; and, modifications to the stream channel characteristics (i.e., Stream Bed and Bank Alterations are anticipated to extend approximately 300-ft. upstream and 450-ft downstream of the bridge crossing). Based on the anticipated improvements, roughly one (1) acre of stream channel would be altered during reconstruction. In addition, the construction of a temporary stream diversion channel (to allow the by-pass of the existing, active stream flows during the reconstruction process) may be required; and, it is anticipated to be routed through the adjacent, privately-owned properties.

In addition, enhanced circulation and access will be provided between WRE and Honoapiilani Highway, Kuihelani Highway, Kuikahi Drive, and local Waikapu area by extending and/or improving the roadway intersections on WRE where adjoining properties and existing right-of-way constraints allow.

As noted previously, new single-lane roundabouts are recommended by the TIAR at each of the following intersections as roundabouts have the potential to reduce both the number of conflict points and act as traffic calming measures:

- E. Waiko Road, the northerly (Wailuku end) terminus of WRE
- Makai Parkway (WCT)
- Main Street (WCT)
- Honoapiilani Highway, the southerly (Maalaea end) terminus of WRE, with provisions for future expansion to a double-lane roundabout once Honoapiilani Highway is modified to a 4-lane roadway.

Features adopted by DPW for these roundabouts include:

- All four (4) single-lane roundabouts will be designed to accommodate all turning movements for semi-trucks (WB-50 design vehicle) and school buses (S-Bus 40 design vehicle), to enhance access and circulation.
- Curvilinear splitter islands along with visual and landscaping elements (within any existing spatial constraints) provide visual cues and delineation to further enhance speed reduction and discourage random pedestrian crossings.
- Pedestrian-activated rectangular rapid flashing beacons (RRFBs) will be installed at the pedestrian crossings at the roundabouts to enhance safety for vehicles and pedestrians.
- Reasonable accommodation for bicycle connectivity and for residential driveways in close proximity to the roundabouts.

The lane geometry of all intersections and accesses to the WRE project are discussed in more detail in the TIAR ["Waiale Road Extension, Traffic Impact Analysis Report" (dated October 2023), prepared by Fehr & Peers] and is contained in APPENDIX "C".

III. DRAINAGE SYSTEM:

A. EXISTING CONDITIONS:

The approximately 8,600 ft. long Waiale Road Extension (WRE) project is aligned generally in a north-south direction; and, varies in elevation from approximately 250 feet to approximately 355 feet M.S.L., typically with prevailing slopes in the westerly to easterly direction, perpendicular to the corridor.

- A Preliminary Drainage Study and Report has been undertaken for the Project by Warren S. Unemori Engineering, Inc. (and is contained in APPENDIX "A" - Preliminary Drainage Report).

The existing runoff from the project site and in the adjacent areas generally flows in a westerly to easterly direction. It is generally conveyed overland and into existing streams, small drainageways, or by existing underground drainage systems (within existing Waiale Road.

The entire WRE project site currently generates approximately 81 cfs of surface runoff based on a 50-year recurrence interval, 1-hour duration storm.

Waikapu Stream is the only major drainageway along the Project that conveys the majority of the existing offsite runoff from drainage areas west (mauka) of the project area:

- Waikapu Stream crosses WRE immediately south of East Waiko Road. The existing stream is a natural earth channel that flows from the West Maui Natural Area Reserve in an east-ward direction, transversing through WRE towards Kuihelani Highway. The runoff is conveyed further downstream towards Kuihelani Highway, where it will eventually turn southward towards the Kealia Pond National Wildlife Refuge at Maalaea Bay, where it will drain into the ocean. The stream is contoured by earthen berms and large boulders lining the top banks to protect the adjacent sugarcane fields to the south from flooding. Further downstream, in the project vicinity, approximately 350 feet east of the proposed bridge where WRE will cross Waikapu Stream, an existing 7' x 28' Conspan runs beneath East Waiko Road where it outlets into Waikapu Stream through a GRP lined emergency overflow. This overflow begins at the existing retention basin approximately 1,200 feet from the Waikapu Stream, which was installed in conjunction with Kehalani Offsite Drainage System, Offsite Drainage Improvements – Phase I (Offsite Drain and Retention Basin from Module 21, Kehalani Mauka to Waikapu Stream).

Based on field observations and on-ground topographic surveys, it appears that the water within the Waikapu Stream appeared exceptionally clear throughout the stream, with no visible turbidity, despite the java plum fruit and accumulated organic matter in some sections. The banks of the stream (consisting of earthen berms and large boulders lining the top-of-banks) are steep throughout the Project area, with no room for a floodplain or adjacent wetland to develop.

B. PROPOSED DRAINAGE IMPROVEMENTS:

All drainage improvements are expected to be implemented pursuant to the current County of Maui's "Rules for the Design of Storm Drainage Facilities", and the "Rules for the Design of Storm Water Treatment Best Management Practices" (adopted 11/09/2012). The existing pre-development drainage patterns will generally be maintained and/or restored; and, any potential increase in runoff generated by the proposed project improvements will be mitigated, so that the runoff released downstream will be no greater than pre-development conditions or what the existing downstream drainage systems were designed to accommodate from the project site. The drainage system will be designed to accommodate the ultimate layouts and improvements required by the County at the proposed intersections.

Wherever practicable, to minimize the disruption to the community and traffic, where directed by DPW, anticipated, master-planned drainlines and drainage structures are expected to be installed in conjunction with the construction of WRE.

A new modern, concrete single-span bridge is proposed for the WRE crossing at Waikapu Stream. The bridge has been designed to accommodate the existing flow rates of Waikapu Stream of 2,000 cfs (FEMA 100-yr). The bridge designed to span across the stream (with pilings to be placed outside of the designated OHWM) to ensure the stream is minimally impacted, maintain a "no rise" condition with no loss of flow conveyance and no increase in the base flood elevation at the gulch for the 100-yr flood discharge; and therefore, will allow the runoff to continue down the existing drainage channels, towards Kuihelani Highway, and eventually southward towards the Kealia Pond National Wildlife Refuge at Maalaea Bay, where it will drain into the ocean, as it is currently doing.

The majority of the onsite and offsite runoff within WRE will be intercepted by drain inlets and conveyed by underground drainage systems to landscaped detention and/or retention basins, which will be sized to accommodate the fully developed project site. These facilities will be strategically located along the project corridor, to provide the necessary capacity and storage to meet or exceed the County water quality standards and attenuate any potential increase in post-development runoff. Thus, no more than the master-planned and/or designed allowable total release rate will be permitted to discharge downstream and continue to flow downstream.

- To accommodate the future WCT development (as agreed to by DPW and in accordance with the latest storm drain master plan for WCT), main drainline crossings will be incorporated into the Project as follows (subject to refinements by WCT):
  - 54"Ø culvert crossing Honoapillani Highway (approx. 130-ft. from its intersection of WRE);
  - 60"Ø culvert crossing WRE in the vicinity of its intersection with Makai Parkway; and,

  - A triple (3) 10'x3' reinforced concrete box culverts crossing WRE, approximately 2,730-ft. from its intersection of Honoapiilani Highway; and, generally in the vicinity of the lowest area along the roadway corridor.

Existing pre-existing runoff generated by the overall drainage area, mauka of the Project, of the undeveloped areas will be conveyed by these drainline crossings and allowed to continue to sheet flow onto the adjacent properties, as they are currently doing. It is our understanding that Waikapu County Town (WCT) will be implementing a regional detention basin for their overall development, to which these crossing will be utilized for their storm runoff conveyance.

The runoff generated within the improved WRE corridor will be intercepted by drain inlets and conveyed to either a landscaped retention basin (for improvements north of Waikapu Stream) or a landscaped detention basin (for improvements south of Waikapu Stream) to mitigate any increase in runoff, such that the pre-development conditions will not be exceeded.

Therefore, since the onsite runoff discharging downstream generated by the Project will not exceed the pre-development conditions, the proposed project improvements are not expected to adversely affect the downstream and adjoining properties.

A more detailed discussion of the existing onsite and offsite surface runoff drainage conditions for each section are contained in APPENDIX "A" – Preliminary Drainage Report.

IV. WASTEWATER SYSTEM:

A. EXISTING CONDITIONS:

The County's wastewater facilities generally collect wastewater from the Wailuku and Kahului Areas and convey it through a series of gravity sewerlines and pumping stations with force mains along existing Waiale Road and Lower Main Street to the Wailuku-Kahului Wastewater Reclamation Facility (W-K WWRF), near Kanaha Pond.

Within our Project vicinity, an existing 4" force main is installed along East Waiko Road to account for the wastewater generated within Waiko Baseyard Subdivision, located farther east (makai) from WRE.

B. PROPOSED WASTEWATER IMPROVEMENTS:

In response to the projected population growth and housing development in central Maui, a new Kehalani Wastewater Pump Station (in conjunction with County's Central Maui Wastewater Treatment Facility), located on the southern region of the existing Stormwater Detention Basin for Kehalani Makai Area (directly across of Maui Memorial Park Garden of Meditation Expansion, at Olomea Street/Waiale Road intersection) will be constructed to provide wastewater services for existing and planned communities (i.e., Kehalani, Wailuku Heights, and Waikapu), as part of the County's decentralization plan to alleviate capacity restraints at the existing Wailuku-Kahului WWRF.

Wastewater will be conveyed from the aforementioned future Kehalani WWPS along existing Waiale Road utilizing an anticipated 18-inch force mainline, towards the northern region of the project vicinity. At the northern terminus (in the vicinity of Ohana Hana Road), an 18-inch force main will be installed within WRE, and extended across the new bridge (supported by the bridge structure). It will then be transitioned to a 24-inch gravity main line along WRE to accommodate connectivity to the WCT development. The 24" gravity main line will continue along WRE (to approximate STA 30+30(±) toward the southwest corner of undeveloped parcel TMK (2) 3-6-003:004; and, provide a stubout (for future extension to the Central Maui Wastewater Reclamation Facility; by others).

- County of Maui is currently evaluating an alternate routing of the 24" gravity sewer line across the existing County-owned property [i.e., TMK (2) 3-6-002:004], which will be coordinated prior to the construction of WRE and accounted for within the Final Construction Documents for WRE.

In addition, a new 18-inch gravity sewer line is anticipated along WRE from Honoapiilani Highway to provide connectivity to:

- A 12-inch sewerline providing wastewater service to the west (mauka) portion of the WCT development (which will include installation a 12-inch stubout at Old Quarry Road, installed in conjunction with WRE); and,
- Provisions for future connection to the future Maaleaa pump station conveyance system (by others).

Minor relocations and/or adjustments of the existing sewer force main on East Waiko Road and minor adjustments to any existing manholes and appurtenances to final finish grade are expected to be undertaken with the WRE project.

C. ANTICIPATED WASTEWATER DEMANDS:

The WRE project in itself (excluding any existing or proposed adjoining developments by others), is not expected to generate any significant additional wastewater demand.

V. WATER SYSTEM:

A. EXISTING CONDITIONS:

1. POTABLE WATER SYSTEM:

The County's potable water service in the project vicinity consists of an existing 12" waterline being supplied from the 300,000 gallon tank near the mauka terminus of W. Waiko Road. The storage tank sits at an elevation of 764 feet. The existing 12" waterline crosses Honoapiilani Highway and extends to the Waiko Baseyard Subdivision, east of the Project site.

2. NON-POTABLE RECYCLED (R1) WATER SYSTEM:

There is currently no non-potable, recycled (R1) water systems within the project vicinity.

B. PROPOSED WATER IMPROVEMENTS:

1. POTABLE WATER SYSTEM:

Wherever practicable, to minimize the disruption to the community and traffic, distribution waterlines are expected to be installed in conjunction with the construction of the Project.

A proposed 12" water main will be installed along the WRE to provide water service to the Central Maui WWRF, as well as fire protection (i.e., fire hydrants) along the roadway corridor and initial irrigation for the landscaping associated with the Project.

In accordance with current water system standards, fire hydrants are proposed to be installed with a maximum spacing of 350 feet along the existing residential Subdivision areas, unless otherwise required by the respective governing agencies.

2. NON-POTABLE RECYCLED (R1) WATER SYSTEM:

Based on the current Waikapu Country Town Recycled (R1) Water System Master Plan, the installation of a 4.0 MG-Capacity Open Storage Reservoir, mauka of Honoapiilani Highway (at approximate Elevation 480), is anticipated, which will utilize an 18-inch recycled (R1) water main to connect the reservoir to the future Central Maui WWRF and also function as a distribution line. The 18-inch recycled (R1) water line will be located within the WCT roadways (mauka of Honoapiilani Highway). WRE will install an 18-inch recycled (R1) waterline from its future connection point at Honoapiilani Highway to the vicinity of the future access to the Central Maui WWRF. The 18-inch recycled (R1) waterline will be extended to the Central Maui WWRF in conjunction with the construction of said facility (by others). From the future access, WRE will install a 12-inch recycled (R1) water line across the Waikapu Stream (supported by the bridge) and will make provisions to extend the distribution line along East Waiko Road and existing Waiale Road, as required by County of Maui, Department of Environmental Management.

To conserve precious potable water resources, drought-tolerant and Hawaiian Native plants are being considered, and all landscape irrigation for the Project will be transferred over from the existing potable water system to be serviced from the WCT Storage Reservoir, once it is operational. Applicable County and State Department of Health permits will be obtained at the time of final design.

C. ANTICIPATED DOMESTIC AND IRRIGATION WATER DEMANDS:

The WRE project in itself (excluding any existing or proposed adjoining developments), is not expected to generate any significant additional domestic water demands, other than that for incidental landscape irrigation along the proposed roadway corridor, which includes the adjoining shared use path and landscaped retention/detention basins. In accordance with direction from DPW, there will be no drinking fountains within this segment of WRE.

Average daily landscape irrigation demands are expected to be approximately 73,100 GPD during the initial plant establishment period; and, reduced to 52,400 GPD once the plant establish period is completed.

Water service for landscape irrigation is expected to be provided by new, strategically placed water meters, ranging from 3/4 to 1-1/2” sizes, since the peak irrigation demand is not expected to exceed 50 gpm for any given service area.

Though initially, the landscape irrigation will be supplied by the 12-inch domestic water line, it will be constructed to transfer the supply to the recycled (R1) water line once the Central Maui WWRF is operational.

VI. ELECTRICAL, TELEPHONE AND CATV SERVICE:

A. EXISTING CONDITIONS:

Electrical, telephone and cable TV service in the Waikapu-Wailuku region is provided by Hawaiian Electric Company (HECO), Hawaiian Telcom and Spectrum, respectively, along the primary utility corridor for HECO’s 69kV overhead transmission line that runs along Honoapiilani Highway and East Waiko Road.

B. PROPOSED ELECTRICAL, TELEPHONE AND CATV IMPROVEMENTS:

Electrical, telephone and cable TV overhead utility poles (which include the 69kV transmission line, communication lines, etc.) in the vicinity of WRE’s intersections with Honoapiilani Highway and East Waiko Road will be relocated and replaced (as required) to accommodate the new roundabout configurations. At these locations, the existing overhead electrical and communication lines will be maintained overhead.

A new underground electrical and communication system (including aboveground transformers, primary switches, handholes, duct lines, etc.) will be installed in conjunction with the Project (including the crossing of Waikapu Stream within the bridge structure) to provide service to Central Maui WWRF and WCT (as needed).

VII. ANTICIPATED CONSTRUCTION COSTS:

A. ORDER OF MAGNITUDE PROBABLE CONSTRUCTION COSTS:

The projected order-of-magnitude probable construction costs are expected to be in the range of $60,000,000 to $70,000,000.

The above projections are subject to refinement based on scope of ultimate regulatory requirements from Federal, State and County agencies, public utilities, final design documents, and contemporary construction costs at the time the improvements will actually be constructed.

Accordingly, this report has been prepared as a summary and preliminary engineering evaluation of the proposed Waiale Road Extension (WRE) project, including existing infrastructure in the vicinity of the project and anticipated project improvements, which will be refined as needed based on the ultimate, final design of the project.

Prepared by:

Bradford A. Wright, P.E.

Reviewed and Approved by:

Clifford N. Mukai, P.E.

VIII. REFERENCES:

1. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Island of Maui, Hawaii, Version 14* September 20, 2016. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

2. Federal Emergency Management Agency, Federal Insurance Administration, *Flood Insurance Rate Map, Maui County, Hawaii*. Community-Panel Number 150003 00393F. November 4, 2015.

3. U.S. Department of Commerce, Weather Bureau, *Rainfall Frequency Atlas of the Hawaiian Islands, Technical Paper No. 43*. 1962.

4. Department of Public Works and Waste Management, County of Maui, *Rules for the Design of Storm Drainage Facilities in the County of Maui.* July 1995.

5. Department of Public Works, County of Maui, *Rules for the Design of Storm Water Treatment Best Management Practices.* November 9, 2012.

6. State of Hawaii, Department of Transportation, Highways Division, *Design Criteria for Highway Drainage* 2010.

7. Fehr & Peers, *Waiale Road Extension, Transportation Impact Analysis Report.* October 2023.

8. AECOS Inc., *A Natural Resource Assessment for the County of Maui, Waiale Road Extension Project, Waikapu, Maui.* July 5, 2022.

9. *Water System Standards, Department of Water Supply, County of Maui 2002.*

10. *Construction Best Management Practices (BMPs) for County of Maui* May 2001.

11. Geolabs, Inc., *Geotechnical Engineering Exploration – Waiale Road Extension*. June 24, 2024.

12. Geolabs, Inc., *Pavement Justification Report, County of Maui – Department of Public Works, Waiale Road Extension.* March 21, 2024.

13. Planning Consultants Hawaii, LLC. *Final Environmental Impact Statement, Waikapu Country Town.* December 2016.

14. Munekiyo Hiraga, Inc. *Final Environmental Assessment, Proposed Waiale Road Extension and East Waiko Road Improvements, TMK (2)3-5-002:014 (por.), 018 (por.), and 888 (por.), TMK (2) 3-5-027:021 (POR.), TMK 92)3-6-002:003 (por.), and TMK (2) 3-8-005:999 (por.).* July 2014.

15. Warren S. Unemori, Inc. D*rainage Report, Kehalani Offsite Drainage System - Phase I, Wailuku, Maui, Hawaii, TMK: (2) 3-5-01: Por. 64; (2) 3-5-02: Por. 1.* January 2004.

16. Otomo Engineering, Inc. *Waikapu Gardens -Phase 2 Affordable Housing Project (Lot F – Waikapu East (Large-Lot) Subdivision No. 3), TMK.: (2) 3-5-002: 018, Waikapu, Maui, Hawaii* Construction Plans. June 24, 2014.

EXHIBITS

A. Project Location Map
B. General Plan
C. Typical Sections
D. Conceptual Road & Utility Plan & Profile (1 of 10 thru 10 of 10)
E. Soils Classification Report (24 pages)
F. Topographic Survey Map of Existing Grades (1 of 4 thru 4 of 4)
G. Flood Insurance Rate Map (1 of 8 thru8 of 8)
H. Sea Level Rise Map
J. Tsunami Evacuation Map
K. Existing Wetlands
L. Special Management Areas

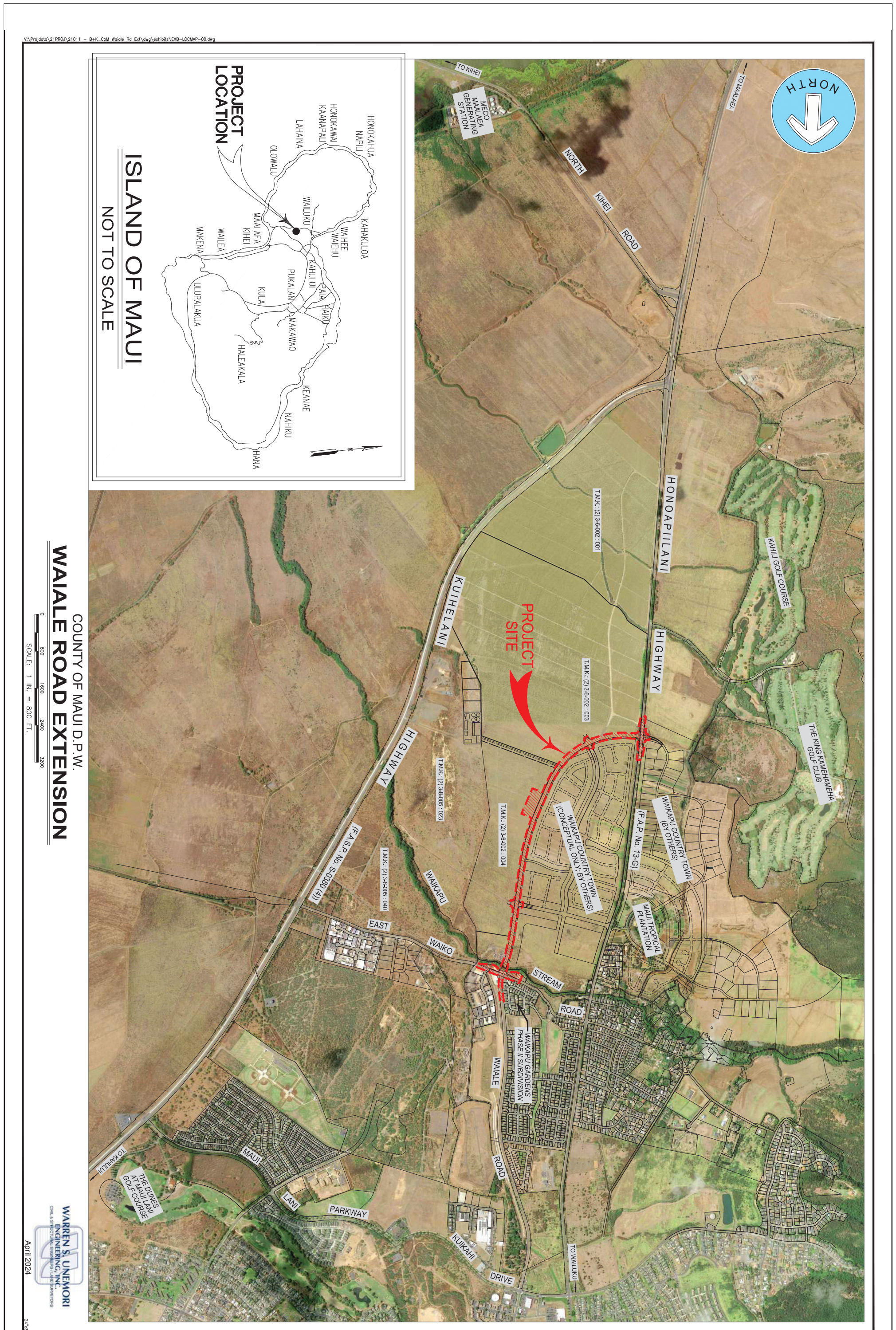


EXHIBIT "A" - PROJECT LOCATION MAP

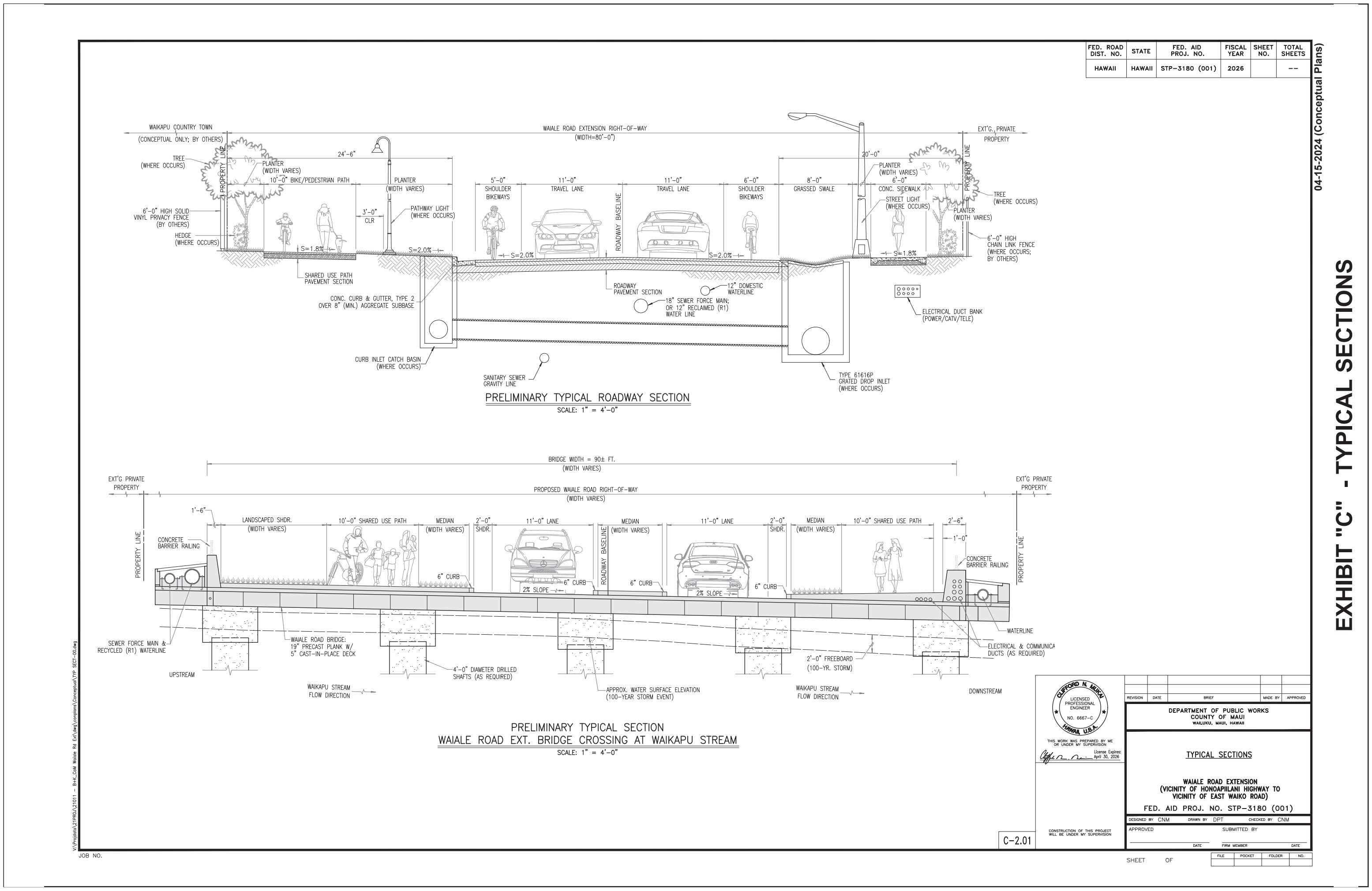


EXHIBIT "C" - TYPICAL SECTIONS
04-15-2024 (Conceptual Plans)
FED. ROAD DIST. NO. HAWAII
STATE HAWAII
FED. AID PROJ. NO. STP-3180 (001)
FISCAL YEAR 2026
PRELIMINARY TYPICAL ROADWAY SECTION
SCALE: 1" = 4'-0"
WAIALE ROAD EXTENSION RIGHT-OF-WAY (WIDTH=80'-0")
WAIKAPU COUNTRY TOWN (CONCEPTUAL ONLY; BY OTHERS)
EXT'G. PRIVATE PROPERTY
TREE (WHERE OCCURS)
PLANTER (WIDTH VARIES)
10'-0" BIKE/PEDESTRIAN PATH
6'-0" HIGH SOLID VINYL PRIVACY FENCE (BY OTHERS)
HEDGE (WHERE OCCURS)
PATHWAY LIGHT (WHERE OCCURS)
5'-0" SHOULDER BIKEWAYS
11'-0" TRAVEL LANE
ROADWAY BASELINE
6'-0" SHOULDER BIKEWAYS
8'-0" GRASSED SWALE
CONC. SIDEWALK
STREET LIGHT (WHERE OCCURS)
6'-0" HIGH CHAIN LINK FENCE (WHERE OCCURS; BY OTHERS)
SHARED USE PATH PAVEMENT SECTION
CONC. CURB & GUTTER, TYPE 2 OVER 8" (MIN.) AGGREGATE SUBBASE
ROADWAY PAVEMENT SECTION
12" DOMESTIC WATERLINE
18" SEWER FORCE MAIN; OR 12" RECLAIMED (R1) WATER LINE
ELECTRICAL DUCT BANK (POWER/CATV/TELE)
CURB INLET CATCH BASIN (WHERE OCCURS)
SANITARY SEWER GRAVITY LINE
TYPE 61616P GRATED DROP INLET (WHERE OCCURS)
PRELIMINARY TYPICAL SECTION
WAIALE ROAD EXT. BRIDGE CROSSING AT WAIKAPU STREAM
SCALE: 1" = 4'-0"
BRIDGE WIDTH = 90± FT. (WIDTH VARIES)
PROPOSED WAIALE ROAD RIGHT-OF-WAY (WIDTH VARIES)
LANDSCAPED SHDR. (WIDTH VARIES)
10'-0" SHARED USE PATH
MEDIAN (WIDTH VARIES)
11'-0" LANE
CONCRETE BARRIER RAILING
SEWER FORCE MAIN & RECYCLED (R1) WATERLINE
WAIALE ROAD BRIDGE: 19" PRECAST PLANK W/ 5" CAST-IN-PLACE DECK
4'-0" DIAMETER DRILLED SHAFTS (AS REQUIRED)
APPROX. WATER SURFACE ELEVATION (100-YEAR STORM EVENT)
2'-0" FREEBOARD (100-YR. STORM)
WATERLINE
ELECTRICAL & COMMUNICATION DUCTS (AS REQUIRED)
UPSTREAM
DOWNSTREAM
WAIKAPU STREAM FLOW DIRECTION
DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII
TYPICAL SECTIONS
WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)
FED. AID PROJ. NO. STP-3180 (001)
C-2.01

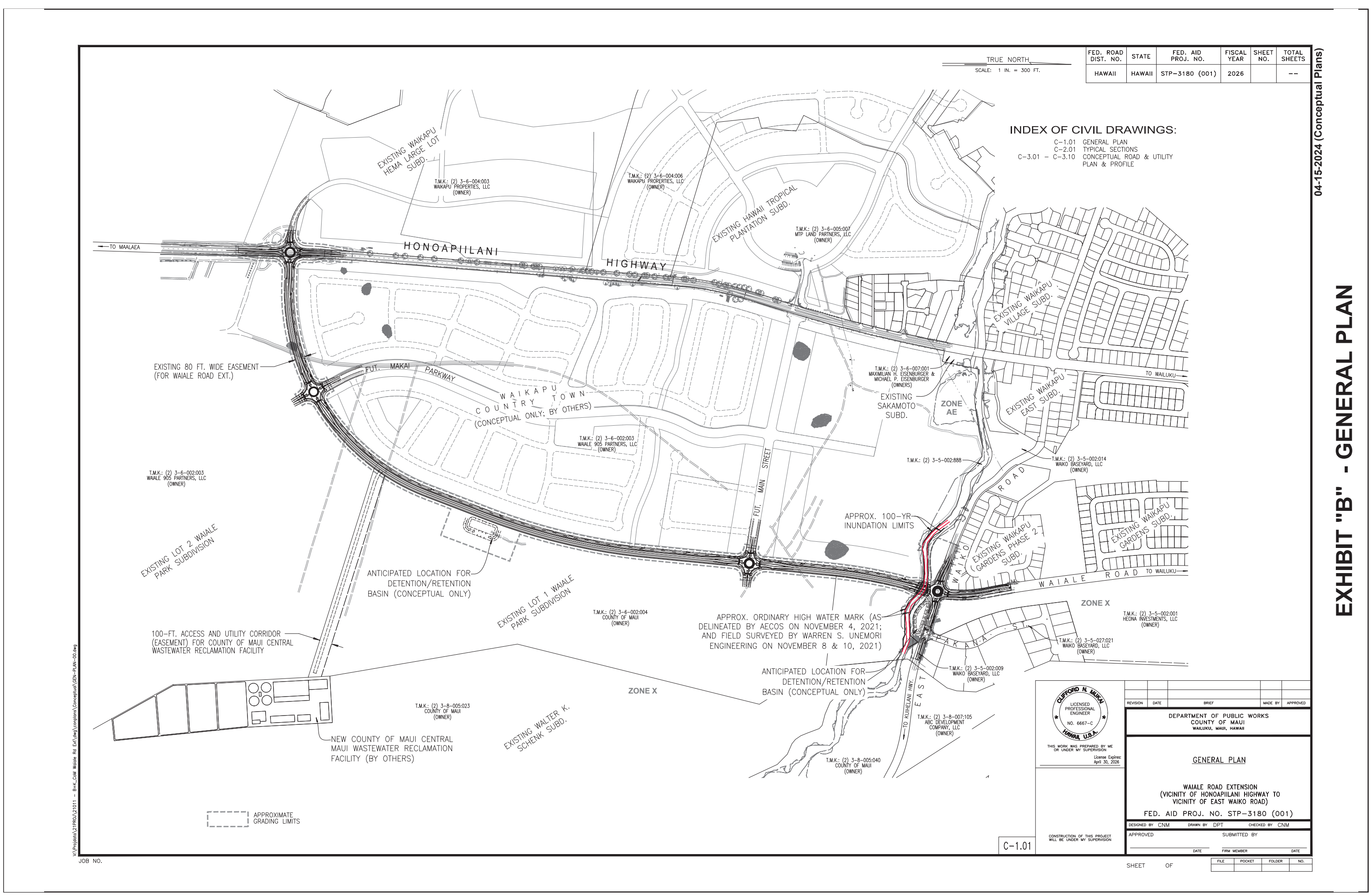
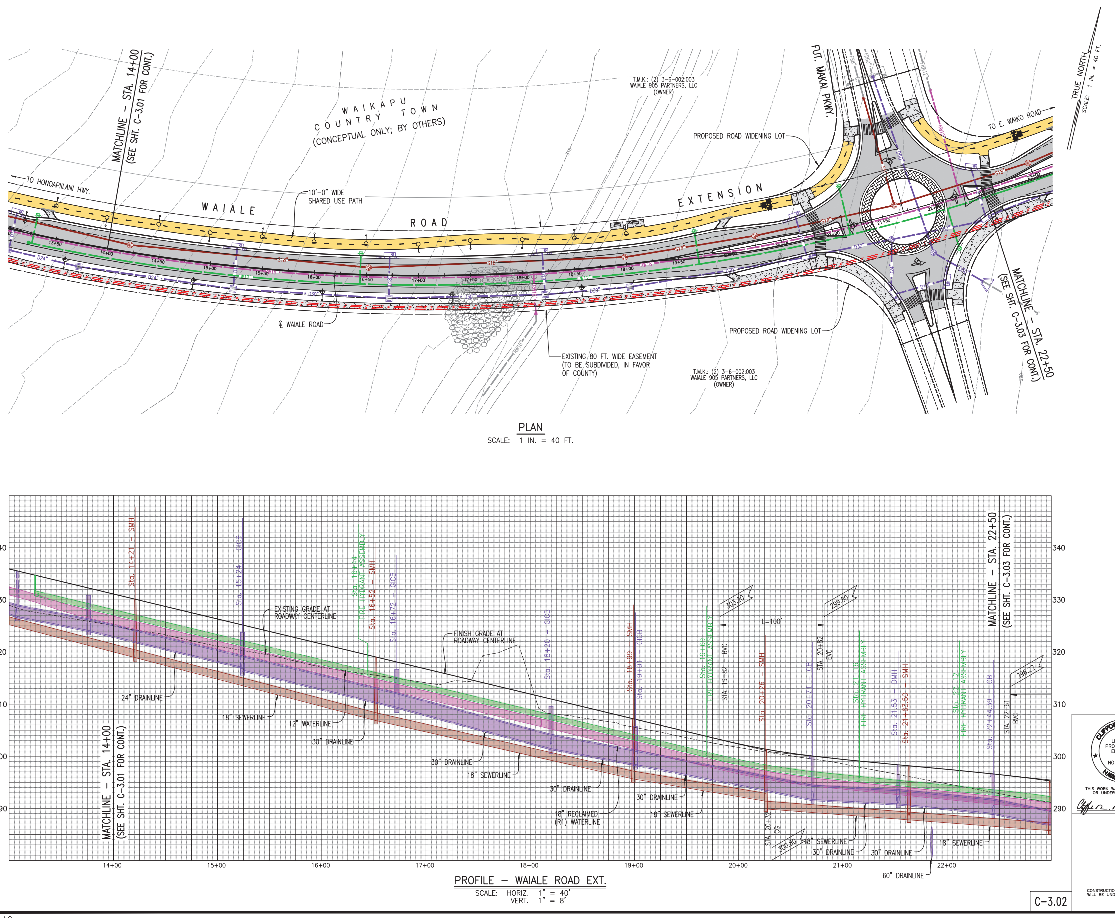


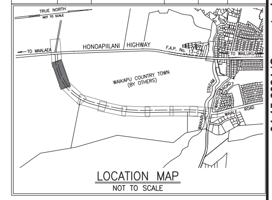
EXHIBIT "B" - GENERAL PLAN
04-15-2024 (Conceptual Plans)
FED. ROAD DIST. NO. HAWAII
STATE HAWAII
FED. AID PROJ. NO. STP-3180 (001)
FISCAL YEAR 2026
TRUE NORTH
SCALE: 1 IN. = 300 FT.
INDEX OF CIVIL DRAWINGS:
C-1.01 GENERAL PLAN
C-2.01 TYPICAL SECTIONS
C-3.01 – C-3.10 CONCEPTUAL ROAD & UTILITY PLAN & PROFILE
HONOAPIILANI HIGHWAY
TO MAALAEA
TO WAILUKU
EXISTING WAIKAPU HEMA LARGE LOT SUBD.
EXISTING HAWAII TROPICAL PLANTATION SUBD.
EXISTING WAIKAPU VILLAGE SUBD.
EXISTING WAIKAPU EAST SUBD.
EXISTING SAKAMOTO SUBD.
ZONE AE
ZONE X
EXISTING 80 FT. WIDE EASEMENT (FOR WAIALE ROAD EXT.)
FUT. MAKAI PARKWAY
WAIKAPU COUNTRY TOWN (CONCEPTUAL ONLY; BY OTHERS)
FUT. MAIN STREET
WAIKO ROAD
WAIALE ROAD
APPROX. 100-YR INUNDATION LIMITS
EXISTING WAIKAPU GARDENS PHASE 2 SUBD.
EXISTING WAIKAPU GARDENS SUBD.
EXISTING LOT 2 WAIALE PARK SUBDIVISION
EXISTING LOT 1 WAIALE PARK SUBDIVISION
ANTICIPATED LOCATION FOR DETENTION/RETENTION BASIN (CONCEPTUAL ONLY)
APPROX. ORDINARY HIGH WATER MARK (AS DELINEATED BY AECOS ON NOVEMBER 4, 2021; AND FIELD SURVEYED BY WARREN S. UNEMORI ENGINEERING ON NOVEMBER 8 & 10, 2021)
100-FT. ACCESS AND UTILITY CORRIDOR (EASEMENT) FOR COUNTY OF MAUI CENTRAL WASTEWATER RECLAMATION FACILITY
NEW COUNTY OF MAUI CENTRAL MAUI WASTEWATER RECLAMATION FACILITY (BY OTHERS)
EXISTING WALTER K. SCHENK SUBD.
APPROXIMATE GRADING LIMITS
DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII
GENERAL PLAN
WAIALE ROAD EXTENSION
(VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)
FED. AID PROJ. NO. STP-3180 (001)
C-1.01

04-15-2024 (Conceptual Plans)

EXHIBIT "D" (2 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--





LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT

CLIFFORD N. MUKAI, LICENSED PROFESSIONAL ENGINEER, NO. 6667-C, HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

REVISION	DATE	BRIEF	MADE BY	APPROVED

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILITY PLAN & PROFILE: WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION (VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

APPROVED | SUBMITTED BY

DATE | FIRM MEMBER | DATE

C-3.02

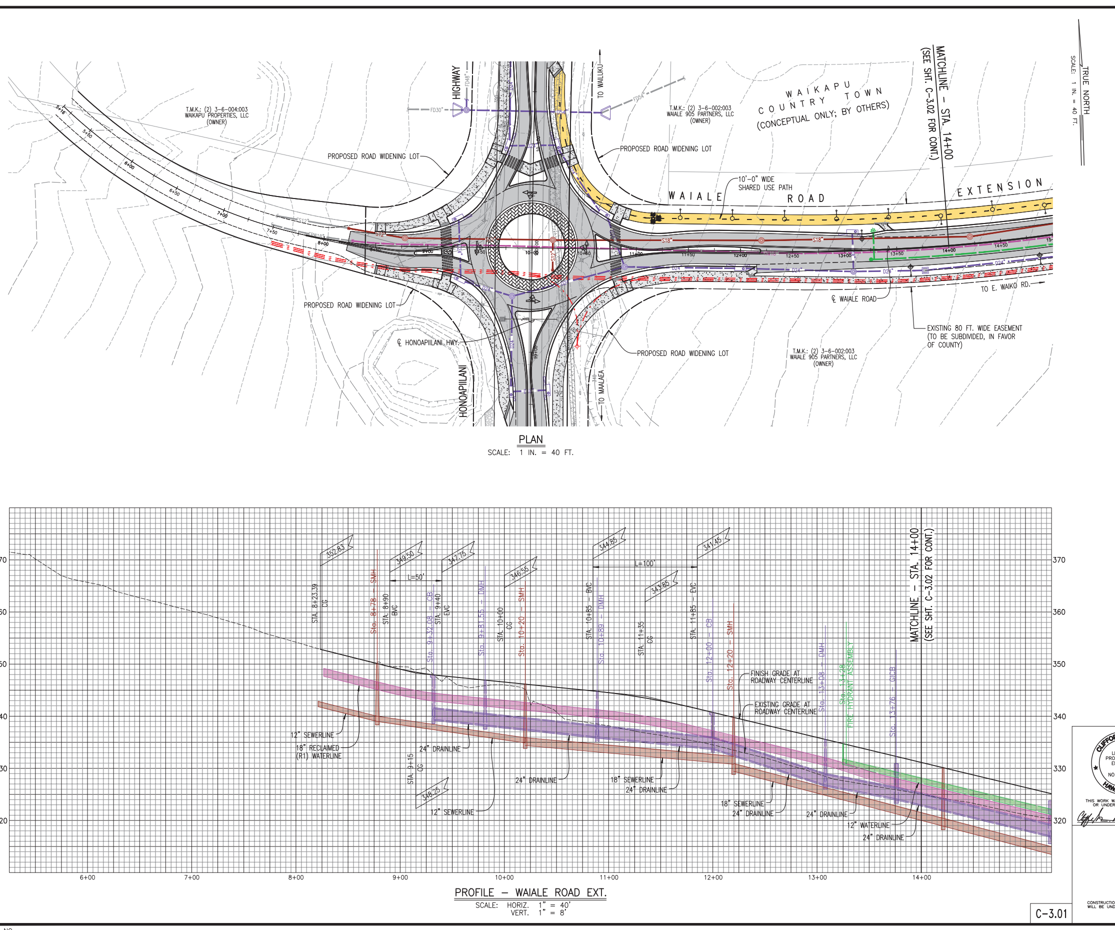
JOB NO.

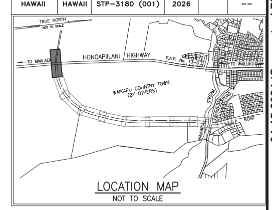
SHEET OF | FILE | POCKET | FOLDER | NO.

04-15-2024 (Conceptual Plans)

EXHIBIT "D" (1 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAWAII	STP-3180 (001)	2026		--





LEGEND:

- GRATED INLET CATCH BASIN
- CURB INLET CATCH BASIN
- DRAIN MANHOLE
- OUTLET STRUCTURE
- SEWER FORCE MAIN W/ SIZE
- RECLAIMED (R1) WATERLINE W/ SIZE
- DRAINLINE W/ SIZE
- SEWER MANHOLE
- SEWER CLEANOUT TO GRADE
- SEWERLINE W/ SIZE
- FUTURE SEWERLINE W/ SIZE
- FUTURE WATERLINE W/ SIZE
- FUTURE REINFORCED (R1) WATERLINE W/ SIZE
- FUTURE DRAINLINE W/ SIZE
- ELECTRIC LINE
- WATER METER
- DETECTOR CHECK ASSEMBLY
- WATER ARV MANHOLE
- WATER VALVE
- FIRE HYDRANT
- FIRE DEPT. CONNECTION
- WATERLINE FOR DOMESTIC SERVICE W/ SIZE
- NEW PAVEMENT AREA
- FEMA FLOOD INSURANCE RATE MAP ZONE (MAP NO. 1500030393F, DATED NOVEMBER 4, 2015)
- EXISTING DRAINLINE W/ SIZE
- EXISTING FORCE MAIN W/ SIZE
- EXISTING WATERLINE W/ SIZE
- EXISTING POWER POLE
- EXISTING HANDHOLE OR HANDHOLE GROUP
- EXISTING SEWER MANHOLE
- EXISTING DRAIN MANHOLE
- EXISTING WATER VALVE
- EXISTING FIRE HYDRANT

CLIFFORD N. MUKAI, LICENSED PROFESSIONAL ENGINEER, NO. 6667-C, HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION

License Expires: April 30, 2026

CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY SUPERVISION

REVISION	DATE	BRIEF	MADE BY	APPROVED

DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
WAILUKU, MAUI, HAWAII

CONCEPTUAL ROAD & UTILTIY PLAN & PROFILE: WAIALE ROAD EXTENSION

WAIALE ROAD EXTENSION (VICINITY OF HONOAPIILANI HIGHWAY TO VICINITY OF EAST WAIKO ROAD)

FED. AID PROJ. NO. STP-3180 (001)

DESIGNED BY CNM | DRAWN BY DPT | CHECKED BY CNM

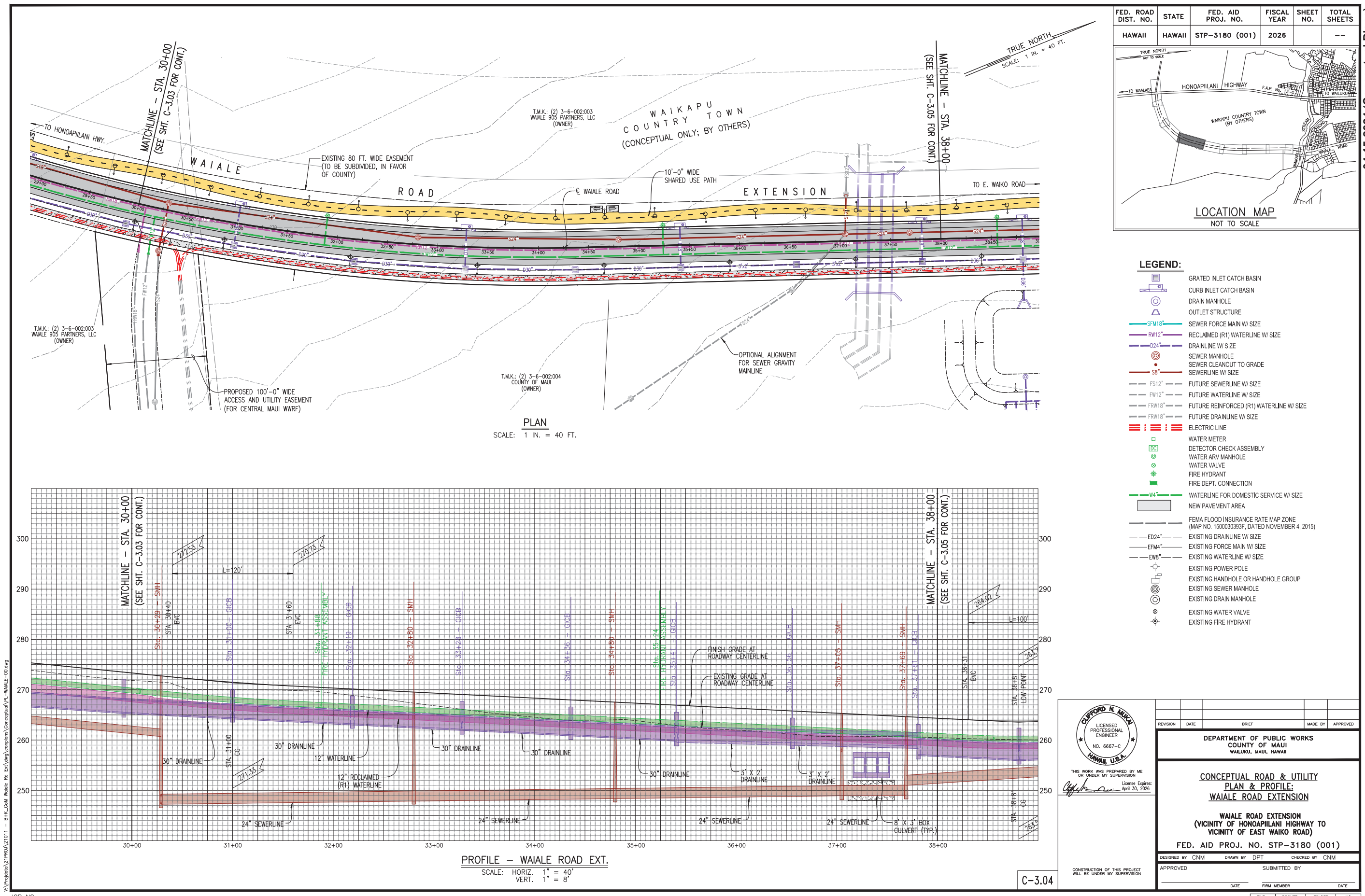
APPROVED | SUBMITTED BY

DATE | FIRM MEMBER | DATE

C-3.01

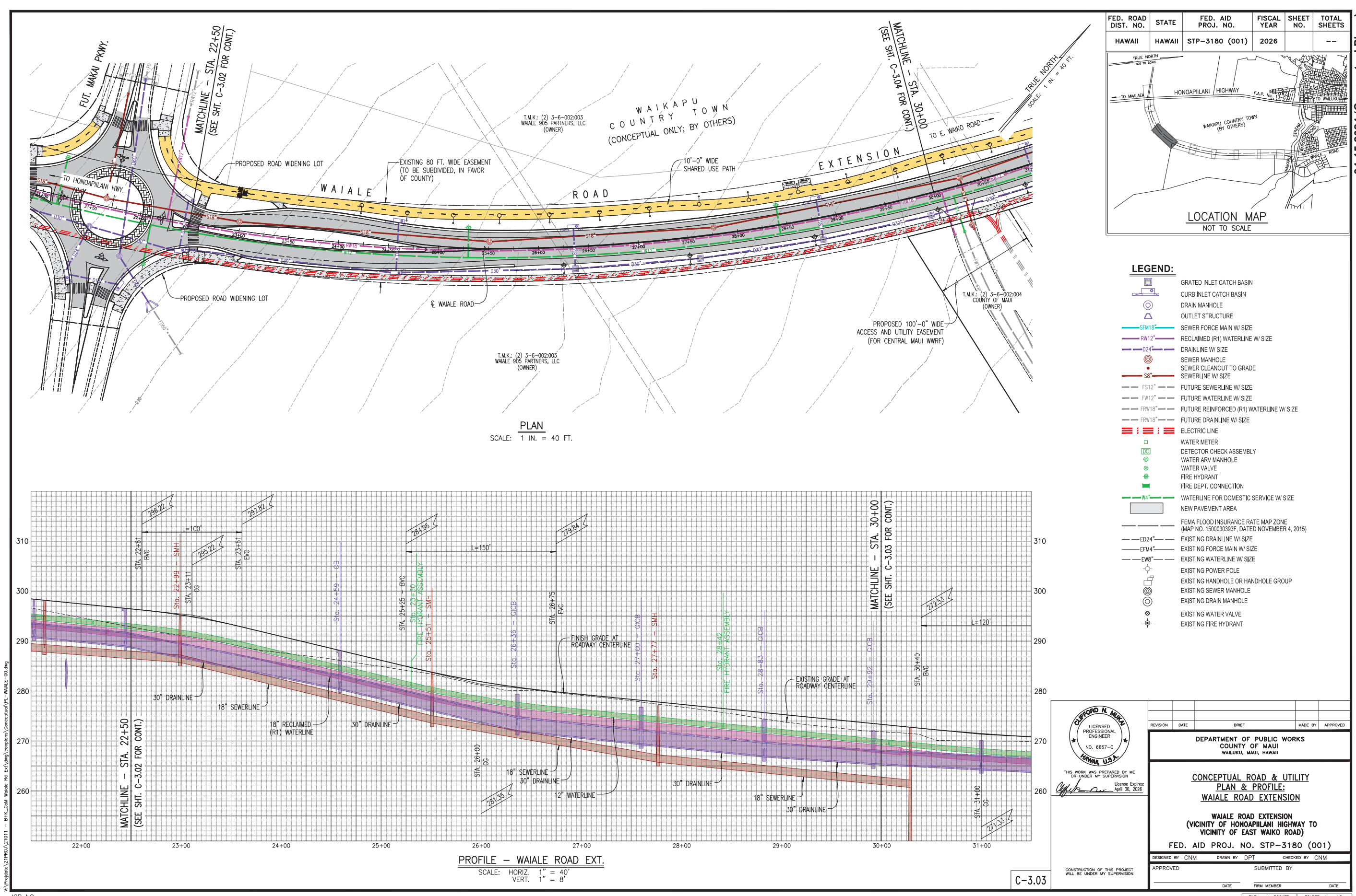
JOB NO.

SHEET OF | FILE | POCKET | FOLDER | NO.



04-15-2024 (Conceptual Plans)

EXHIBIT "D" (4 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE



04-15-2024 (Conceptual Plans)

EXHIBIT "D" (3 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE

EXHIBIT "D" (6 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE

04-15-2024 (Conceptual Plans)

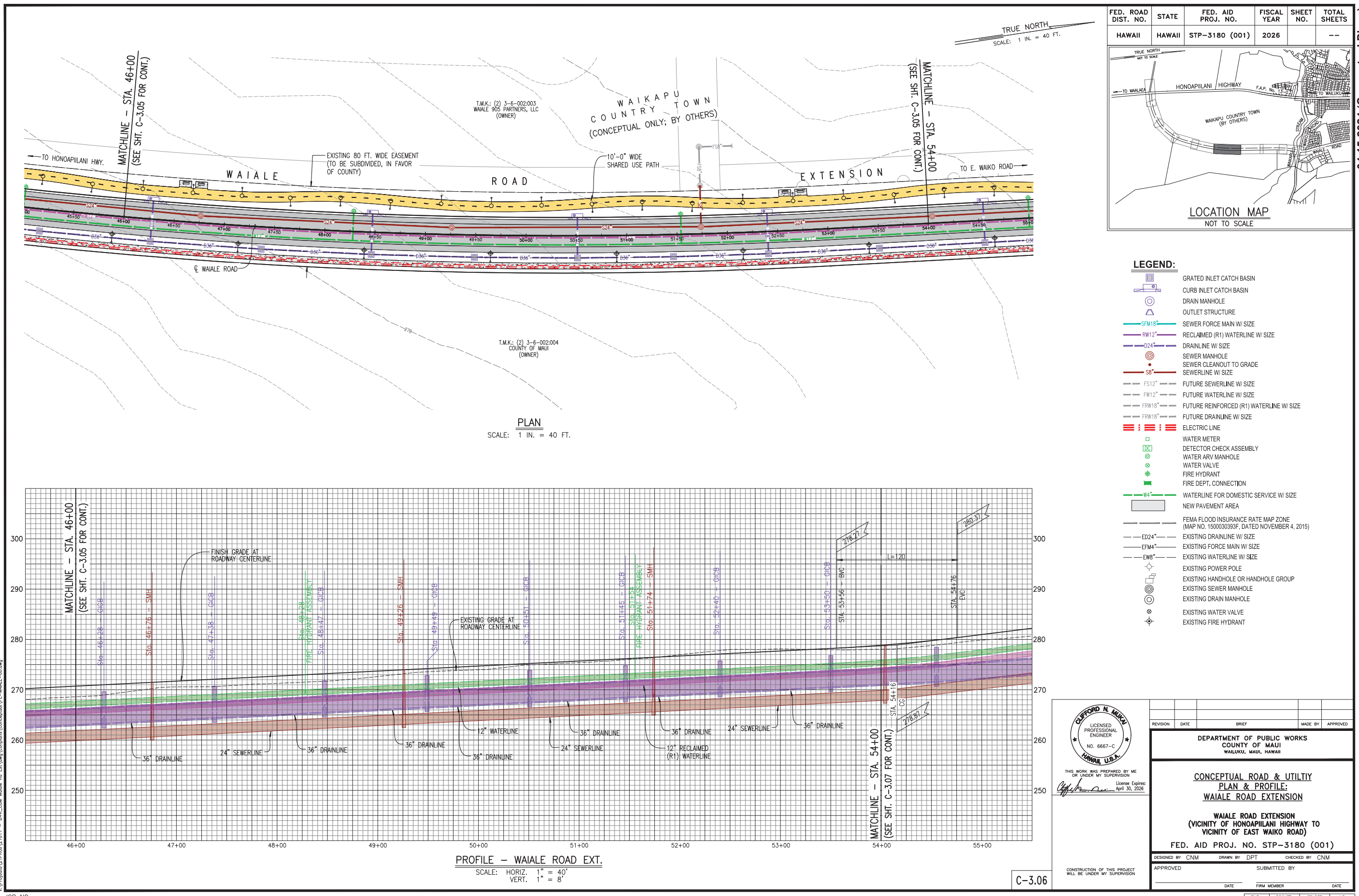
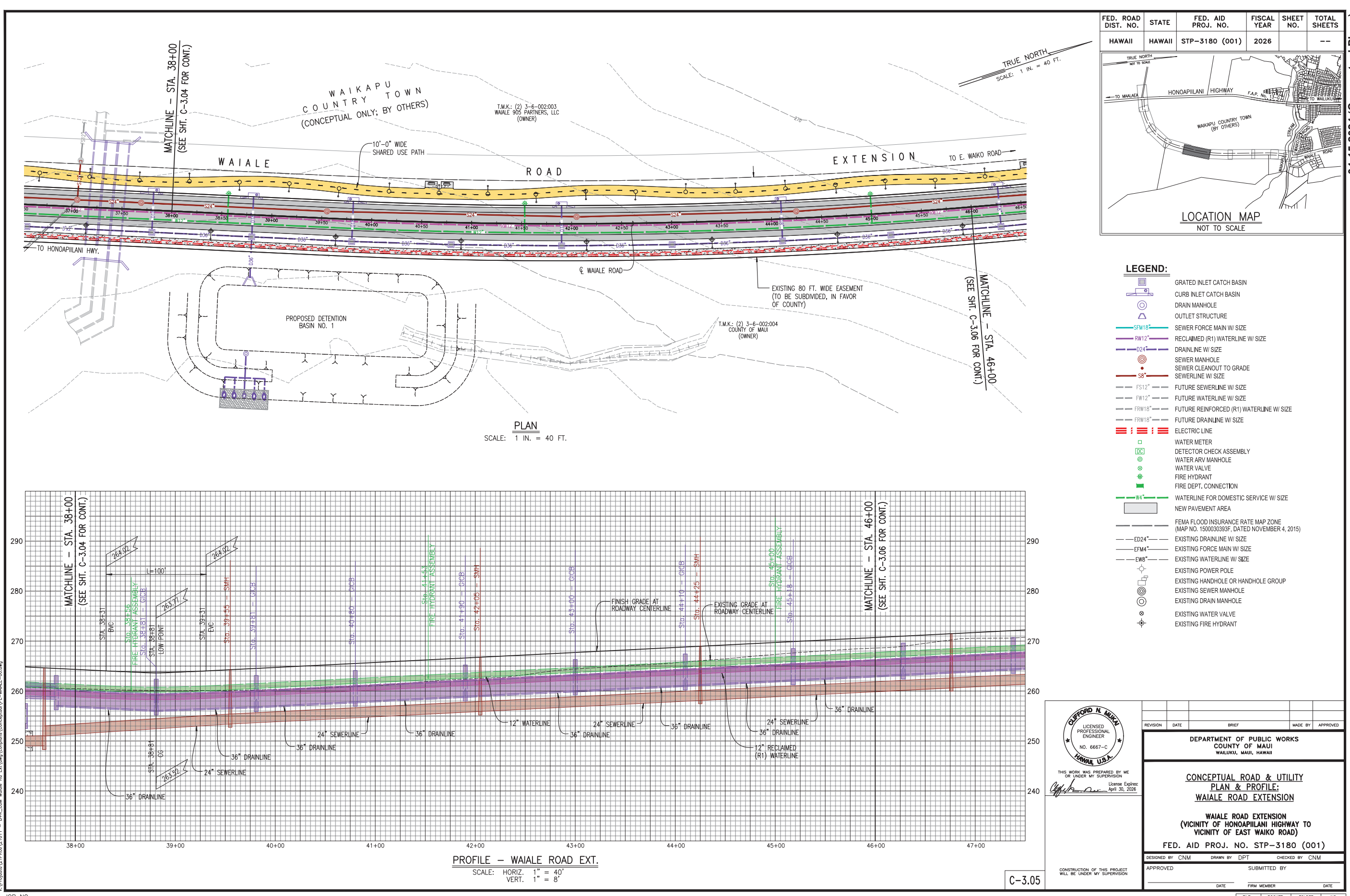


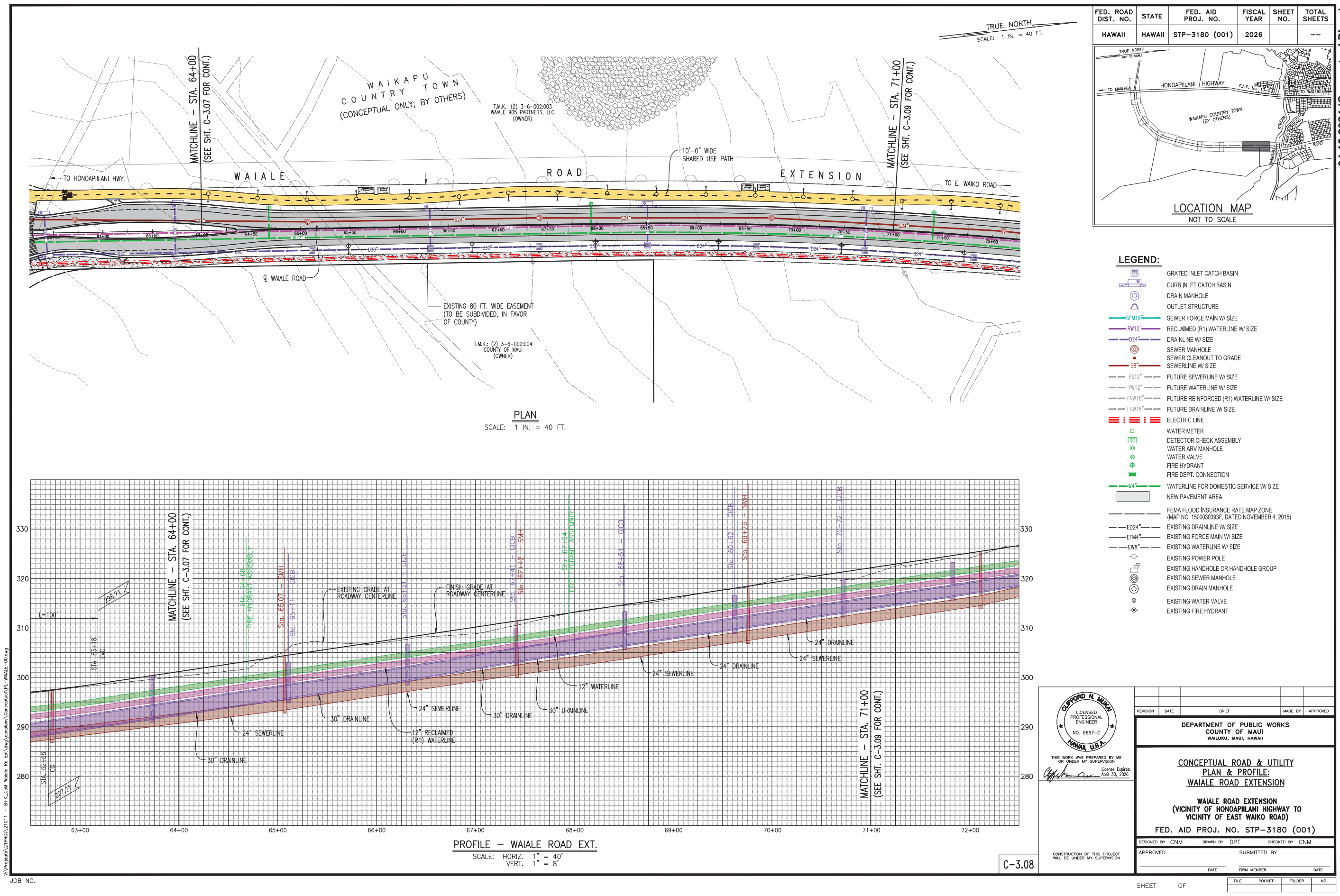
EXHIBIT "D" (5 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE

04-15-2024 (Conceptual Plans)



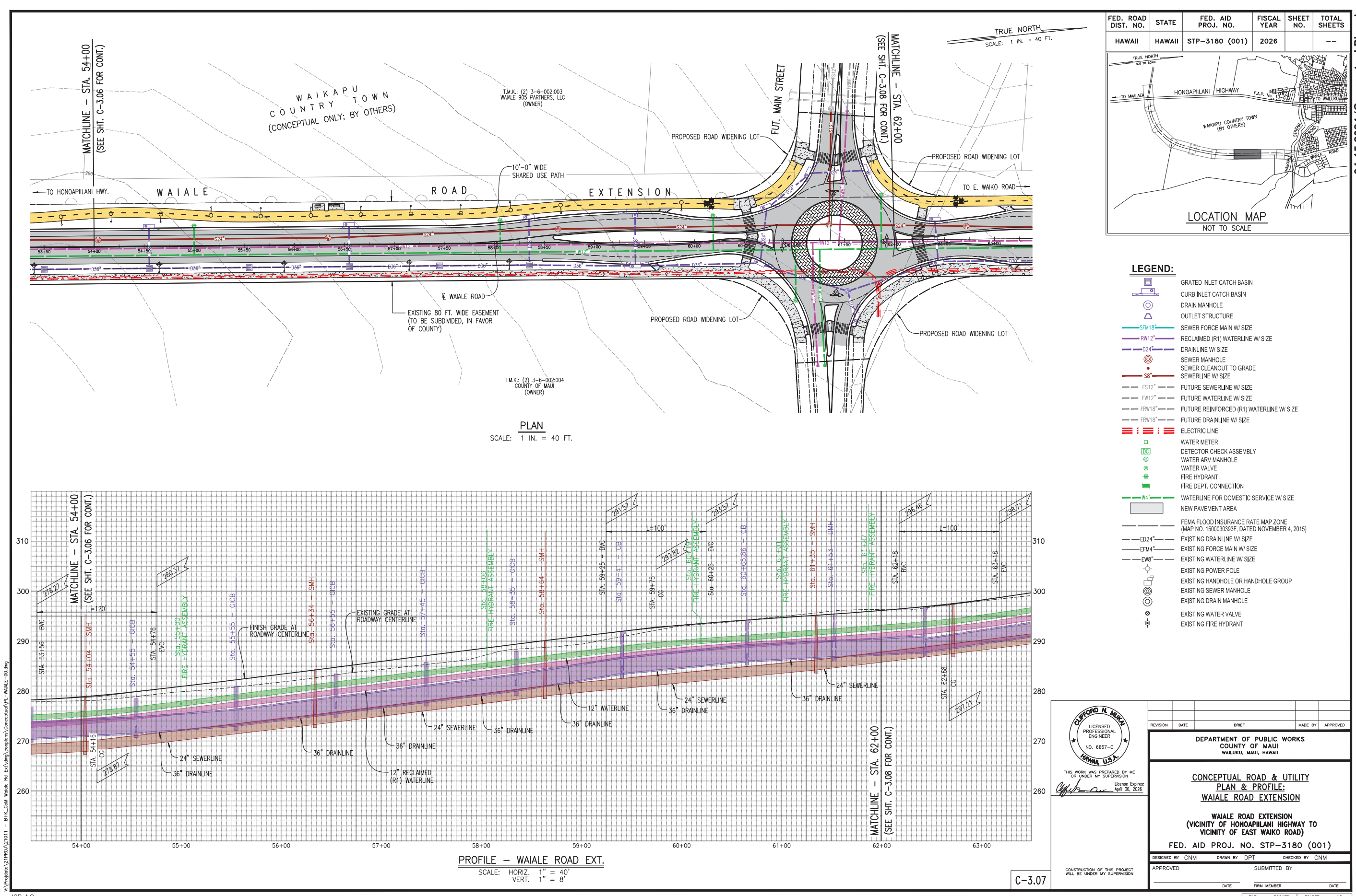
04-15-2024 (Conceptual Plans)

EXHIBIT "D" (8 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE



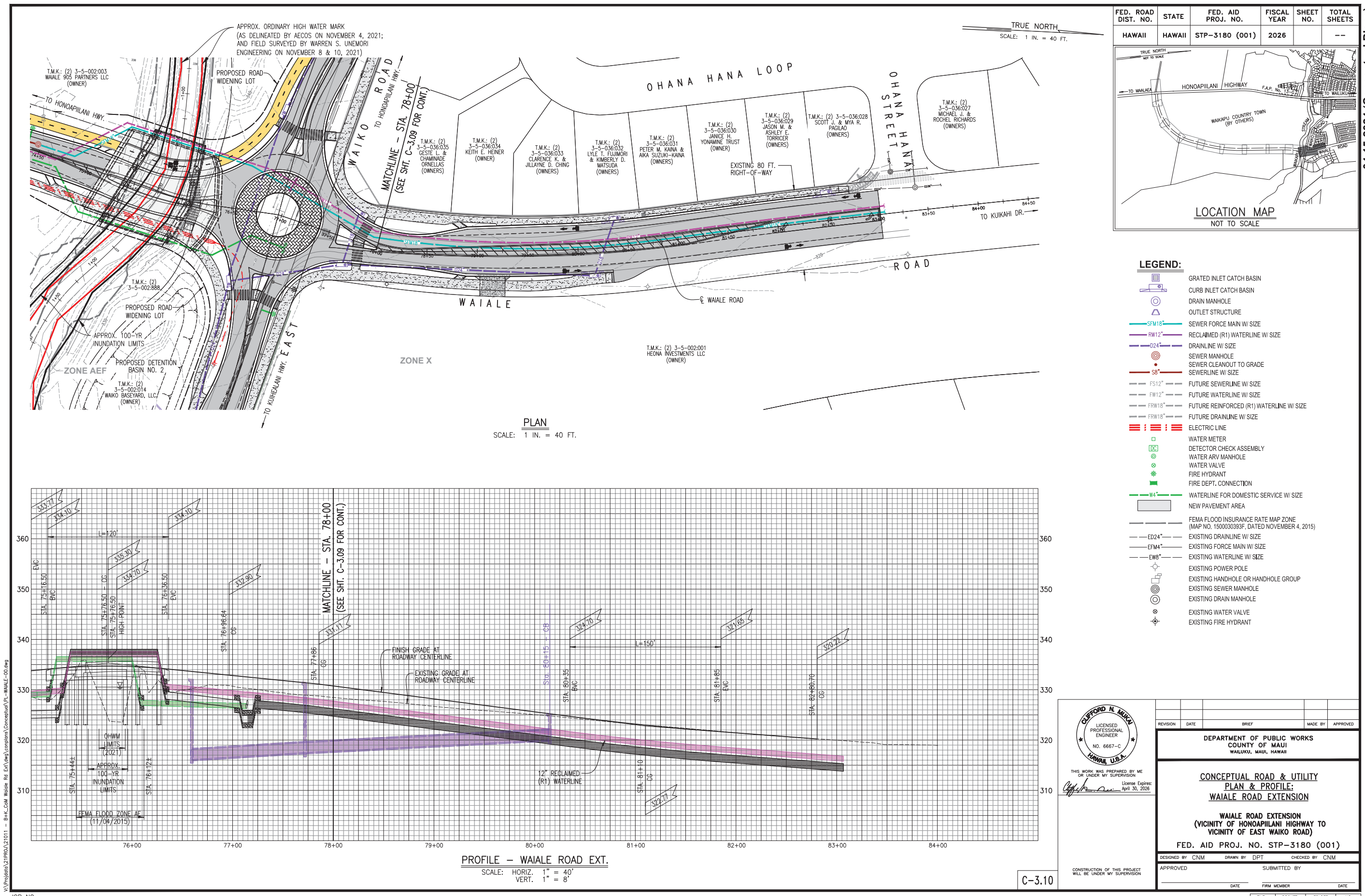
04-15-2024 (Conceptual Plans)

EXHIBIT "D" (7 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE



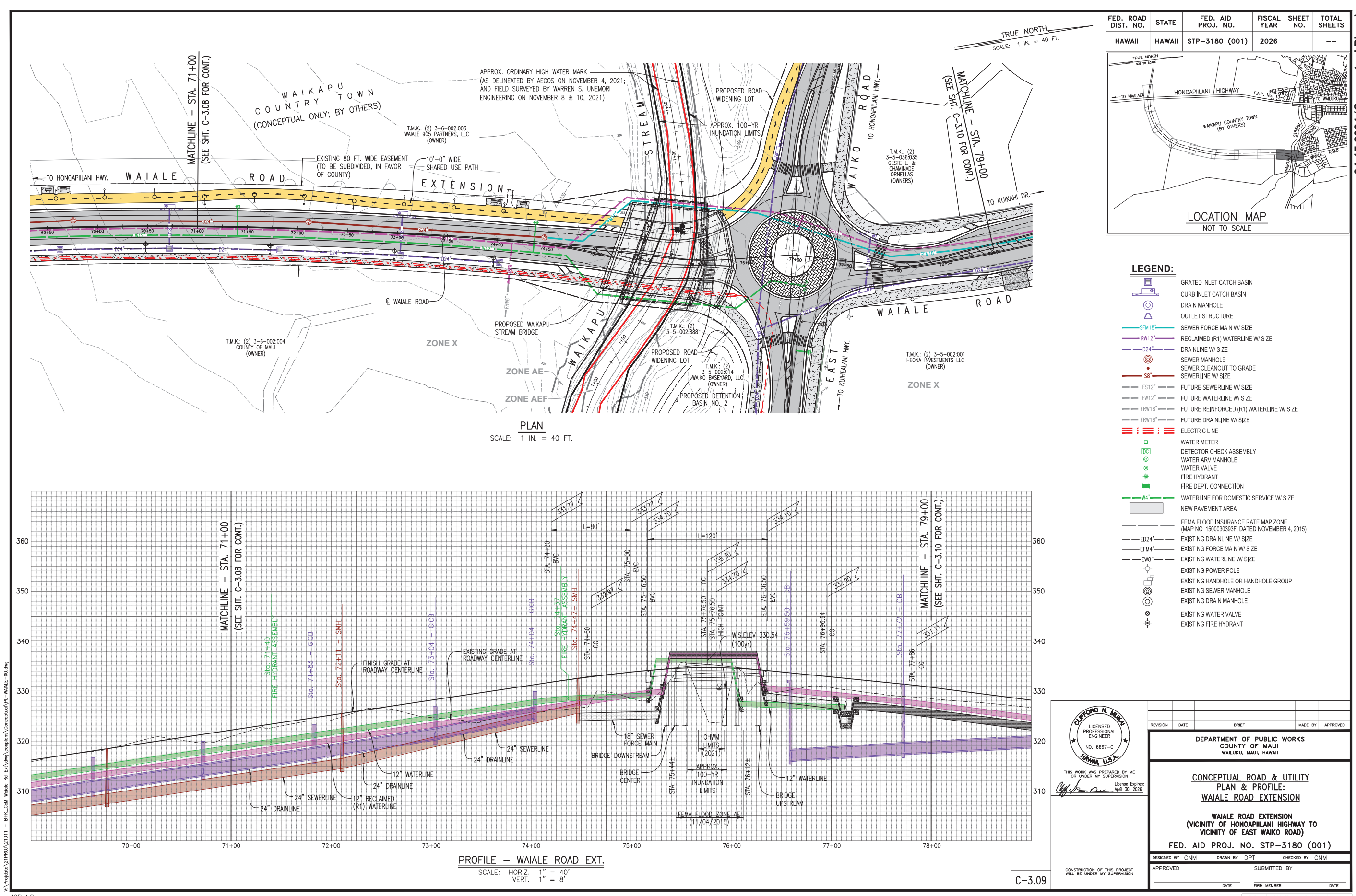
04-15-2024 (Conceptual Plans)

EXHIBIT "D" (10 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE



04-15-2024 (Conceptual Plans)

EXHIBIT "D" (9 of 10) - CONCEPTUAL ROAD & UTILITY PLAN & PROFILE



United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Island of Maui, Hawaii

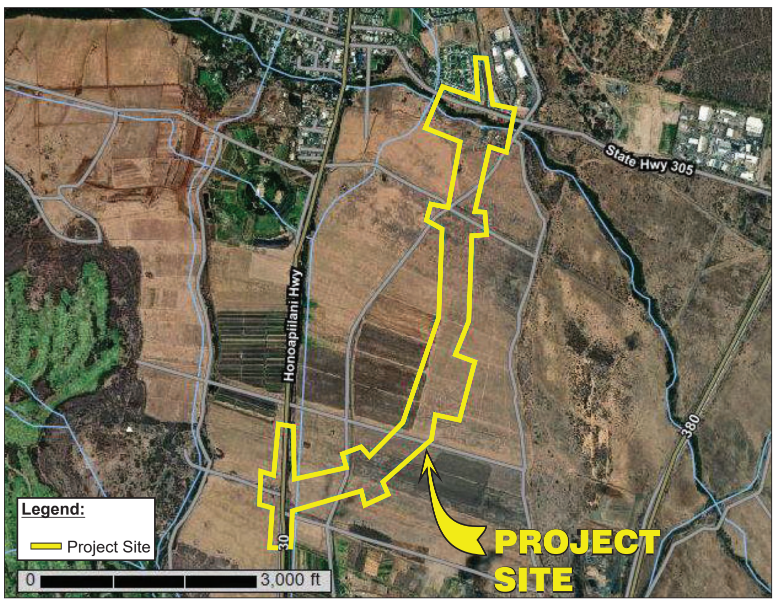


EXHIBIT "E" - SOILS CLASSIFICAION REPORT

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

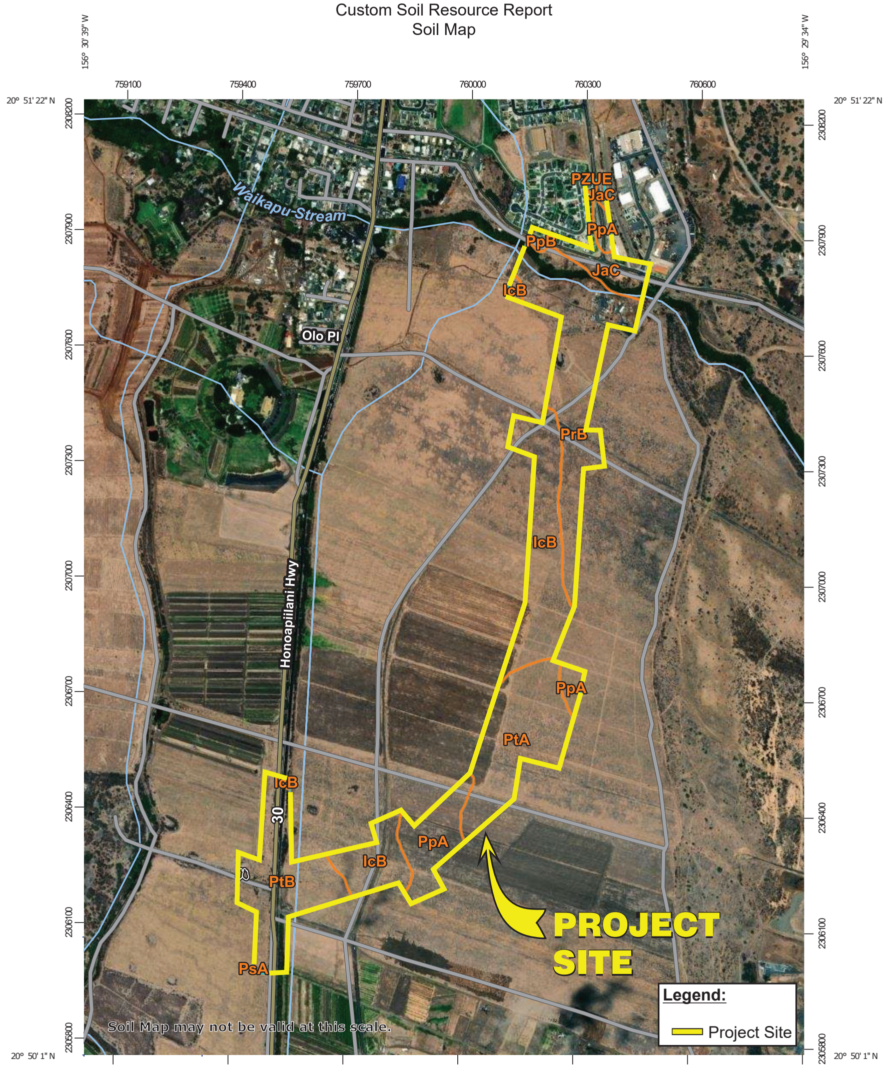
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:12,100 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 4N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 21, Sep 8, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 29, 2017—Oct 11, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
IcB	Iao clay, 3 to 7 percent slopes, MLRA 163	23.4	23.9%
JaC	Jaucas sand, 0 to 15 percent slopes, MLRA 163	5.5	5.6%
PpA	Pulehu silt loam, 0 to 3 percent slopes	10.3	10.5%
PpB	Pulehu silt loam, 3 to 7 percent slopes	0.7	0.7%
PrB	Pulehu cobbly silt loam, 3 to 7 percent slopes	24.4	24.9%
PsA	Pulehu clay loam, 0 to 3 percent slopes , MLRA 163	0.0	0.0%
PtA	Pulehu cobbly clay loam, 0 to 3 percent slopes	17.3	17.7%
PtB	Pulehu cobbly clay loam, 3 to 7 percent slopes	16.0	16.3%
PZUE	Puuone sand, 7 to 30 percent slopes	0.2	0.2%
Totals for Area of Interest		**97.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They

generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Island of Maui, Hawaii

IcB—Iao clay, 3 to 7 percent slopes, MLRA 163

Map Unit Setting

National map unit symbol: 2yys0
Elevation: 100 to 500 feet
Mean annual precipitation: 23 to 36 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Iao and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iao

Setting

Landform: Alluvial fans, mountain slopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Concave, convex
Parent material: Weathered alluvium derived from basalt

Typical profile

Ap - 0 to 15 inches: clay
Bw1 - 15 to 25 inches: clay
Bw2 - 25 to 48 inches: clay
BC - 48 to 60 inches: silty clay

Properties and qualities

Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Urban land

Percent of map unit: 10 percent
Landform: Alluvial fans, mountain slopes

Custom Soil Resource Report

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Linear, concave, convex
Hydric soil rating: No

Wailuku

Percent of map unit: 3 percent
Landform: Alluvial fans, mountain slopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Paia

Percent of map unit: 2 percent
Landform: Alluvial fans, mountain slopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Concave, convex
Hydric soil rating: No

JaC—Jaucas sand, 0 to 15 percent slopes, MLRA 163

Map Unit Setting

National map unit symbol: 2w02z
Elevation: 0 to 1,140 feet
Mean annual precipitation: 13 to 77 inches
Mean annual air temperature: 73 to 77 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Jaucas and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Jaucas

Setting

Landform: Beaches
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Sand sized coral and sea shells sandy marine deposits derived from sedimentary rock

Typical profile

AC - 0 to 13 inches: sand

C1 - 13 to 22 inches: sand
C2 - 22 to 60 inches: sand

Properties and qualities
Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 99 percent
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups
Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

PpA—Pulehu silt loam, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: hqbh
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: silt loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups
Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PpB—Pulehu silt loam, 3 to 7 percent slopes

Map Unit Setting
National map unit symbol: hqbj
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: silt loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PrB—Pulehu cobbly silt loam, 3 to 7 percent slopes

Map Unit Setting
National map unit symbol: hqbl
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: cobbly silt loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): 2e

Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Hydric soil rating: No

PsA—Pulehu clay loam, 0 to 3 percent slopes , MLRA 163

Map Unit Setting
National map unit symbol: 2x1vv
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 50 inches
Mean annual air temperature: 72 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Flood plains, stream terraces, alluvial fans
Landform position (two-dimensional): Toeslope, backslope, footslope
Landform position (three-dimensional): Base slope, tread, rise
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, concave
Parent material: Alluvium derived from igneous rock

Typical profile
Ap - 0 to 21 inches: clay loam
2C1 - 21 to 33 inches: loam
3C2 - 33 to 37 inches: loamy sand
4C3 - 37 to 47 inches: fine sandy loam
5C4 - 47 to 60 inches: silt loam

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups
Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B

Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

Minor Components

Mala

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Ewa

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Waialua

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope, rise
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

PtA—Pulehu cobbly clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: hqbn
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile

H1 - 0 to 21 inches: cobbly clay loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PtB—Pulehu cobbly clay loam, 3 to 7 percent slopes

Map Unit Setting

National map unit symbol: hqbp
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: cobbly clay loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PZUE—Puuone sand, 7 to 30 percent slopes

Map Unit Setting
National map unit symbol: hqb7
Elevation: 50 to 350 feet
Mean annual precipitation: 20 to 30 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition
Puuone and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Puuone

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Coral seashells

Typical profile
H1 - 0 to 20 inches: sand
H2 - 20 to 40 inches: cemented material

Properties and qualities
Slope: 7 to 30 percent

Custom Soil Resource Report

Depth to restrictive feature: 20 to 40 inches to cemented horizon
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 100 percent
Available water supply, 0 to 60 inches: Very low (about 1.4 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

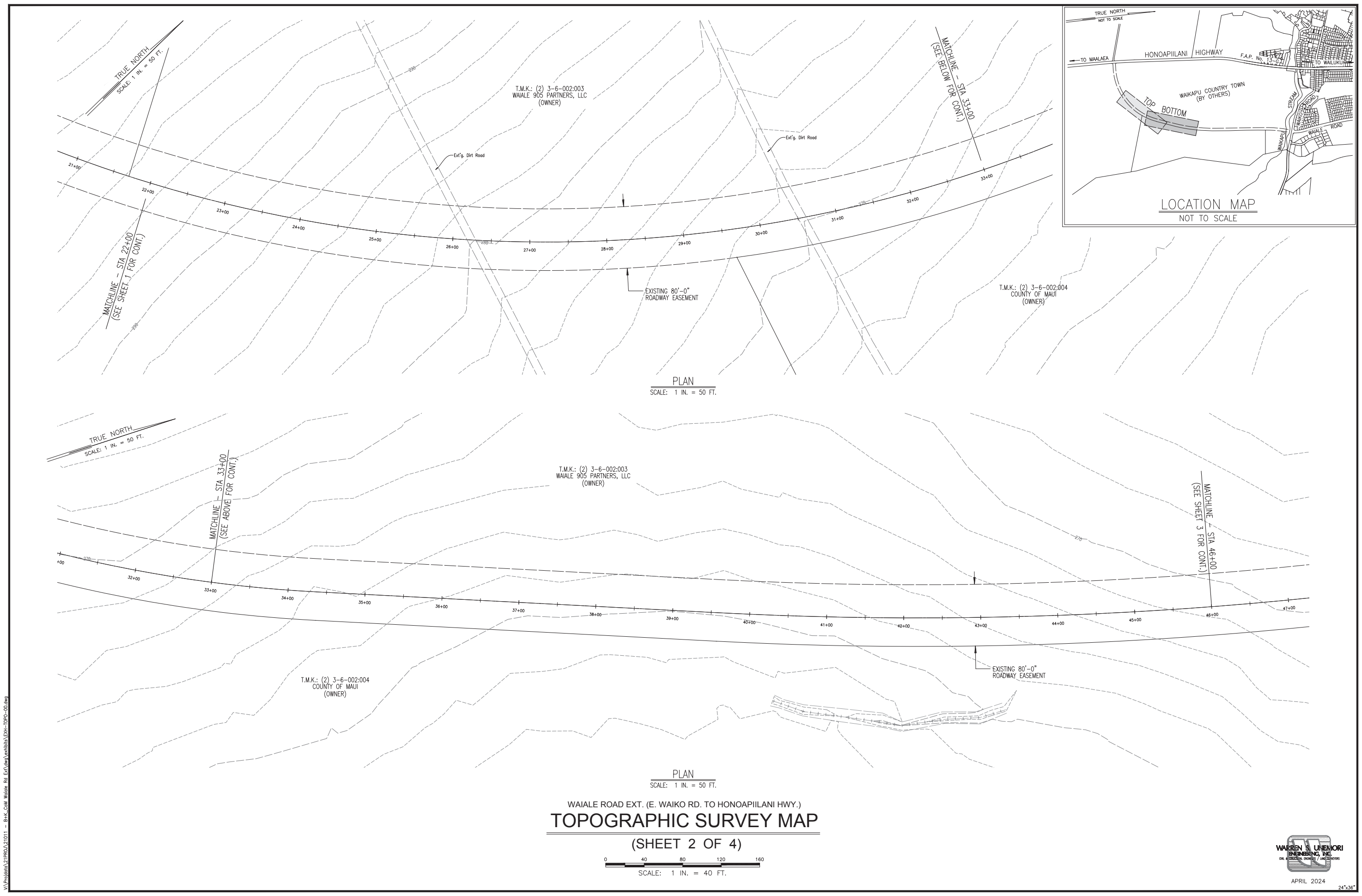
United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf



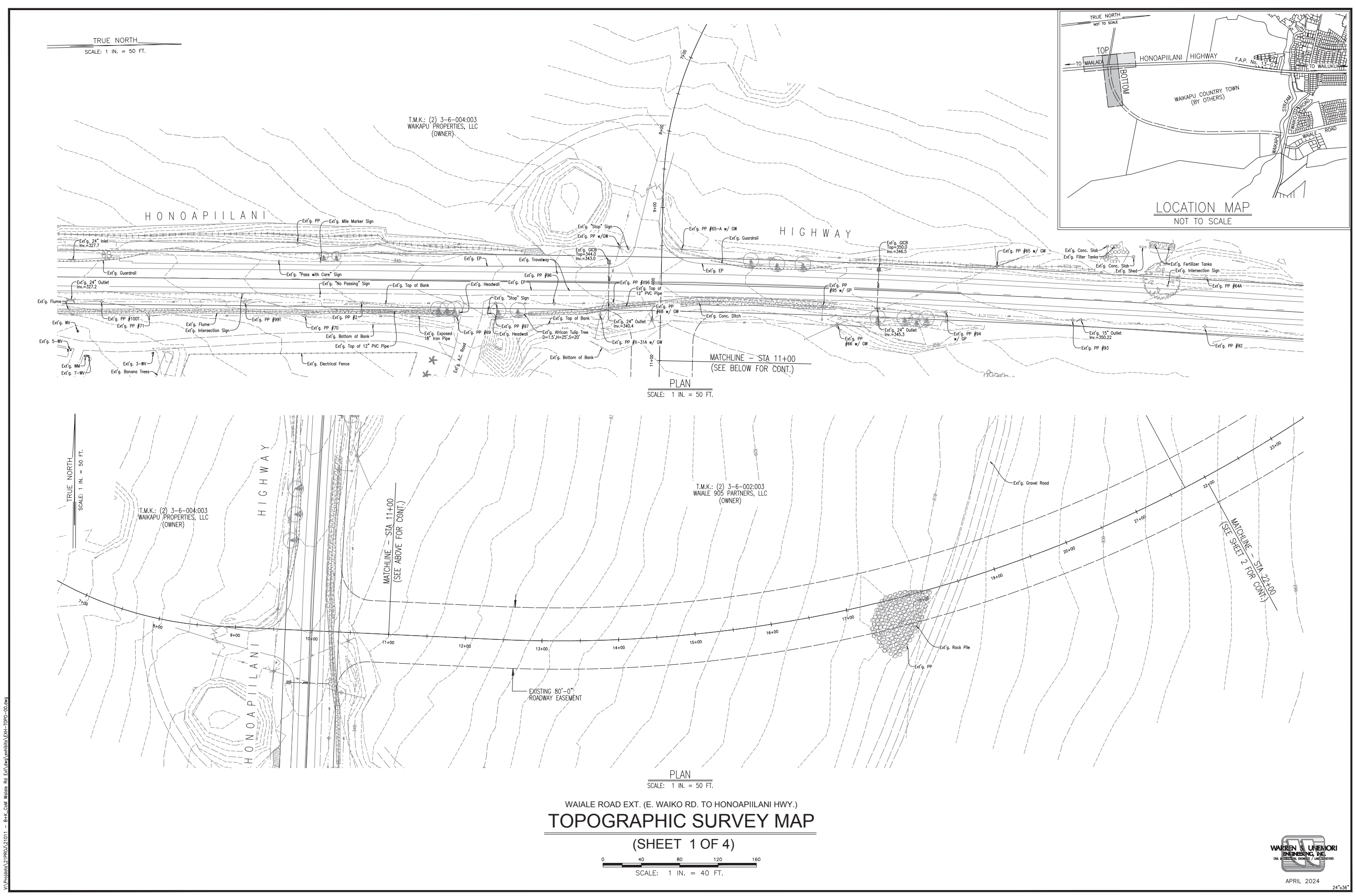


EXHIBIT "F" (2 of 4) - TOPOGRAPHIC SURVEY MAPS OF EXISTING GRADES

EXHIBIT "F" (1 of 4) - TOPOGRAPHIC SURVEY MAPS OF EXISTING GRADES

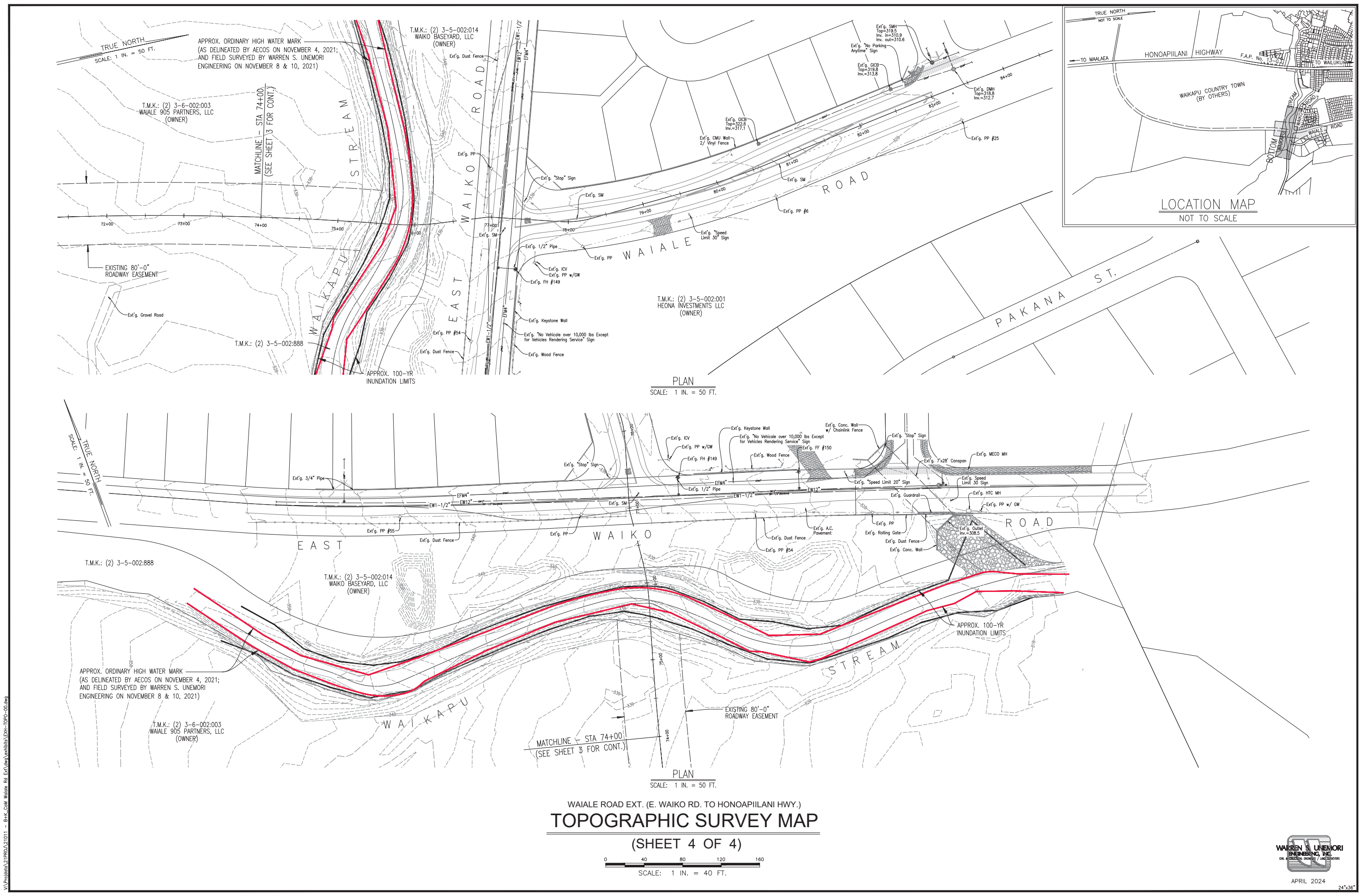


EXHIBIT "F" (4 of 4) - TOPOGRAPHIC SURVEY MAPS OF EXISTING GRADES

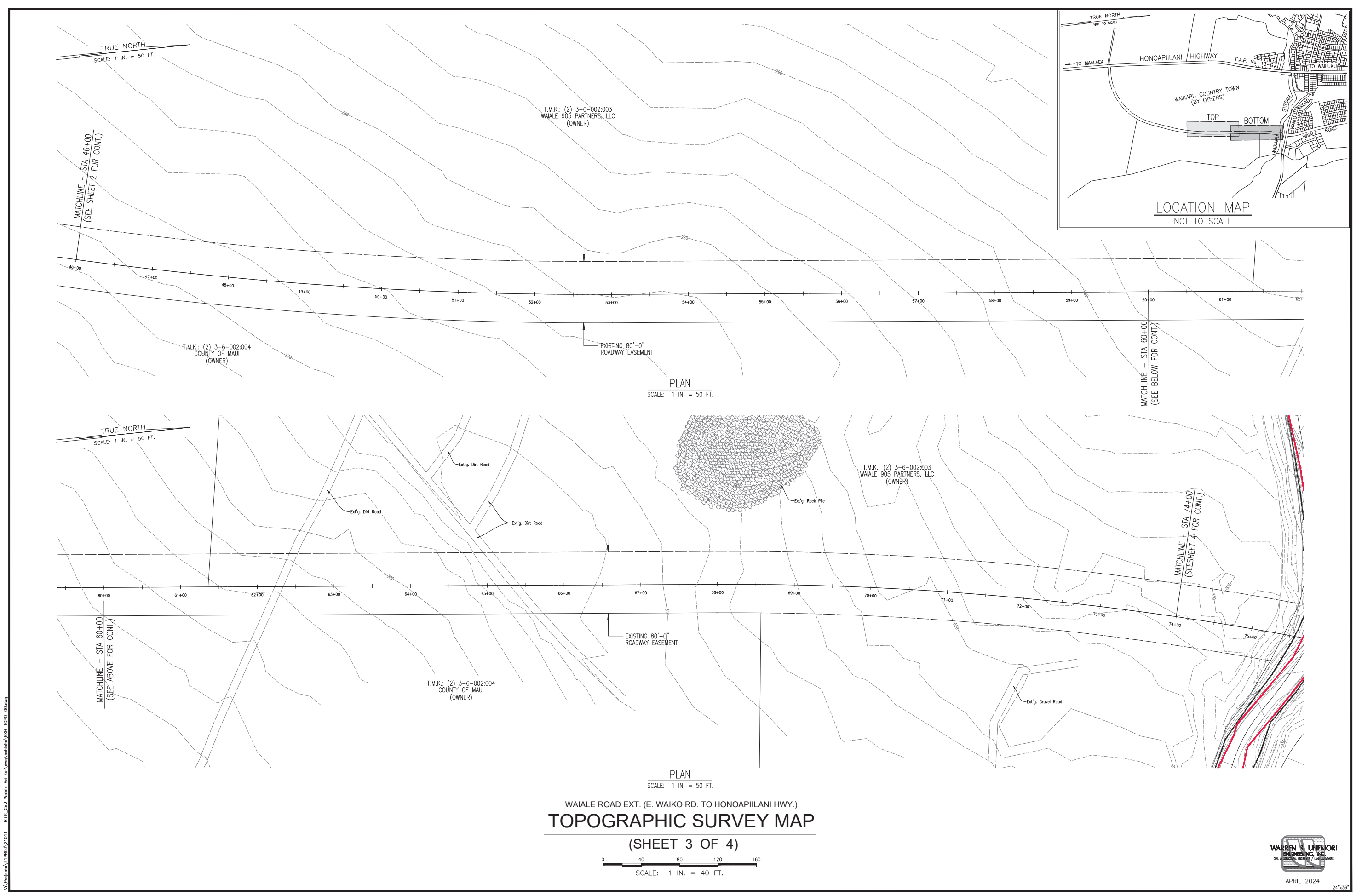
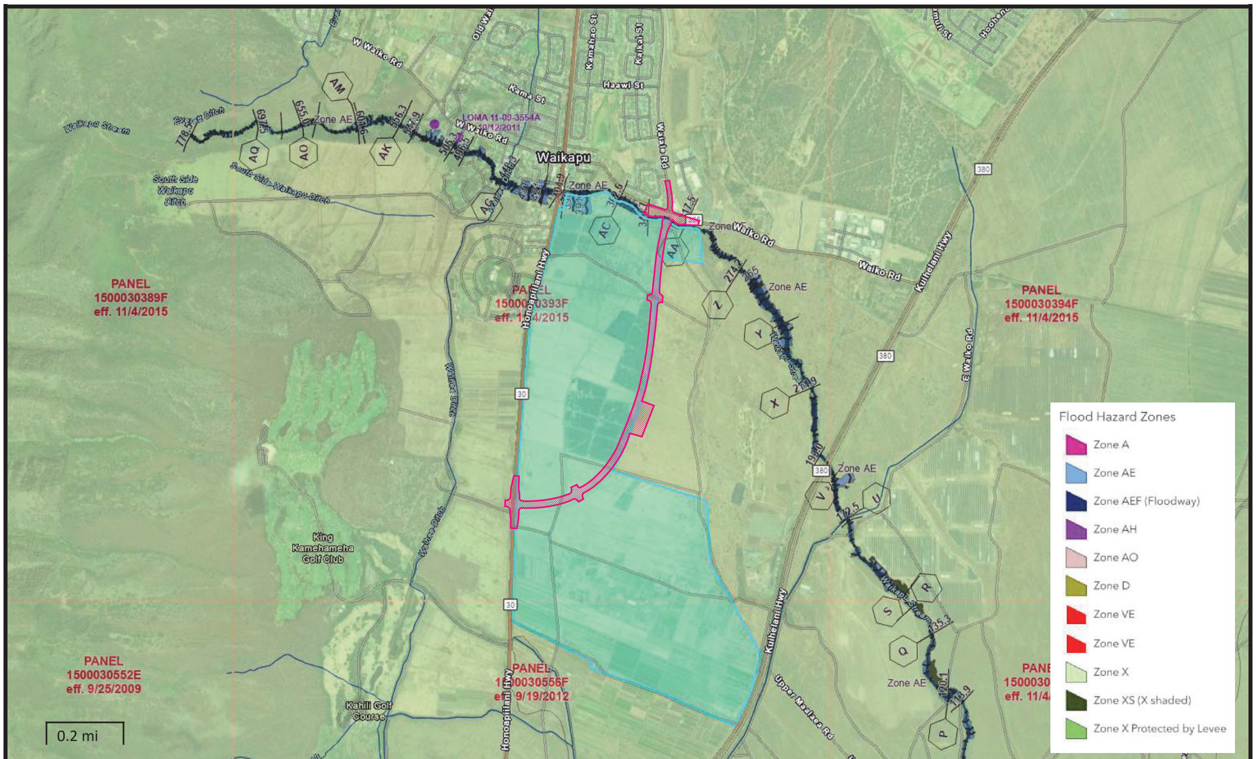


EXHIBIT "F" (3 of 4) - TOPOGRAPHIC SURVEY MAPS OF EXISTING GRADES



Flood Hazard Map

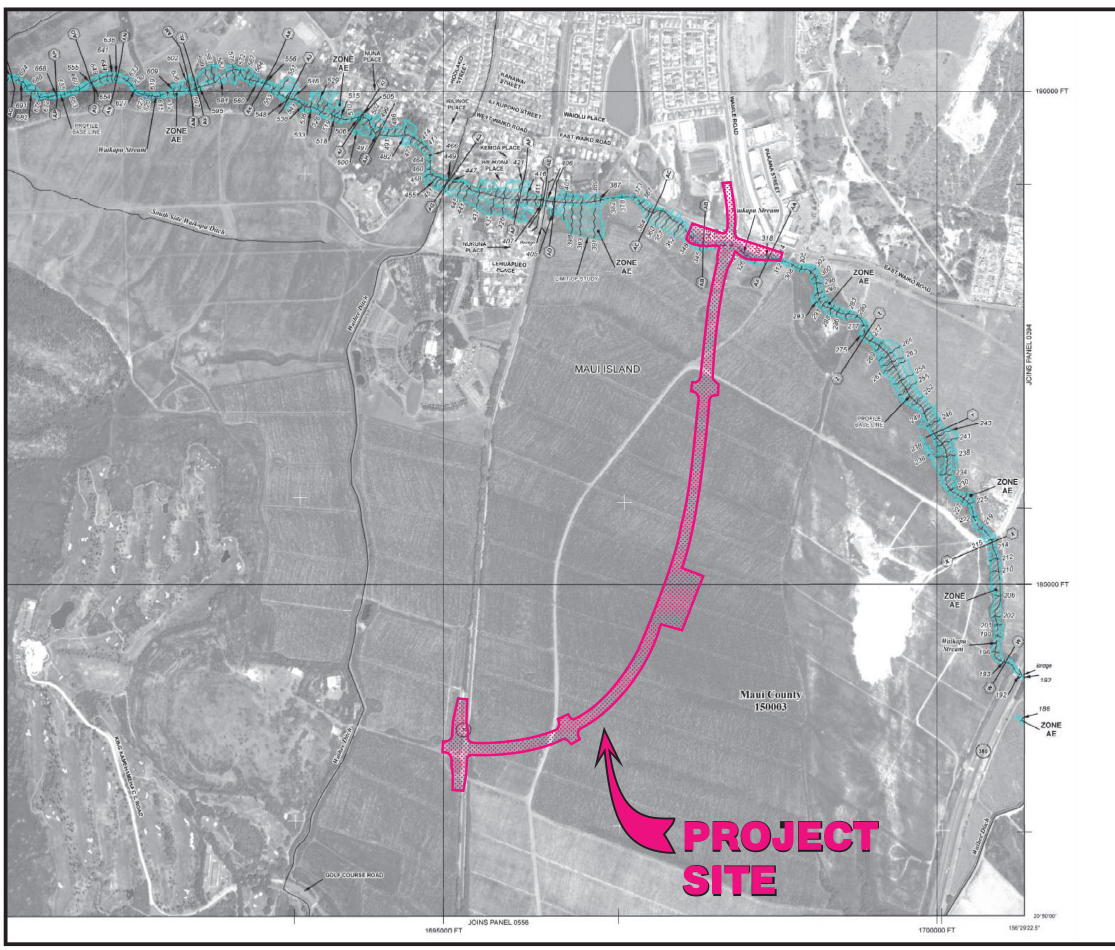
Title: Waiale 905 Partners LLC [TMK (2) 3-6-002:003]

Notes: Flood Zone(s) on parcel: AE, AEF, X

MAP GENERATED:	APRIL 2024
FIRM INDEX DATE:	NOVEMBER 04, 2015
FEMA FIRM PANEL:	1500030393F
PANEL EFFECTIVE DATE:	NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (2 of 8) - FLOOD INSURANCE RATE MAP



MAP SCALE 1" = 1000'±

500 0 500 1000 1500 2000 FEET

300 0 300 600 METERS

NFIP

PANEL 0393F

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

MAUI COUNTY, HAWAII

PANEL 393 OF 825

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MAUI COUNTY	150003	0393	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 1500030393F

MAP REVISED NOVEMBER 4, 2015

Federal Emergency Management Agency

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Areas to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

EXHIBIT "G" (1 of 8) - FLOOD INSURANCE RATE MAP

Flood Hazard Map

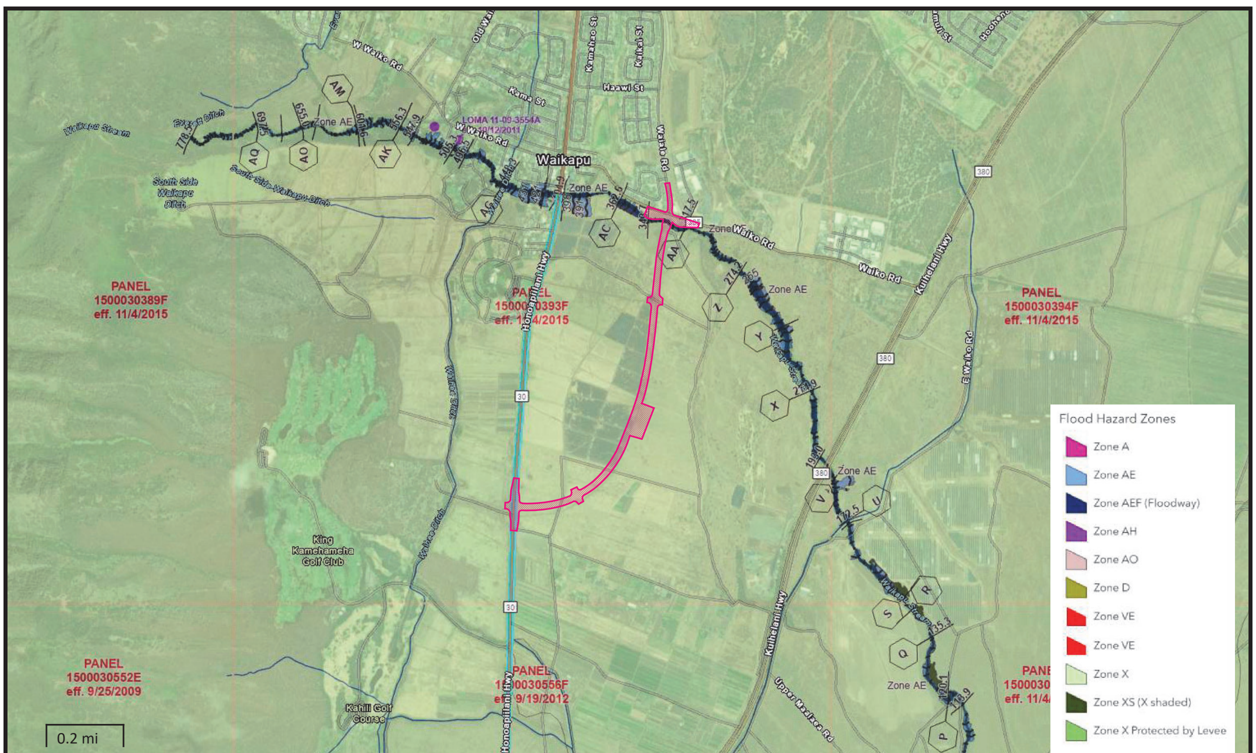
Title: East Waiko ROAD [TMK (2) 3-5-002:999]

Notes: Flood Zone(s) on parcel: AE, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (4 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

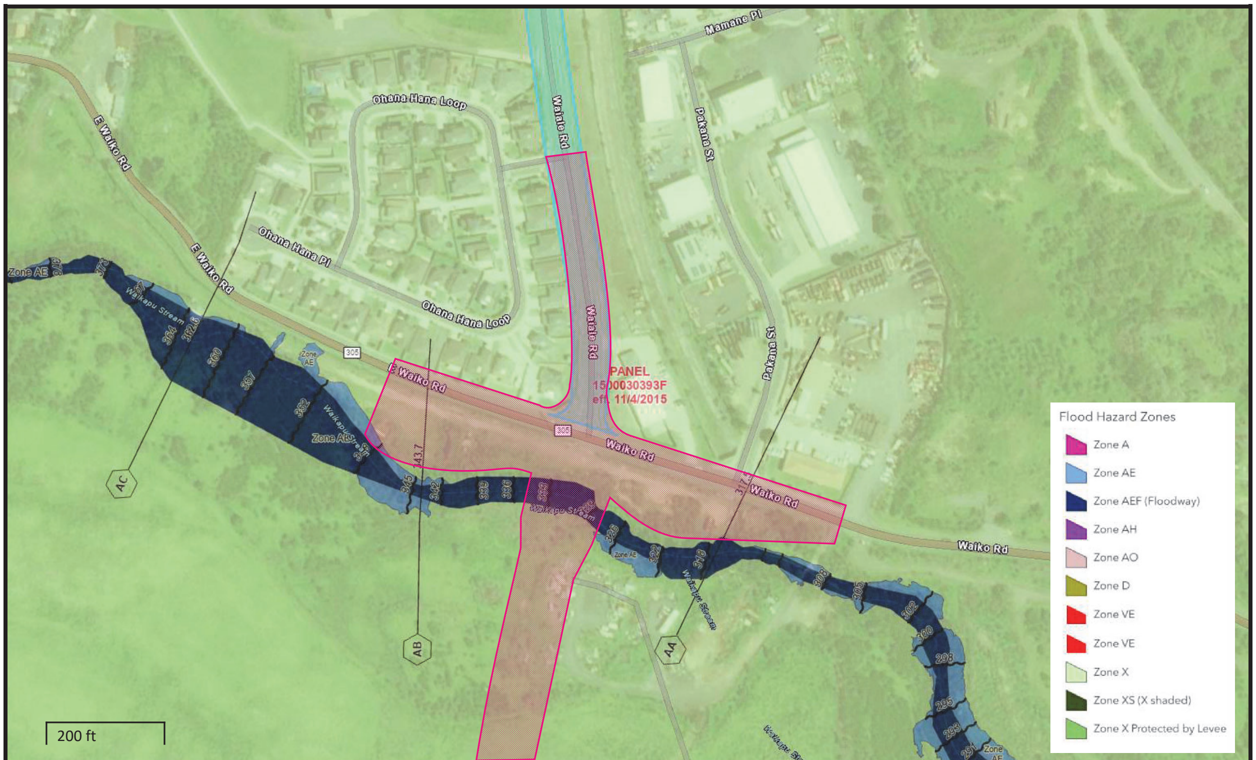
Title: Honoapilani Highway [TMK (2) 3-6-999:999]

Notes: Flood Zone(s) on parcel: AEF, VE, X, XS

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (3 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

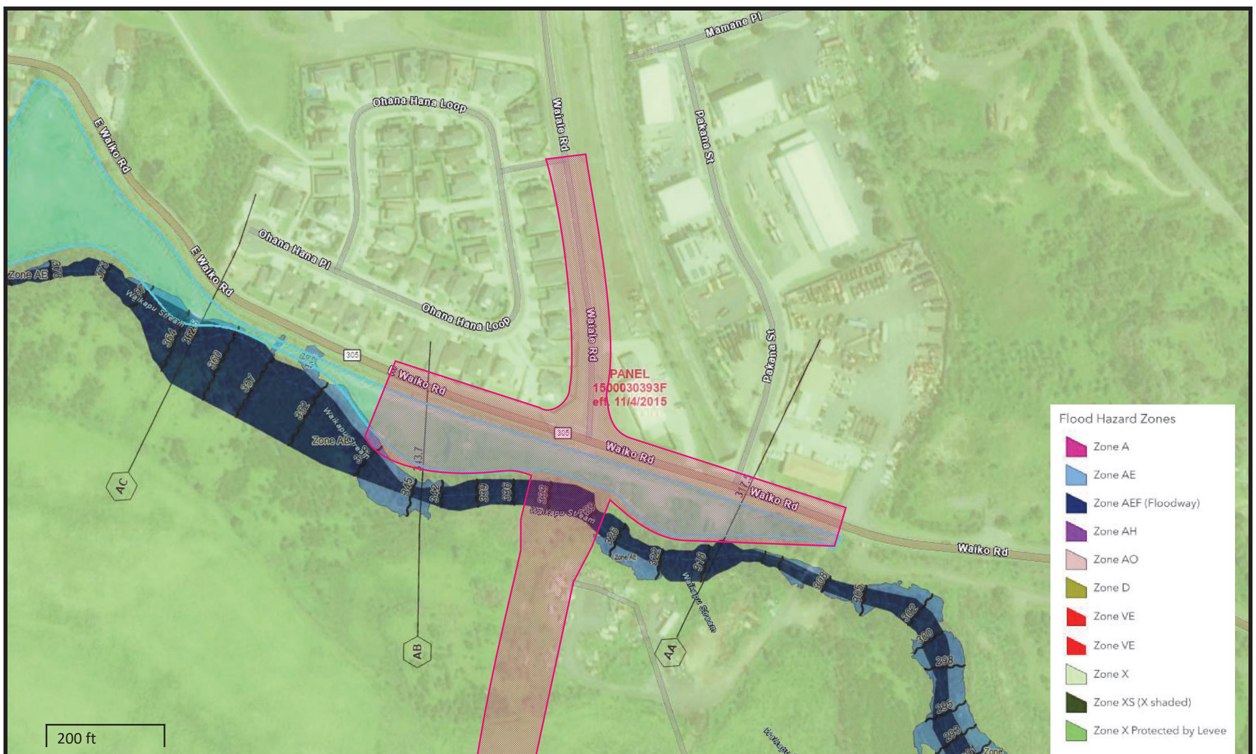
Title: Waiale Road [TMK (2) 3-5-002:999]

Notes: Flood Zone(s) on parcel: X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (6 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

Title: Waiko Baseyard, LLC [TMK (20 3-5-002:014]

Notes: Flood Zone(s) on parcel: AE, AEF, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (5 of 8) - FLOOD INSURANCE RATE MAP

Flood Hazard Map

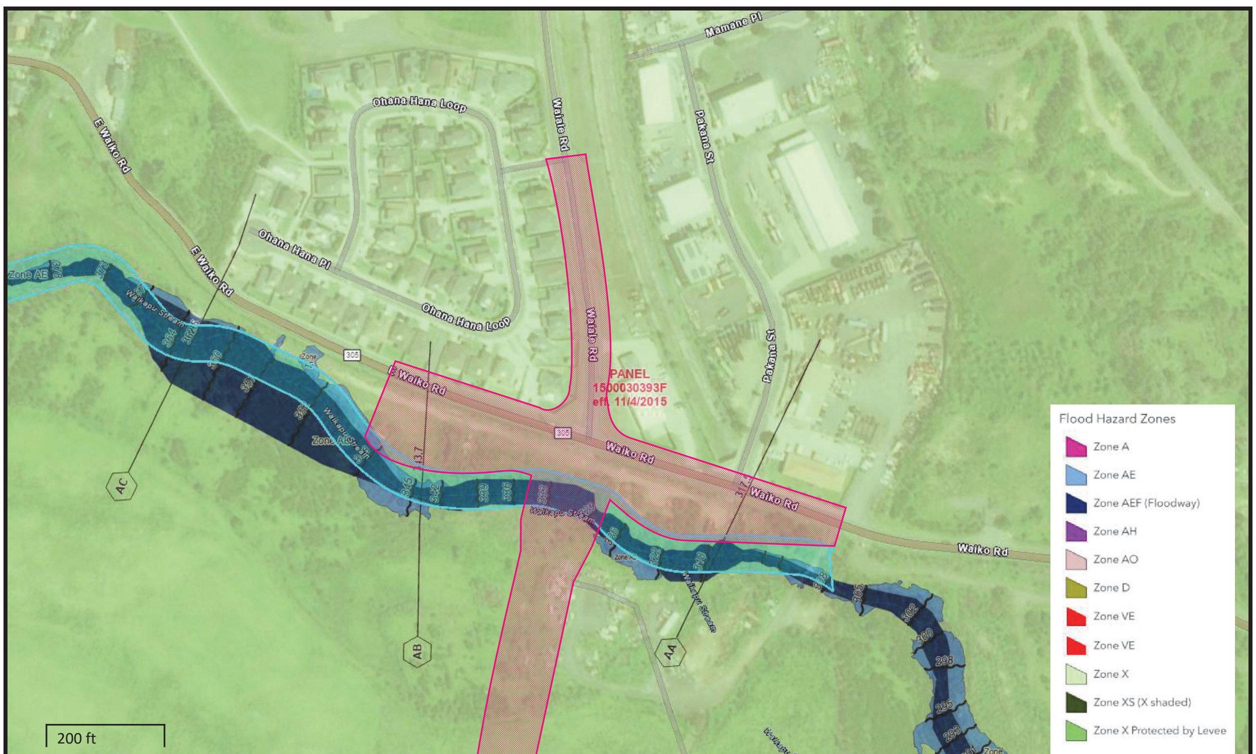
Title: Waiko Baseyard, LLC [TMK (2) 3-5-002:009]

Notes: Flood Zone(s) on parcel: X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (8 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

Title: Waikapu Stream [TMK 92) 3-5-002:888]

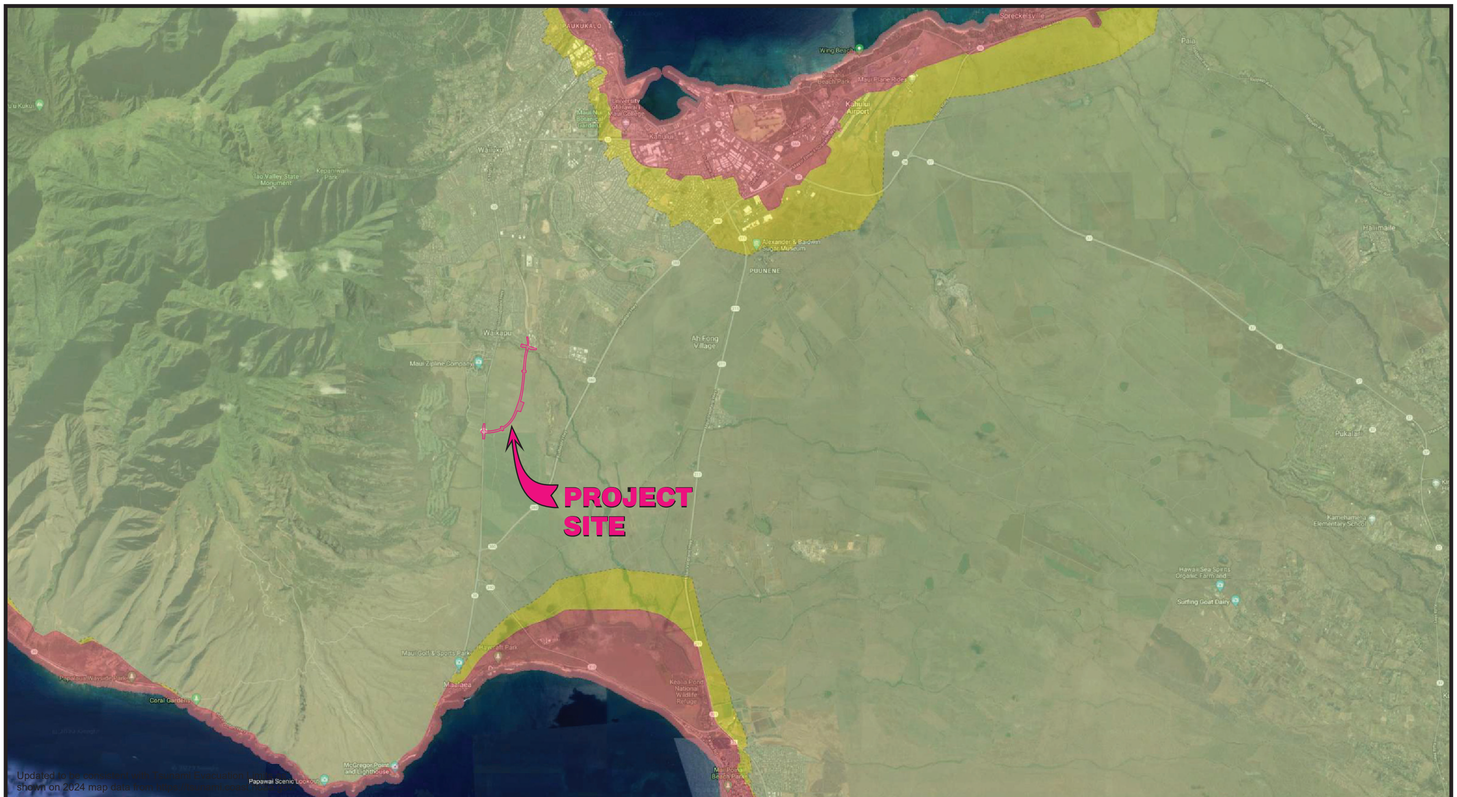
Notes: Flood Zone(s) on parcel: AE, AEF, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "G" (7 of 8) - FLOOD INSURANCE RATE MAP

EXHIBIT "J" - TSUNAMI EVACUATION MAP



For most Tsunami Warnings, evacuate out of the red zone; in the unlikely case of an "Extreme Tsunami Warning", evacuate out of the red and yellow zones

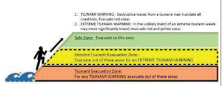
Remain at least 100 feet away from inland waterways and harbors connected to the ocean due to wave surges and possible flooding

Boaters should move vessels to at least 50 fathoms (300 ft) deep and 2 miles away from harbor entrances; follow all directions from the Captain of the Port

Structural steel or reinforced concrete buildings of six or more stories provide increased protection on or above the fourth floor; if you are caught near the shoreline consider using vertical evacuation

These maps do not consider the destructive effects of a locally generated tsunami. If you feel strong shaking, move inland immediately, well inland from the red tsunami evacuation zone

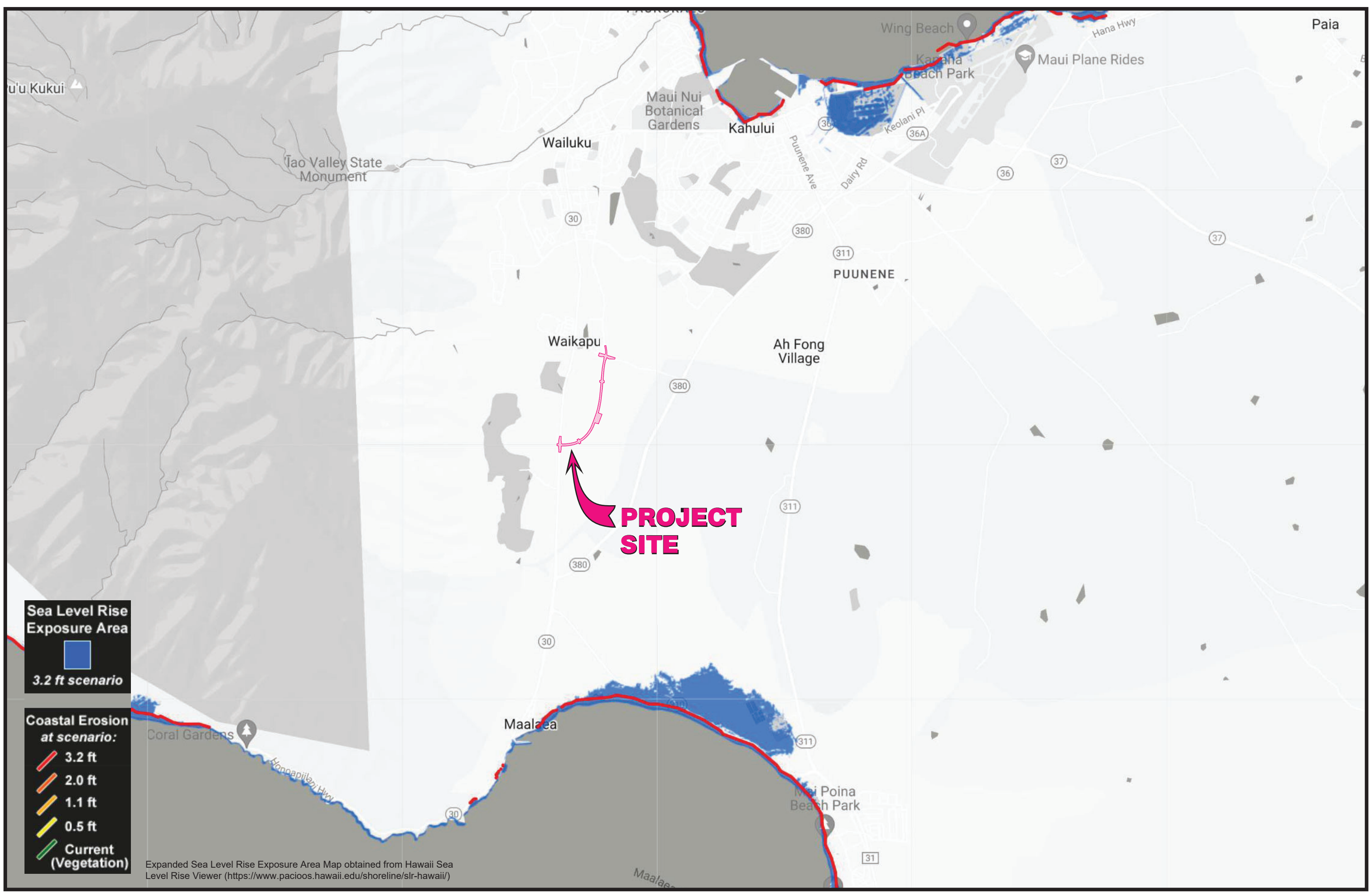
The evacuation zone is a guideline and should be considered the minimum safe evacuation distance



Legend

- Police Station
- Fire Station
- Hospital
- EMS
- Public/Private School
- Road
- Safe Zone
- Tsunami Evacuation Zone
- Extreme Tsunami Evacuation Zone

EXHIBIT "H" - SEA LEVEL RISE MAP



&HQWUDO 0DXL 6SHFLDO 0DQDJHPHQW $

April 2024

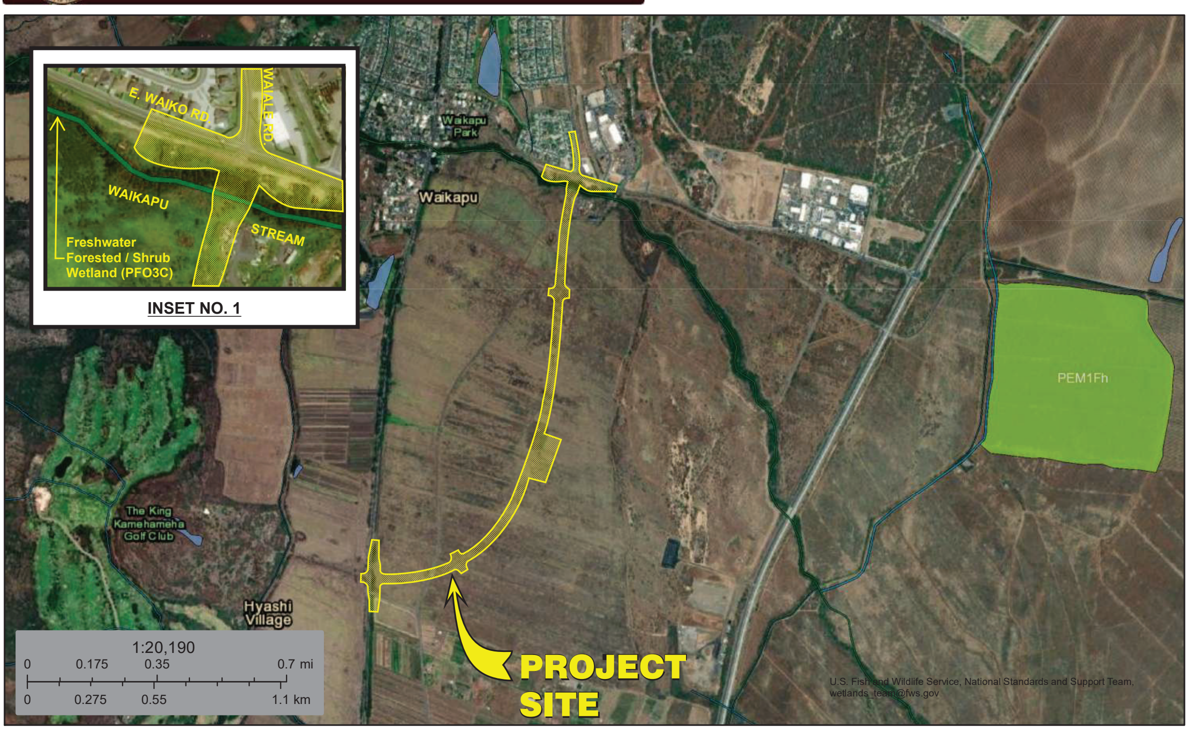
Special Management Areas (SMA)

Expanded Special Management Areas (SMA) Map for the State of Hawaii
obtained from Hawaii Statewide GIS Program (County of Maui, dated: May, 2022)
(https://geoportal.hawaii.gov/datasets/HiStateGIS::special-management-areas-sma/explore)

EXHIBIT "L" - SPECIAL MANAGEMENT AREAS

U.S. Fish and Wildlife Service
National Wetlands Inventory

West Maui Wetlands



This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

EXHIBIT "K" - EXISTING WETLANDS

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

APPENDIX A

Preliminary Drainage Report

[DRAFT]

Established 1969

Preliminary Drainage Report for

Waiale Road Extension (Vicinity of Honoapiilani Highway to Vicinity of East Waiko Road)

County Project No. 21-33
Federal Aid Project No. STP-3180 (001)

Wailuku, Maui, Hawaii
TMK: (2)3-5-02: 009; and,
Portions of TMK: (2)3-5-02: 001, 014 & 888;
(2)3-6-02: 003 & 004; (2)3-6-04: 003; and,
(2)3-5-036:035

Prepared For:

Engineering Division
Department of Public Works
County of Maui

CLIFFORD N. MUKAI
LICENSED PROFESSIONAL ENGINEER
NO. 6667-C
HAWAII, U.S.A.

License Expires April 30, 2026

Warren S. Unemori Engineering, Inc.
Civil and Structural Engineers - Land Surveyors
Wells Street Professional Center
2145 Wells Street, Suite 403
Wailuku, Maui, Hawaii 96793

Date: June 2024

TABLE OF CONTENTS

Warren S. Unemori Engineering, Inc. *Civil and Structural Engineers • Land Surveyors*
Preliminary Drainage Report for Waiale Road Ext. (Vicinity of Honoapiilani Hwy. to Vicinity of East Waiko Road)

Preliminary Drainage Report for Waiale Road Extension (Vicinity of Honoapiilani Highway to Vicinity of East Waiko Road)

Waikapu, Wailuku, Maui, Hawaii

I. PURPOSE

This report has been prepared to examine both the existing drainage conditions and the proposed drainage plan for the County of Maui DPW's Waiale Road Extension (Vicinity of Honoapiilani Highway to Vicinity of East Waiko Road) project.

II. PROPOSED PROJECT

A. Site Location

The Waiale Road Extension (WRE) project is located in Waikapu, on the island of Maui, and in the State of Hawaii. The project begins in the vicinity of the existing intersection of Honoapiilani Highway and Old Quarry Road (at approximately Milemarker 3.4) and extends in a generally north-south direction to the northern terminus at the intersection of East Waiko Road and existing Waiale Road (approximately 2,000 feet east of Honoapiilani Highway). The proposed roadway improvements are approximately 8,600 feet in length and is the makai boundary for the separately proposed community development Waikapu Country Town (WCT) which will be privately constructed (see EXHIBIT "A").

B. Project Description:

The proposed WRE will improve traffic circulation, local access, and provide better connectivity in and around the urban areas of Kahului and Wailuku. It will include pedestrian-friendly access and connectivity to nearby residential subdivisions, future community developments (e.g., Waikapu Country Town), recreational facilities, shopping, eating attractions, schools, parks, and other community-oriented destinations.

The approximately 8,600± feet long project corridor will follow the existing 80'-0" Easement "A-1", as shown on Waiale Park (Large Lot) Subdivision (File Plan No. 3.2278), for a majority of the project. Improvements are expected to include, but are not limited to:

- Clearing, grubbing, and grading the existing and proposed roadway corridor.
- Implementation of single-lane roundabouts at the four (4) major intersections along Waiale Road Ext.:
  - Honoapiilani Highway;

- Main Street (as shown on WCT Master Plan);
- Makai Parkway (as shown on WCT Master Plan);
- East Waiko Road.

- Implementation of a modern, concrete free-span bridge at Waikapu Stream, accommodating the proposed water, sewer force main and reclaimed water lines to be mounted to the exterior (and enclosed) on both upstream and downstream sides, as required;
- Roadway improvements consisting of: asphalt concrete and/or Portland cement pavement, concrete curb and gutters, concrete sidewalks and ADA-accessible curb ramps, signage and striping;
- Asphalt concrete paved multi-use pathway;
- Retaining walls, railing, fencing and sound walls (where required);
- Streetlights along the roadways, pole mounted lighting, and appurtenances;
- Overhead and underground electrical, telephone, cable and internet systems (including streetlights, pathway lights, underground ducts, transformers, handholes, manholes, ground mounted cabinets, and appurtenances, where required);
  - Existing overhead electrical power transmission lines are expected to remain overhead along Honoapiilani Highway and East Waiko Road; and,
  - Relocation and/or replacement of existing utility poles (e.g., 69kV, telcom, cable, etc.) will be required to accommodate proposed roundabout configurations.
- Drainage improvements consisting, but not limited to: Concrete headwalls, inlet and outlet structures, drain inlets, manholes, underground drainage piping (including box culverts, etc.), at-grade landscaped detention basins, and appurtenances;
- Underground water transmission and distribution mains (for potable water and fire protection) and appurtenances, where applicable, including fire hydrants along entire length of corridor to enhance fire protection for adjoining properties;
- Sewer improvements consisting of, but not limited to underground force mains and gravity sewer piping, manholes and appurtenances;
- Recycled (R1) Water improvements consisting of, but not limited to underground recycled (R1) water transmission mains and appurtenances; and,
- Landscaping and irrigation [expected to be supplied initially from potable water system and transitions to the new reclaimed (R1) waterline, when available].

In addition to enhancing vehicular circulation throughout this area, WRE will also encourage alternatives to vehicular modes of transportation by incorporating a landscaped multi-use pedestrian and bicycle path along this section, as well as shoulder bikeways. This attractive, pedestrian-friendly pathway will provide connectivity and continuity to the adjacent residential subdivisions and future community development) in the area.

Temporary construction-phase measures are expected to be implemented from the inception of any ground disturbing activities, and maintained as required for erosion and sedimentation mitigation (e.g., dust fences, silt fences, filtration berms, temporary sedimentation basins, etc.), pursuant to applicable provisions of:

- Storm Water Permanent Best Management Practices Manual (State of Hawaii Department of Transportation (dated April 2015);
- Chapter 20.08 of the Maui County Code, "Soil Erosion and Sedimentation Control";
- Construction Best Management Practices (BMPs) for the County of Maui (dated May 2001);
- Title MC-15, Subtitle 01, Chapter 111, "Rules for the Design of Storm Water Treatment Best Management Practices" (adopted November 9, 2012); and,
- Any applicable conditions and requirements of the project-specific National Pollutant Discharge Elimination System (NPDES) Permit, including Hawaii Administrative Rules (HAR) Chapter 11-55, Appendix K.

All sitework construction is expected to conform to the requirements and recommendations of the Project Geotechnical (Soils) Engineer of Record, as described in the Geotechnical Engineering Exploration Report for Waiale Road Extension, conducted by Geolabs, Inc. (dated June 26, 2024); and, the applicable requirements of the "Rules for the Design of Storm Drainage Facilities for the County of Maui", Title MC-15, Chapter 4; and, the "Rules for the Design of Storm Water Treatment Best Management Practices" (adopted 11/09/2012); and, the Maui County Code. The County is expected to retain the Project Geotechnical Engineer of Record (i.e., Geolabs, Inc.), to provide all construction phase monitoring and testing in accordance with the recommendations of the forementioned Soils Report and requirements of the County of Maui.

III. EXISTING CONDITIONS

A. Topography, Groundcover and Soil Classifications

The existing WRE roadway corridor extends from the vicinity of Honoapiilani Highway (near Milemarker 3.4) and proceeds in an easterly to northerly direction along the Easement "A-1" [as designated on Waiale Park (Large Lot) Subdivision (File Plan No. 3.2278)], where it crosses Waikapu Stream, until it connects in the vicinity of East Waiko Road at the southern terminus of existing Waiale Road. The majority of the WRE roadway corridor is currently undeveloped, and traverses through open fallow grassland used for sugarcane production. The existing ground is characterized by a gently sloping topography with longitudinal slopes generally ranging from 2% to 7% (generally in a westerly to easterly direction), and cross slopes of approximately 0% to 4% along existing roadways (i.e. Honoapiilani

Highway, East Waiko Road, Waiale Road). Natural vegetation includes, but is not limited to Guinea grass, ruderal herbs, and java plum.

According to the Soil Survey of the Island of Maui, prepared by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS), the predominant soil classifications underlying the proposed WRE project site area (see EXHIBIT "B"):

- Iao Clay (IcB);
  - The Iao Clay, which mainly occurs in the central area of WRE, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 3 to 7 percent slopes.
- Jaucas Sand (JaC):
  - Jaucas sand, which only occurs along Waiale Road, is characterized as being excessively-drained soil, with low runoff.
  - Slopes: 0 to 15 percent slopes.
- Pulehu Silt Loam (PpA);
  - Pulehu silt loam, which occurs throughout the Waiale Road Ext. Project limits, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 0 to 3 percent slopes.
- Pulehu Silt Loam (PpB);
  - Pulehu silt loam, which only occurs on the mauka side of East Waiko Road, is characterized as being well-drained soil, with low runoff.
  - Slopes: 3 to 7 percent slopes.
- Pulehu Cobbly Silt Loam (PrB);
  - The predominant Pulehu cobbly silt loam, which only occurs at the northernmost portion of WRE, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 3 to 7 percent slopes.
- Pulehu Clay Loam (PsA);
  - Pulehu clay loam, which only occurs at Honoapiilani Highway, is characterized as being well-drained soil, with low runoff.
  - Slopes: 0 to 3 percent slopes.
- Pulehu Cobbly Clay Loam (PtA);
  - Pulehu cobbly clay loam, which only occurs at the southernmost portion of WRE, is characterized as being well-drained soil, with low runoff.
  - Slopes: 0 to 3 percent slopes.
- Pulehu Cobbly Clay Loam (PtB);
  - Pulehu cobbly clay loam, which only occurs at the southernmost portion of WRE, is characterized as being well-drained soil, with medium runoff.
  - Slopes: 3 to 7 percent slopes.

- Puuone Sand (PZUE);
  - Puuone sand, which only occurs at the northermost region of the project limits (at Waiale Road), is characterized as being somewhat excessively-drained soil, with medium runoff.
  - Slopes: 7 to 30 percent slopes.

B. <u>Existing Drainage Conditions</u>

The existing runoff from the project site and in the adjacent areas generally flows in a westerly (mauka) to easterly (makai) direction. It is generally conveyed overland and into existing streams, small drainageways, or by existing underground drainage systems (within existing Waiale Road). The runoff is conveyed further downstream to Kuihelani Highway where it routed through existing drainage culverts, and continues southward towards the Kealia Pond National Wildlife Refuge at Maalaea Bay, and eventually to the ocean.

The entire WRE project site currently generates approximately 43 cfs of surface runoff based on a 50-year recurrence interval, 1-hour duration storm.

For the purposes of this drainage report, the WRE project will be evaluated in two (2) distinct drainage sections (see EXHIBIT "A"):

A) From the vicinity of Honoapiilani Highway to Waikapu Stream;
B) From Waikapu Stream to northerly terminus (in vicinity of East Waiko Road)

<u>Section A - Vicinity of Honoapiilani Highway to Waikapu Stream</u>

The majority of WRE lies within an existing drainage area that begins on the West Maui Mountains (just south of Waikapu Valley), crosses Honoapiilani Highway and extends to Kuihelani Highway (refer to Page 3 of EXHIBIT "G"). The overall regional drainage area is approximately 1,540 acres and is currently undeveloped (except for the Honoapiilani Highway roadway corridor and its associated culvert crossings conveying local runoff). The drainage area associated with WRE is 15.40 acres. The area generally consists of open grassland covering fallow sugarcane fields and scattered rock piles. Several existing agricultural access roads (e.g., gravel roads, dirt roads, etc.) have been used in agricultural production. The existing runoff travels aboveground in a westerly (mauka) to easterly direction from Honoapiilani Highway towards Kuihelani Highway, through existing culverts and ultimately to the ocean.

<u>Section B – Waikapu Stream to northerly terminus</u>

From the northern bank of Waikapu Stream to the paved roadway of East Waiko Road, the land is currently undeveloped. The existing runoff generated in this undeveloped property and the paved East Waiko Road travels in a westerly (mauka) to easterly direction and is conveyed overland or in shallow roadside swales until it enters the Waikapu Stream downstream of the new bridge crossing.

At the northernmost end of the project, Waiale Road is currently a fully developed asphalt concrete roadway. Near Ohana Hana Street, an existing drainage system was constructed (in conjunction with Waikapu Gardens – Phase 2 Affordable Housing Project) which receives runoff generated on the west (mauka) side of the roadway and conveys it northerly in an underground piped system, where it outlets into an existing private retention basin (installed in conjunction with Waikapu Gardens Subdivision Drainage Improvements).

On the east side of existing Waiale Road (approximately 1,200 feet from the East Waiko Road and Waiale Road intersection), there is an existing retention basin (i.e., Phase I Retention Basin) that was installed in conjunction with Kehalani Offsite Drainage System, Offsite Drainage Improvements – Phase I (Offsite Drain and Retention Basin from Module 21, Kehalani Mauka to Waikapu Stream). A shotcrete lined emergency overflow extends from the south-west corner of this retention basin, along the east side of Waiale Road; and, towards the north-west corner of East Waiko Road and Pakana Street intersection, where it transitions into a 7' x 28' ConSpan culvert beneath East Waiko Road, and eventually outlets into Waikapu Stream through a GRP lined emergency overflow.

<u>Waikapu Stream</u>

Waikapu Stream flows from the West Maui Natural Area Reserve in an eastward direction, turning southward at Waiale Road, where it will eventually drain into the ocean through the Kealia Pond National Wildlife Refuge at Maalaea Bay. In the vicinity of the project, Waikapu Stream is directly south of the East Waiko Road and Waiale Road intersection and contoured by earthen berms and large boulders lining the top banks of the stream to protect the adjacent fields from flooding.

C. Flood and Tsunami Zone

According to Panel Number 150003 0393F of the Flood Insurance Rate Map, dated November 4, 2015, prepared by the United States Federal Emergency Management Agency, the majority of the project site is situated within Zone "X", which is designated as an area outside the 0.2% chance flood plain and of minimal flood hazard (See Exhibit "C"). At the crossing with Waikapu Stream, the roadway corridor crosses a designated Zone "AEF" (Floodway Areas in Zone AE). Zone "AEF" designates the channel of a stream plus any adjacent floodplain areas that must be kept free from encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

According to Tsunami Evacuation Map (dated 2023) the entire project site is located within the Maui County Safe Zone (see EXHIBIT "D" – Tsunami Evacuation Map).

IV. DRAINAGE PLAN

A. General

The drainage plan that will be implemented for the proposed improvements shall include minimal alteration to the natural pre-development drainage patterns; and, mitigate the increase in runoff generated by the proposed roadway improvements, such that the runoff released downstream will be no greater than the pre-development conditions or the allowable runoff that the existing drainage systems were originally master-planned to accommodate from the project site (see EXHIBITS "E" & "F"). The WRE drainage system will be designed to accommodate the ultimate layouts and improvements required by the County at the proposed intersections and as needed by adjoining developments (i.e., Waikapu Country Town). All drainage improvements are expected to be implemented pursuant to the current County of Maui's "Rules for the Design of Storm Drainage Facilities" and the "Rules for the Design of Storm Water Treatment Best Management Practices" (adopted 11/09/2012).

In the absence of any onsite stormwater detention systems, the total onsite surface runoff that could potentially be generated by the construction of the WRE and the transitions to the existing roadways, is approximately 81 cfs, based on a 50-year frequency interval, 1-hour duration storm. However, an above-ground landscaped detention basin (i.e., Detention Basin No. 1) and an aboveground landscaped retention basin (i.e., Retention Basin No. 2) will be implemented to mitigate the potential 38 cfs increase in surface runoff and limit the peak onsite runoff so there will be no net increase in onsite runoff leaving the project site.

<u>Section A - Vicinity of Honoapiilani Highway to Waikapu Stream</u>

The onsite surface runoff generated by the new roadway improvements along WRE (including Honoapiilani Highway intersection improvements) will be captured by new catch basins and conveyed in underground piped systems to Detention Basin No. 1, through an outlet structure. The detention basin will be sized to limit the peak onsite runoff to no more than pre-existing release rates.

To accommodate the future WCT development (as agreed to by DPW and in accordance with the latest storm drain master plan for WCT) main drainline crossings will be incorporated into the Project as follows (subject to refinements by WCT):

- 54"Ø culvert crossing Honoapillani Highway (approx. 130-ft. from its intersection of WRE);

- 60”Ø culvert crossing WRE in the vicinity of its intersection with Makai Parkway; and,
- A triple (3) 10’x3’ reinforced concrete box culverts crossing WRE, approximately 2,730-ft. from its intersection with Honoapiilani Highway, and, generally in the vicinity of the lowest area along the roadway corridor.

Existing runoff generated by the remainder of the larger drainage area will be conveyed, as needed, through the master-planned culvert crossings and allowed to discharge downstream, as it is presently doing. Upon construction of WCT (by others), the master-planned culverts will be extended to a separate, regional detention basin installed in conjunction with WCT.

Waikapu Stream

A new concrete bridge is proposed for the WRE crossing at Waikapu Stream. The bridge has been designed to accommodate the existing flow rates of Waikapu Stream of 2,000 cfs (FEMA 100-yr). The bridge is designed to span across the stream (with drilled shafts to be constructed outside of the designated OHWM) to ensure the stream is minimally impacted. The bridge is designed to maintain a “no rise” condition with no loss of flow conveyance and no increase in the base flood elevation at the gulch for the 100-yr flood discharge; and therefore, will allow the runoff to continue down the existing drainage channels, towards Kuihelani Highway, and eventually southward towards the Kealia Pond National Wildlife Refuge at Maalaea Bay, where it will drain into the ocean, as it is currently doing.

Section B – Waikapu Stream to northerly terminus

This drainage section will be separated into two (2) areas (refer to EXHIBIT “F” – Post-Development Drainage Area Map):

- Section B-1, from Waikapu Stream to STA 80+40±; and
- Section B-2, from STA 80+40± to the northerly terminus.

For Section B-1, the generated runoff will be collected in catch basins and conveyed to Retention Basin No. 2 through a piped drainage system (this includes the replacement of an existing grated inlet catch basin, near STA 80+40±, with a curb inlet catch basin and re-directing the runoff to the new drainage system). The retention basin will be sized to mitigate the increase of runoff, such that no more than pre-existing rates will be allowed to be discharged downstream, into Waikapu Stream as it is currently doing.

For Section B-2, the generated runoff will be collected into a new catch basin (which will replace the existing grated inlet catch basin near the intersection of Ohana Hana Street) and convey the runoff into the existing retention basin installed in conjunction with Waikapu Gardens, as it is presently doing.

B. Hydrologic Calculations

The hydrologic calculations are based on the "Rules for the Design of Storm Drainage Facilities in the County of Maui", Title MC-15, Chapter 4 and the "Rainfall Frequency Atlas of the Hawaiian Islands", Technical Paper No. 43, U. S. Department of Commerce, Weather Bureau. The rational method was used to estimate the runoff for this project.

Rational Formula used (for component onsite project areas):

$Q = CIA$

Where
Q = Rate of Flow (cfs)
C = Runoff Coefficient
I = Rainfall Intensity (inches/hour)
A = Area (Acres)

The design storm used in the calculations for this project is a 50-year recurrence interval, 1-hour duration storm with a precipitation of approximately 2.5 inches. A minimum time of concentration of five (5) minutes was used, per the “Design Criteria for Highway Drainage,” State of Hawaii Department of Transportation, 2010.

APPENDIX A contains the hydrologic calculations used to determine the impact of the proposed project in terms of drainage conditions by comparing the peak flows generated prior to and after development.

C. Conclusion

This report evaluates both the existing drainage conditions and the proposed drainage improvements for the WRE project, which also includes the intersection improvements with the adjacent roadways, as needed to accommodate the proposed transitions for the roundabouts. According to the analysis contained herein, all drainage improvements are expected to be implemented pursuant to the current County of Maui’s Rules for Design of Storm Drainage Facilities. For the ultimate buildout of Waiale Road Extension, the construction of the landscaped detention and retention basins will attenuate the potential increase in post-development runoff, so that no more than the pre-existing peak flow release rates will be discharged, and continue to flow downstream as it is presently doing.

Therefore, it is our professional opinion that the proposed Waiale Road Extension Project will not adversely affect the adjoining and downstream properties.

VII. REFERENCES

1. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Island of Maui, Hawaii, Version 14* September 20, 2016. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

2. Federal Emergency Management Agency, Federal Insurance Administration, *Flood Insurance Rate Map, Maui County, Hawaii*. Community-Panel Number 150003 00393F. November 4, 2015.

3. U.S. Department of Commerce, Weather Bureau, *Rainfall Frequency Atlas of the Hawaiian Islands, Technical Paper No. 43*. 1962.

4. Department of Public Works and Waste Management, County of Maui, *Rules for the Design of Storm Drainage Facilities in the County of Maui.* July 1995.

5. Department of Public Works, County of Maui, *Rules for the Design of Storm Water Treatment Best Management Practices.* November 9, 2012.

10. State of Hawaii, Department of Transportation, Highways Division, *Design Criteria for Highway Drainage* 2010.

12. Fehr & Peers, *Waiale Road Extension, Transportation Impact Analysis Report.* October 2023.

12. Y. Ebisu & Associates, *Acoustic Study for the Proposed Waiale Road Extension Project, MP 12+0.97 to 13+00.11 and 13+00.72 to 141+00.47, Waikapu, Maui, Hawaii.* August 2023.

12. AECOS Inc., *A Natural Resource Assessment for the County of Maui, Waiale Road Extension Project, Waikapu, Maui.* July 5, 2022.

13. *Water System Standards, Department of Water Supply, County of Maui 2002.*

14. *Construction Best Management Practices (BMPs) for County of Maui* May 2001.

15. Geolabs, Inc., *Geotechnical Engineering Exploration – Waiale Road Extension.* June 2024.

EXHIBITS

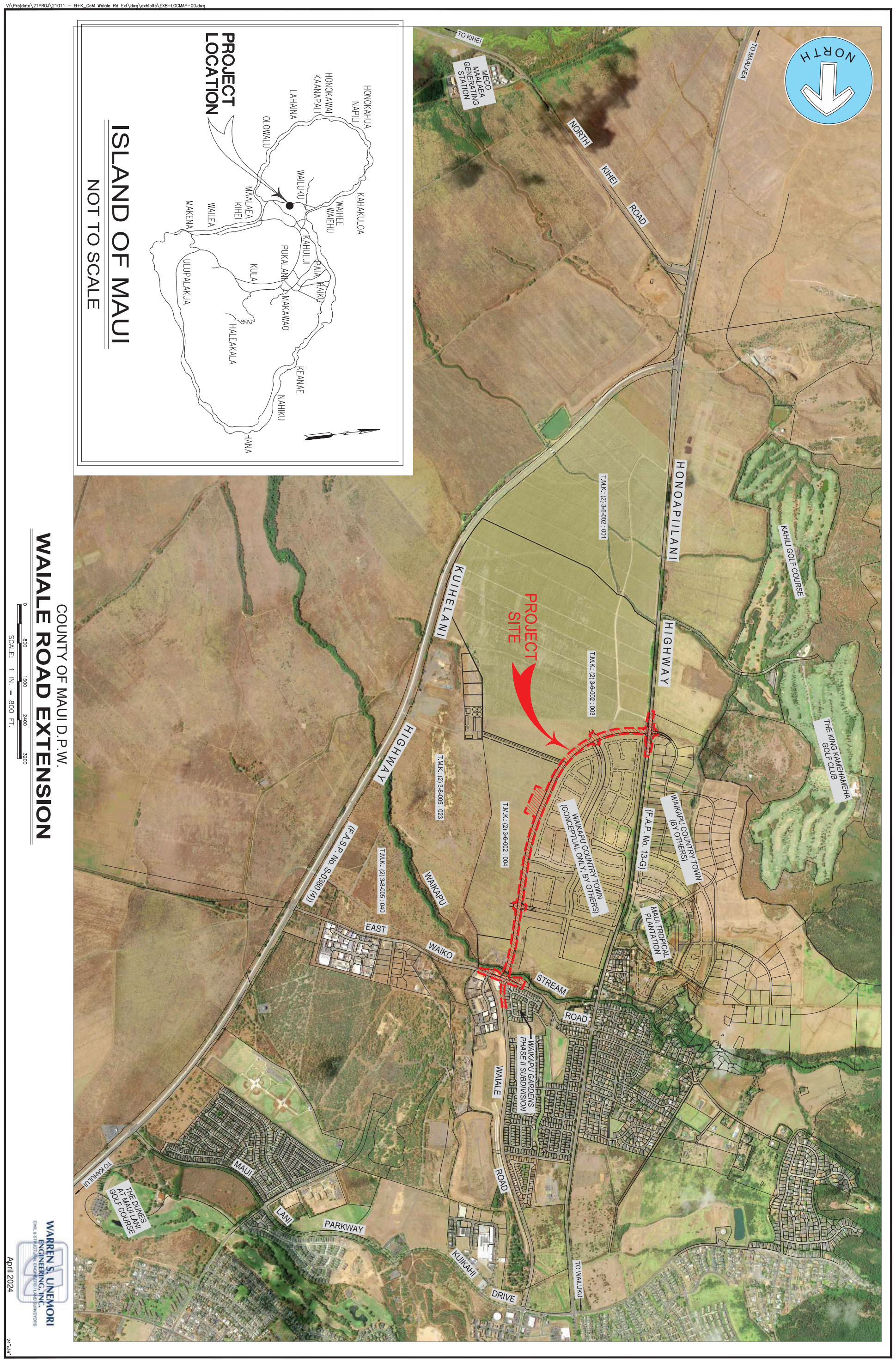


EXHIBIT "A" - PROJECT LOCATION MAP

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Island of Maui, Hawaii

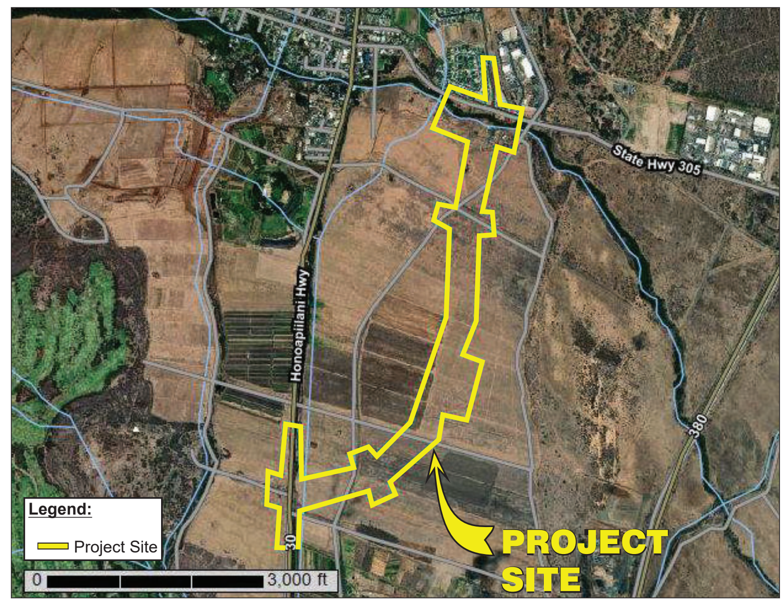


EXHIBIT "B" - SOILS CLASSIFICAION REPORT

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

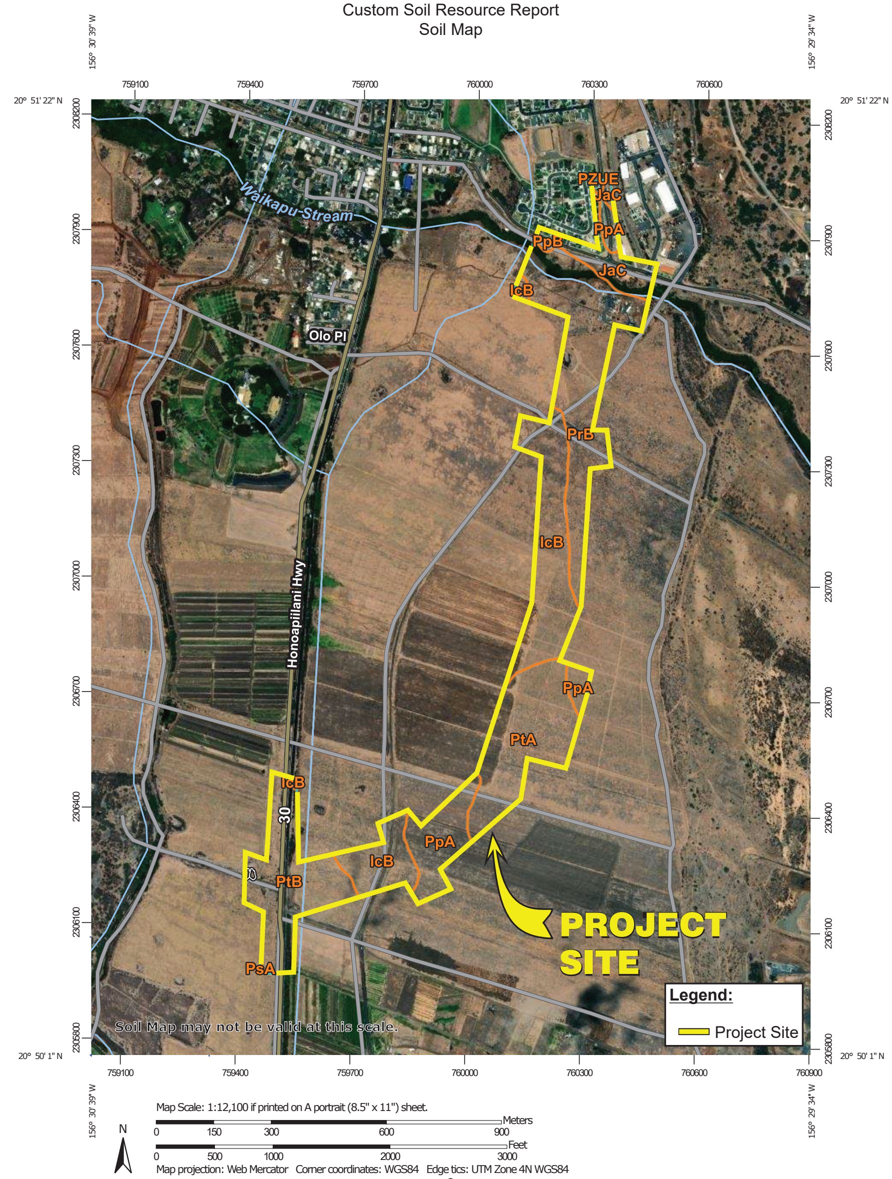
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 21, Sep 8, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 29, 2017—Oct 11, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
IcB	Iao clay, 3 to 7 percent slopes, MLRA 163	23.4	23.9%
JaC	Jaucas sand, 0 to 15 percent slopes, MLRA 163	5.5	5.6%
PpA	Pulehu silt loam, 0 to 3 percent slopes	10.3	10.5%
PpB	Pulehu silt loam, 3 to 7 percent slopes	0.7	0.7%
PrB	Pulehu cobbly silt loam, 3 to 7 percent slopes	24.4	24.9%
PsA	Pulehu clay loam, 0 to 3 percent slopes , MLRA 163	0.0	0.0%
PtA	Pulehu cobbly clay loam, 0 to 3 percent slopes	17.3	17.7%
PtB	Pulehu cobbly clay loam, 3 to 7 percent slopes	16.0	16.3%
PZUE	Puuone sand, 7 to 30 percent slopes	0.2	0.2%
Totals for Area of Interest		**97.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Island of Maui, Hawaii

IcB—Iao clay, 3 to 7 percent slopes, MLRA 163

Map Unit Setting

National map unit symbol: 2yys0
Elevation: 100 to 500 feet
Mean annual precipitation: 23 to 36 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Iao and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iao

Setting

Landform: Alluvial fans, mountain slopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Concave, convex
Parent material: Weathered alluvium derived from basalt

Typical profile

Ap - 0 to 15 inches: clay
Bw1 - 15 to 25 inches: clay
Bw2 - 25 to 48 inches: clay
BC - 48 to 60 inches: silty clay

Properties and qualities

Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Urban land

Percent of map unit: 10 percent
Landform: Alluvial fans, mountain slopes

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Linear, concave, convex
Hydric soil rating: No

Wailuku
Percent of map unit: 3 percent
Landform: Alluvial fans, mountain slopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Concave, convex
Hydric soil rating: No

Paia
Percent of map unit: 2 percent
Landform: Alluvial fans, mountain slopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Lower third of mountainflank, rise
Down-slope shape: Linear
Across-slope shape: Concave, convex
Hydric soil rating: No

JaC—Jaucas sand, 0 to 15 percent slopes, MLRA 163

Map Unit Setting
National map unit symbol: 2w02z
Elevation: 0 to 1,140 feet
Mean annual precipitation: 13 to 77 inches
Mean annual air temperature: 73 to 77 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition
Jaucas and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Jaucas

Setting
Landform: Beaches
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Convex, linear
Parent material: Sand sized coral and sea shells sandy marine deposits derived from sedimentary rock

Typical profile
AC - 0 to 13 inches: sand

C1 - 13 to 22 inches: sand
C2 - 22 to 60 inches: sand

Properties and qualities
Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 99 percent
Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups
Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

PpA—Pulehu silt loam, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: hqbh
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: silt loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups
Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PpB—Pulehu silt loam, 3 to 7 percent slopes

Map Unit Setting
National map unit symbol: hqbj
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: silt loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PrB—Pulehu cobbly silt loam, 3 to 7 percent slopes

Map Unit Setting
National map unit symbol: hqbl
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: cobbly silt loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): 2e

Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Hydric soil rating: No

PsA—Pulehu clay loam, 0 to 3 percent slopes , MLRA 163

Map Unit Setting

National map unit symbol: 2x1vv
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 50 inches
Mean annual air temperature: 72 to 79 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Pulehu and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting

Landform: Flood plains, stream terraces, alluvial fans
Landform position (two-dimensional): Toeslope, backslope, footslope
Landform position (three-dimensional): Base slope, tread, rise
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, concave
Parent material: Alluvium derived from igneous rock

Typical profile

Ap - 0 to 21 inches: clay loam
2C1 - 21 to 33 inches: loam
3C2 - 33 to 37 inches: loamy sand
4C3 - 37 to 47 inches: fine sandy loam
5C4 - 47 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B

Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

Minor Components

Mala

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Ewa

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Waialua

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope, rise
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

PtA—Pulehu cobbly clay loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: hqbn
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: cobbly clay loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PtB—Pulehu cobbly clay loam, 3 to 7 percent slopes

Map Unit Setting
National map unit symbol: hqbp
Elevation: 0 to 300 feet
Mean annual precipitation: 10 to 35 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Pulehu and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pulehu

Setting
Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium

Typical profile
H1 - 0 to 21 inches: cobbly clay loam
H2 - 21 to 60 inches: silty clay loam

Properties and qualities
Slope: 3 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: NoneOccasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups
Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: B
Ecological site: R158XY002HI - Isohyperthermic Torric Naturalized Grassland
Hydric soil rating: No

PZUE—Puuone sand, 7 to 30 percent slopes

Map Unit Setting
National map unit symbol: hqb7
Elevation: 50 to 350 feet
Mean annual precipitation: 20 to 30 inches
Mean annual air temperature: 73 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition
Puuone and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Puuone

Setting
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Coral seashells

Typical profile
H1 - 0 to 20 inches: sand
H2 - 20 to 40 inches: cemented material

Properties and qualities
Slope: 7 to 30 percent

Depth to restrictive feature: 20 to 40 inches to cemented horizon
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 100 percent
Available water supply, 0 to 60 inches: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

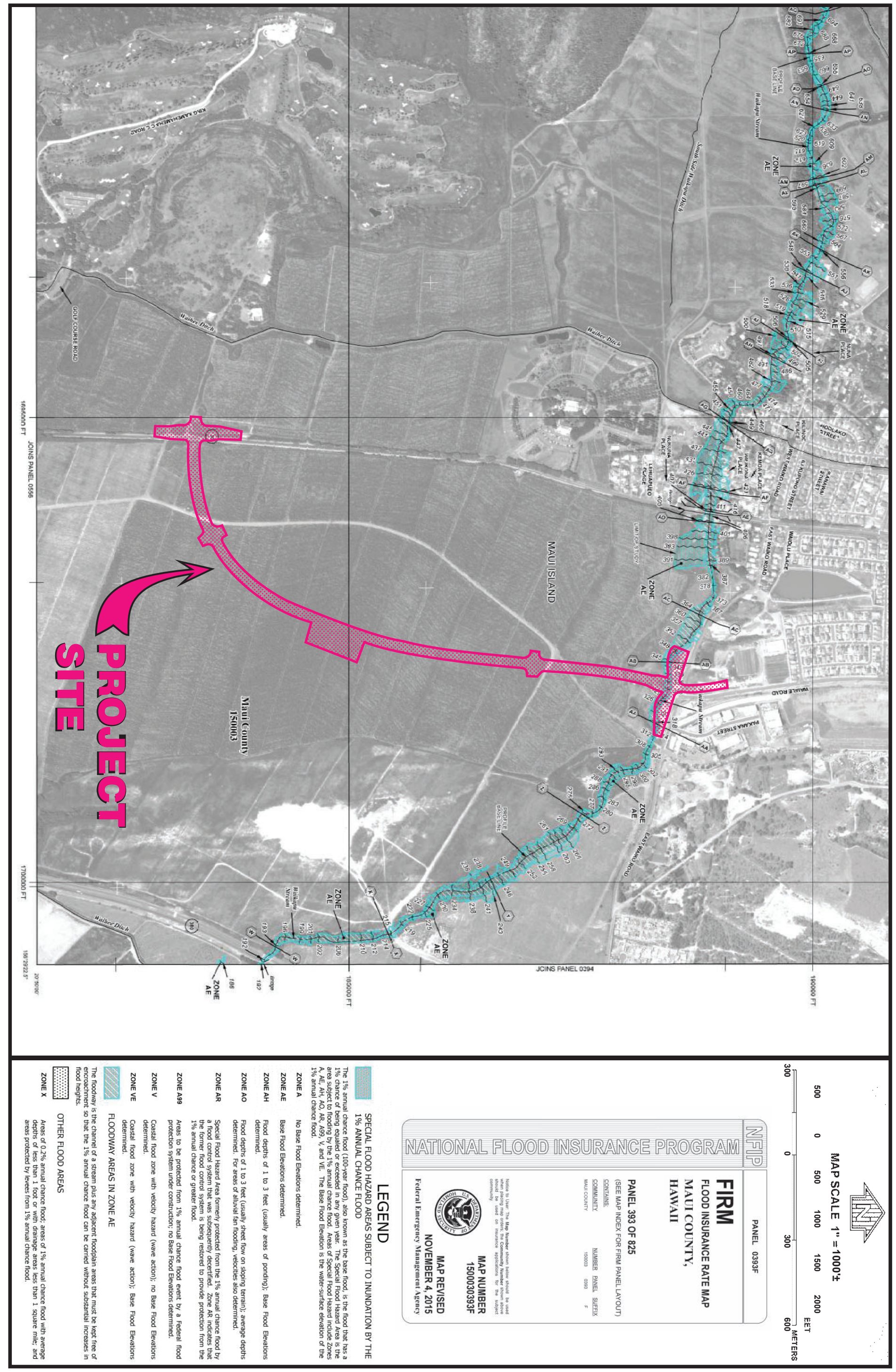
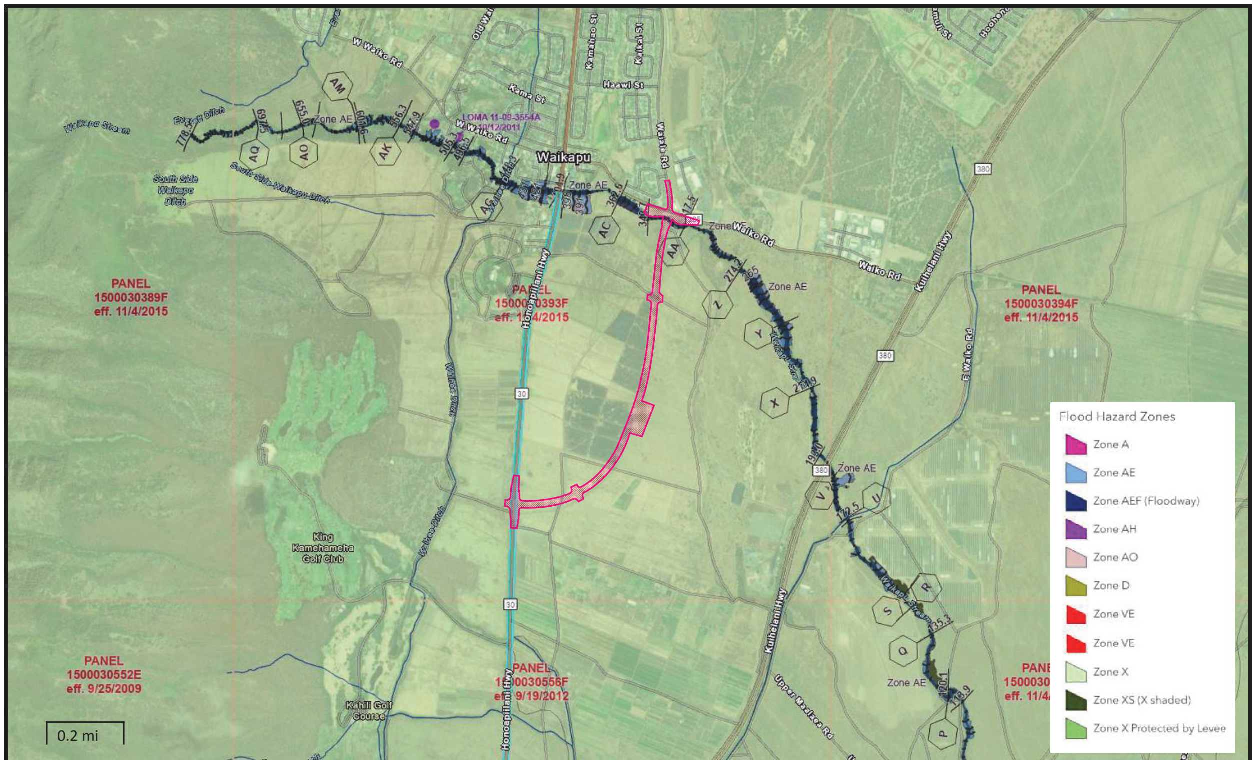


EXHIBIT "C" (1 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

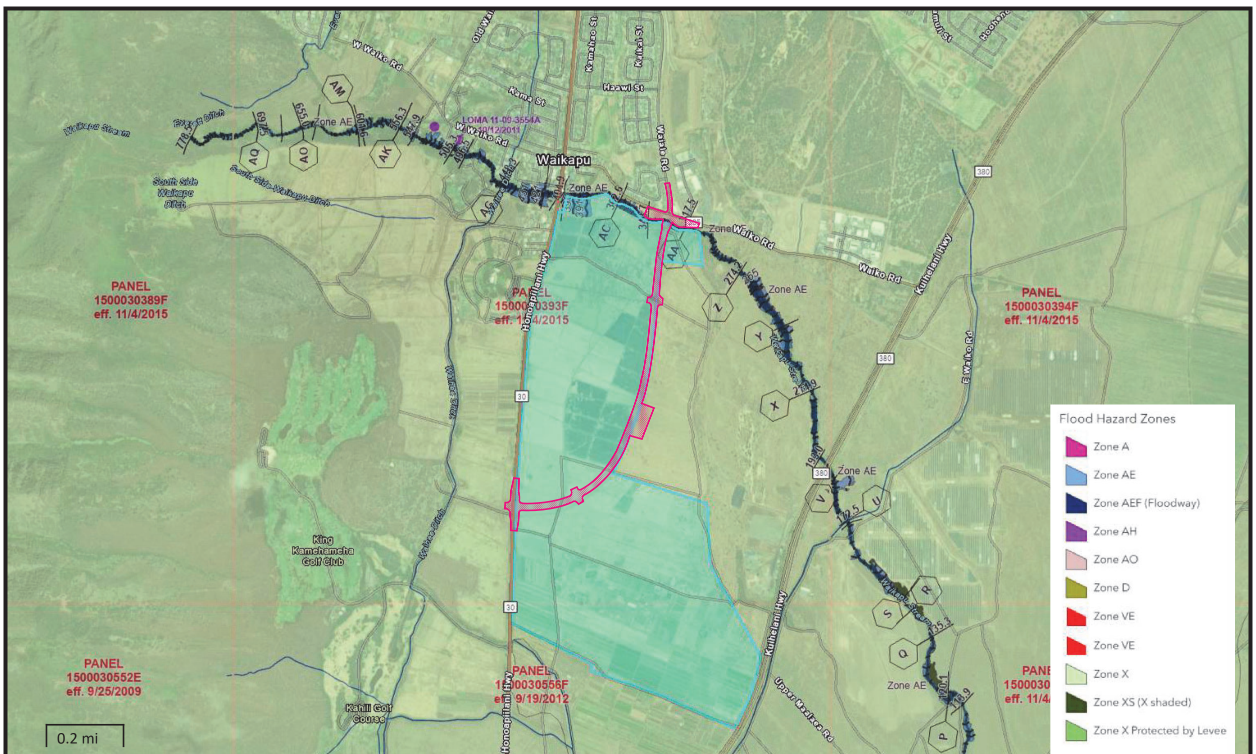
Title: Honoapilani Highway [TMK (2) 3-6-999:999]

Notes: Flood Zone(s) on parcel: AEF, VE, X, XS

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (3 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

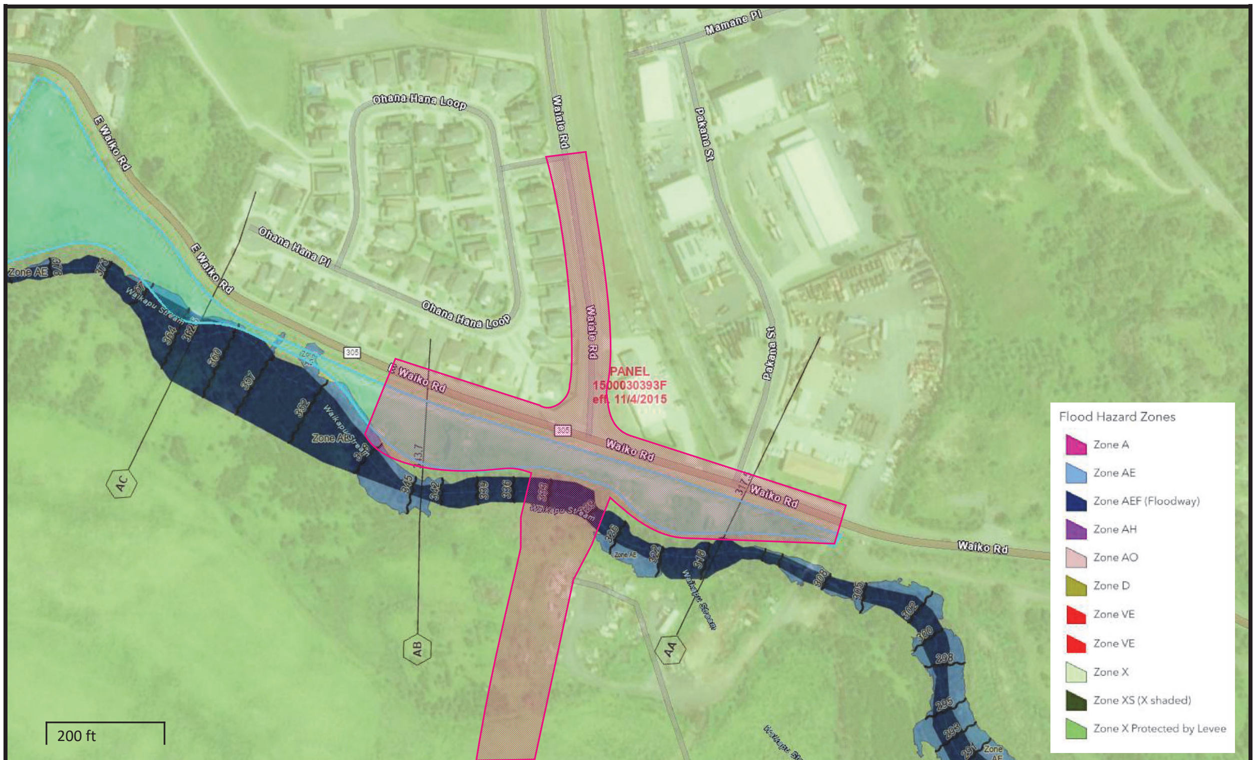
Title: Waiale 905 Partners LLC [TMK (2) 3-6-002:003]

Notes: Flood Zone(s) on parcel: AE, AEF, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (2 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

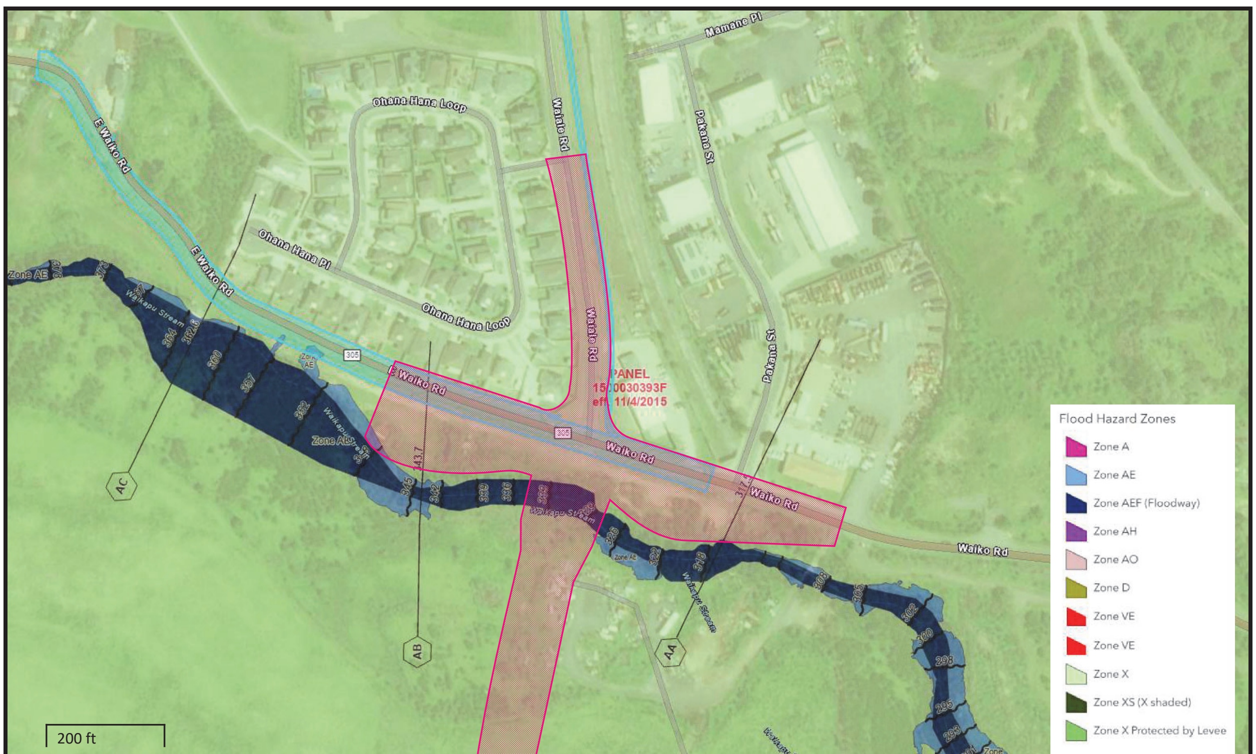
Title: Waiko Baseyard, LLC [TMK (20 3-5-002:014]

Notes: Flood Zone(s) on parcel: AE, AEF, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (5 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

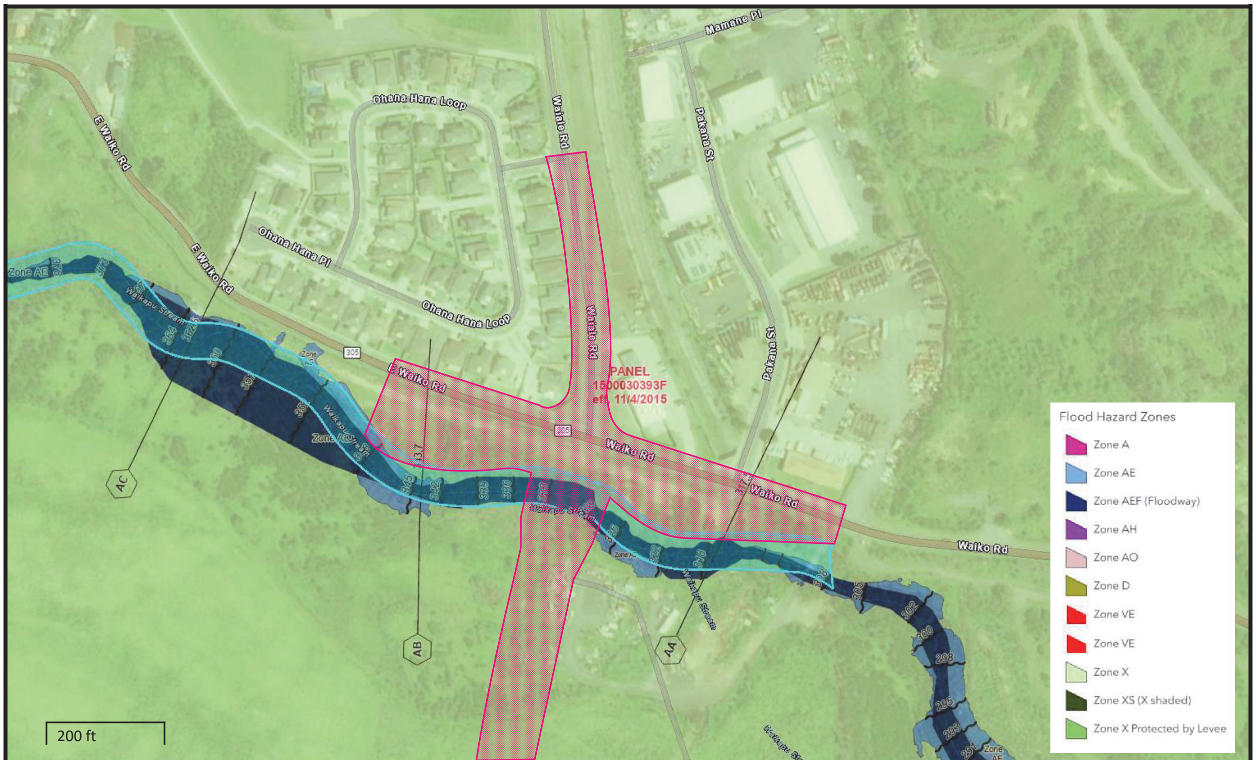
Title: East Waiko ROAD [TMK (2) 3-5-002:999]

Notes: Flood Zone(s) on parcel: AE, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (4 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

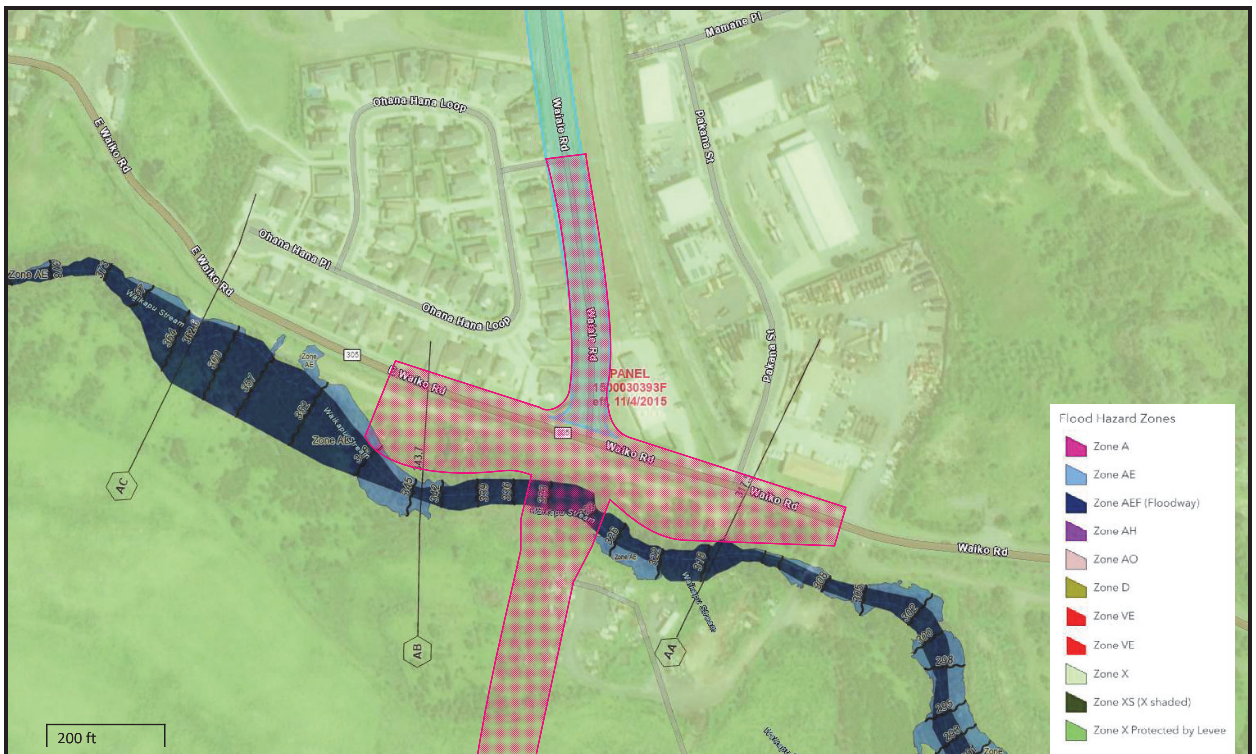
Title: Waikapu Stream [TMK 92) 3-5-002:888]

Notes: Flood Zone(s) on parcel: AE, AEF, X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (7 of 8) - FLOOD INSURANCE RATE MAP



Flood Hazard Map

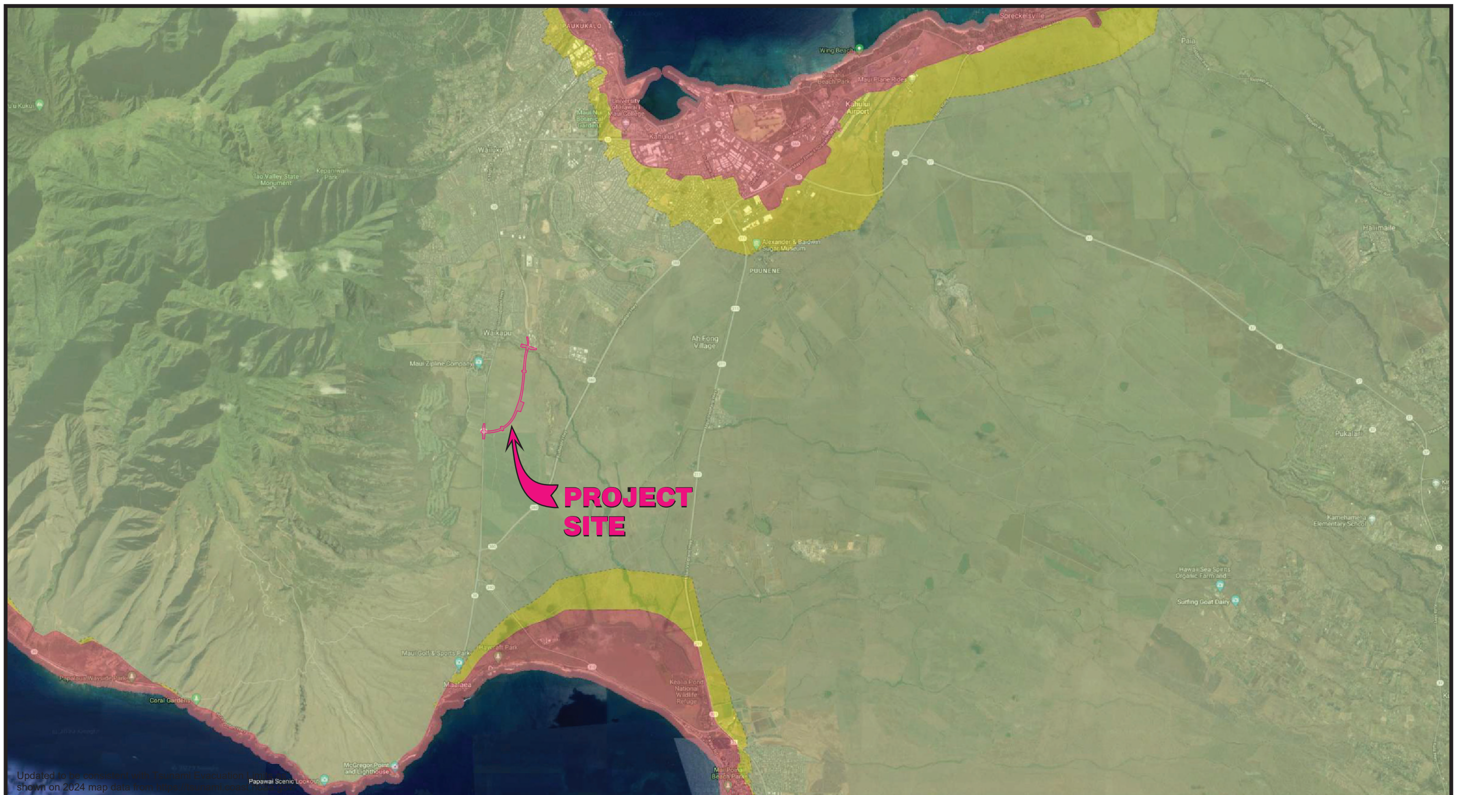
Title: Waiale Road [TMK (2) 3-5-002:999]

Notes: Flood Zone(s) on parcel: X

MAP GENERATED: APRIL 2024
FIRM INDEX DATE: NOVEMBER 04, 2015
FEMA FIRM PANEL: 1500030393F
PANEL EFFECTIVE DATE: NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (6 of 8) - FLOOD INSURANCE RATE MAP



For most Tsunami Warnings, evacuate out of the red zone; in the unlikely case of an "Extreme Tsunami Warning", evacuate out of the red and yellow zones

Remain at least 100 feet away from inland waterways and harbors connected to the ocean due to wave surges and possible flooding

Boaters should move vessels to at least 50 fathoms (300 ft) deep and 2 miles away from harbor entrances; follow all directions from the Captain of the Port

Structural steel or reinforced concrete buildings of six or more stories provide increased protection on or above the fourth floor; if you are caught near the shoreline consider using vertical evacuation

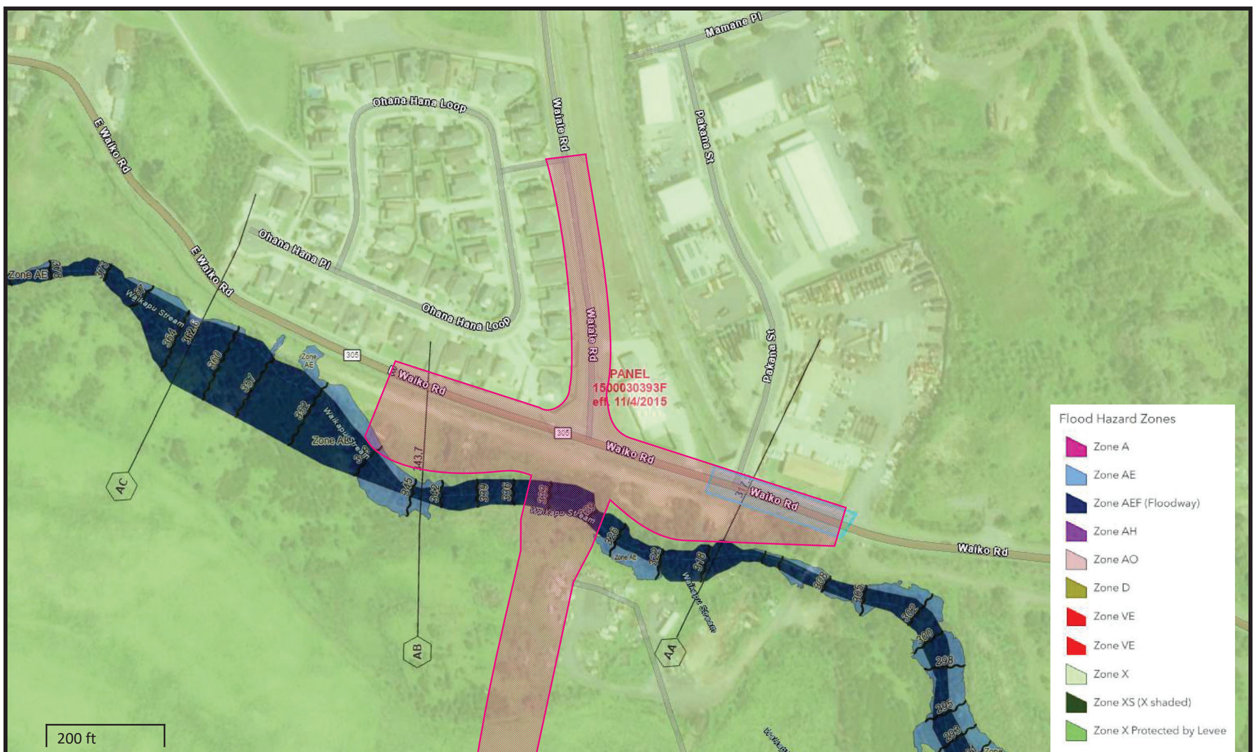
These maps do not consider the destructive effects of a locally generated tsunami. If you feel strong shaking, move inland immediately, well inland from the red tsunami evacuation zone

The evacuation zone is a guideline and should be considered the minimum safe evacuation distance

Legend

Police Station	Road
Fire Station	Safe Zone
Hospital	Tsunami Evacuation Zone
EMS	Extreme Tsunami Evacuation Zone
Public/Private School	

EXHIBIT "D" - TSUNAMI EVACUATION MAP



Flood Hazard Map

Title: Waiko Baseyard, LLC [TMK (2) 3-5-002:009]

Notes: Flood Zone(s) on parcel: X

MAP GENERATED:	APRIL 2024
FIRM INDEX DATE:	NOVEMBER 04, 2015
FEMA FIRM PANEL:	1500030393F
PANEL EFFECTIVE DATE:	NOVEMBER 04, 2015

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

EXHIBIT "C" (8 of 8) - FLOOD INSURANCE RATE MAP

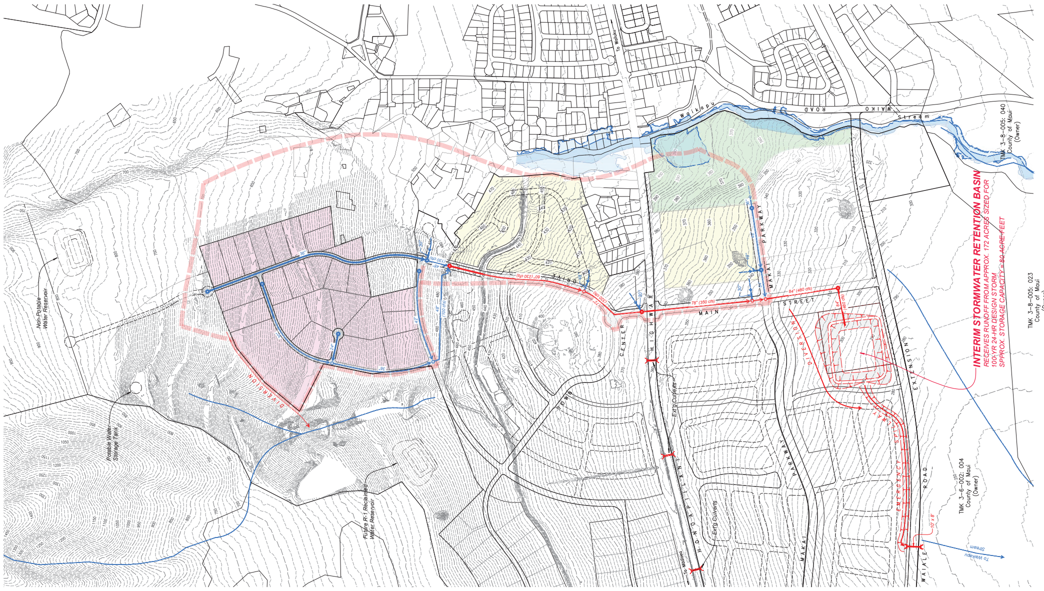
EXHIBIT "G" (1 of 3) - WAIKAPU COUNTRY TOWN DRAINGE MASTER PLAN (1 of 3)

Waikapu Country Town
INTERIM DRAINAGE MASTER PLAN

PAGE 1 OF 3

April 19, 2024

SCALE: 1 INCH = 300 FEET



DRAINAGE SYSTEM NOTES

1. Design of the Waikapu Country Town storm drainage sytem shall conform to Maui County Administrative Rules Title MC-15, Chapter 4, "Rules for the Design of Storm Drainage Facilities in the County of Maui," adopted by Maui County Dept. of Public Works on July 14, 1995.
2. Construction of the Waikapu Country Town storm drainage system shall conform to the latest revisions of the Maui County Dept. of Public Works "Standard Details of Public Works Construction" (1984) and "Hawaii Standard Specifications for Road and Bridge Construction" (2005) where applicable.
3. Drainline sizes appearing on this plan are preliminary in nature and are intended to be adjusted during final design when the specific installation requirements and characteristics of each drainline segment are more clearly understood.

ZONING SUB-DISTRICTS

- TOWN CENTER
- MAIN STREET
- COMMERCIAL/EMPLOYMENT
- RESIDENTIAL
- RURAL
- SCHOOL
- PARK
- OPEN SPACE

DRAINAGE SYSTEM LEGEND

- PRIMARY STORM DRAIN MAINLINE SIZED TO CONVEY 100 YR - 24 HR. DESIGN STORM
- SECONDARY STORM DRAIN MAINLINE SIZED TO CONVEY 50 YR - 1 HR. DESIGN STORM
- MANHOLE WITH DRAINLINE STUBOUT
- DRAINLINE CONNECTION BY FUTURE DEVELOPMENT
- FLOW LINE OF EXISTING STREAM OR GULLY
- NEW OPEN DRAINAGE CHANNEL
- NEW SURFACE RUNOFF DIVERSION

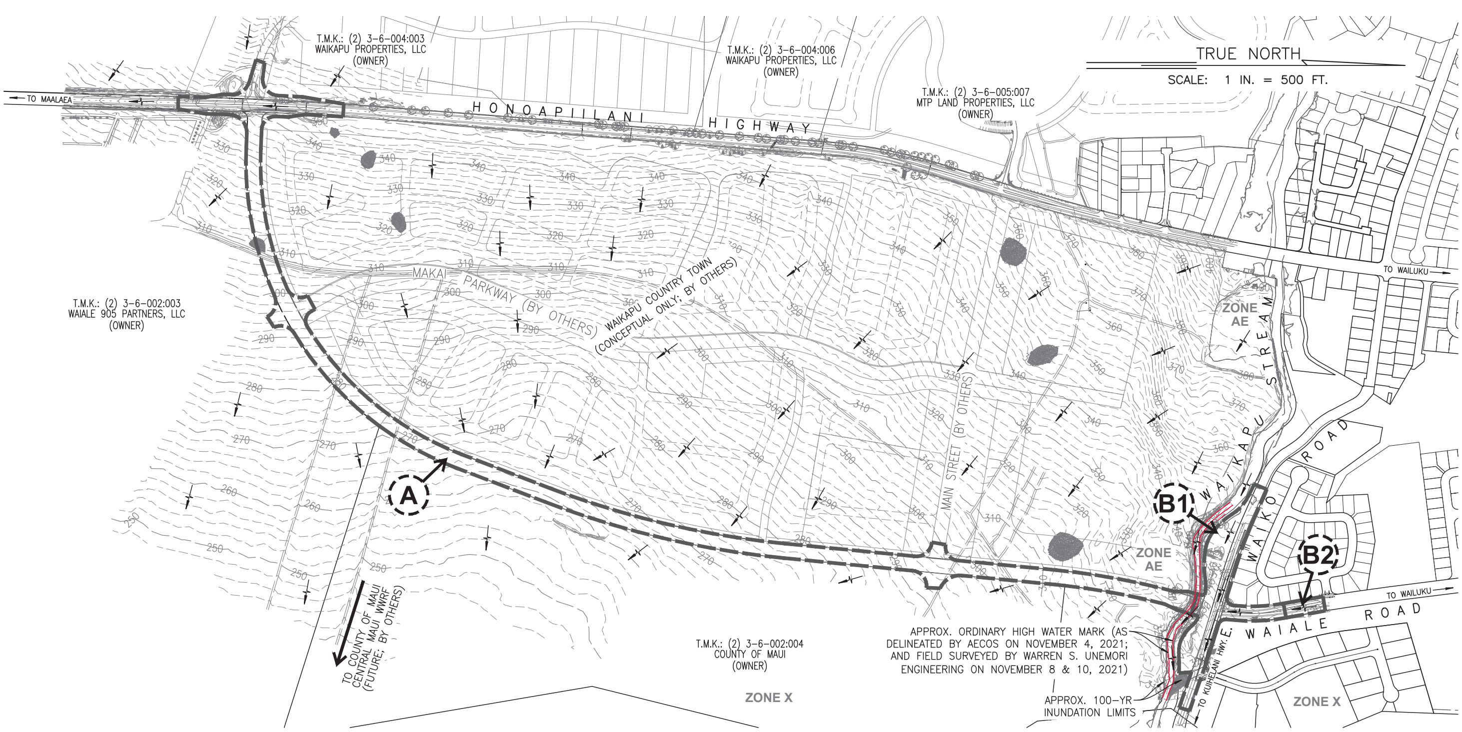


EXHIBIT "E" - PRE-DEVELOPMENT DRAINAGE AREA MAP

0 500 1000 1500 2000

SCALE: 1 IN. = 500 FT.

LEGEND:

- APPROX. DRAINAGE AREAS BOUNDARIES
- (1) DRAINAGE AREA ID'S
- FLOW ARROWS

NOTE:

PROPOSED DRAINAGE IMPROVEMENTS ARE CONCEPTUAL AND SUBJECT TO CHANGE (INCLUDING BUT NOT LIMITED TO SUBSURFACE DRAINS, DRYWELLS, DRAINLINES, DRAIN INLETS, ROADWAY CULVERTS, DETENTION BASINS, ETC.)

WARREN S. UNEMORI ENGINEERING, INC.
CIVIL & STRUCTURAL ENGINEERS / LAND SURVEYORS

April 2024

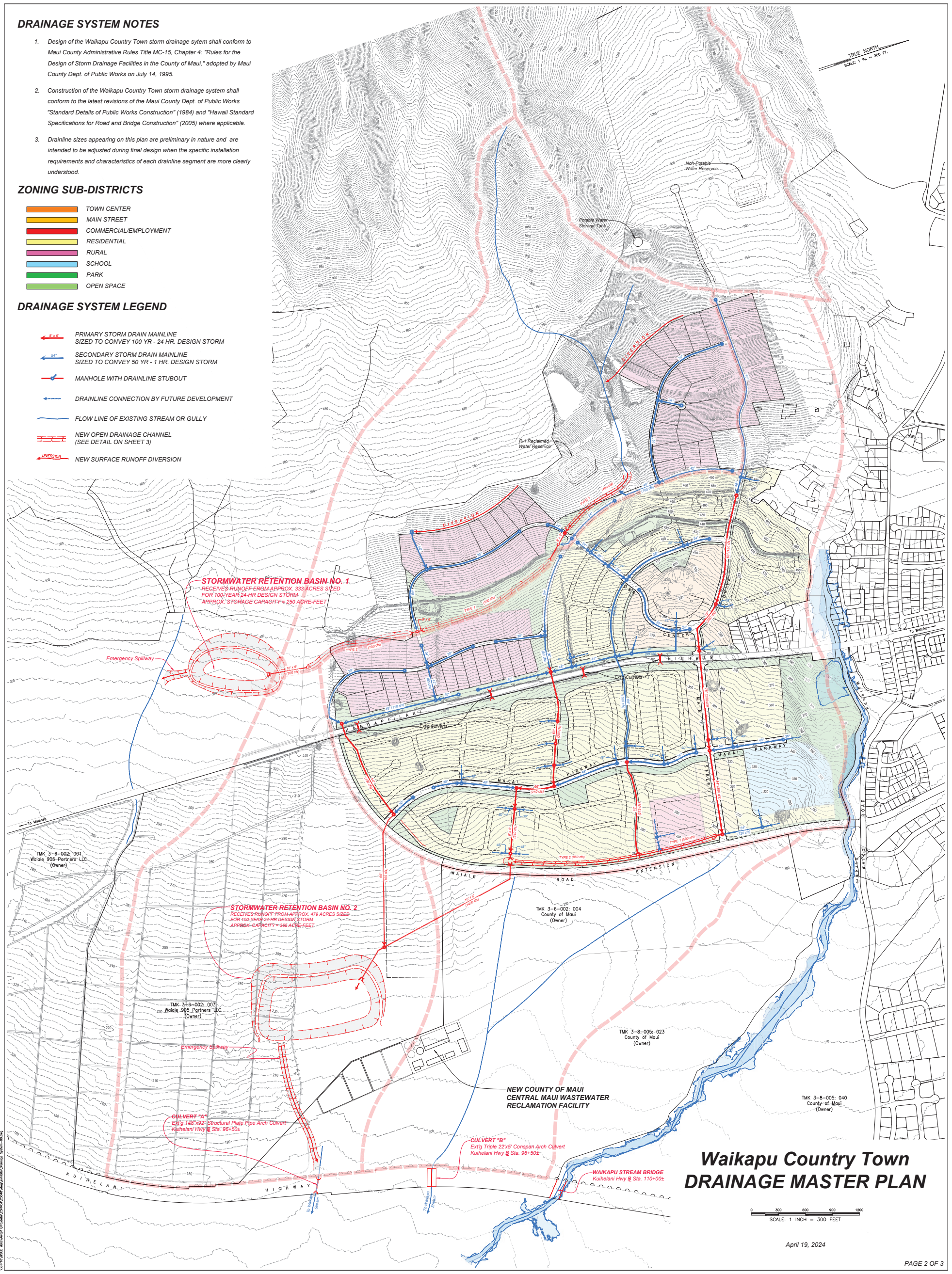


EXHIBIT "G" (2 of 3) - WAIKAPU COUNTRY TOWN DRAINGE MASTER PLAN (1 of 3)

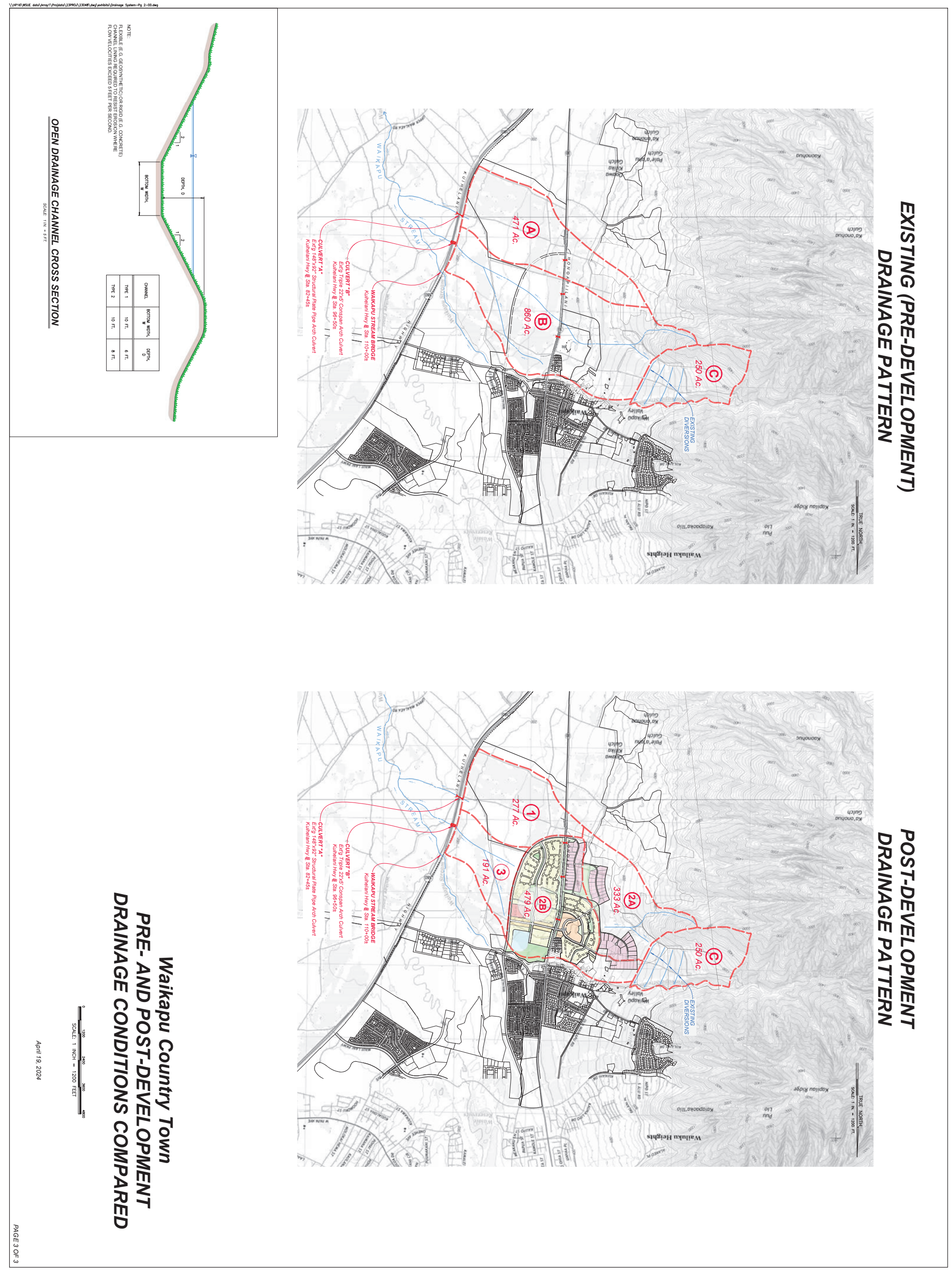


EXHIBIT "G" (3 of 3) - WAIKAPU COUNTRY TOWN DRAINGE MASTER PLAN (1 of 3)

APPENDIX A

Hydrologic Calculations

Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

HYDROLOGIC CALCULATIONS: PRE-DEVELOPMENT (EXISTING) AREA A

Purpose: To estimate the 50-year, 1-hour post-development peak runoff from the project area along Waiale Road Ext., from the vicinity of its intersection with Honoapiilani Highway (STA 10+00±) to the Waikapu Stream at proposed bridge crossing (STA 75+76±).

I. 50-Yr. - 1 Hr. Rainfall:

From "Rainfall Frequency Atlas of the Hawaiian Islands", for Waikapu, Maui, Hawaii
R(50 Yr.-1Hr.) = 2.5

2. Total Area:

Area (Total) (Ac.):				15.40

3. Runoff Coefficents:

		Comp. Area	Comp. 'C'	
Streets (Asphalt):	0.95	0.76	0.05	
Driveway/Walks (Bike Path):	0.85	0.00	0.00	
Landscape:	0.22	0.00	0.00	
Undeveloped:	0.30	14.46	0.28	
Concrete Channel:	0.85	0.17	0.01	
Min. Runoff Coeff't., Weighted 'C' Coefficient:				0.34

4. Time of Concentration:

Approx. Elev. Diff'l. (ft.):		13
Higher Elev. (ft.):	306	
Lower Elev. (ft.):	293	
Approx. Runoff Length (ft.):		331
Average Slope:		3.9%
Time of Concentration (min.):		8

5. Intensity:

Intensity (in./hr.):	5.5

6. Total Runoff:

Q = C x I x A (cfs):	**28.66**

* Ref. Table 2 from "Rules for the Design of Storm Drainage Facilities in the County of Maui"

Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

HYDROLOGIC CALCULATIONS: POST-DEVELOPMENT (PROPOSED) AREA A

Purpose: To estimate the 50-year, 1-hour post-development peak runoff from the project area along Waiale Road Ext., from the vicinity of its intersection with Honoapiilani Highway (STA 10+00±) to the Waikapu Stream at proposed bridge crossing (STA 75+76±).

I. 50-Yr. - 1 Hr. Rainfall:

From "Rainfall Frequency Atlas of the Hawaiian Islands", for Waikapu, Maui, Hawaii
R(50 Yr.-1Hr.) = 2.5

2. Total Area:

Area (Total) (Ac.): 15.40

3. Runoff Coefficents:

		Comp. Area	Comp. 'C'
Streets (Asphalt):	0.95	5.98	0.37
Driveway/Walks (Bike Path):	0.85	3.69	0.20
Landscape:	0.22	5.48	0.08
Undeveloped:	0.30	0.24	0.00
Concrete Channel:	0.85	0.00	0.00

Min. Runoff Coeff't., Weighted 'C' Coefficient: 0.66

4. Time of Concentration:

Approx. Elev. Diff'l. (ft.):		6
Higher Elev. (ft.):	281	
Lower Elev. (ft.):	275	
Approx. Runoff Length (ft.):		282
Average Slope:		2.1%
Time of Concentration (min.):		6

5. Intensity:

Intensity (in./hr.): 6.2

6. Total Runoff:

Q = C x I x A (cfs): 62.60

* Ref. Table 2 from "Rules for the Design of Storm Drainage Facilities in the County of Maui"

Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

HYDROLOGIC CALCULATIONS: PRE-DEVELOPMENT (EXISTING) AREA B1

Purpose: To estimate the 50-year, 1-hour post-development peak runoff from the project area along Waiale Road Ext., from Waikapu Stream at proposed bridge crossing (STA 75+76±) to STA 80+40±.

I. 50-Yr. - 1 Hr. Rainfall:

From "Rainfall Frequency Atlas of the Hawaiian Islands", for Waikapu, Maui, Hawaii
R(50 Yr.-1Hr.) = 2.5

2. Total Area:

Area (Total) (Ac.): 4.59

3. Runoff Coefficents:

		Comp. Area	Comp. 'C'
Streets (Asphalt):	0.95	1.13	0.23
Driveway/Walks (Bike Path):	0.85	0.08	0.01
Landscape:	0.22	0.57	0.03
Undeveloped:	0.30	2.82	0.18
Retention Basin:	0.22	0.00	0.00

Min. Runoff Coeff't., Weighted 'C' Coefficient: 0.46

4. Time of Concentration:

Approx. Elev. Diff'l. (ft.):		31
Higher Elev. (ft.):	354	
Lower Elev. (ft.):	323	
Approx. Runoff Length (ft.):		875
Average Slope:		3.5%
Time of Concentration (min.):		7.5

5. Intensity:

Intensity (in./hr.): 5.7

6. Total Runoff:

Q = C x I x A (cfs): 11.99

* Ref. Table 2 from "Rules for the Design of Storm Drainage Facilities in the County of Maui"

Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

HYDROLOGIC CALCULATIONS: POST-DEVELOPMENT (PROPOSED) AREA B1

Purpose: To estimate the 50-year, 1-hour post-development peak runoff from the project area along Waiale Road Ext., from Waikapu Stream at proposed bridge crossing (STA 75+76±) to STA 80+40±.

I. 50-Yr. - 1 Hr. Rainfall:

From "Rainfall Frequency Atlas of the Hawaiian Islands", for Waikapu, Maui, Hawaii
R(50 Yr.-1Hr.) = 2.5

2. Total Area:

Area (Total) (Ac.):				4.59

3. Runoff Coefficents:

		Comp. Area	Comp. 'C'	
Streets (Asphalt):	0.95	1.38	0.29	
Driveway/Walks (Bike Path):	0.85	0.67	0.12	
Landscape:	0.22	0.58	0.03	
Undeveloped:	0.30	1.37	0.09	
Retention Basin:	0.22	0.58	0.03	
Min. Runoff Coeff't., Weighted 'C' Coefficient:				0.56

4. Time of Concentration:

Approx. Elev. Diff'l. (ft.):		15
Higher Elev. (ft.):	360	
Lower Elev. (ft.):	345	
Approx. Runoff Length (ft.):		400
Average Slope:		3.8%
Time of Concentration (min.):		5

5. Intensity:

Intensity (in./hr.):	6.4

6. Total Runoff:

Q = C x I x A (cfs):	**16.33**

* Ref. Table 2 from "Rules for the Design of Storm Drainage Facilities in the County of Maui"

Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

HYDROLOGIC CALCULATIONS: PRE-DEVELOPMENT (EXISTING) AREA B2

Purpose: To estimate the 50-year, 1-hour post-development peak runoff from the project area along Waiale Road Ext., from STA 80+40± to northerly terminus at the intersection of Waiale Road and Ohana Hana Street (STA 83+00±).

I. 50-Yr. - 1 Hr. Rainfall:

From "Rainfall Frequency Atlas of the Hawaiian Islands", for Waikapu, Maui, Hawaii
R(50 Yr.-1Hr.) = 2.5

2. Total Area:

Area (Total) (Ac.):				0.40

3. Runoff Coefficents:

		Comp. Area	Comp. 'C'	
Streets (Asphalt):	0.95	0.25	0.58	
Driveway/Walks (Bike Path):	0.85	0.00	0.01	
Landscape:	0.22	0.16	0.08	
Undeveloped:	0.30	0.00	0.00	
Min. Runoff Coeff't., Weighted 'C' Coefficient:				0.67

4. Time of Concentration:

Approx. Elev. Diff'l. (ft.):		4
Higher Elev. (ft.):	324	
Lower Elev. (ft.):	320	
Approx. Runoff Length (ft.):		210
Average Slope:		1.9%
Time of Concentration (min.):		5

5. Intensity:

Intensity (in./hr.):	6.4

6. Total Runoff:

Q = C x I x A (cfs):	**1.73**

* Ref. Table 2 from "Rules for the Design of Storm Drainage Facilities in the County of Maui"

Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

HYDROLOGIC CALCULATIONS: POST-DEVELOPMENT (PROPOSED) AREA B2

Purpose: To estimate the 50-year, 1-hour post-development peak runoff from the project area along Waiale Road Ext., from STA 80+40± to northerly terminus at the intersection of Waiale Road and Ohana Hana Street (STA 83+00±).

I. 50-Yr. - 1 Hr. Rainfall:

From "Rainfall Frequency Atlas of the Hawaiian Islands", for Waikapu, Maui, Hawaii
R(50 Yr.-1Hr.) = 2.5

2. Total Area:

Area (Total) (Ac.):				0.40

3. Runoff Coefficents:

		Comp. Area	Comp. 'C'	
Streets (Asphalt):	0.95	0.24	0.58	
Driveway/Walks (Bike Path):	0.85	0.05	0.10	
Landscape:	0.22	0.11	0.06	
Undeveloped:	0.30	0.00	0.00	
Min. Runoff Coeff't., Weighted 'C' Coefficient:				0.74

4. Time of Concentration:

Approx. Elev. Diff'l. (ft.):				2
Higher Elev. (ft.):		323		
Lower Elev. (ft.):		321		
Approx. Runoff Length (ft.):				185
Average Slope:				1.1%
Time of Concentration (min.):				5

5. Intensity:

Intensity (in./hr.):				6.4

6. Total Runoff:

Q = C x I x A (cfs):				**1.91**

* Ref. Table 2 from "Rules for the Design of Storm Drainage Facilities in the County of Maui"

APPENDIX B

Preliminary Detention and Retention Basin Storage
System Volume Estimation Calculations

Pond Estimated Storage Detailed Report: Pond Estimated Storage - Detention Basin No. 1

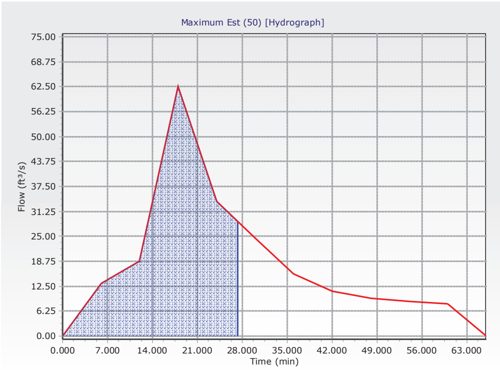
Element Details			
ID	15	Notes	
Label	Pond Estimated Storage - Detention Basin No. 1		

Detention Storage Estimates -- Target Peak Outflow Rate

Return Event	Peak In (ft³/s)	Target (ft³/s)	Lower (ac-ft)	Linear (ac-ft)	Curvilinear (ac-ft)	Upper (ac-ft)	Total (ac-ft)
50	62.60	28.66	(N/A)	(N/A)	(N/A)	1.062	(N/A)

Calculation Time Ranges

Return Event	Lower (From) (min)	Lower (To) (min)	Linear (From) (min)	Linear (To) (min)	Curvilinear (From) (min)	Curvilinear (To) (min)	Upper (From) (min)	Upper (To) (min)	Total (From) (min)	Total (To) (min)
50	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	0.000	27.284	(N/A)	(N/A)



Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

STORM WATER TREATMENT CALCULATIONS: WATER QUALITY DESIGN VOLUME

Objective: To determine the required Water Quality Design Volume (WQDV), per the County of Maui, Department of Public Works' "Rules for the Design of Storm Water Treatment Best Management Practices", to be stored within Detention Basin No.1 located to the South of Waiale Road Ext. Calculations include tributary areas from Honoapiilani Highway, Waiale Road Ext., and Waikapu Stream. See Exhibit F - Conceptual Post Developement Draiange Area Map, Drainage Area A.

I. Design Storm:

The design storm for the detention based system is 1.0" per MCC § 15-111-5.1.B:

Rainfall (in.): 1.0

2. Post-Developed Area:

Total Area (Ac.): 15.40
Impervious Area (Ac.): 9.67

3. Runoff Coefficient:

The EPA volumetric runoff coefficient, C, calculated from the formula given in MCC § 15-111-

C = 0.05 + (0.009) * (IMP)

where, IMP = percentage of impervious area
= [(Impervious Area)/(Total Area)] * 100

IMP (%) : [(9.67) / (15.40)]* 100 = 62.8
Runoff Coeff't., C : 0.05 + (0.009) * (62.8) = 0.62

4. Water Quality Design Volume Required:

The required Water Quality Design Volume (WQDV) for Detention Basin No. 1 is computed by the MCC § 15-111-5.a.1.C:

WQDV = C * 1" * A * 3630
where, WQDV = water quality design volume in cubic feet
C = EPA volumetric runoff coefficient
A = total area of the site in acres
3630 = conversion factor

WQDV (cf.) : (0.62) * (1.0 in.) * (15.40ac.) * 3630 = 34,387
WQDV (ac.ft..) : = 0.79

5. Water Quality Design Volume Available:

Available Storage volumes for Detention Basin No. 1:

Detention Basin No.1 Capacity = 1.062 ac.ft.
WQDV Available = 1.062 ac.ft. ≥ 0.79 ac.ft. WQDV Required

Pond Estimated Storage Detailed Report: Pond Estimated Storage - Retension Basin No. 2

Element Details		
ID	21	Notes
Label	Pond Estimated Storage - Retension Basin No. 2	

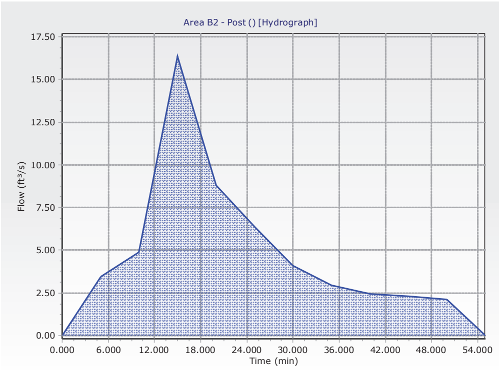
Detention Storage Estimates -- Target Peak Outflow Rate

Return Event	Peak In (ft³/s)	Target (ft³/s)	Lower (ac-ft)	Linear (ac-ft)	Curvilinear (ac-ft)	Upper (ac-ft)	Total (ac-ft)
50	16.33	11.99	(N/A)	(N/A)	(N/A)	(N/A)	0.370

Calculation Time Ranges

Return Event	Lower (From) (min)	Lower (To) (min)	Linear (From) (min)	Linear (To) (min)	Curvilinear (From) (min)	Curvilinear (To) (min)	Upper (From) (min)	Upper (To) (min)	Total (From) (min)	Total (To) (min)
50	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	0.000	55.000

Pond Estimated Storage Detailed Report: Pond Estimated Storage - Retenstion Basin No. 2



Warren S. Unemori Engineering, Inc.
Wells Street Professional Center
2145 Wells Street , Suite 403
Wailuku, Maui , Hawaii 96793

Date: April 2024

STORM WATER TREATMENT CALCULATIONS: WATER QUALITY DESIGN VOLUME

Objective: To determine the required Water Quality Design Volume (WQDV), per the County of Maui, Department of Public Works' "Rules for the Design of Storm Water Treatment Best Management Practices", to be stored within Retention Basin No. 2 located to the North of Waikapu Stream, at the southeast corner of Waiale Road/East Waiko Road inersection. Calculations include tributary areas from Waikapu Stream, Waiale Road Ext., East Waiko Road, and Waiale Road. See Exhibit F - Conceptual Post Developement Draiange Area Map, Drainage Area B1.

I. Design Storm:

The design storm for the detention based system is 1.0" per MCC § 15-111-5.1.B:

Rainfall (in.): 1.0

2. Post-Developed Area:

Total Area (Ac.): 4.59
Impervious Area (Ac.): 2.05

3. Runoff Coefficient:

The EPA volumetric runoff coefficient, C, calculated from the formula given in MCC § 15-111-

C = 0.05 + (0.009) * (IMP)

where, IMP = percentage of impervious area
= [(Impervious Area)/(Total Area)] * 100

IMP (%) :	[(2.05) / (4.59)]* 100	=	44.7
Runoff Coeff't., C :	0.05 + (0.009) * (44.7)	=	0.45

4. Water Quality Design Volume Required:

The required Water Quality Design Volume (WQDV) for Detention Basin No. 1 is computed by the MCC § 15-111-5.a.1.C:

WQDV = C * 1" * A * 3630
where, WQDV = water quality design volume in cubic feet
C = EPA volumetric runoff coefficient
A = total area of the site in acres
3630 = conversion factor

WQDV (cf.) :	(0.45) * (1.0 in.) * (4.59ac.) * 3630	=	7,530
WQDV (ac.ft..) :		=	0.17

5. Water Quality Design Volume Available:

Available Storage volumes for Retention Basin No. 2:

Retention Basin No.2 Capacity = 0.370 ac.ft.
WQDV Available = 0.370ac.ft. ≥ 0.17 ac.ft. WQDV Required

APPENDIX B-1

Geotechnical Engineering Exploration Report

GEOTECHNICAL ENGINEERING EXPLORATION

WAIALE ROAD EXTENSION

WAIKAPU, MAUI, HAWAII

W.O. 8345-00 JUNE 26, 2024

Prepared for

BOWERS + KUBOTA CONSULTING, INC.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

W.O. 8345-00 JUNE 26, 2024

Prepared for

BOWERS + KUBOTA CONSULTING, INC.

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

DRAFT

SIGNATURE	4-30-26 EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
94-429 Koaki Street, Suite 200 • Waipahu, HI 96797

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

June 26, 2024
W.O. 8345-00

Ms. Kathleen Chu
Bowers + Kubota Consulting, Inc.
94-408 Akoki Street, Suite 201-A
Waipahu, HI 96797

Dear **Ms. Chu:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Waiale Road Extension, Waikapu, Maui, Hawaii," prepared for the design of the project.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated August 17, 2021.

Please note that the soil and rock samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage requirements, if appropriate.

Detailed discussion and specific design recommendations are contained in the body of this report. If there is any point that is unclear, please contact our office.

Very truly yours,

GEOLABS, INC.

DRAFT

Gerald Y. Seki, P.E.
Vice President

GS:JS:RY:as

GEOTECHNICAL ENGINEERING EXPLORATION
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
W.O. 8345-00 JUNE 26, 2024

TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING EXPLORATION
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
W.O. 8345-00 JUNE 26, 2024

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration generally encountered a surface fill layer consisting of loose to very dense silty sand, silty gravel and gravelly sand, and medium stiff to hard sandy clay and sandy silt. The surface fill layer was underlain by alluvial soils generally consisting of loose to very dense silty sands, sandy gravel and gravelly sand, medium stiff to hard sandy clay, and cobbles andboulders extending to the maximum depth explored of 51.75 feet below the existingground surface.

Groundwater was encountered in Boring Nos. B-6, B-9, and P-5 at depths of about 8.3 to 48 feet below the existing ground surface at the time of our field exploration. However, it should be noted that the water levels recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site. In addition, groundwater levels may vary with seasonal rainfall, time of the year, and other factors.

Based on the subsurface information and the foundation loads provided, we believe that a deep foundation system consisting of drilled shafts embedded into the underlying alluvial deposits may be used to support the abutment structures for the bridge structure. A minimum shaft diameter of 4 feet should be used with a minimum shaft length of about 50 feet below the planned bottom-of-footing elevations. For the lateral load analysis for the drilled shafts, stiffness modeling parameters consisting of non-linear p-y curves were provided.

A test shaft program consisting of the construction of one load test shaft is recommended for the project. Due to the high capacities recommended for the drilled shafts, a conventional load test would not be practicable. Therefore, we recommend conducting a bi-directional axial load test on the reinforced load test shafts using an expandable base load cell (Osterberg Load Cell).

Based on our laboratory test results, the clayey soils encountered at the site exhibit moderate shrink/swell characteristics when subjected to fluctuations in the soil moisture contents. To reduce the potential for future distress to the lightly loaded slabs-on-grade resulting from shrinking and swelling of the near-surface clayey soils, we recommend providing a minimum of 12 inches of non-expansive select granular fill material below the slab cushion fill. Prior to placing the non-expansive select granular fill capping, we recommend properly preparing the slab-on-grade subgrades by scarifying to a depth of about 8 inches, moisture conditioning to at least 2 percent above the optimum moisture, and compacting to a minimum of 90 percent relative compaction.

DRAFT Geotechnical Exploration Report - June 26, 2024

In general, the on-site materials generated from the excavations may be reused as a source of general fill materials provided that the materials are screened of over-sized materials (greater than 3 inches in maximum dimension) and are free of deleterious materials.

The text of this report should be referred to for detailed discussion and specific design recommendations.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

This report presents the results of our geotechnical engineering exploration conducted for the Waiale Road Extension project in Waikapu on the Island of Maui, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings and geotechnical recommendations resulting from our field exploration, laboratory testing, and engineering analyses for the project. These findings and geotechnical recommendations are intended for the design of the new bridge crossing structure, site grading, and underground utilities only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report. A separate Pavement Justification Report was prepared by our office for the design of new pavements for the project.

1.1 Project Considerations

The project site is located in the Waikapu area on the Island of Maui, Hawaii. The project consists of the extension of Waiale Road from East Waiko Road to Honoapiilani Highway. The roadway extension will be about 8,600 linear feet in length and generally be accommodated by a future 80-foot right-of-way. We understand that a new bridge crossing will be required over the existing Waikapu Stream. In addition, new underground utilities will be installed along the roadway, and intersection improvements will be constructed at the Waiale Road/East Waiko Road intersection and Waiale Road Extension/Honoapiilani Highway intersection.

1.2 Purpose and Scope

The purpose of our geotechnical engineering exploration is to obtain an overview of the subsurface conditions at the project site to develop a generalized soil data set to formulate geotechnical recommendations for the design of the proposed project. The scope of work for this exploration included the following tasks and work efforts:

1. Research and review of available in-house subsurface information in the project vicinity and other project information.
2. Mobilization and demobilization of trail clearing equipment and operator.

3. Performing trail clearing with mechanized construction equipment.
4. Boring location stakeout and utility clearance/toning by our field personnel.
5. Obtain street usage/excavation permits from the County of Maui and the Hawaii Department of Transportation (HDOT).
6. Mobilization and demobilization of a truck-mounted drill rig currently on the Island of Maui and two operators from Oahu to the project site and back.
7. Drilling and sampling 21 exploratory borings extending to depths of about 10 to 51.75 feet below the existing ground surface. Obtaining bulk surface samples for R-Value testing.
8. Performance of permeability testing in eight boreholes at depths of about 26 to 31 feet below the existing ground surface.
9. Coordination of trail clearing, field exploration and logging of the borings by our field engineer/geologist.
10. Laboratory testing of selected soil samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
11. Analyses of the field and laboratory data to formulate geotechnical recommendations pertaining to the design of the proposed project.
12. Preparation of this geotechnical engineering report summarizing our work on the project and presenting our findings and geotechnical recommendations for the design of the project.
13. Coordination of our overall work on the project by our senior engineer.
14. Quality assurance of our work and client/design team consultation by our principal engineer.
15. Miscellaneous work efforts such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration methodology and the Logs of Borings are presented in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Photographs of core samples retrieved from our field exploration are presented in Appendix C. Results of the permeability tests performed are presented in Appendix D.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

Of interest to our geotechnical analysis are the subsurface materials encountered at the project site, the engineering properties of the materials encountered, and the variability of the subsurface conditions across the project site. Therefore, the following subsections provide a description of the geologic setting of the project site, the surface and subsurface conditions encountered at the site, and a discussion of the items needed for seismic design, such as seismicity, soil liquefaction, and the soil profile characteristics for seismic analysis.

2.1 Regional Geology

The Island of Maui was built by two major volcanoes, the older West Maui (Tertiary Epoch) and the more recent East Maui, also known as Haleakala (Pleistocene Epoch). The Isthmus of Maui is a narrow, gently sloping plain located between these two volcanoes. The project site is located at the central portion of this gently sloping plain.

The Isthmus of Maui was created by lava flows from Haleakala ponding on West Maui. It is comprised of alluvium washed from the slopes of West Maui and East Maui (Haleakala). The erosional processes are dominated by the detachment of soil and rock masses from the mountain walls, and the soil materials are transported downslope toward the Isthmus primarily by gravity as colluvium. Once these materials reach the stream in the central portion of a valley, alluvial processes become dominant, and the sediments are transported and deposited as alluvium.

In general, stream flows in Hawaii are intermittent and flashy, such that the stream flows transmit large volumes of water for a very short duration. Because of this, the transport of sediments is intermittent, and the bulk of the stream's hydraulic load consists of a poorly sorted mixture of boulders, cobbles, gravel, sands, and fines. When the erosional base levels change, these sediment loads are left as deposits.

When deposits are left in-place for long periods of time, chemical processes begin to alter the materials simultaneously, causing a breakdown or weathering of the materials. Chemical processes also cause induration, or cementation, of the coarse-grained portion of the sediment into a poorly consolidated sedimentary rock or conglomerate.

Simultaneously, erosion continues in the areas above the valley floors and upstream in headwaters. This continued erosion generates material, which is transported downslope, covering the older alluvial soil deposits. Depending on the local base level and rate of transport, these newer sediments are generally transient in terms of geologic time. In addition, their consistency and density are generally less than those of the older, partially consolidated deposits.

Underlying the alluvial soil deposits are overlapping lava from the West Maui and East Maui volcanoes. The bulk of the Haleakala Shield was built during the late Pliocene and early Pleistocene Epoch by thinly bedded basaltic lava flows of the Honomanu Volcanic Series. During the Pleistocene Epoch, the characteristics of the lava changed to very hard, thickly bedded flows of andesitic composition. These lavas have been grouped as the Kula Volcanic Series.

Further complicating the stratigraphy of the Isthmus was the development of broad fringing reefs in the bay formed at the juncture between West Maui and East Maui and glacio-eustatic sea level changes that occurred during the Pleistocene Epoch in response to the advance and retreat cycles of continental glaciation. During the glacial advances, water was bound into the widespread glaciers as ice on a year-round basis, and less water was available to fill the ocean basins. As a consequence, global sea levels fell below the current sea level. During the retreats, more water was available, and sea levels rose.

When the sea levels fell, the fringing reefs, with their complement of calcium carbonate sand derived from both detrital and bioclastic sources, were exposed to the prevailing tradewinds, which blew in about the same direction as the current tradewinds but were estimated to have an average velocity of about 60 miles per hour. These winds, transporting the loose sand from the reef areas, resulted in a strip of sand dunes (aeolian deposits) that extended from the present Wailuku-Kahului area to as far as the south coast of the Maui Isthmus, blanketing the volcanic and alluvial deposits on the floor of the Isthmus. Sugar cane operations in the past decades have brought the project site to its present conditions.

2.2 Existing Site Conditions

The project site is located south of the intersection of Waiale Road and East Waiko Road, extends to the south through vacant land, and terminates at Honoapiilani Highway approximately 0.85 miles south of the entrance to the Maui Tropical Plantation in the Waikapu area on the Island of Maui, Hawaii. The approximate project area is shown on the Overall Site Plan, Plate 2.

Generally, the existing ground surface within the project area consists of vacant flat land covered with low to medium vegetation consisting of dried grasses and shrubs. A previously cleared access road was observed running in a north-south orientation located west of the proposed road extension. Based on the topographic plan provided, the project site generally slopes down toward the south with elevations ranging from +347.5 to +259 feet Mean Sea Level.

2.3 Subsurface Conditions

We explored the subsurface conditions at the project site by drilling and sampling 21 borings, designated as Boring Nos. B-1 through B-13, and P-1 through P-8, extending to depths ranging from about 10 to 51.75 feet below the existing ground surface. Permeability tests were performed in Boring Nos. P-1 through P-8 at the project site in support of the dry well design. Five bulk samples, designated as Bulk-1 through Bulk-5, were collected for laboratory R-value testing to evaluate the pavement support of the near-surface soils. The approximate boring and bulk sample locations are shown on the Overall Site Plan, Plate 2, and Site Plans, Plates 3.1 through 3.9.

The borings generally encountered a fill layer consisting of loose to very dense silty sands, silty gravel, and gravelly sand, medium stiff to hard sandy clays, and sandy silts, extending to depths of approximately 1.4 to 8 feet below the existing ground surface. The surface fills were generally underlain by alluvial soils consisting of loose to very dense silty sands, sandy gravel, and gravelly sand, medium stiff to hard sandy silts, sandy clay, and cobbles and boulders, extending to the maximum depth explored of 51.75 feet below the existing ground surface. It should be noted that alluvial deposits consisting of cobbles and boulders were encountered in Boring Nos. B-6, B-8, B-9, B-10, B-11, B-12, B-13, and P-4, P-6, P-7, and P-8 between depths of 1 and 51.75 feet below the existing ground surface. The basalt cobbles and boulders were generally moderately to slightly weathered and hard.

We encountered groundwater in Boring Nos. B-6, B-9, and P-5 at depths of about 8.3 to 48 feet below the existing ground surface at the time of our field exploration. However, it should be noted that the water levels recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site. In addition, groundwater levels may vary with seasonal rainfall, time of the year, and other factors.

Detailed descriptions of the materials encountered in the borings are presented on the Logs of Borings in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Photographs of core samples retrieved from our field exploration are presented in Appendix C. Results of the permeability tests performed at selected locations are presented in Appendix D.

2.4 Seismic Design Considerations

Based on the American Association of State Highway and Transportation for Load and Resistance Factor Design (AASHTO LRFD), Ninth Edition, 2020, the project may be subject to seismic activity and seismic design considerations will need to be addressed. The following sections provide discussions on the seismicity, soil profile type for seismic design, and the potential for liquefaction at the project site.

2.4.1 Earthquake and Seismicity

In general, earthquakes that occur throughout the world are caused solely by shifts in the tectonic plates. In contrast, earthquake activity in Hawaii is linked primarily to volcanic activity. Therefore, earthquake activity in Hawaii generally occurs before or during volcanic eruptions. In addition, earthquakes may result from the underground movement of magma that comes close to the surface but does not erupt. The Island of Hawaii experiences thousands of earthquakes each year, but most of the earthquakes are so small that they can only be detected by sensitive instruments. However, some of the earthquakes are strong enough to be felt, and a few cause minor to moderate damage.

In general, earthquakes (associated with volcanic activity) are most common on the Island of Hawaii. Earthquakes that are directly associated with the movement of magma are concentrated beneath the active Kilauea and Mauna Loa Volcanoes on the Island of Hawaii. Because the majority of the earthquakes in Hawaii (over 90 percent of earthquakes) are related to volcanic activity, the risk of high seismic activity and degree of ground shaking diminishes with increased distance from the Island of Hawaii. The Island of Hawaii has experienced numerous earthquakes greater than Magnitude 5 (M5+); however, earthquakes are not confined only to the Island of Hawaii.

To a lesser degree, the Island of Maui has experienced numerous earthquakes greater than Magnitude 5. Therefore, moderate to strong earthquakes have occurred in the County of Maui. The effects of earthquakes occurring on the Islands of Hawaii and Maui may be felt on the Island of Oahu. For example, several small landslides occurred on the Island of Oahu as a result of the Maui Earthquake of 1938 (M6.8). In addition, some houses on the Island of Oahu were reportedly damaged as a result of the Lanai Earthquake of 1871 (M7+).

In the last 150 years of recorded history, we are not aware of earthquakes greater than Magnitude 6 that have occurred on the Island of Oahu. An earthquake of Magnitude 4.8 to 5.9 occurred along the Diamond Head Fault in 1948 on the Island of Oahu. The moderate tremor resulted in broken store windows, rupture building walls, and broken underground water mains.

2.4.2 Soil Profile Type for Seismic Design

Based on the subsurface materials encountered at the project site and the geologic setting of the area, it is our opinion that the project site may be classified from a seismic analysis standpoint as being a “Stiff Soil” site corresponding to a Site Class D soil profile type based on AASHTO 2020 LRFD Bridge Design Specifications, 9th Edition (Table 3.10.3.1-1).

Based on the AASHTO 2020 LRFD Bridge Design Specifications, the bridge structure will need to be designed based on an earthquake return period of

1,000 years. Based on a 1,000-year return period and the anticipated Site Class, the following seismic design parameters were estimated and may be used for the seismic analysis of the bridge structure planned for the project.

SEISMIC DESIGN PARAMETERS WAIALE ROAD BRIDGE CROSSING AASHTO 2020 LRFD BRIDGE DESIGN SPECIFICATIONS 1,000-YEAR RETURN PERIOD (~7% PROBABILITY OF EXCEEDANCE IN 75 YEARS)	
Parameter	**Value**
MCE Peak Bedrock Acceleration, PBA (Site Class B)	0.246g
Spectral Response Acceleration (Site Class B), S_S	0.562g
Spectral Response Acceleration (Site Class B), S_1	0.163g
Site Class	“D”
Site Coefficient, F_{pga}	1.31
Site Coefficient, F_a	1.35
Site Coefficient, F_v	2.15
MCE Peak Ground Acceleration, PGA (Site Class D) or A_s	0.322g
Design Spectral Response Acceleration, S_{DS}	0.760g
Design Spectral Response Acceleration, S_{D1}	0.350g

2.4.3 Liquefaction Potential

Based on the AASHTO 2020 LRFD Bridge Design Specifications, 9th Edition, the project site may be subject to seismic activity and the potential for soil liquefaction at the project site will need to be evaluated.

Soil liquefaction is a condition where saturated cohesionless soils near the ground surface undergo a substantial loss of strength due to the build-up of excess pore water pressures resulting from cyclic stress applications induced by earthquakes. In this process, when the loose saturated sand deposit is subjected to vibration (such as during an earthquake), the soil tends to densify and decrease in volume causing an increase in pore water pressure. If drainage is unable to occur rapidly enough to dissipate the build-up of pore water pressure, the effective stress (internal strength) of the soil is reduced.

Under sustained vibrations, the pore water pressure build-up could equal the overburden pressure, essentially reducing the soil shear strength to zero and causing it to behave as a viscous fluid. During liquefaction, the soil acquires a mobility sufficient to permit both horizontal and vertical movements. If not confined, it will result in significant deformations.

Soils most susceptible to liquefaction are loose, uniformly graded, fine-grained sands and loose silts with little cohesion. The major factors affecting the liquefaction characteristics of a soil deposit are as follows:

FACTORS	LIQUEFACTION SUSCEPTIBILITY
Grain Size Distribution	Fine and uniform sands and silts are more susceptible to liquefaction than coarse or well-graded sands.
Initial Relative Density	Loose sands and silts are most susceptible to liquefaction. Liquefaction potential is inversely proportional to relative density.
Magnitude and Duration of Vibration	Liquefaction potential is directly proportional to the magnitude and duration of the earthquake.

Based on the subsurface conditions encountered, the phenomenon of soil liquefaction is not a design consideration for this project site. The risk for potential liquefaction is non-existent at this project site based on the subsurface conditions encountered (stiff clayey and/or dense soils, cobbles, and bounders in the absence of groundwater within the depths of the borings).

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Our field exploration generally encountered a surface fill layer consisting of loose to very dense silty sands, silty gravel, and gravelly sand, medium stiff to hard sandy clays, and sandy silts, extending to depths of approximately 1.4 to 8 feet below the existing ground surface. The surface fills were generally underlain by alluvial soils consisting of loose to very dense silty sands, sandy gravel, and gravelly sand, medium stiff to hard sandy silts, sandy clay, and cobbles and boulders extending to the maximum depth explored of 51.75 feet below the existing ground surface. Groundwater was encountered in Boring Nos. B-6, B-9, and P-5 at depths of about 8.3 to 48 feet below the existing ground surface at the time of our field exploration.

Based on the subsurface information and the foundation loads provided, we recommend using deep foundations consisting of drilled shafts for foundation support of the abutment structures for the proposed bridge structure crossing over the Waikapu Stream. Based on the subsurface conditions encountered, the drilled shaft foundations would derive support principally from adhesion between the drilled shaft and the underlying alluvial deposits.

Our laboratory tests indicate the near-surface clayey soils may exhibit moderate shrink/swell potential when subjected to moisture fluctuations. To reduce the potential for future distress to the lightly loaded slabs-on-grade resulting from shrinking and swelling of the clayey soils, we recommend placing a capping layer consisting of non-expansive select granular fill material below the slabs-on-grade and walkway.

Detailed discussions of our findings and geotechnical recommendations for the project are presented in the following sections.

3.1 Bridge Crossing Foundations

In general, we understand that the new bridge structure will be about 105 feet wide and 90 feet long and span over the Waikapu Stream. Based on the information provided, the new bridge will be single-span reinforced concrete bridge structure supported by reinforced cast-in-place concrete abutments at both ends.

Based on the subsurface conditions encountered, and the preliminary foundation loads provided, we recommend using drilled shaft foundations with a nominal diameter of 4 feet to support the proposed bridge structure. The drilled shaft foundations would derive support principally from adhesion between the drilled shaft and the alluvial deposits encountered in the borings. The contribution from end-bearing of the drilled shafts has been discounted in our analyses due to the difficulties of obtaining a clean bottom for end-bearing shafts in these subsurface conditions during construction.

Based on the preliminary foundation plans provided, we understand that the abutments (drilled shaft cap beam) will be positioned far enough away from the streambed and it is anticipated that the scour elevations will not extend below the abutments and expose the drilled shaft. Therefore, the potential for erosion due to scour around the drilled shaft foundations has been excluded from our analysis. We understand that the scour depths and extent will be evaluated by a hydraulics engineer. The foundation recommendations presented herein will be modified appropriately upon completion of the scour analysis by others.

Based on our engineering analyses and the above assumptions, we recommend using drilled shafts with the following compressive load capacities for the strength limit state based on Load and Resistance Factor Design (LRFD) methods for the design of highway bridges. For the strength limit state, a resistance factor of 0.70 has been applied for the design of the drilled shaft foundations. Based on the spacing of the drilled shafts (4 diameters center-to-center), a group efficiency factor of 1 was applied to the strength limit state capacity for the drilled shafts presented in the following table.

DRAFT FOUNDATION LAYOUT AND DRILLED SHAFT CAPACITIES

Abutment Identification	No. of Drilled Shafts	Shaft Diameter (feet)	Drilled Shaft Length (feet)	Compressive Load Capacity Per Drilled Shaft (kips)
				Factored Strength Limit State
North	6	4	45	1,875
South	6	4	45	1,875

3.1.1 Lateral Load Resistance

In general, lateral load resistance for the drilled shaft is a function of the stiffness of the surrounding soil/rock, the stiffness of the shaft, allowable deflection at the top of the shaft, and induced moment in the shaft. To evaluate the lateral load resistance of the new bridge structures, stiffness modeling parameters were estimated based on the subsurface conditions encountered in the drilled borings. The stiffness modeling parameters were obtained using the program LPILE 2022 for Windows, which is a microcomputer adaptation of a finite difference, laterally loaded pile program. The analysis was carried out to generate non-linear "p-y" curves to represent soil moduli at various depths. Results of the generated non-linear "p-y" curves are summarized and presented on Plates 4.1 and 4.2.

3.1.2 Foundation Settlements

Settlement of the drilled shaft foundation will result from elastic compression of the drilled shaft and subgrade response of the foundation embedded in the alluvial deposits. Total settlements of the drilled shafts are estimated to be on the order of about 0.5 inches with differential settlements between the drilled shafts not exceeding about one-half that amount. We believe that these settlements are essentially elastic and should occur as the loads are applied.

3.1.3 Drilled Shaft Construction Considerations

In general, the performance of drilled shafts depends significantly upon the contractor's method of installation and construction procedures. The following conditions would have a significant effect on the effectiveness and cost of the drilled shaft foundations.

The load-bearing capacities of drilled shafts depend, to a significant extent, on the friction between the shaft and the surrounding soils and/or formation. Therefore, proper construction techniques, especially during the drilling operations, are important. The contractor should exercise care in drilling the shaft holes and in placing concrete into the drilled holes.

Based on the anticipated subsurface conditions described above, some of the geotechnical considerations associated with drilled shaft foundations are discussed below.

3.1.3.a Obstructions, Cobbles and Boulders

Where obstructions, cobbles, and boulders are anticipated, some difficult drilling conditions will likely be encountered and should be expected. The drilled shaft subcontractor will need to have the appropriate equipment and tools to drill through these types of natural or man-made obstructions where encountered. The drilled shaft subcontractor will need to demonstrate that the proposed drilling equipment (and coring tools, where appropriate) will be capable of installing the drilled shafts to the recommended depths and dimensions.

It should be noted that cavities and voids may be encountered in the subsurface materials. Therefore, the actual volume of concrete required to fill the drilled shaft foundation may be appreciably more than the theoretical concrete volume.

3.1.3.b Shallow Groundwater Conditions

Groundwater was encountered in one our borings located near the bridge crossing during our field exploration. Therefore, groundwater may be anticipated within the depths of the drilled shaft excavations and concrete placement by tremie methods will be required during drilled shaft construction. The concrete should be placed in a suitable manner by displacing the water in an upward fashion from the bottom of the drilled hole. A low-shrink concrete mix with high slump (7 to 9 inches slump range) should be used to provide close contact between the drilled shafts and the surrounding soils. The concrete should be placed in a suitable manner to reduce the potential for segregation of the aggregates from the concrete mix.

In addition, the concrete should be placed promptly after drilling (within 24 hours after substantial completion of the holes) to reduce the potential for softening of the sides of the drilled holes.

It is imperative for a Geolabs representative to be present during construction to observe the drilling and installation of drilled shafts. Although the drilled shaft designs are primarily based on skin friction, the bottom of the drilled hole should be relatively free of loose materials prior to the placement of concrete. Therefore, Geolabs' observation of the drilled shaft installation operations is necessary to confirm the assumed subsurface conditions.

3.1.4 Test Shaft Program

A test shaft program is normally required and highly recommended for bridge foundation projects. Considering the diameter and structural load capacities of the drilled shafts, we recommend performing a test shaft program, including the performance of one instrumented load test at the bridge crossing site, to fulfill the following objectives:

- To examine the adequacy of the methods and equipment proposed by the contractor to install the high-capacity drilled shafts into the existing subsurface soil deposits.
- To confirm or modify the estimated tip elevations of the drilled shafts.
- To assess the contractor's method of placing and extracting the temporary casing for the drilled shaft.
- To assess the contractor's method of concrete placement.

To achieve these objectives, we recommend that the test shaft program consists of drilling one 4-foot diameter test shaft extending to a depth of about 50 feet below the existing ground surface. The location of the test shaft should be near, but outside of the planned abutment foundation location. A recommended load test shaft location will be provided upon completion of the final bridge foundation layout. In general, the load test shaft should be structurally reinforced and instrumented with embedment strain gauges for load testing purposes. The embedment strain gauges should be

placed starting from an elevation of about 5 feet above and below the load cell and subsequently at the pre-determined intervals, as shown on the Deep Foundation Load Test Detail, Plate 5.

Due to the high capacities recommended for the drilled shafts, a conventional load test would not be practical and would be costly to conduct. Therefore, we recommend conducting a bi-directional axial load test on the reinforced load test shaft using an expandable base load cell (Osterberg Load Cell). The expandable base load cell will need to be installed within the load test shaft reinforcing cage prior to lowering the cage in place.

The drilled shaft load test should be performed in general accordance with the Quick Load Test Method of ASTM D1143. The load test shaft should be loaded to failure to evaluate the ultimate side shear resistance and end-bearing components of the shaft. Installation of the expandable load cells, installation of the embedment strain gauges, performance of the bi-directional axial load tests, and presentation of the load test data should be performed by a professional experienced in these types of load testing procedures. The load test shaft should be loaded at increments of about 100 to 200 kips and should be held for a minimum of 4 hours (each hold) at 100%, 150%, and 200% of the design load intervals for the selected test shaft to evaluate the potential for creep effects.

Considering the specialized nature of the test shaft program, we recommend that a Geolabs representative be present during the test shaft program to evaluate the contractor's method of drilled shaft installation and to evaluate the subsurface materials encountered. In addition, Geolabs should observe the instrumented load test on the reinforced load test shafts. It should be noted that the drilled shaft design was developed from our analysis using the available field exploration data provided by others. Therefore, observation of the drilled shaft installation operations by Geolabs is a vital part of the foundation design to confirm our design assumptions.

3.1.5 Non-Destructive Integrity Testing

Based on the critical nature of the drilled shaft foundations for the replacement bridge structure, we recommend conducting non-destructive integrity testing on the test shaft and production drilled shafts for the project. Crosshole Sonic Logging (CSL) is one of the non-destructive integrity testing methods that has gained widespread use and acceptance for integrity testing of drilled shafts.

Crosshole Sonic Logging techniques are based on the propagation of sound waves through concrete. In general, the actual velocity of sound wave propagation in concrete is dependent on the concrete material properties, geometry of the element, and wavelength of the sound waves. When ultrasonic frequencies are generated, Pressure (P) waves and Shear (S) waves travel through the concrete. If anomalies are contained in the concrete, the anomalies will reduce the P-wave travel velocity in the concrete. Anomalies in the drilled shaft concrete may include soil particles, gravel, water, voids, contaminated concrete, and highly segregated constituent particles.

The transit time of an ultrasonic P-wave signal may be measured between an ultrasonic transmitter and receiver in two parallel water-filled access tubes placed into the concrete during construction. The P-wave velocity can be obtained by dividing the measured transit time from the distance between the transmitter and receiver. Therefore, anomalies may be detected (if they exist).

In general, the access tubes should be securely attached to the interior of the reinforcing cage as near to parallel as possible in the drilled shaft. We recommend casting a minimum of four access tubes into the concrete of the 4-foot diameter drilled shafts.

In addition, the access tubes should extend from the bottom of the drilled shaft reinforcing cage to at least 3.5 feet above the top of the shaft. It is imperative that joints required to achieve the full length of the access tubes should be watertight. The contractor is responsible for taking extra care to prevent damage to the access tubes during the placement of the reinforcing cage into the drilled hole. The tubes should be filled with potable water as soon as possible after concrete placement, but water

filling of the access tubes should not be later than 4 hours after the concrete placement. Subsequently, the top of the access tubes should be capped with watertight caps.

The Crosshole Sonic Logging (CSL) test of drilled shafts should be conducted after at least 7 days of curing time, but no later than 28 days after concrete placement. In addition, the CSL test of drilled shafts should be performed in general accordance with ASTM D6760. In the event that a drilled shaft is found to have significant anomalies and/or is suspected to be defective based on the CSL testing and/or field observations, the drilled shaft should be cored to evaluate the integrity of the concrete in the drilled shaft. The coring location within the drilled shaft should be determined by our representative, who should be present to observe the installation of the drilled shafts. After completion of the crosshole sonic logging of the drilled shafts, all the access tubes should be filled with grout of the same strength as the drilled shaft concrete.

3.2 Structural Approach Slabs

To reduce the potential for appreciable abrupt differential settlements between the drilled shaft supported bridge structure and the compacted backfills behind the abutment structures, we recommend providing structure approach slabs at the abutment locations. In general, the structure approach slabs should be at least 20 feet long.

The structure approach slabs should be supported on a minimum of 8 inches of aggregate subbase course placed on a prepared subgrade. The subgrade should be scarified to a depth of about 8 inches, moisture-conditioned to above the optimum moisture content, and compacted to no less than 95 percent relative compaction. The aggregate subbase course should also be moisture-conditioned to above the optimum moisture content and compacted to at least 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with AASHTO T-180 (or ASTM D1557). Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

3.3 Retaining Walls

In general, retaining structures, including the abutment wall and wing walls, should be designed to resist the lateral earth pressures due to the adjacent soils and surcharge effects. Parameters for the design of foundations for the abutment walls supported on drilled shafts have been provided in the "Bridge Crossing Foundations" section herein. Design of foundations for the retaining walls and other walls (not structurally connected to the bridge structure) should be based on the parameters presented in the following subsections.

3.3.1 Shallow Retaining Wall Foundations

We understand that retaining walls may be required for the wing walls of the new bridge structure. In general, we anticipate that shallow foundations bearing on fill consisting of hard sandy silts, medium dense to dense silty sands and gravel, and alluvial deposits consisting of dense silty gravels and hard cobbles and boulders encountered at the project site may be utilized for support of the planned retaining walls. Based on our field exploration, we believe that the following values may be used to evaluate the bearing support, sliding resistance, and passive pressure resistance of the planned retaining walls based on LRFD design methods.

RETAINING WALL FOUNDATIONS			
Description	**Extreme Event Limit State**	**Strength Limit State**	**Service Limit State**
Bearing Pressure	12,000 psf	6,000 psf	4,000 psf
Coefficient of Sliding Friction	0.40	0.34	N/A
Passive Pressure Resistance	330 pcf	165 pcf	N/A

In general, foundations should be embedded a minimum of 2 feet below the lowest adjacent finished grades. Foundations next to utility trenches or easements should be embedded below a 45-degree imaginary plane extending upward from the bottom edge of the utility trench, or they should extend to a depth as deep as the inverts of

the utility lines. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential for appreciable foundation settlement.

For sloping ground conditions, the footing should extend deeper to obtain a minimum 6-foot setback distance measured horizontally from the outside edge of the footing to the face of the slope. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

Based on a service limit state bearing pressure of 4,000 pounds per square foot (psf), we estimate that foundation settlements under the anticipated design loads for foundations bearing on the stiff to very stiff fill to be less than 1 inch.

Lateral loads acting on the structure may be resisted by frictional resistance between the base of the foundation and the bearing soil and by passive earth pressure developed against the near-vertical faces of the embedded portion of the foundation. The values presented in the table above, expressed in pounds per square foot per foot of embedment (pcf), may be used to evaluate the passive pressure resistance for footings embedded and bearing on the medium dense to dense and stiff to very hard fills and alluvium. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches should be neglected.

3.3.2 Static Lateral Earth Pressures

Retaining structures, including the abutment walls and wing walls, should be designed to resist the lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the retaining structures. The recommended lateral earth pressures for design of retaining structures, expressed in equivalent fluid pressures, are presented in the following table.

LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING STRUCTURES			
Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Level Backfill	Horizontal	34	53
	Vertical	None	None
Maximum 2H:1V Sloping Backfill	Horizontal	48	67
	Vertical	12	17

The values provided above assume that Type A Structure Backfill Material conforming to Section 703.20 of the Hawaii Standard Specifications for Road and Bridge Construction, 2005 (HSS) will be used to backfill behind the retaining structures. It is assumed that the backfill behind retaining structures will be compacted to at least 90 percent relative compaction. In general, an active condition may be used for gravity retaining walls or walls that are free to deflect by as much as 0.5 percent of the wall height. If the tops of walls are not free to deflect beyond this degree or are restrained, the walls should be designed for the at-rest condition. These lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the walls.

Surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the depth of the wall should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the wall, a rectangular distribution with uniform pressure equal to 34 percent of the vertical surcharge pressure acting over the entire height of the wall, which is free to deflect (cantilever), may be used in the design. For walls that are restrained, a rectangular distribution equal to 53 percent of the vertical surcharge pressure acting over the entire height of the wall may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.3.3 Dynamic Lateral Earth Pressures

Dynamic lateral earth forces due to seismic loading (a_{max}= 0.32g) may be estimated by using $7.2H^2$ pounds per lineal foot of wall length for level backfill conditions, where H is the height of the wall in feet. It should be noted that the dynamic lateral earth forces provided assume that the wall will be allowed to move laterally by up to about 3 inches in the event of an earthquake. The resultant force should be assumed to act through the mid-height of the wall. An appropriately reduced factor of safety may be used when dynamic lateral earth forces are accounted for in the design of the retaining structures.

If the estimated amount of lateral movement is not acceptable, the retaining structure should be designed with higher dynamic lateral forces for a restrained condition. For a restrained condition (less than 0.5 inches of lateral movement), dynamic lateral forces due to seismic loading may be estimated using $14.5H^2$ pounds per lineal foot of wall (H measured in feet) for level backfill conditions.

3.3.4 Drainage

Retaining walls should be well-drained to reduce the potential for the build-up of hydrostatic pressures. A typical drainage system would consist of a 12-inch wide zone of permeable material, such as drain rock (AASHTO M43 Size No. 67), directly adjacent to the wall with a perforated pipe (perforations facing down) at the base of the wall discharging to an appropriate outlet or weepholes. As an alternative, a prefabricated drainage product, such as MiraDrain or EnkaDrain, may be used instead of the drainage material. The prefabricated drainage product should also be hydraulically connected to a perforated pipe at the base of the wall.

Backfill behind the permeable drainage zone should consist of Type A Structure Backfill Material conforming to Section 703.20 of the HSS (a minimum of 95 percent relative compaction). Unless covered by concrete slabs or pavements, the upper 12 inches of backfill should consist of relatively impervious material to reduce the potential for water infiltration behind the walls. In addition, the backfill below the drainage outlet (or weepholes) should consist of the relatively impervious material to reduce the potential for water infiltration into the footing subgrade. The relatively impervious material should be compacted to no less than 90 percent relative compaction.

3.3 Concrete Slabs-On-Grade

We understand concrete slabs-on-grade will be used for the sidewalks for the project. Our laboratory tests indicate the near-surface clayey and silty soils exhibit low to moderate shrink/swell potential when subjected to moisture fluctuations. Unless walkways constructed above these potentially expansive soils are properly designed, there is a potential for future distress to the lightly loaded walkways resulting from shrinking and swelling of the cohesive soils due to changes in the moisture content.

To reduce the potential for appreciable structural distress resulting from swelling of the subgrade soils, we recommend properly preparing the subgrade soils prior to fill placement. Flatwork, such as the planned sidewalks required for the project should be underlain by a minimum 12-inch thick layer of non-expansive, select granular material or aggregate subbase. The subgrade soils below the flatwork should be scarified to a minimum depth of about 8 inches, moisture-conditioned to at least 2 percent above the optimum content, and recompacted to a minimum of 90 percent relative compaction. The non-expansive, select granular material (or aggregate subbase) should be compacted to a minimum of 90 percent relative compaction. To reduce the potential for substantial shrinkage cracks developing in the slabs, control joints should be provided at intervals equal to the width of the walkways with expansion joints at right-angle intersections. It should be emphasized that the areas adjacent to the walkway should be backfilled tightly against the slab edges with low expansion, relatively impervious soils. These areas also should be graded to divert water away from the slabs and to reduce the potential for water ponding around the slabs and foundations.

The underlying subgrade soils should be wetted and kept moist until the final placement of slab concrete. Where shrinkage cracks are observed after compaction of the subgrade, we recommend preparing the subgrade soils again as recommended above. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavation of the soft areas and replacement with well-compacted fill.

3.4 Site Grading

Based on the grading plan provided, we anticipate minor cuts and fills of about 5 feet or less will be required to achieve the finished grades. In general, grading work should conform to Section 200 of the Hawaii Standard Specifications for Road and Bridge Construction (2005) and the site-specific recommendations contained in this report. Items of site grading that are addressed in the subsequent subsections include the following:

1. Site Preparation
2. Fills and Backfills
3. Fill Placement and Compaction Requirements
4. Excavations

A Geolabs representative should monitor the site grading operations to observe whether undesirable materials are encountered during the excavation and scarification process and to confirm whether the exposed subsurface conditions are similar to those encountered in our field exploration.

3.4.1 Site Preparation

At the on-set of earthworks, the area within the contract grading limits should be cleared and grubbed thoroughly. Vegetation, debris, deleterious materials, existing pavements, and other unsuitable materials should be removed and disposed of properly off-site or in a designated area to reduce the potential for contamination of the excavated materials.

Soft and yielding areas encountered during clearing and grubbing below areas designated to receive fill and/or future improvements should be over-excavated to expose firm natural materials, and the resulting excavation should be backfilled with well-compacted fill. The excavated soft soils should not be reused as fill materials and should be properly disposed of off-site or in a designated area.

After clearing and grubbing, the exposed subgrades in areas to receive fill and finished subgrades in cut areas should be scarified to a depth of about 8 inches, moisture-conditioned to at least 2 percent above the optimum moisture, and recompacted to a minimum of 90 percent relative compaction. The compaction requirements for finished subgrades subjected to vehicular traffic, such as the pavement subgrades, should be increased to a minimum of 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Where shrinkage cracks are observed after the subgrade compaction, we recommend preparing the subgrade soil again as recommended above. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavating the soft areas and replacing these areas with engineered fill. A Geolabs field representative should evaluate the need for over-excavation due to soft subgrade soil conditions.

3.4.2 Fills and Backfills

In general, the excavated on-site materials generated from the excavations may be reused as a source of general fill materials, provided that the materials are screened of over-sized materials (greater than 3 inches in maximum dimension) and are free of deleterious materials.

Imported materials required for site filling should consist of select granular fill material, such as crushed coralline and/or basaltic materials. The materials should be well-graded from coarse to fine with particles no greater than 3 inches in largest dimension. In addition, the materials also should contain between 10 and 30 percent particles passing the No. 200 sieve. The materials should have a California Bearing Ratio (CBR) value of 20 or higher, and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. Imported fill materials should be tested for the above requirements prior to being transported to the project site for the intended use.

Aggregate base course and subbase course should meet the material requirements as specified in Section 703 of the Hawaii State Standard Specifications. Imported fill materials should be tested for conformance with these recommendations prior to delivery to the project site for the intended use.

DRAFT Geotechnical Exploration Report - June 26, 2024
SECTION 3. DISCUSSION AND RECOMMENDATIONS

3.4.3 Fill Placement and Compaction Requirements

Fill materials consisting of the on-site soils should be moisture-conditioned to at least about 2 percent above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D1557. Optimum moisture is the water content (percentage by weight) corresponding to the maximum dry density.

Imported fill materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts of about 8 inches in loose thickness, and compacted to a minimum of 90 or 95 percent relative compaction, as appropriate. Aggregate base course and subbase materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 95 percent relative compaction.

Compaction should be accomplished by sheepsfoot rollers or other types of acceptable compaction equipment. Water tamping, jetting, or ponding should not be allowed to compact the fills. Where compaction is less than required, additional compactive effort should be applied with adjustment of moisture content, as necessary, to obtain the specified compaction.

3.4.4 Excavations

The project site is underlain by relatively stiff and/or dense fill material and alluvial deposits. It is anticipated that the near-surface fills and residual soils may be readily excavated with normal excavation equipment, such as excavators and ripping with large bulldozers. However, we encountered very dense cobbles and boulders within the alluvial deposits. Therefore, there is a potential to encounter hard cobbles and/or boulders in the excavations that may require the use of hoerams or chipping. The contractor must exercise care to avoid creating overhang and/or unsafe conditions.

The previous discussions regarding the rippability of the surface materials are based on the anticipated subsurface at the project site and our experience in the project vicinity. Contractors bidding on this project should be encouraged to review and understand the geologic environment of the project site and to examine the site conditions and soil data to make their own interpretation.

3.5 Underground Utilities

We anticipate that new underground utility lines may be required for the proposed project. The contractor should determine the methods and equipment to be used for excavation, subject to practical limits and safety considerations. The excavation should comply with all applicable local, state, and federal safety requirements. The contractor should be responsible for trench shoring design and installation. Trench shoring and bracing should conform to the appropriate health and safety requirements.

In general, we recommend providing granular bedding consisting of 6 inches of No. 3B Fine gravel (ASTM C33, No. 67 gradation) under the pipes. The initial backfill up to about 12 inches above the pipes should consist of free-draining backfills, such as No. 3B Fine gravel, to reduce the potential for pipe damage from compaction of the backfill. It is critical to use a free-draining granular material to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. The use of on-site soils as backfill directly around utility pipes is not recommended.

The upper portion of the trench backfill from the level 12 inches above the pipes to the finished subgrade should consist of the approved on-site soils with a maximum particle size of 6 inches or less or select granular fill material. The backfill material should be moisture-conditioned to about 2 percent above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction (to reduce the potential for future ground subsidence). The upper 3 feet of the trench backfill below pavements should be compacted to not less than 95 percent relative compaction. Mechanical compaction equipment should be used to compact the materials at the project site. Water tamping, jetting, or ponding should not be used to compact the backfill material.

3.6 Permeability Tests

We understand that the project may require on-site storm water runoff management, such as detention basins or bioswales. In order to obtain subsurface infiltration information in support of the planning of the proposed infiltration systems, we conducted ten constant head permeability tests and nine falling head permeability tests in the drilled borings identified as Boring Nos. P-1 thorough P-8. The permeability test results are presented in Appendix D.

The constant head tests were performed by pumping water into the borings until the water surface stabilized and remained at equilibrium for a sufficient period of time. The water height at the rate of pumping were then measured to provide data upon which to base calculations of the subsoil permeability. After completion of the constant head test, the water inside the boring was allowed to drop for the performance of a falling head test. The time intervals and water level drop were recorded to provide data upon which to base the calculation of the permeability values of the subsoils.

The results of the constant and falling head permeability test are summarized in the table below and are presented in Appendix D.

PERMEABILITY TEST RESULTS

Test Location	Test Type	Test Depth (feet)	Test Elevation (feet MSL)	Flow Rate (gpm)	Permeability (ft/min)
P-1	Constant Head	30	+309	24.2	0.0093
	Falling Head	30	+309	N/A	0.0008
P-2	Constant Head	30	+258	4.4	0.0020
	Falling Head	30	+258	N/A	0.0002
P-3	Constant Head	30	+239	4	0.0019
	Falling Head	30	+239	N/A	0.0001

PERMEABILITY TEST RESULTS					
Test Location	Test Type	Test Depth (feet)	Test Elevation (feet MSL)	Flow Rate (gpm)	Permeability (ft/min)
P-4	Constant Head	30	+229	6.1	0.0031
	Falling Head	30	+229	N/A	0.0006
P-5	Constant Head	30	+239.5	4.2	0.0500
	Falling Head	30	+239.5	N/A	0.0056
P-6	Constant Head	26	+274	4.6	0.0020
	Constant Head	31	+269	1.9	0.0008
	Falling Head	31	+269	N/A	0.0001
P-7	Constant Head	26	+302	12.6	0.0050
	Falling Head	26	+302	N/A	0.0021
	Constant Head	30.5	+297	8.9	0.0035
	Falling Head	30.5	+297	N/A	0.0008
P-8	Constant Head	30	+291.5	4	0.0016
	Falling Head	30	+291.5	N/A	0.0002

Based on the results of the field permeability tests, the average permeability rates at these locations indicate that available methods of storm water management would be feasible for this project. It should be noted that the permeability value presented above is the rate of permeability through the soil exposed at the bottom of a 4.5-inch diameter borehole, which may not represent the actual permeability condition within a typical infiltration chamber footprint or an open basin. Due to the variability of the subsurface conditions, the absorption capacity of the selected stormwater disposal system should be confirmed by conducting additional permeability and infiltration tests during construction.

3.7 Drainage

The finished grades adjacent to the new sidewalks and roadways should be sloped to shed water away from the new structures and to reduce the potential for ponding around the new structures. Excessive landscape watering near the sidewalks also should be avoided.

These drainage requirements are essential for the proper performance of the new structures because ponded water could cause subsurface soil saturation and subsequent heaving or loss of strength. The excavations should be properly backfilled against the new structures edges to reduce the potential for excessive water infiltration into the subsurface. Drainage swales should be provided as soon as possible and should be maintained to drain surface water runoff away from the new structures.

3.8 Design Review

Preliminary and final drawings and specifications for the project should be forwarded to Geolabs for review and written comments prior to bid solicitation for construction. This review is necessary to evaluate conformance of the plans and specifications with the intent of the foundation and earthwork recommendations provided herein. If this review is not made, Geolabs cannot be responsible for misinterpretation of our recommendations.

3.9 Post-Design Services/Services During Construction

Geolabs should be retained to provide geotechnical engineering services during construction. The critical items of construction monitoring that require "Special Inspections" include the following:

1. Review of drilled shaft foundation installation submittals
2. Observation of the load test shaft installation and load testing.
3. Observation of the production drilled shaft installation.
4. Observation of the foundation excavation and preparation.
5. Observation of fill and backfill placement.
6. Observation of roadway subgrade excavation and compaction.

A Geolabs representative also should monitor other aspects of earthwork construction to observe compliance with the intent of the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. Geolabs should be accorded the opportunity to provide geotechnical engineering services during construction to confirm our assumptions in providing the recommendations presented herein.

If the actual exposed subsurface conditions encountered during construction differ from those assumed or considered in this report, Geolabs should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based in part upon information obtained from the borings and bulk samples. Variations of the subsurface conditions between and beyond the field data points may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report.

The boring locations indicated in this report are approximate, having been taped from existing features shown on the drawings received from Warren S. Unemori Engineering, Inc. on September 6, 2022. Elevations shown on the logs of borings were obtained by interpolating between the spot elevations and contour lines shown on the same plan. The physical locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

The stratification breaks represented on the Logs of Borings show the approximate boundaries between soil/rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text of this report. The data has been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation in seasonal rainfall and other factors.

This report has been prepared for the exclusive use of Bowers + Kubota Consulting, Inc. for specific application to the proposed Waiale Road Extension project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the design engineers in the design of the proposed project. Therefore, this report may not contain sufficient data and/or the proper information to serve as the basis for construction cost estimates nor for bidding purposes. A contractor wishing to bid on this project should retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen subsurface conditions, such as cavities, perched groundwater, soft deposits, or hard layers may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the project site. It should be noted that the equipment, techniques, and personnel used to conduct a geo-environmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

DRAFT
By ____________________
Jason Seidman, P.E.
Senior Project Engineer

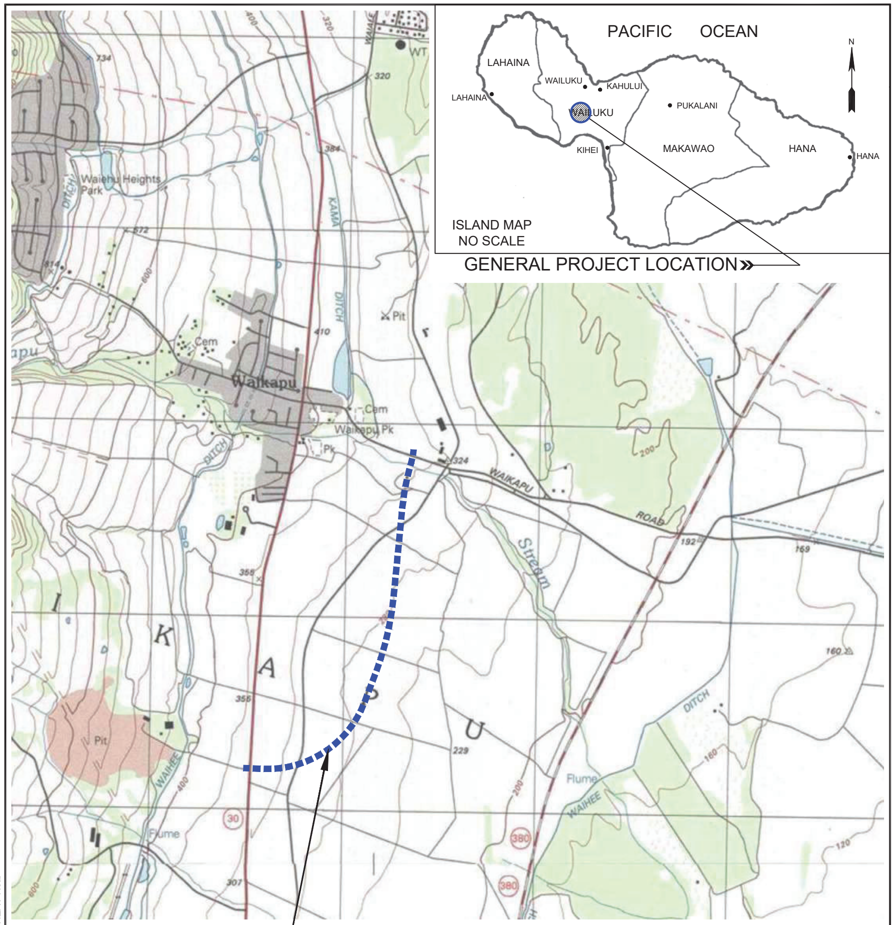
DRAFT
By ____________________
Gerald Y. Seki, P.E.
Vice President

GS:JS:RY:as

h:\8300Series\8345-00.ry1

PLATES

DRAFT Geotechnical Exploration Report - June 26, 2024



PROJECT LOCATION

PROJECT LOCATION MAP

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

2000 1000 0 2000 FT.
GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	1
1" = 2,000'	8345-00	

CAD User: KIM File Last Updated: June 17, 2022 5:35:02pm Plot Date: December 01, 2023 - 4:42:57pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00PLM.dwg\1
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb

LEGEND:

APPROXIMATE BORING LOCATION

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

SITE PLAN - 1

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.1

DRAFT Geotechnical Exploration Report - June 26, 2024

LEGEND:

APPROXIMATE BORING LOCATION

APPROXIMATE BULK SAMPLE LOCATION

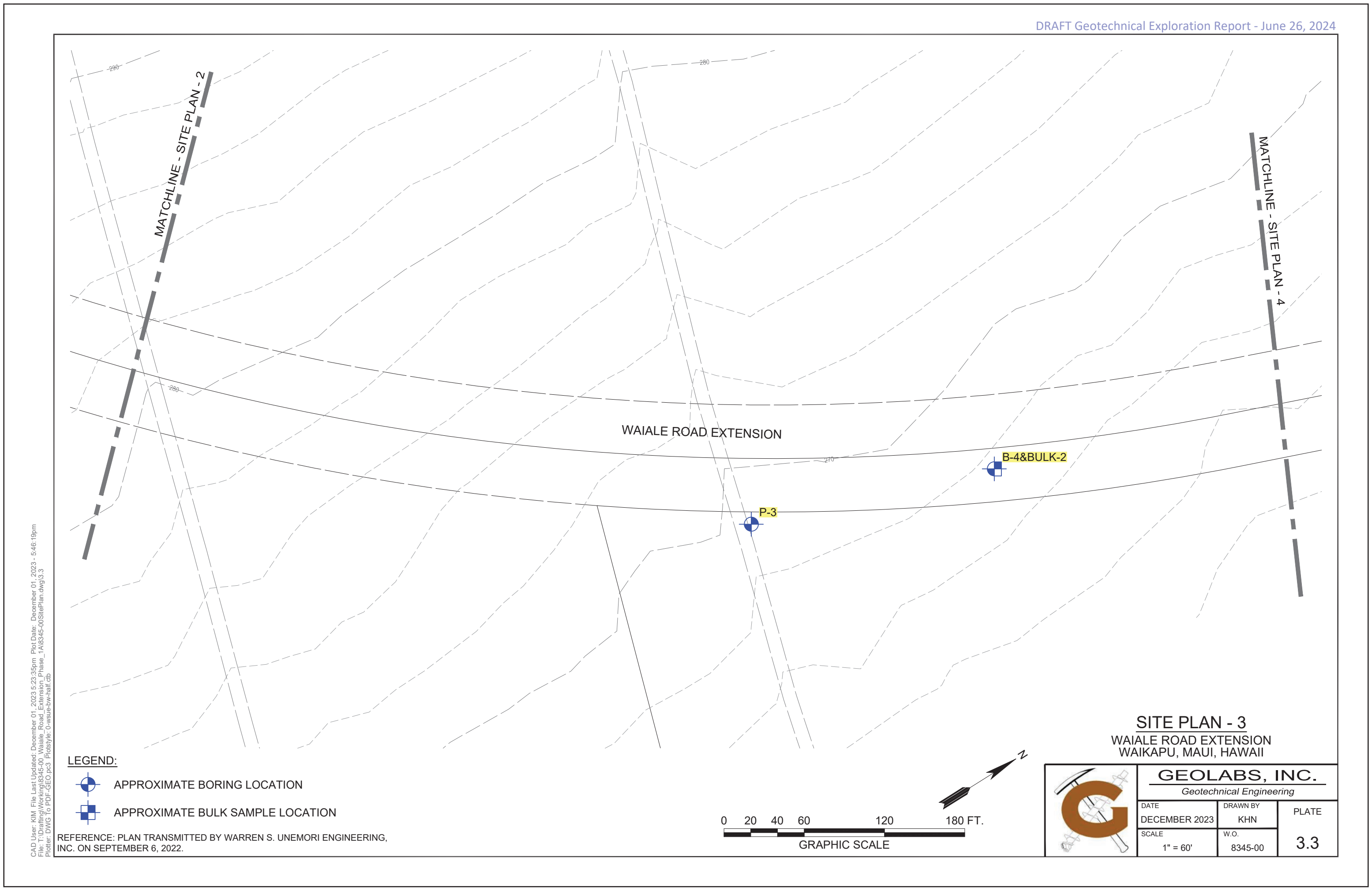
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

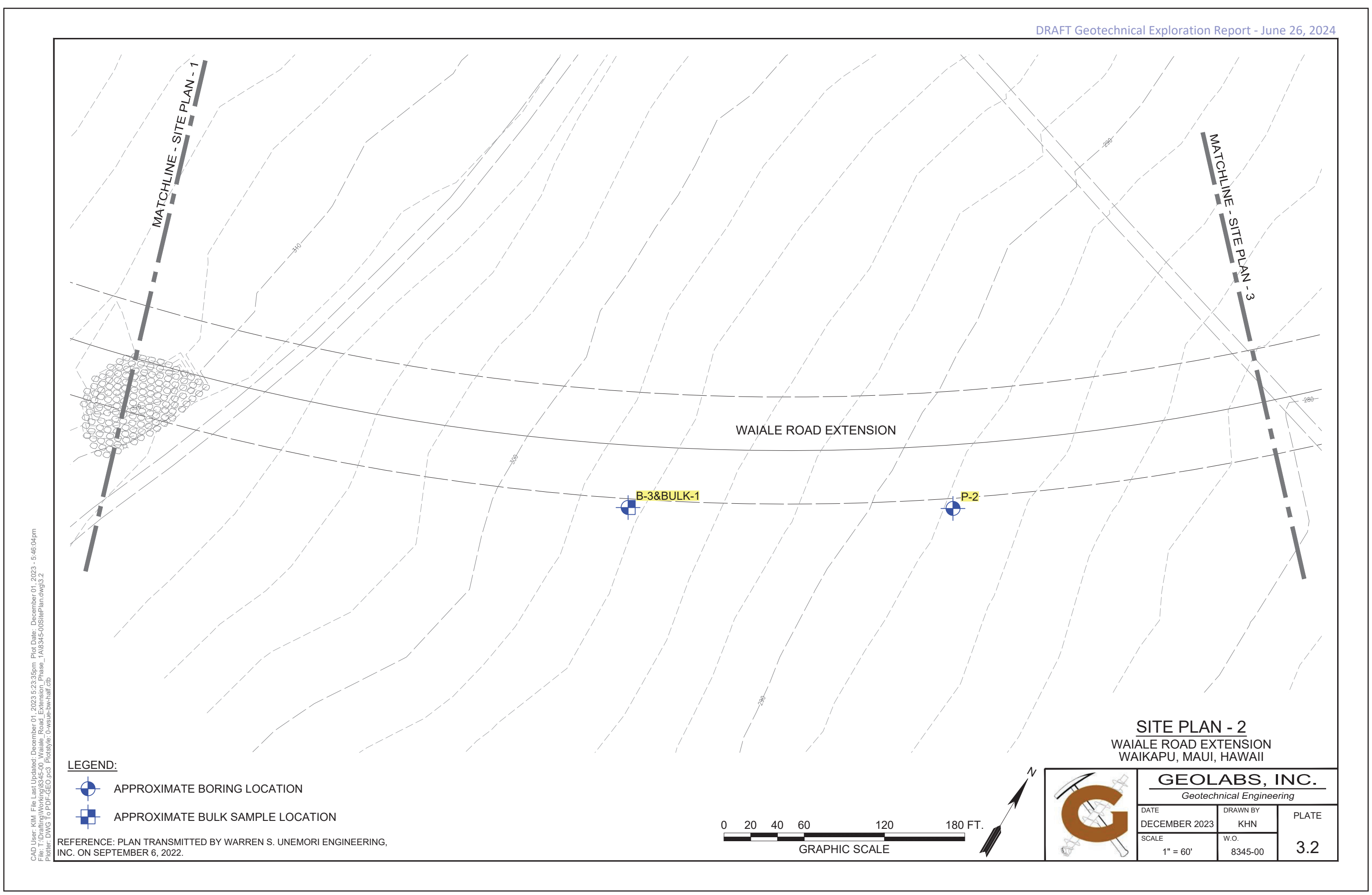
OVERALL SITE PLAN

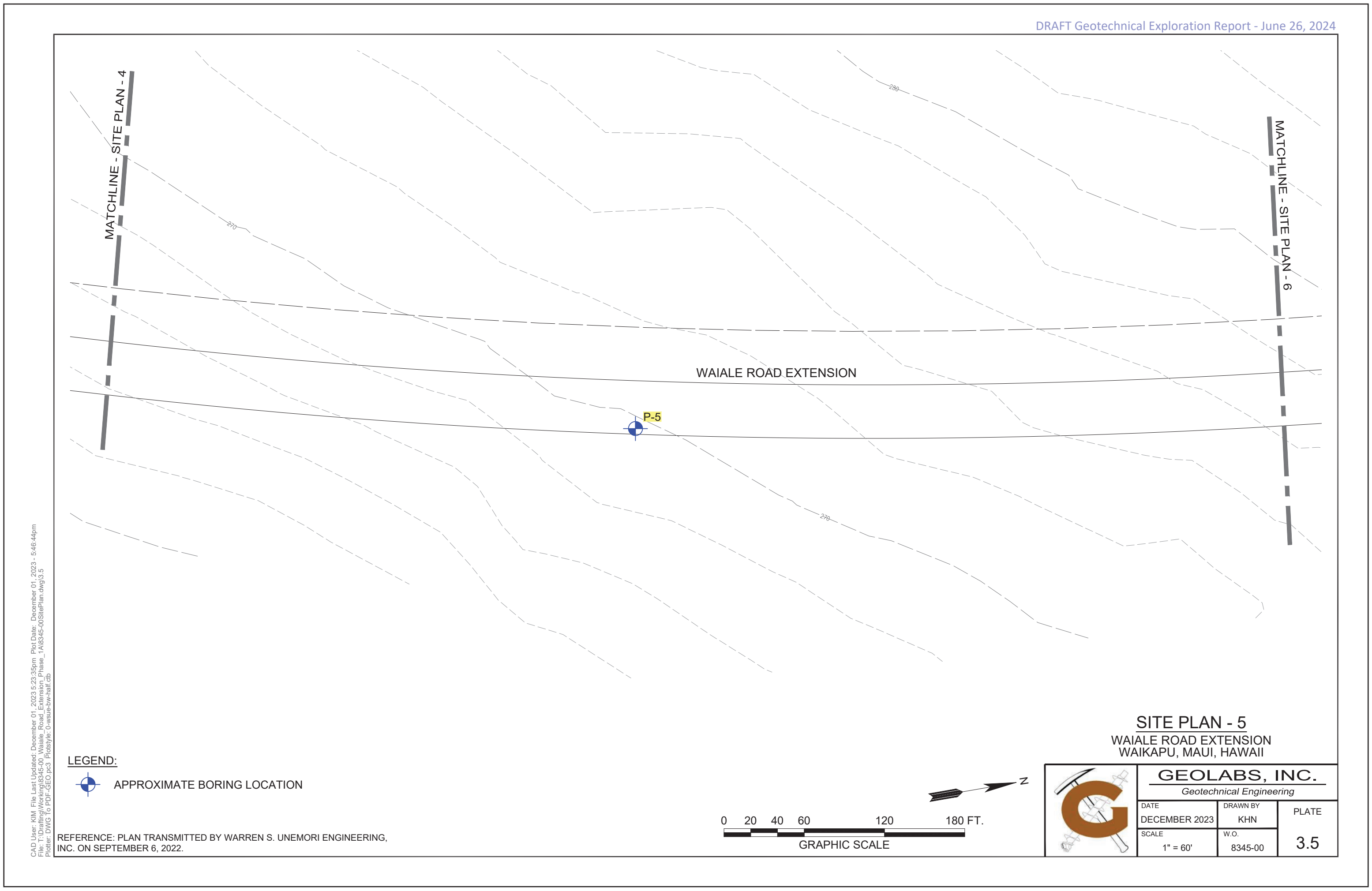
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

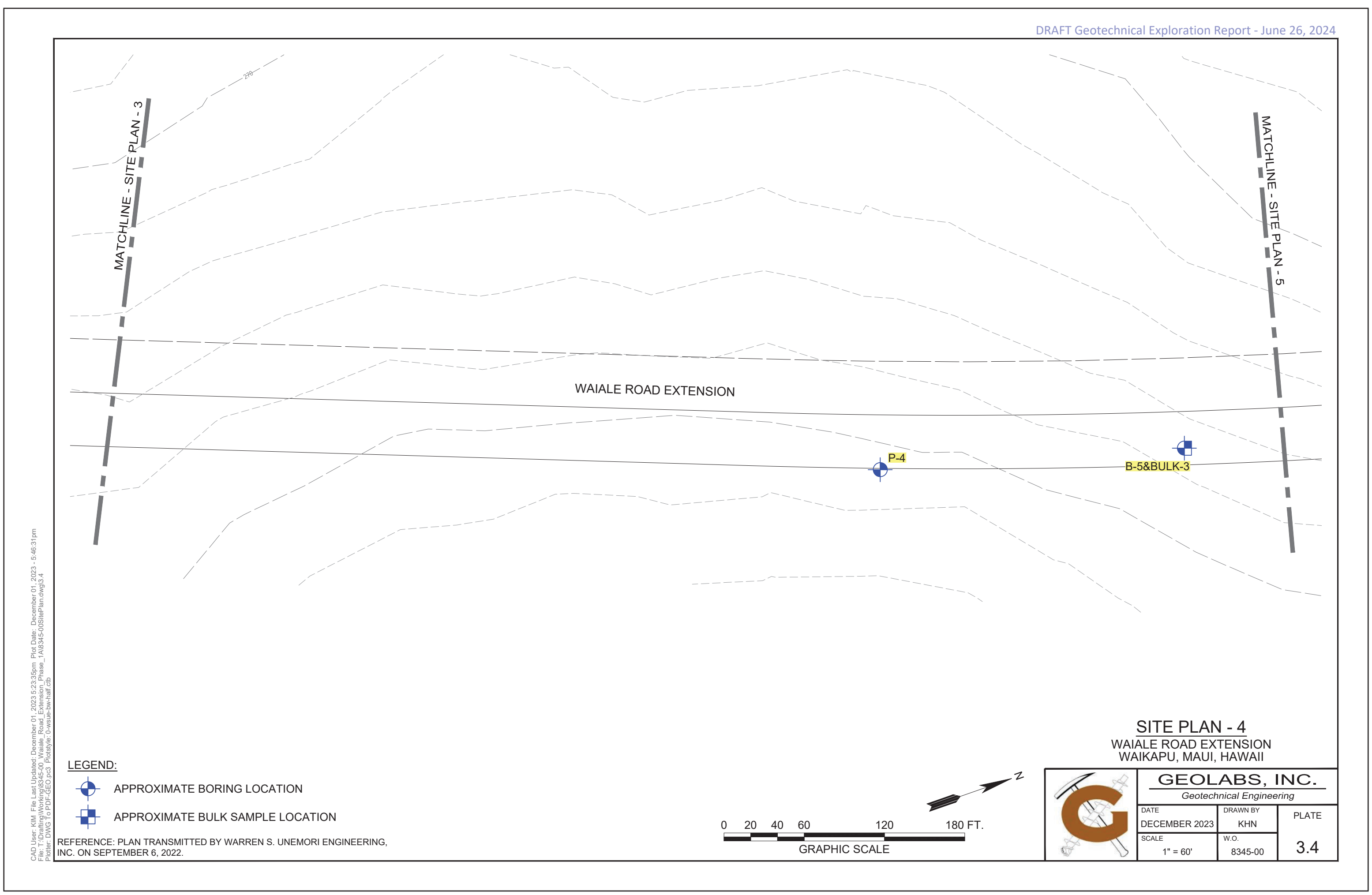
DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 500'	8345-00	2


MATCHLINE - SITE PLAN - 2
MATCHLINE - SITE PLAN - 4
WAIALE ROAD EXTENSION
B-4&BULK-2
P-3
SITE PLAN - 3
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
LEGEND:
APPROXIMATE BORING LOCATION
APPROXIMATE BULK SAMPLE LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
GEOLABS, INC.
Geotechnical Engineering
DATE DECEMBER 2023
DRAWN BY KHN
SCALE 1" = 60'
W.O. 8345-00
PLATE 3.3

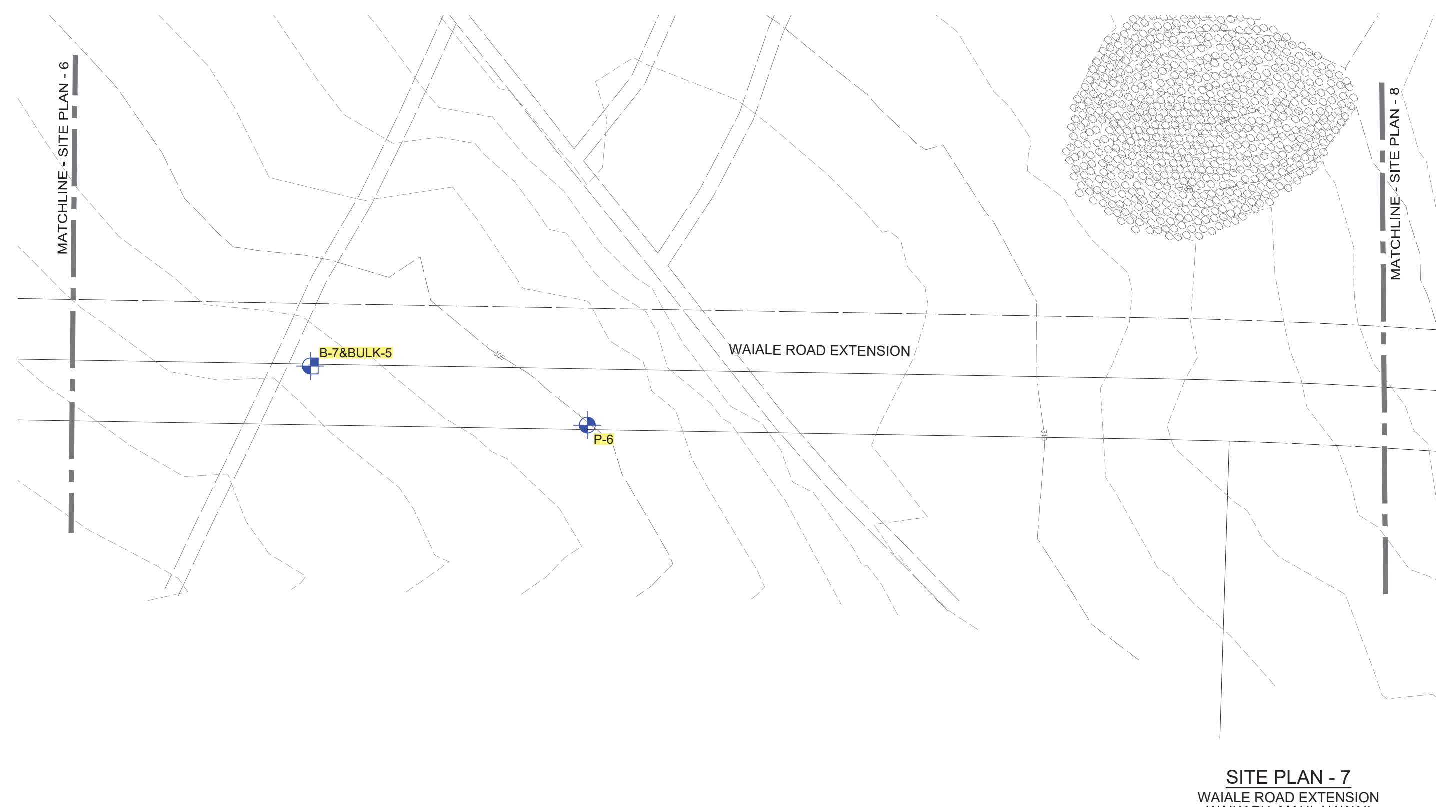

MATCHLINE - SITE PLAN - 1
MATCHLINE - SITE PLAN - 3
WAIALE ROAD EXTENSION
B-3&BULK-1
P-2
SITE PLAN - 2
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
LEGEND:
APPROXIMATE BORING LOCATION
APPROXIMATE BULK SAMPLE LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
GEOLABS, INC.
Geotechnical Engineering
DATE DECEMBER 2023
DRAWN BY KHN
SCALE 1" = 60'
W.O. 8345-00
PLATE 3.2



DRAFT Geotechnical Exploration Report - June 26, 2024
MATCHLINE - SITE PLAN - 4
MATCHLINE - SITE PLAN - 6
WAIALE ROAD EXTENSION
P-5
LEGEND:
APPROXIMATE BORING LOCATION
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
SITE PLAN - 5
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
PLATE
SCALE
1" = 60'
W.O.
8345-00
3.5



DRAFT Geotechnical Exploration Report - June 26, 2024
MATCHLINE - SITE PLAN - 3
MATCHLINE - SITE PLAN - 5
WAIALE ROAD EXTENSION
P-4
B-5&BULK-3
LEGEND:
APPROXIMATE BORING LOCATION
APPROXIMATE BULK SAMPLE LOCATION
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
SITE PLAN - 4
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
PLATE
SCALE
1" = 60'
W.O.
8345-00
3.4



SITE PLAN - 7
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

LEGEND:
- APPROXIMATE BORING LOCATION
- APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

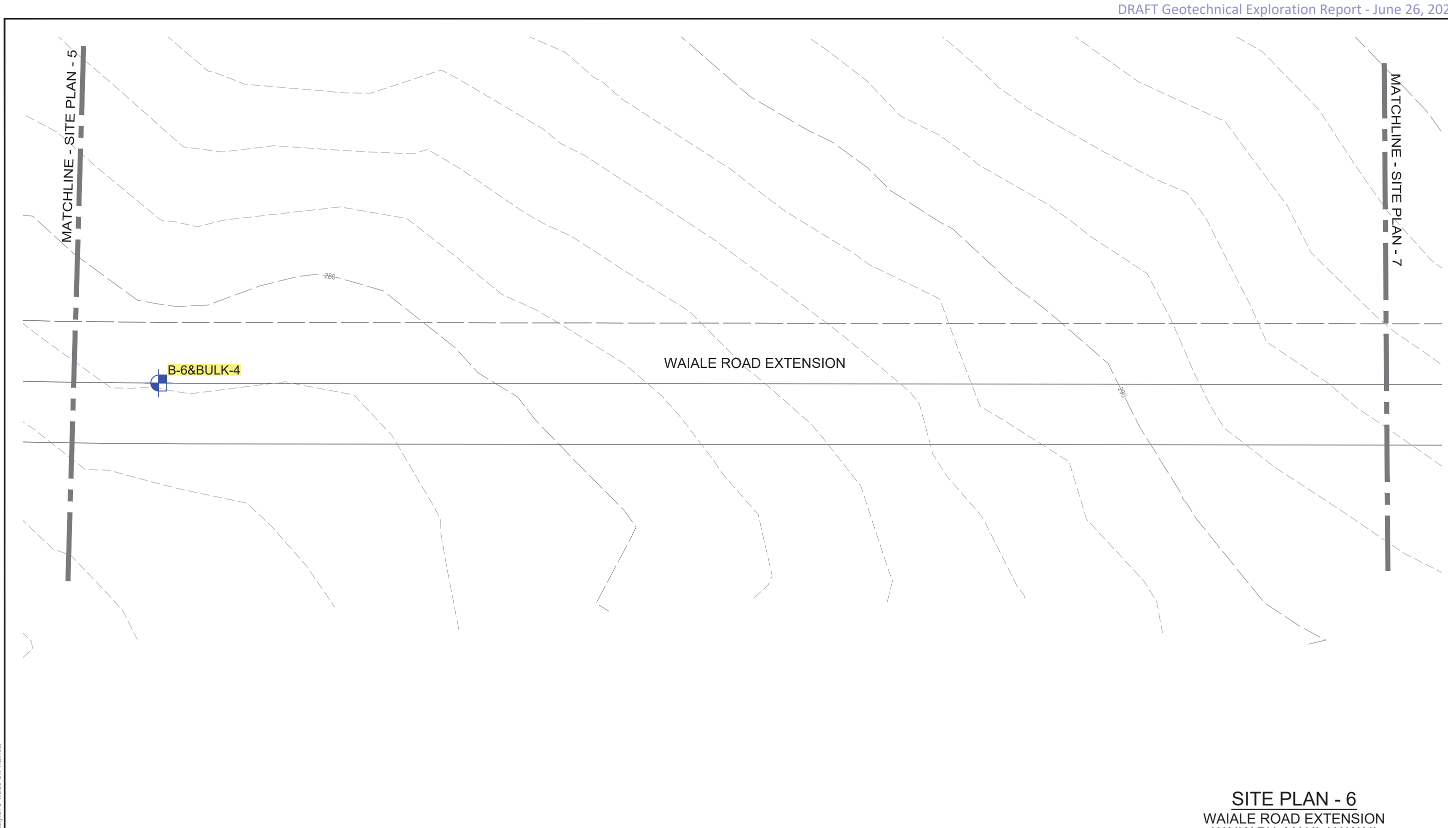
N

0 20 40 60 120 180 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.7

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:13pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.7
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb



SITE PLAN - 6
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

LEGEND:
- APPROXIMATE BORING LOCATION
- APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

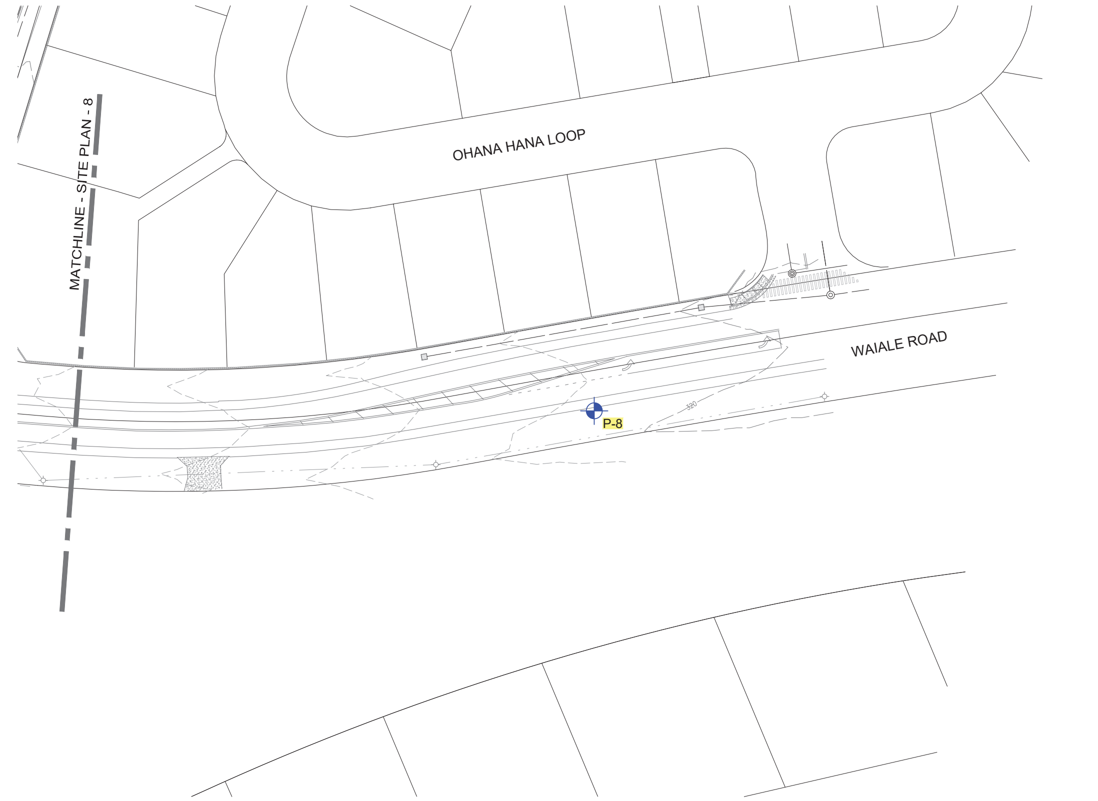
N

0 20 40 60 120 180 FT.
GRAPHIC SCALE

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.6

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:01pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.6
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb



SITE PLAN - 9

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

LEGEND:

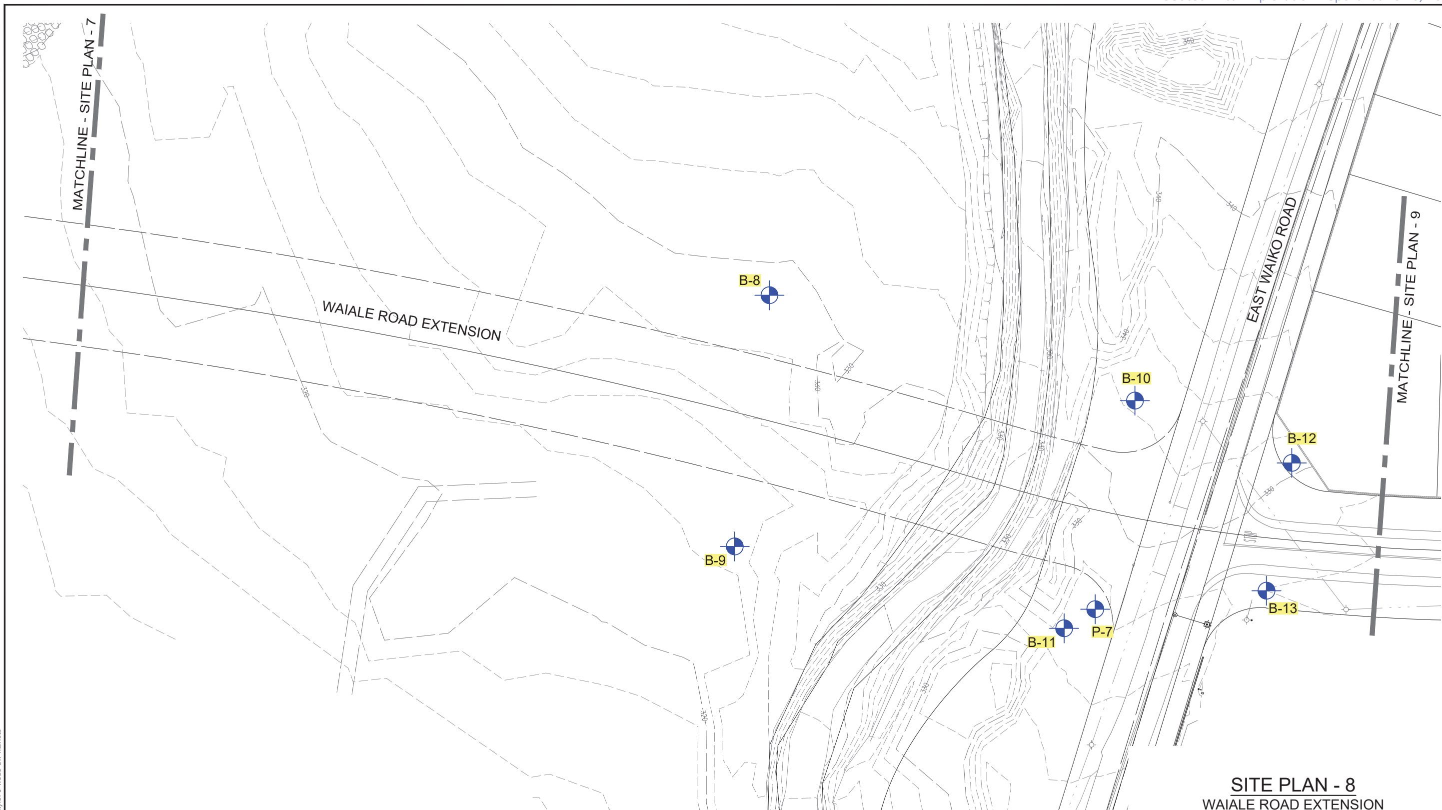
APPROXIMATE BORING LOCATION

0 20 40 60 120 180 FT.
GRAPHIC SCALE

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

GEOLABS, INC. Geotechnical Engineering		
DATE: DECEMBER 2023	DRAWN BY: KHN	PLATE
SCALE: 1" = 60'	W.O. 8345-00	3.9

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:39pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.9
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb



SITE PLAN - 8

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

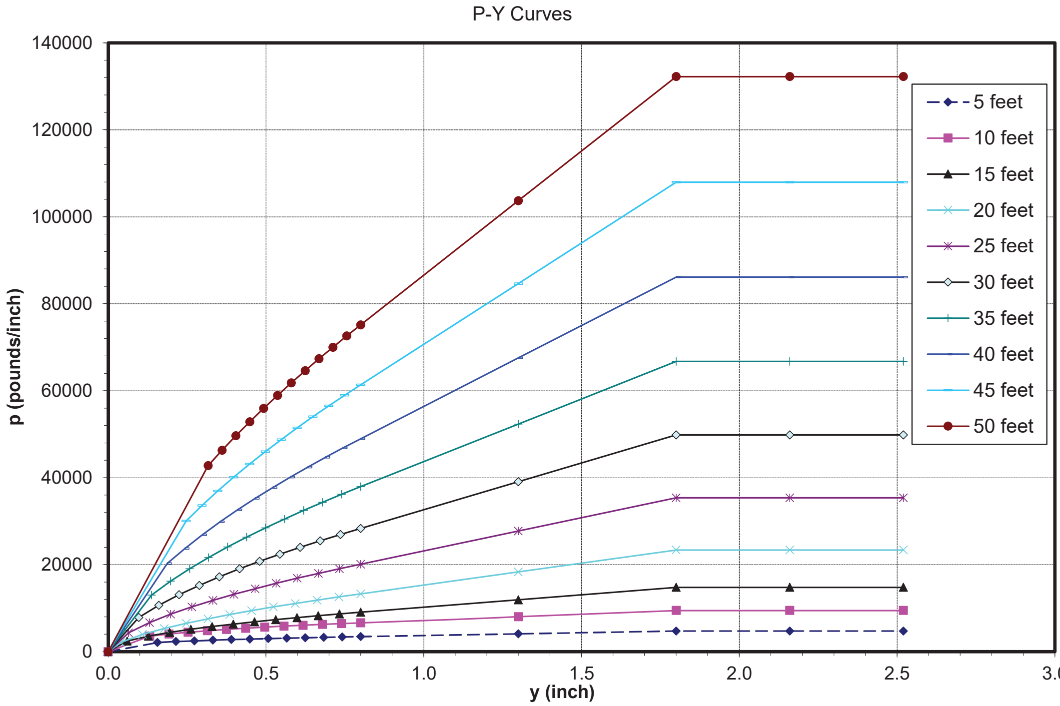
0 20 40 60 120 180 FT.
GRAPHIC SCALE

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

GEOLABS, INC. Geotechnical Engineering		
DATE: DECEMBER 2023	DRAWN BY: KHN	PLATE
SCALE: 1" = 60'	W.O. 8345-00	3.8

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:29pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.8
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
P-Y Curves

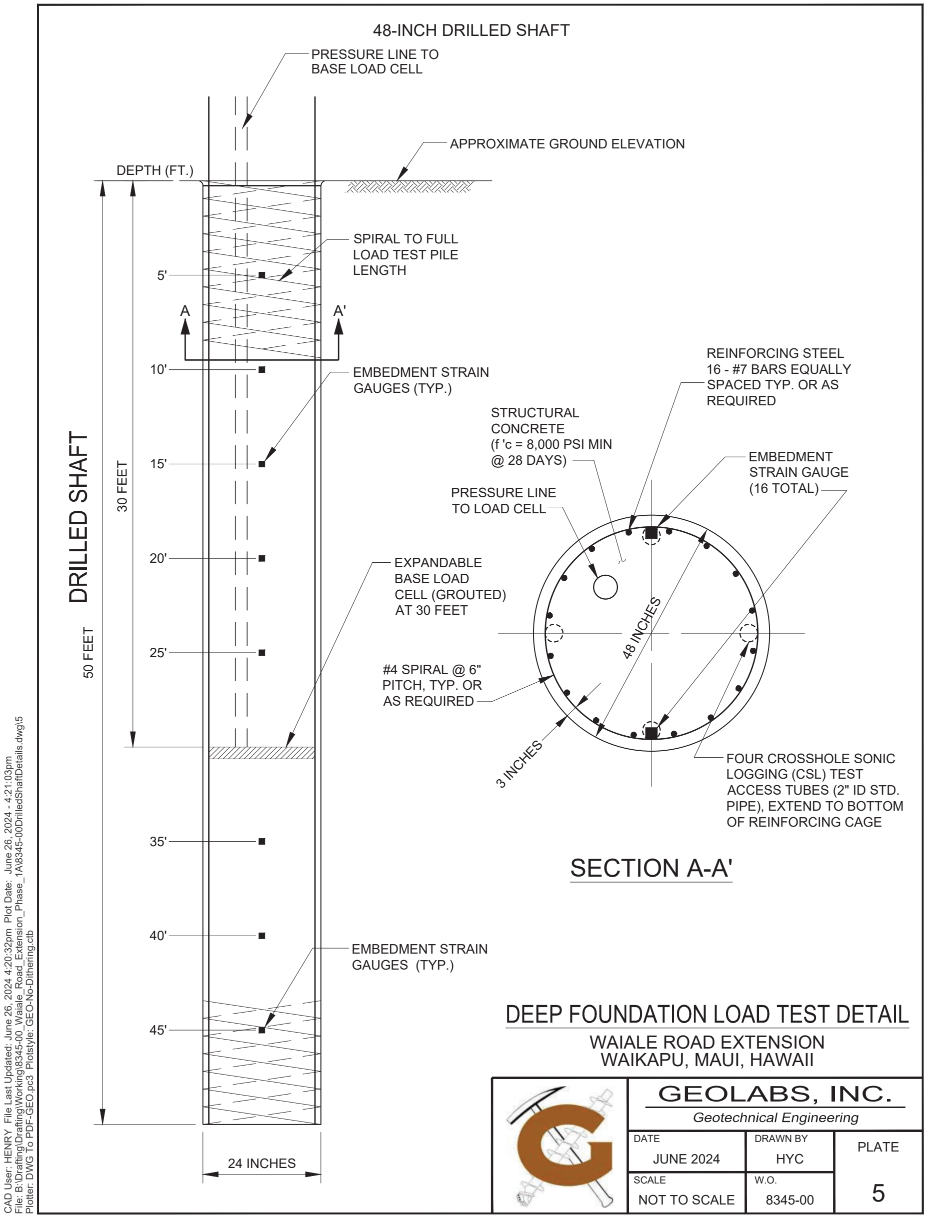


DRAFT Geotechnical Exploration Report - June 26, 2024

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
P-Y Curves

5 feet		10 feet		15 feet		20 feet		25 feet	
y	p	y	p	y	p	y	p	y	p
(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	2106.9	0.1	3564.0	0.1	2430.1	0.0	2136.3	0.1	4344.2
0.2	2319.5	0.2	4059.9	0.1	3560.2	0.1	3949.4	0.1	6699.6
0.3	2494.6	0.3	4461.3	0.2	4416.3	0.2	5327.4	0.2	8605.9
0.3	2645.2	0.3	4803.6	0.3	5135.1	0.2	6504.7	0.3	10270.7
0.4	2778.2	0.4	5104.8	0.3	5767.5	0.3	7557.9	0.3	11776.6
0.4	2897.9	0.4	5375.5	0.4	6338.8	0.4	8523.7	0.4	13167.3
0.5	3007.1	0.5	5622.4	0.5	6864.1	0.5	9423.5	0.5	14469.0
0.6	3107.9	0.6	5850.3	0.5	7353.0	0.5	10270.9	0.5	15699.2
0.6	3201.6	0.6	6062.4	0.6	7812.2	0.6	11075.5	0.6	16870.0
0.7	3289.3	0.7	6261.2	0.7	8246.7	0.7	11844.0	0.7	17990.7
0.7	3372.0	0.7	6448.7	0.7	8660.0	0.7	12581.6	0.7	19068.0
0.8	3450.2	0.8	6626.3	0.8	9055.1	0.8	13292.3	0.8	20107.4
1.3	4101.0	1.3	8051.7	1.3	11929.1	1.3	18343.3	1.3	27748.2
1.8	4751.7	1.8	9477.1	1.8	14803.1	1.8	23394.4	1.8	35389.0
2.2	4751.7	2.2	9477.1	2.2	14803.1	2.2	23394.4	2.2	35389.0
2.5	4751.7	2.5	9477.1	2.5	14803.1	2.5	23394.4	2.5	35389.0

30 feet		35 feet		40 feet		45 feet		50 feet	
y	p	y	p	y	p	y	p	y	p
(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)	(inch)	(pounds/inch)
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	7843.4	0.1	13011.8	0.2	20260.6	0.2	30032.3	0.3	42799.1
0.2	10674.7	0.2	16222.7	0.2	23728.6	0.3	33609.4	0.4	46310.9
0.2	13084.5	0.3	19066.0	0.3	26896.0	0.3	36955.9	0.4	49658.7
0.3	15235.9	0.3	21658.3	0.4	29838.9	0.4	40117.3	0.4	52866.9
0.4	17206.8	0.4	24064.0	0.4	32605.3	0.4	43125.6	0.5	55954.1
0.4	19041.5	0.4	26323.6	0.5	35227.9	0.5	46004.2	0.5	58935.1
0.5	20768.6	0.5	28464.3	0.5	37730.1	0.5	48771.0	0.6	61821.9
0.5	22407.6	0.6	30505.9	0.6	40129.6	0.6	51440.1	0.6	64624.3
0.6	23972.7	0.6	32463.0	0.6	42439.9	0.6	54022.7	0.7	67350.4
0.7	25474.4	0.7	34346.7	0.7	44671.8	0.7	56528.0	0.7	70007.2
0.7	26921.1	0.7	36166.0	0.7	46834.0	0.7	58963.6	0.8	72600.4
0.8	28319.3	0.8	37928.1	0.8	48933.7	0.8	61336.1	0.8	75135.3
1.3	39080.7	1.3	52340.8	1.3	67528.5	1.3	84643.8	1.3	103686.7
1.8	49842.0	1.8	66753.4	1.8	86123.3	1.8	107951.5	1.8	132238.1
2.2	49842.0	2.2	66753.4	2.2	86123.3	2.2	107951.5	2.2	132238.1
2.5	49842.0	2.5	66753.4	2.5	86123.3	2.5	107951.5	2.5	132238.1


48-INCH DRILLED SHAFT
PRESSURE LINE TO BASE LOAD CELL
APPROXIMATE GROUND ELEVATION
DEPTH (FT.)
SPIRAL TO FULL LOAD TEST PILE LENGTH
5'
A
A'
10'
EMBEDMENT STRAIN GAUGES (TYP.)
15'
20'
25'
35'
40'
45'
DRILLED SHAFT
30 FEET
50 FEET
EXPANDABLE BASE LOAD CELL (GROUTED) AT 30 FEET
EMBEDMENT STRAIN GAUGES (TYP.)
24 INCHES
REINFORCING STEEL 16 - #7 BARS EQUALLY SPACED TYP. OR AS REQUIRED
STRUCTURAL CONCRETE (f 'c = 8,000 PSI MIN @ 28 DAYS)
PRESSURE LINE TO LOAD CELL
EMBEDMENT STRAIN GAUGE (16 TOTAL)
48 INCHES
#4 SPIRAL @ 6" PITCH, TYP. OR AS REQUIRED
3 INCHES
FOUR CROSSHOLE SONIC LOGGING (CSL) TEST ACCESS TUBES (2" ID STD. PIPE), EXTEND TO BOTTOM OF REINFORCING CAGE
SECTION A-A'
DEEP FOUNDATION LOAD TEST DETAIL
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
JUNE 2024
DRAWN BY
HYC
PLATE
5
SCALE
NOT TO SCALE
W.O.
8345-00

APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions at the project site by drilling and sampling 21 borings, designated as Boring Nos. B-1 through B-13, and P-1 through P-8, extending to depths ranging from about 10 to 51.75 feet below the existing ground surface. The borings were drilled using a truck-mounted drill rig equipped with continuous flight augers and rotary coring tools. The approximate boring locations are shown on the Overall Site Plan, Plate 2, and Site Plans, Plates 3.1 through 3.9.

Our geologist classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the drilling operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), as shown on the Soil Log Legend, Plate A-0.1. Deviations made to the soil classification in accordance with ASTM D2487 are described on the Soil Classification Log Key, Plate A-0.2. Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1.1 through A-21.

Relatively "undisturbed" soil samples were obtained in general accordance with ASTM D3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. In addition, some samples were obtained from the drilled borings in general accordance with ASTM D1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the "Penetration Resistance" on the Logs of Borings at the appropriate sample depths. The penetration resistance shown on the Logs of Borings indicates the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

Core samples of the rock materials encountered at the project site were obtained by using diamond core drilling techniques in general accordance with ASTM D2113, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method that uses a hollow bit to cut into the rock formation. The rock material left in the hollow core of the bit is mechanically recovered for examination and description. Rock cores were described in general accordance with the Rock Description System, as shown on the Rock Log Legend, Plate A-0.3. The Rock Description System is based on the publication "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses" by the International Society for Rock Mechanics (March 1977). Graphical representations of the materials encountered are presented on the Logs of Borings at the appropriate depths.

Recovery (REC) may be used as a subjective guide to the interpretation of the relative quality of rock masses, where appropriate. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (RQD) is also a subjective guide to the relative quality of rock masses. RQD is defined as the percentage of the core run in rock that is sound material in excess of 4 inches in length without any discontinuities, discounting any drilling, mechanical, and handling-induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run in rock, the RQD would be 50 percent and would be shown on the Logs of Borings as RQD = 50%. Generally, the following is used to describe the relative quality of the rock based on the "Practical Handbook of Physical Properties of Rocks and Minerals" by Robert S. Carmichael (1989).

Rock Quality	**RQD** (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

The excavation characteristic of a rock mass is a function of the relative hardness of the rock, its relative quality, brittleness, and fissile characteristics. A dense rock formation with a high RQD value would be very difficult to excavate and probably would require more arduous methods of excavation.

GEOLABS, INC.
Geotechnical Engineering

Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS; MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE	GRAVELS; MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS; LESS THAN 5% FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES; MORE THAN 12% FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS; 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS; LESS THAN 5% FINES	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES; MORE THAN 12% FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS; 50% OR MORE OF MATERIAL PASSING THROUGH NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT 50 OR MORE	MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

- (2-INCH) O.D. STANDARD PENETRATION TEST
- (3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
- SHELBY TUBE SAMPLE
- GRAB SAMPLE
- CORE SAMPLE
- WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
- WATER LEVEL OBSERVED IN BORING AFTER DRILLING
- WATER LEVEL OBSERVED IN BORING OVERNIGHT

- LL LIQUID LIMIT (NP=NON-PLASTIC)
- PI PLASTICITY INDEX (NP=NON-PLASTIC)
- TV TORVANE SHEAR (tsf)
- UC UNCONFINED COMPRESSION OR UNIAXIAL COMPRESSIVE STRENGTH
- TXUU UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

Plate
A-0.1

LOG LEGEND FOR SOIL 8345-00.GPJ GEOLABS.GDT 7/6/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

Soil Classification Log Key
(with deviations from ASTM D2488)

GEOLABS, INC. CLASSIFICATION*

GRANULAR SOIL (- #200 <50%)	COHESIVE SOIL (- #200 ≥ 50%)
• **PRIMARY** constituents are composed of the largest percent of the soil mass. Primary constituents are capitalized and bold (i.e., **GRAVEL, SAND**)	• **PRIMARY** constituents are based on plasticity. Primary constituents are capitalized and bold (i.e., **CLAY, SILT**)
• **SECONDARY** constituents are composed of a percentage less than the primary constituent. If the soil mass consists of 12 percent or more fines content, a cohesive constituent is used (**SILTY** or **CLAYEY**); otherwise, a granular constituent is used (**GRAVELLY** or **SANDY**) provided that the secondary constituent consists of 20 percent or more of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** GRAVEL, **CLAYEY** SAND) and precede the primary constituent.	• **SECONDARY** constituents are composed of a percentage less than the primary constituent, but more than 20 percent of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** CLAY, **SILTY** CLAY, **CLAYEY** SILT) and precede the primary constituent.
• **accessory descriptions** compose of the following: with some: >12% with a little: 5 - 12% with traces of: <5% accessory descriptions are lower cased and follow the Primary and Secondary Constituents (i.e., SILTY GRAVEL **with a little sand**)	• **accessory descriptions** compose of the following: with some: >12% with a little: 5 - 12% with traces of: <5% accessory descriptions are lower cased and follow the Primary and Secondary Constituents (i.e., SILTY CLAY **with some sand**)

EXAMPLE: Soil Containing 60% Gravel, 25% Sand, 15% Fines. Described as: **SILTY GRAVEL** with some sand

RELATIVE DENSITY / CONSISTENCY

Granular Soils			Cohesive Soils			
N-Value (Blows/Foot)		Relative Density	N-Value (Blows/Foot)		PP Readings (tsf)	Consistency
SPT	MCS		SPT	MCS		
0 - 4	0 - 7	Very Loose	0 - 2	0 - 4		Very Soft
4 - 10	7 - 18	Loose	2 - 4	4 - 7	< 0.5	Soft
10 - 30	18 - 55	Medium Dense	4 - 8	7 - 15	0.5 - 1.0	Medium Stiff
30 - 50	55 - 91	Dense	8 - 15	15 - 27	1.0 - 2.0	Stiff
> 50	> 91	Very Dense	15 - 30	27 - 55	2.0 - 4.0	Very Stiff
			> 30	> 55	> 4.0	Hard

MOISTURE CONTENT DEFINITIONS

Dry: Absence of moisture, dry to the touch

Moist: Damp but no visible water

Wet: Visible free water

ABBREVIATIONS

WOH: Weight of Hammer

WOR: Weight of Drill Rods

SPT: Standard Penetration Test Split-Spoon Sampler

MCS: Modified California Sampler

PP: Pocket Penetrometer

GRAIN SIZE DEFINITION

Description	Sieve Number and / or Size
Boulders	> 12 inches (305-mm)
Cobbles	3 to 12 inches (75-mm to 305-mm)
Gravel	3-inch to #4 (75-mm to 4.75-mm)
Coarse Gravel	3-inch to 3/4-inch (75-mm to 19-mm)
Fine Gravel	3/4-inch to #4 (19-mm to 4.75-mm)
Sand	#4 to #200 (4.75-mm to 0.075-mm)
Coarse Sand	#4 to #10 (4.75-mm to 2-mm)
Medium Sand	#10 to #40 (2-mm to 0.425-mm)
Fine Sand	#40 to #200 (0.425-mm to 0.075-mm)

**Soil descriptions are based on ASTM D2488-09a, Visual-Manual Procedure, with the above modifications by Geolabs, Inc. to the Unified Soil Classification System (USCS).*

Plate
A-0.2

SOIL CLASS LOG KEY 8345-00.GPJ GEOLABS.GDT 7/6/23

GEOLABS, INC.

Geotechnical Engineering

Rock Log Legend

ROCK DESCRIPTIONS

	BASALT		**CONGLOMERATE**
	BOULDERS		**LIMESTONE**
	BRECCIA		**SANDSTONE**
	CLINKER		**SILTSTONE**
	COBBLES		**TUFF**
	CORAL		**VOID/CAVITY**

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Massive:	Greater than 24 inches apart
Slightly Fractured:	12 to 24 inches apart
Moderately Fractured:	6 to 12 inches apart
Closely Fractured:	3 to 6 inches apart
Severely Fractured:	Less than 3 inches apart

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered:	Rock shows no sign of discoloration or loss of strength.
Slightly Weathered:	Slight discoloration inwards from open fractures.
Moderately Weathered:	Discoloration throughout and noticeably weakened though not able to break by hand.
Highly Weathered:	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
Extremely Weathered:	Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard:	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
Hard:	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
Medium Hard:	Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce. Example: Porous rock such as clinker, cinder, and coral reef
Soft:	Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot. Example: Weathered rock, chalk-like coral reef
Very Soft:	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

Plate

A-0.3

LOG LEGEND FOR ROCK 8345-00.GPJ GEOLABS.GDT 7/6/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.

Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring

B-1

Approximate Ground Surface Elevation (feet): 347.5 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%) (Field)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0				8-inch **ASPHALTIC CONCRETE**
										GW	Gray **SANDY GRAVEL** (base material)
Sieve -#200 = 17.3%	14	98			43					SM	Brownish gray **SILTY SAND** with some gravel, medium dense, dry (fill)
	18 10				23						
Direct Shear	18	62			21		5				
											grades to light brown
										GW-GM	Light brown **SANDY GRAVEL** with a little silt, medium dense, dry (alluvium)
Sieve -#200 = 10.6%	9				30		10				
Direct Shear	22	65			42		15				
	24				42		20				grades to dense
										SM	Brown **SILTY SAND** with traces of gravel, medium dense, dry (alluvium)
Sieve -#200 = 36.3%	16	92			32		25				
					65		30				grades to very dense
							35				

Date Started:	January 21, 2022	Water Level: ∇	Not Encountered
Date Completed:	January 21, 2022		
Logged By:	G. Castle	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 1.1

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-1

(Continued from previous plate)

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											Boring terminated at 31.5 feet
											* Elevations estimated from Plan transmitted by Warren S. Unemori Engineering, Inc. on September 6, 2022.
							40				
							45				
							50				
							55				
							60				
							65				
							70				

Laboratory: Other Tests, Moisture Content, Dry Density. Field: Core Recovery, RQD, Penetration Resistance, Pocket Pen.

Date Started:	January 21, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 21, 2022		
Logged By:	G. Castle	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 1.2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-2

Approximate Ground Surface Elevation (feet): 337.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	18	97			9/6" +50/4"					CL	Brown **SANDY CLAY** with some gravel, hard, moist (fill)
	3				42					ML	Brown **SANDY SILT**, hard, dry to moist (alluvium)
	5	107			48		5				grades to very stiff
	11				14		10			ML	Brown **SANDY SILT** with some gravel, stiff, dry (alluvium)
Direct Shear	15	69			16		15				
Sieve - #200 = 37.5%	13				50/4"		20			SM	Brown **SILTY SAND** with traces of gravel, very dense, dry (alluvium)
	19	73			50/4"		25				
	17				39		30			GP	Brown **GRAVELLY SAND** with some clay, dense, moist (alluvium)
											Boring terminated at 31.5 feet
							35				

Laboratory: Other Tests, Moisture Content, Dry Density. Field: Core Recovery, RQD, Penetration Resistance, Pocket Pen.

Date Started:	January 3, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 3, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-3**

Approximate Ground Surface Elevation (feet): 296.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	CL	Brown **SANDY CLAY** with some gravel, stiff, dry (fill)
	13	104			20				
	10				16				grades to very stiff
	19	64			11		5	CL	Brown **SANDY CLAY**, medium stiff, moist (alluvium)
	16				10		10		grades to stiff
							11.5		Boring terminated at 11.5 feet

Date Started: January 3, 2022	Water Level: ⊻ Not Encountered		Plate
Date Completed: January 3, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		A - 3
Total Depth: 11.5 feet	Drilling Method: 4" Solid-Stem Auger		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-4**

Approximate Ground Surface Elevation (feet): 267.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	ML	Brown **SANDY SILT**, medium stiff, moist (fill)
Sieve - #200 = 60.4% LL=40 PI=13	29	78			10				
	10				8				
	19	80			42		5	ML	Brown **SANDY SILT**, very stiff, moist (alluvium)
	8				50/4"		10	GM	Brownish gray **SANDY GRAVEL** with some silt, very dense, dry (alluvium)
							10.83		Boring terminated at 10.83 feet

Date Started: January 3, 2022	Water Level: ⊻ Not Encountered		Plate
Date Completed: January 3, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		A - 4
Total Depth: 10.83 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-5**

Approximate Ground Surface Elevation (feet): 263 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
	23	90			20			CL	Brown **SANDY CLAY** with traces of gravel, stiff, moist (fill)
LL=48 PI=23	14				42			CL	Brown **SANDY CLAY** with traces of gravel, hard, moist (alluvium)
	27	67			50/3"		5		
	4				35/6" +50/4"		10	GM	Gray **SANDY GRAVEL**, very dense, dry (alluvium)
									Boring terminated at 11.33 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35

Date Started:	January 3, 2022	Water Level: ∇	Not Encountered	Plate
Date Completed:	January 3, 2022			
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*	A - 5
Total Depth:	11.33 feet	Drilling Method:	4" Solid-Stem Auger	
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-6**

Approximate Ground Surface Elevation (feet): 278 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
					29			CL	Brown **SANDY CLAY** with some gravel, very stiff, moist (fill)
	11				50/4"				
			77				5		Gray **COBBLES AND BOULDERS (BASALTIC)** with some sand and gravel, slightly weathered, hard, moist (alluvium)
			33						
	7				44		10 ∇		
									Boring terminated at 12.5 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35

Note:
The water level recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site.

Date Started:	January 12, 2022	Water Level: ∇	11.1 ft. 01/12/2022 1534 HRS	Plate
Date Completed:	January 12, 2022			
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*	A - 6
Total Depth:	12.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring	
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-7

Approximate Ground Surface Elevation (feet): 297 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
Sieve - #200 = 45.7%	18	95			79			SM	Brown **SILTY SAND** with some gravel, dense, moist (fill)
	2				20/4"				grades to very dense
	3	119			36/6" +50/3"		5	GP	Grayish brown **SANDY GRAVEL**, very dense, dry (alluvium)
					50/0" Ref.		10		Boring terminated at 10 feet

Date Started:	January 6, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 6, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	10 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 7

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-8

Approximate Ground Surface Elevation (feet): 329.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								CL	Brown **SANDY CLAY** with some gravel, moist (alluvium)
UC= 8870 psi			65						Gray **COBBLES AND BOULDERS (BASALTIC)** with some gravel, moderately weathered, hard (alluvium)
			40				5		
			27				10		
			58				15		
UC= 25320 psi			43				20		
UC= 5540 psi			42				25		
UC= 6350 psi			37				30		
							35		

Date Started:	January 4, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 4, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	50 feet	Drilling Method:	4" Solid-Stem Auger & HQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 8.1

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-8**

(Continued from previous plate)

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
			30						
			72				40		
UC= 7940 psi									
			33				45		
							50		Boring terminated at 50 feet
							55		
							60		
							65		
							70		

Date Started:	January 4, 2022
Date Completed:	January 4, 2022
Logged By:	A. Ayorinde
Total Depth:	50 feet
Work Order:	8345-00
Water Level: ⊽	Not Encountered
Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Drilling Method:	4" Solid-Stem Auger & HQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 8.2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-9**

Approximate Ground Surface Elevation (feet): 323 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								CL	Brown **SANDY SILT** with some gravel, hard, moist (fill)
	3	87			64				
Sieve - #200 = 13.5%	4				39			GM	Brownish gray **SILTY GRAVEL** with some sand, dense, dry (alluvium)
	3	133			57		5		
									grades to very dense
	5				24/6" +50/3"		10		
	9	84			42/6" +50/3"		15		
UC= 11300 psi			78						Brownish gray **COBBLES AND BOULDERS (BASALTIC)** with some sand and gravel, moderately weathered, hard, moist (alluvium)
	6				58		20		
			74						
UC= 6510 psi UC= 3490 psi			87				25		
			20				30		
							35		

Date Started:	January 5, 2022
Date Completed:	January 5, 2022
Logged By:	A. Ayorinde
Total Depth:	50.7 feet
Work Order:	8345-00
Water Level: ⊽	48.0 ft. 01/05/2022 1446 HRS
Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Drilling Method:	4" Solid-Stem Auger & HQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 9.1

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-9**

(Continued from previous plate)

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
	9		45		35/6" +22/4"				
Sieve - #200 = 12.6%	18		55		57		40		grades with pockets of brown silty gravel (GM) with some sand
UC= 9790 psi			42				45		
	11				20/2"		50		
									Boring terminated at 50.7 feet

Date Started: January 5, 2022	Water Level: ▽ 48.0 ft. 01/05/2022 1446 HRS		Plate
Date Completed: January 5, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		
Total Depth: 50.7 feet	Drilling Method: 4" Solid-Stem Auger & HQ Coring		A - 9.2
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-10**

Approximate Ground Surface Elevation (feet): 332.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
Sieve - #200 = 32.7%	14	101			51			SM	Grayish brown **SILTY SAND** with a little gravel and cobbles (basaltic), medium dense, dry (fill)
	2				17/6" +25/2"				
	7	112	0		58		5		Gray **COBBLES AND BOULDERS (BASALTIC)** with a little sand and gravel, slightly weathered, hard (alluvium)
			71						
			51		25/1"		10		
	4		70		35/4"		15		
			50				20		
			45		25/0" Ref.		25		
			55				30		

Date Started: December 13, 2021	Water Level: ▼ Not Encountered		Plate
Date Completed: December 14, 2021			
Logged By: D. Gremminger	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		
Total Depth: 50.9 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		A - 10.1
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-10

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									(Continued from previous plate)
			22						
	17				25/4"				grades with seams of multi-color silty sand
UC= 6290 psi			58						
			23						
	19				45/5"				
									Boring terminated at 50.9 feet

Date Started:	December 13, 2021	Water Level:	Not Encountered
Date Completed:	December 14, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	50.9 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 10.2

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-11

Approximate Ground Surface Elevation (feet): 327.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								GM	Tannish brown **SILTY GRAVEL** with some sand, dense, dry (fill)
Sieve - #200 = 18.2%	7	114			61				
	6				35/3"				
									grades with a little cobbles (basaltic)
									Gray **COBBLES AND BOULDERS (BASALTIC)** with some gravel and sand, slightly weathered, hard, moist (alluvium)
			42						
			57		30/4"				
			45		20/0" Ref.				
			22						
			50		35/4"				
			25						
			38		20/0" Ref.				

Date Started:	December 15, 2021	Water Level:	Not Encountered
Date Completed:	December 16, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	51.75 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 11.1

GEOLABS, INC.

Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-11**

(Continued from previous plate)

Depth scale (feet): 40, 45, 50, 55, 60, 65, 70

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
			47					
			70		25/0" Ref.			
UC= 15220 psi								
			30					
	18				36/6" +35/3"			grades with seams of reddish brown sandy silt
								Boring terminated at 51.75 feet

Date Started:	December 15, 2021	Water Level:	Not Encountered
Date Completed:	December 16, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	51.75 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 11.2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.

Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-12**

Approximate Ground Surface Elevation (feet): 330.5 *

Depth scale (feet): 5, 10, 15, 20, 25, 30, 35

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
							SM	Tannish brown **SILTY SAND** with some gravel, very dense, dry (fill)
Sieve - #200 = 27.2%	8		35		25/5"			Gray **COBBLES AND BOULDERS (BASALTIC)**, slightly weathered, hard (alluvium)
					29			grades to medium dense
			57					grades with some brown silty sand
Sieve - #200 = 9.4%	8				38			grades with pockets of sandy gravel (GW-GM) with a little silt, dense
			57					
			28					
UC= 5790 psi	1		17		25/3"			grades to very dense
	7				72			
			71					
								Boring terminated at 30 feet

Date Started:	July 29, 2022	Water Level:	Not Encountered
Date Completed:	July 29, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	30 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 12

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-13

Approximate Ground Surface Elevation (feet): 328 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%) (Field)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GW-GM	Tannish brown **GRAVELLY SAND** with a little silt, medium dense, dry (fill)
Sieve - #200 = 9.5%	3	88			22						
	6				10					SM	Tannish brown **SILTY SAND** with a little gravel, medium dense, dry (fill)
Sieve - #200 = 18.6%	22	100			21/6" +50/5"						grades to very dense
							5				
			51								Gray slightly vesicular **COBBLES AND BOULDERS (BASALTIC)**, slightly weathered, hard, dry (alluvium)
							10				
			60								
UC= 2740 psi											
							15				
			88								
UC= 4240 psi											
							20				
			95								
UC= 15320 psi											
											grades with some silty sand
							25				
			50								
							30				Boring terminated at 30 feet
UC= 2960 psi											
							35				

Date Started:	July 27, 2022	Water Level: ∇	Not Encountered
Date Completed:	July 27, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	30 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 13

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
P-1

Approximate Ground Surface Elevation (feet): 339 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%) (Field)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										SM	Brown **SILTY SAND** with some gravel, loose, moist (fill)
Sieve - #200 = 23.1%	16	88			8						
Sieve - #200 = 65.0%	21				22					ML	Brown **SANDY SILT**, very stiff, moist (alluvium)
Direct Shear	31	84			28						
							5				
							10			GP	Brownish gray **GRAVELLY SAND** with traces of silt, medium dense, dry (alluvium)
Sieve - #200 = 2.8%	7				26						
							15				
	15	82			70						grades with some cobbles, dense
			29								
							20				
	12				13/6" +12/2"						grades to very dense
			54								
							25			SM	Brown **SILTY SAND** with a little gravel, medium dense, moist (alluvium)
Direct Shear	34	85			20						
			0								
							30				
Sieve - #200 = 39.9%	33				27						
											Boring terminated at 31.5 feet
							35				

Date Started:	January 6, 2022	Water Level: ∇	Not Encountered
Date Completed:	January 6, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 14

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
P-2

Approximate Ground Surface Elevation (feet): 288 *

Other Tests (Laboratory)	Moisture Content (%) (Laboratory)	Dry Density (pcf) (Laboratory)	Core Recovery (%) (Field)	RQD (%) (Field)	Penetration Resistance (blows/foot) (Field)	Pocket Pen. (tsf) (Field)	Depth (feet)	USCS	Description
							0	CL	Brown **SANDY CLAY**, stiff, moist (fill)
	22	91			20				
	15				9				
	34	86			61		5	ML	Brown **SANDY SILT** with some gravel, hard, moist (alluvium)
	22				25		10		grades to very stiff
	22	87			50/5"		15		
			0					SP	Brownish gray **GRAVELLY SAND**, very dense, moist (alluvium)
	28				18		20		
			0					SM	Brown **SILTY SAND** with traces of gravel, medium dense, moist (alluvium)
					27		25		
			0						
LL=NP PI=NP Sieve - #200 = 45.8%	18	102			28		30		
									Boring terminated at 31.5 feet
							35		

Date Started: January 10, 2022	Water Level: ∇ Not Encountered		Plate
Date Completed: January 10, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		
Total Depth: 31.5 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		A - 15
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
P-3

Approximate Ground Surface Elevation (feet): 269 *

Other Tests (Laboratory)	Moisture Content (%) (Laboratory)	Dry Density (pcf) (Laboratory)	Core Recovery (%) (Field)	RQD (%) (Field)	Penetration Resistance (blows/foot) (Field)	Pocket Pen. (tsf) (Field)	Depth (feet)	USCS	Description
							0	SW-SM	Grayish brown **GRAVELLY SAND** with a little silt, medium dense, dry (fill)
Sieve - #200 = 10.5%	8	85			33				
	14				8			SM	Brown **SILTY SAND** with traces of gravel, loose, moist (alluvium)
Sieve - #200 = 48.0%	19	89			51		5		grades to medium dense
	18				13		10		grades with some gravel
	76	57			52		15		
Sieve - #200 = 22.7%	28				16		20		
			0						
	21	89			57		25	CL	Brown **SANDY CLAY**, hard, moist (alluvium)
			0						
	41				27		30		grades to very stiff
									Boring terminated at 31.5 feet
							35		

Date Started: January 10, 2022	Water Level: ∇ Not Encountered		Plate
Date Completed: January 10, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK		
Total Depth: 31.5 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		A - 16
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 6/26/24

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-4**

Approximate Ground Surface Elevation (feet): 259 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	CL	Brown **SANDY CLAY**, very stiff, moist (fill)
	21	99			31				
	17				34			CL	Brown **SANDY CLAY** with traces of gravel, hard, moist (alluvium)
	22	84			24/6" +50/4"		5		
			45						Gray **COBBLES AND BOULDERS (BASALTIC)** with a little sand and gravel, moderately weathered, hard, moist (alluvium)
	7				45/6" +50/2"		10		
			61						
	13	120			45		15		grades to medium dense
			33						
	31				42		20		grades with pockets of clayey silt
			29						
									grades with brown mottling
	15	113			46/6" +50/3"		25		grades to very dense
			33						
					20/4"		30		Boring terminated at 30.3 feet
							35		

Date Started:	January 11, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 11, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	30.3 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 17

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-5**

Approximate Ground Surface Elevation (feet): 269.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	CL	Brown **SANDY CLAY**, stiff, moist (fill)
	23	92			19				
	21				26				grades to very stiff
	20	59	45		50/5"		5		Gray **COBBLES AND BOULDERS (BASALTIC)** with a little sand and gravel, moderately weathered, hard (alluvium)
							⊻		
	5				55		10		
			38						
Sieve - #200 = 2.7%	6	112			31		15		grades with pockets of sandy gravel
			24						
			18		25/3"		20		
									grades with pockets of silty sand
Sieve - #200 = 47.3%	30	89			40		25		
			31						
					21/3"		30		Boring terminated at 30.3 feet **Note:** The water level recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site.
							35		

Date Started:	January 12, 2022	Water Level: ⊻	8.3 ft. 01/12/2022 1230 HRS
Date Completed:	January 12, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	30.3 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 18

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-6**

Approximate Ground Surface Elevation (feet): 300 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
Sieve - #200 = 56.4%	17	87			17/6" +25/3"		ML	Grayish brown **SANDY SILT** with traces of gravel, hard, moist (fill)
	3				112			
	6	140			39/6" +50/4"			Grayish brown subrounded **COBBLES AND BOULDERS (BASALTIC)**, moderately weathered, hard, moist (alluvium)
			89					
			65		10/0" Ref.			
			100		10/0" Ref.			
			61		10/0" Ref.			
							SM	Brown **SILTY SAND (BASALTIC)** with some gravel and traces of cobbles, medium dense, moist (alluvium)
	11				20			
			24					
Sieve - #200 = 18.1%	29				13			grades to brownish gray
								Boring terminated at 32.5 feet

Date Started:	January 21, 2022	Water Level: ▽	Not Encountered
Date Completed:	January 28, 2022		
Logged By:	Castle & Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	32.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 19

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-7**

Approximate Ground Surface Elevation (feet): 327.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
Sieve - #200 = 26.7%	19	82			70		SM	Brownish tan **SILTY SAND** with some gravel, dense, dry (fill)
	4				15			grades with a little cobbles, medium dense
			0					
	8	113			39			Gray **COBBLES AND BOULDERS (BASALTIC)** with some sand and gravel, moderately weathered, hard, moist (alluvium)
			38					
	36		24		25/2"			
			39		65/6"			
UC= 3960 psi			64		30/2"			
			45					
	7				30/3"			
								Boring terminated at 31.25 feet

Date Started:	December 16, 2021	Water Level: ▼	Not Encountered
Date Completed:	December 17, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.25 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 20

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC. Geotechnical Engineering	WAIALE ROAD EXTENSION WAIKAPU, MAUI, HAWAII	Log of Boring P-8

Approximate Ground Surface Elevation (feet): 321.5 *

Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								SM	Tannish brown **SILTY SAND** with a little gravel, medium dense, dry (fill)
Sieve - #200 = 38.9%	11	87			27				
	11				20				grades with some cobbles
	10	94			50/4"		5		grades to very dense
			48						Gray slightly vesicular **COBBLES AND BOULDERS (BASALTIC)**, slightly weathered, hard, moist (alluvium)
	9				27		10		
			40						
	5	91			50/3"		15		
			90						
UC= 8080 psi									
			78				20		
UC= 22670 psi									
			25				25		
Sieve - #200 = 5.2%	23				35		30		grades with pockets of brown sand (SP-SM) with a little silt and traces of gravel, dense
									Boring terminated at 31.5 feet
							35		

Date Started:	July 28, 2022	Water Level: ∇	Not Encountered
Date Completed:	July 28, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 21

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

APPENDIX B

APPENDIX B

Laboratory Tests

Moisture Content (ASTM D2216) and Unit Weight (ASTM D2937) determinations were performed on selected samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Borings at the appropriate sample depths.

Three Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits and to aid in soil classification. The test results are summarized on the Logs of Borings at the appropriate sample depths. A graphic presentation of the test results is provided on Plate B-1.

Thirty-four Sieve Analysis tests (ASTM D6913) were performed on selected soil samples to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic representations of the grain size distributions are provided on Plates B-2 through B-8.

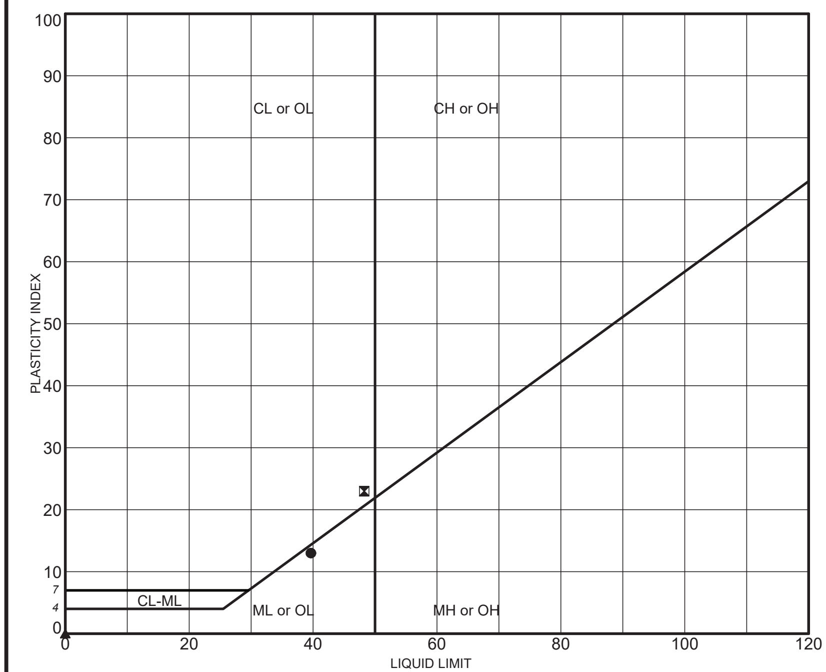
Six one-inch Ring Swell tests were performed on relatively undisturbed and remolded samples to evaluate the swelling potential of the on-site materials under surcharge pressures. The test results are presented on Plate B-9.

Nineteen Uniaxial Compressive Strength tests (ASTM D7012, Method C) were performed on selected intact core samples to evaluate the uniaxial compressive strength of the rock cores tested. The test results are presented on Plate B-10.

Five Direct Shear tests (ASTM D3080) were performed on selected samples to evaluate the undrained shear strength of the in-situ soils. The approximate in-situ effective overburden pressure was used as the applied confining pressure for relatively “undisturbed” soil sample. The test results and the stress-strain curves are presented on Plates B-11 through B-15.

Five laboratory Resistance (R) Value tests (ASTM D2844) were performed by Ninyo & Moore on bulk samples of the near-surface soils to evaluate the pavement support characteristics of the soils. The test results are presented on Plates B-16 through B-20.

DRAFT Geotechnical Exploration Report - June 26, 2024



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-4	3.0-4.5	40	27	13	Brown sandy silt (ML)
⧗	B-5	3.0-4.5	48	25	23	Brown sandy clay (CL)
▲	P-2	30.0-31.5	NP	NP	NP	Brown silty sand (SM) with traces of gravel

NP = NON-PLASTIC

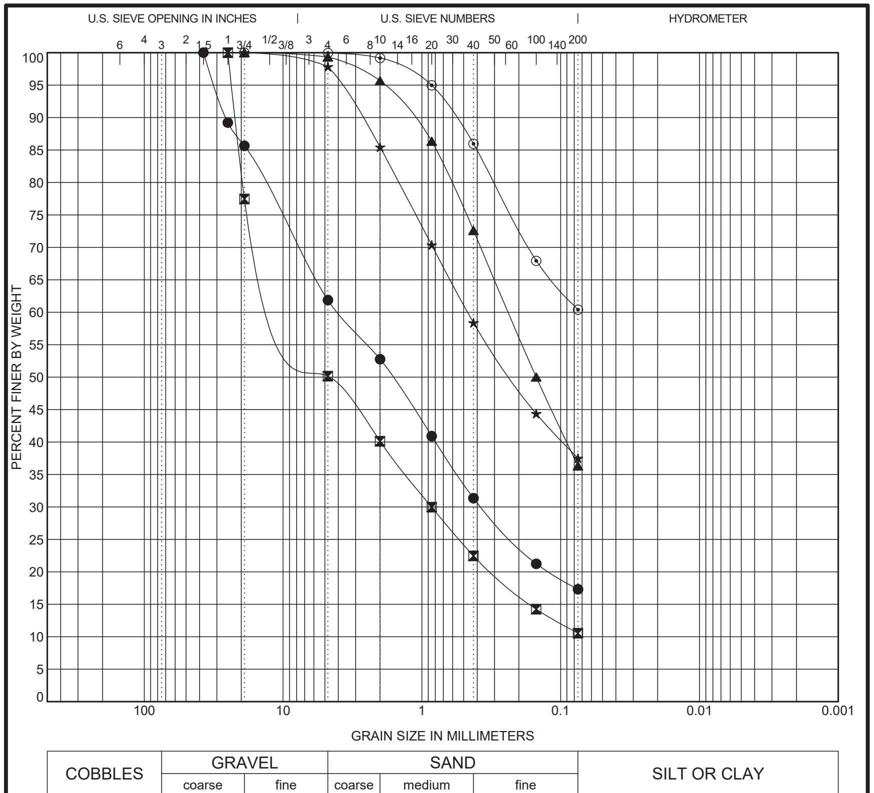
G_ATTERBERG PI-100 LL-120 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 1



Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
● B-1	1.0-2.5	Brownish gray silty sand (SM) with some gravel					
⧗ B-1	10.0-11.5	Light brown sandy gravel (GW-GM) with a little silt				1.4	115.9
▲ B-1	25.0-26.5	Brown silty sand (SM) with traces of gravel					
★ B-2	20.0-20.8	Brown silty sand (SM) with traces of gravel					
⊙ B-4	1.0-2.5	Brown sandy silt (ML)					

Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
● B-1	1.0-2.5	37.5	3.977	0.37		38.1	44.6	17.3
⧗ B-1	10.0-11.5	25	7.835	0.853		49.9	39.6	10.6
▲ B-1	25.0-26.5	19	0.238			0.7	63.0	36.3
★ B-2	20.0-20.8	19	0.467			2.2	60.3	37.5
⊙ B-4	1.0-2.5	19				0.1	39.5	60.4

G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

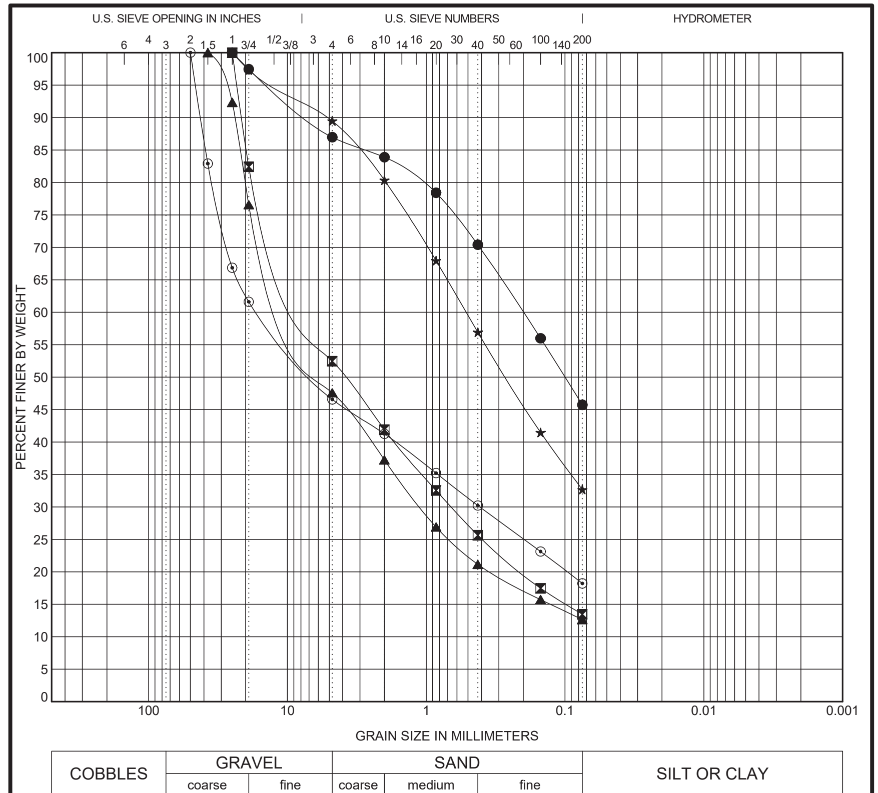
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 2

DRAFT Geotechnical Exploration Report - June 26, 2024



Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
● B-7	1.0-2.5	Brown silty sand (SM) with some gravel					
⧗ B-9	3.0-4.5	Brownish gray silty gravel (GM) with some sand					
▲ B-9	40.0-41.5	Brown silty gravel (GM) with some sand					
★ B-10	1.0-2.5	Grayish brown silty sand (SM) with a little gravel					
⊙ B-11	1.0-2.5	Tannish brown silty gravel (GM) with some sand					

Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
● B-7	1.0-2.5	25	0.201			13.0	41.2	45.7
⧗ B-9	3.0-4.5	25	6.737	0.66		47.6	39.0	13.5
▲ B-9	40.0-41.5	37.5	8.603	1.099		52.4	35.0	12.6
★ B-10	1.0-2.5	25	0.516			10.5	56.8	32.7
⊙ B-11	1.0-2.5	50	16.393	0.412		53.4	28.4	18.2

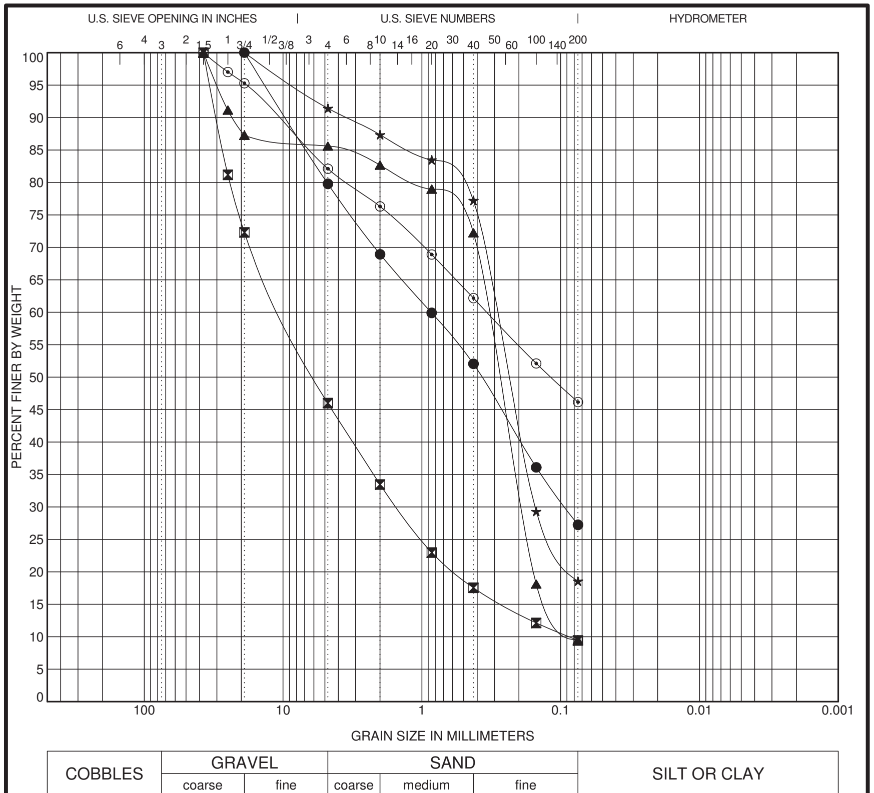
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 3



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-12	1.0-1.4	Tannish brown silty sand (SM) with some gravel					
⧗	B-12	10.0-11.5	Gray sandy gravel (GW-GM) with a little silt				2.6	114.3
▲	B-13	1.0-2.5	Tannish brown gravelly sand (SW-SM) with a little silt				1.4	4.3
★	B-13	2.5-4.0	Tannish brown silty sand (SM) with a little gravel					
⊙	BULK-1	0.5-1.5	Brown clayey sand (SC) with some gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-12	1.0-1.4	19	0.858	0.093		20.2	52.5	27.2
⧗	B-12	10.0-11.5	37.5	9.935	1.508	0.087	54.0	36.6	9.4
▲	B-13	1.0-2.5	37.5	0.336	0.189	0.078	14.4	76.1	9.5
★	B-13	2.5-4.0	19	0.292	0.152		8.6	72.9	18.6
⊙	BULK-1	0.5-1.5	37.5	0.339			17.9	35.9	46.2

G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 6/26/24

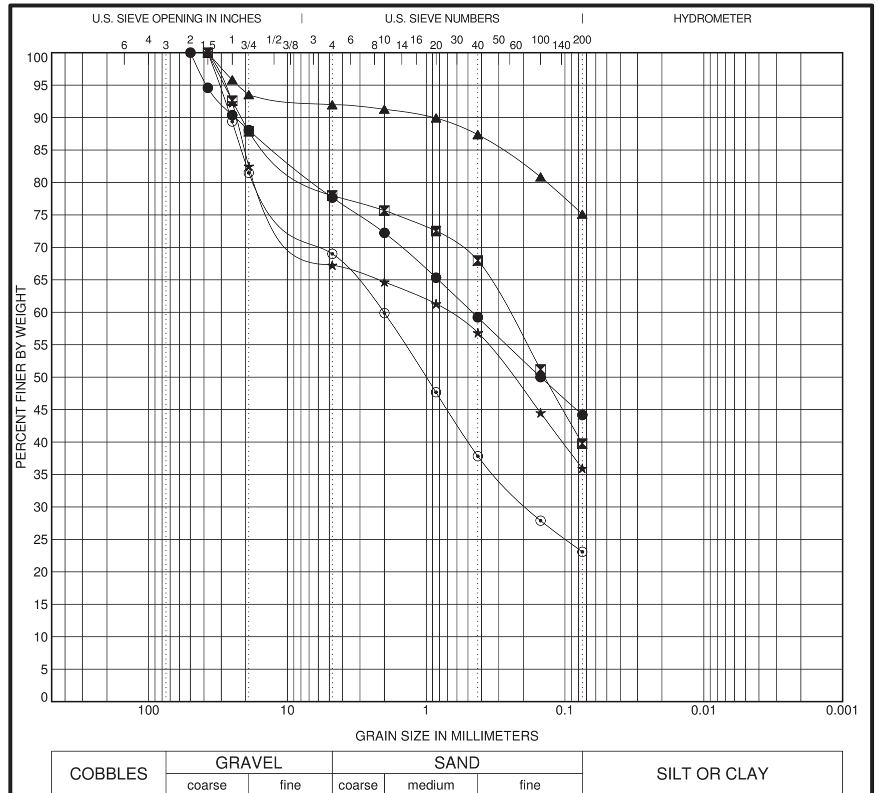
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 4

DRAFT Geotechnical Exploration Report - June 26, 2024



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	BULK-2	0.5-1.5	Brown silty sand (SM) with some gravel					
⧗	BULK-3	0.5-1.5	Brown clayey sand (SC) with some gravel					
▲	BULK-4	0.5-1.5	Brown sandy clay (CL) with a little gravel					
★	BULK-5	0.5-1.5	Brown silty gravel (GM) with some sand					
⊙	P-1	1.0-2.5	Brown silty sand (SM) with some gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	BULK-2	0.5-1.5	50	0.465			22.3	33.5	44.2
⧗	BULK-3	0.5-1.5	37.5	0.259			22.0	38.2	39.8
▲	BULK-4	0.5-1.5	37.5				8.0	16.9	75.1
★	BULK-5	0.5-1.5	37.5	0.694			32.8	31.3	35.9
⊙	P-1	1.0-2.5	37.5	2.025	0.187		31.0	45.9	23.1

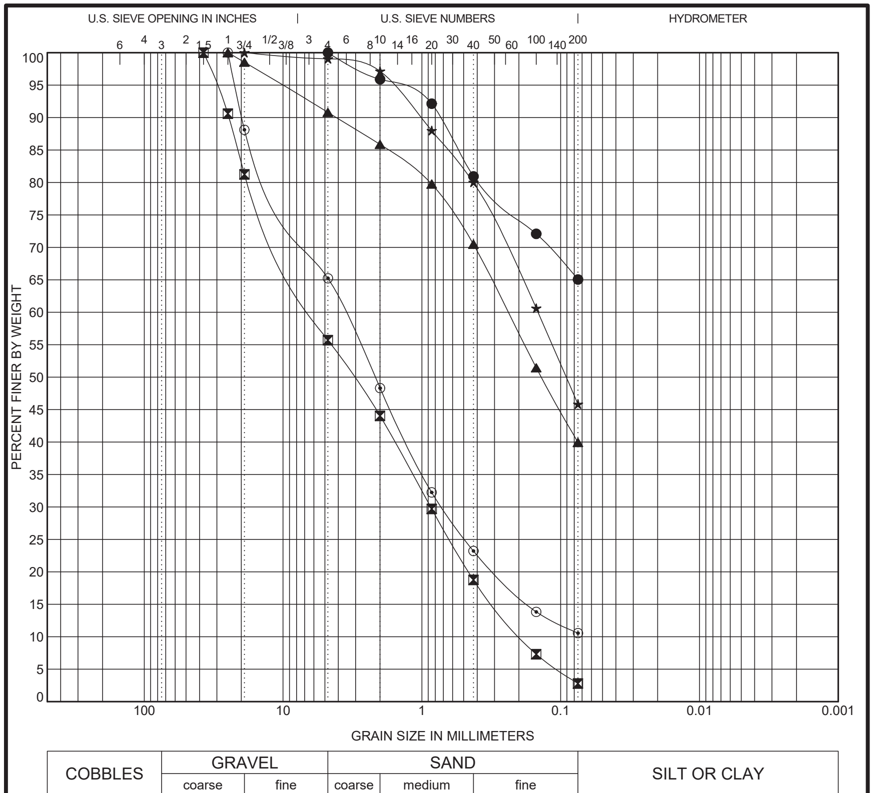
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 6/26/24

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 5



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	P-1	3.0-4.5	Brown sandy silt (ML)					
⧗	P-1	10.0-11.5	Brownish gray gravelly sand (SP) with traces of silt				0.7	31.3
▲	P-1	30.0-31.5	Brown silty sand (SM) with a little gravel					
★	P-2	30.0-31.5	Brown silty sand (SM) with traces of gravel	NP	NP	NP		
⊙	P-3	1.0-2.5	Grayish brown gravelly sand (SW-SM) with a little silt				2.1	54.4

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	P-1	3.0-4.5	4.75				0.0	35.0	65.0
⧗	P-1	10.0-11.5	37.5	5.999	0.865	0.192	44.3	52.9	2.8
▲	P-1	30.0-31.5	25	0.24			9.2	50.9	39.9
★	P-2	30.0-31.5	19	0.146			1.0	53.2	45.8
⊙	P-3	1.0-2.5	25	3.636	0.716		34.8	54.7	10.5

G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

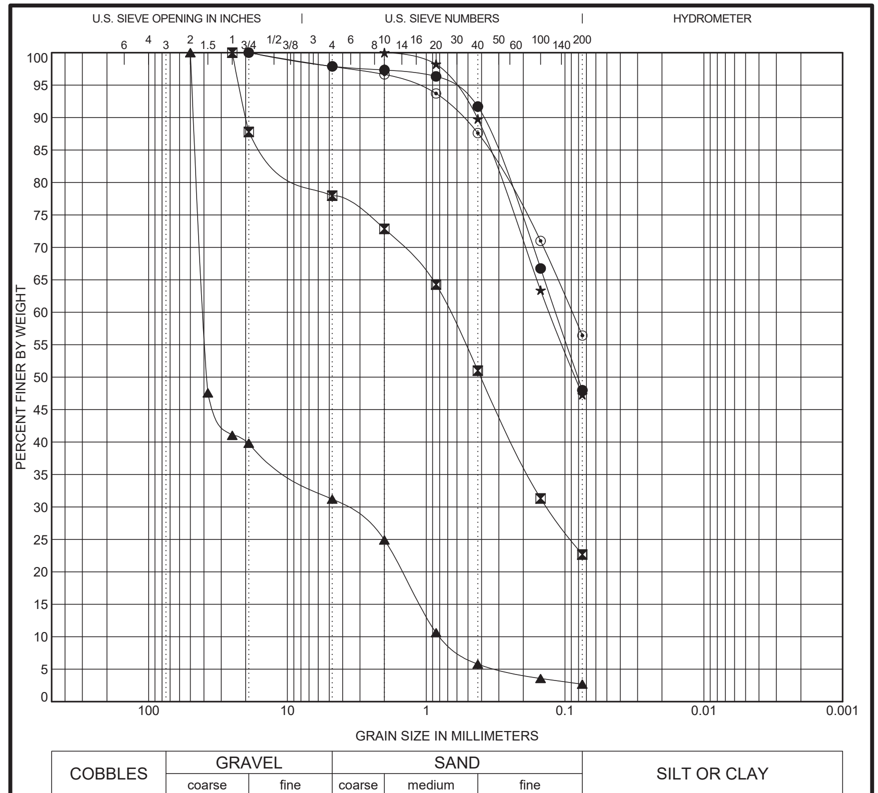
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 6

DRAFT Geotechnical Exploration Report - June 26, 2024



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	P-3	5.0-6.5	Brown silty sand (SM) with traces of gravel					
⧗	P-3	20.0-21.5	Brown silty sand (SM) with some gravel					
▲	P-5	15.0-16.5	Brown sandy gravel (GP) with traces of silt				0.5	51.5
★	P-5	25.0-26.5	Brown silty sand (SM)					
⊙	P-6	1.0-2.3	Grayish brown sandy silt (ML) with traces of gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	P-3	5.0-6.5	19	0.117			2.1	49.9	48.0
⧗	P-3	20.0-21.5	25	0.68	0.135		22.0	55.3	22.7
▲	P-5	15.0-16.5	50	40.147	4.03	0.779	68.8	28.5	2.7
★	P-5	25.0-26.5	2	0.13			0.0	52.7	47.3
⊙	P-6	1.0-2.3	19	0.089			2.1	41.5	56.4

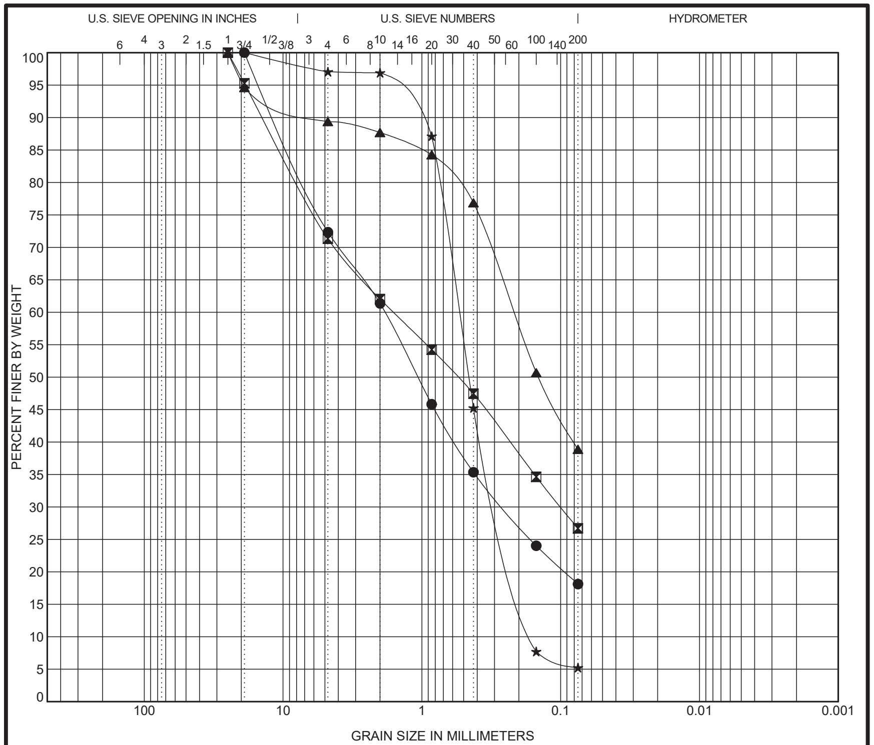
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 7



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	P-6	31.0-32.5	Brown silty sand (SM) with some gravel					
⧗	P-7	1.0-2.5	Brownish tan silty sand (SM) with some gravel					
▲	P-8	1.0-2.5	Tannish brown silty sand (SM) with a little gravel					
★	P-8	30.0-31.5	Brown sand (SP-SM) with a little silt and traces of gravel				0.9	3.4

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	P-6	31.0-32.5	19	1.856	0.26		27.7	54.2	18.1
⧗	P-7	1.0-2.5	25	1.602	0.1		28.7	44.6	26.7
▲	P-8	1.0-2.5	25	0.217			10.6	50.5	38.9
★	P-8	30.0-31.5	19	0.542	0.278	0.16	2.9	91.8	5.2

G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 8

DRAFT Geotechnical Exploration Report - June 26, 2024

Location	Depth (feet)	Soil Description	Dry Density (pcf)	Moisture Contents Initial (%)	Moisture Contents Air-Dried (%)	Moisture Contents Final (%)	Ring Swell (%)
B-3*	5.0 - 6.5	Brown sandy clay	67.9	17.2	13.0	50.6	0.7
B-3**	5.0 - 6.5	Brown sandy clay	87.2	24.0	19.0	35.9	6.8
B-5*	1.0 - 2.5	Brown sandy clay with traces of gravel	104.1	22.1	18.1	23.6	1.8
B-5**	1.0 - 2.5	Brown sandy clay with traces of gravel	104.2	22.2	18.1	23.1	1.8
P-2**	1.0 - 2.5	Brown sandy clay	106.9	24.9	19.1	25.0	2.5
P-4**	1.0 - 2.5	Brown sandy clay	107.5	23.5	17.8	25.0	5.1

NOTE: Samples tested were either relatively undisturbed or remolded in 2.4-inch diameter by 1-inch high rings. They were air-dried overnight and then saturated for 24 hours under a surcharge pressure of 55 psf.

* Relatively Undisturbed
** Remolded

G_RING_SWELL_TEST 8345-00.GPJ GEOLABS.GDT 6/26/24

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

SUMMARY OF RING SWELL TESTS

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 9

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-8	1 - 2.8	4.810	2.400	2.00	154.1	40,145	8,870
B-8	19 - 19.4	4.820	2.420	1.99	172.6	116,445	25,320
B-8	24 - 24.4	4.820	2.410	2.00	163.6	25,255	5,540
B-8	30.5 - 30.9	4.840	2.420	2.00	165.3	29,210	6,350
B-8	41.75 - 42.15	4.810	2.400	2.00	163.1	35,940	7,940
B-9	16.75 - 17.16	4.880	2.430	2.01	163.5	52,420	11,300
B-9	24.5 - 24.9	4.830	2.400	2.01	165.6	29,465	6,510
B-9	26 - 26.4	4.830	2.410	2.00	187.1	15,935	3,490
B-9	43 - 43.4	4.820	2.400	2.01	167.1	44,280	9,790
B-10	41.33 - 41.33	6.550	3.270	2.00	143.7	52,785	6,290
B-11	42.5 - 43.05	6.540	3.280	1.99	153.7	128,585	15,220
B-12	19.5 - 2	6.500	3.250	2.00	169.1	48,065	5,790
B-13	10.75 - 11.29	6.500	3.250	2.00	179.6	22,710	2,740
B-13	17 - 17.5	6.500	3.250	2.00	173.4	35,150	4,240
B-13	20.25 - 20.79	6.500	3.250	2.00	183.2	127,080	15,320
B-13	29.5 - 30	6.480	3.240	2.00	172.8	24,365	2,960
P-7	21 - 21.55	6.546	3.280	2.00	172.1	33,440	3,960
P-8	16.25 - 16.79	6.480	3.240	2.00	180.8	66,650	8,080
P-8	21.5 - 22	6.500	3.250	2.00	187.5	188,025	22,670

ASTM D7012 (METHOD C)

Note: Samples were not prepared in accordance with ASTM D4543. Therefore, results reported may differ from results obtained from a test specimen that meets the requirements of Practice D4543

G_ROCK_UC_TEST_PORTRAIT 8345-00.GPJ GEOLABS.GDT 12/1/23

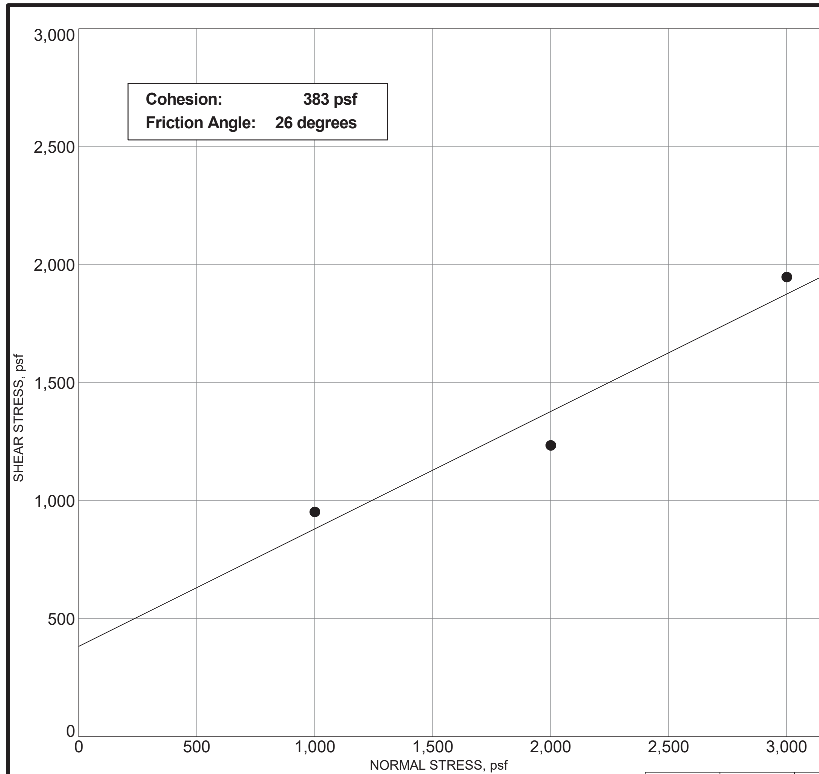
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

UNIAXIAL COMPRESSIVE STRENGTH TEST

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 10

DRAFT Geotechnical Exploration Report - June 26, 2024



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	17.7	20.3	14.3
	Dry Density, pcf	62.1	66.3	80.1
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	48.4	44.0	31.3
	Dry Density, pcf	59.7	70.1	84.4
	Height, inches	1.041	0.946	0.949
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0024	0.0023	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**953**	**1235**	**1948**
	Shear Displacement, inches	0.43	0.41	0.42

Sample: B-1
Depth: 5.0 - 6.5 feet
Description: Brownish gray silty sand with some gravel

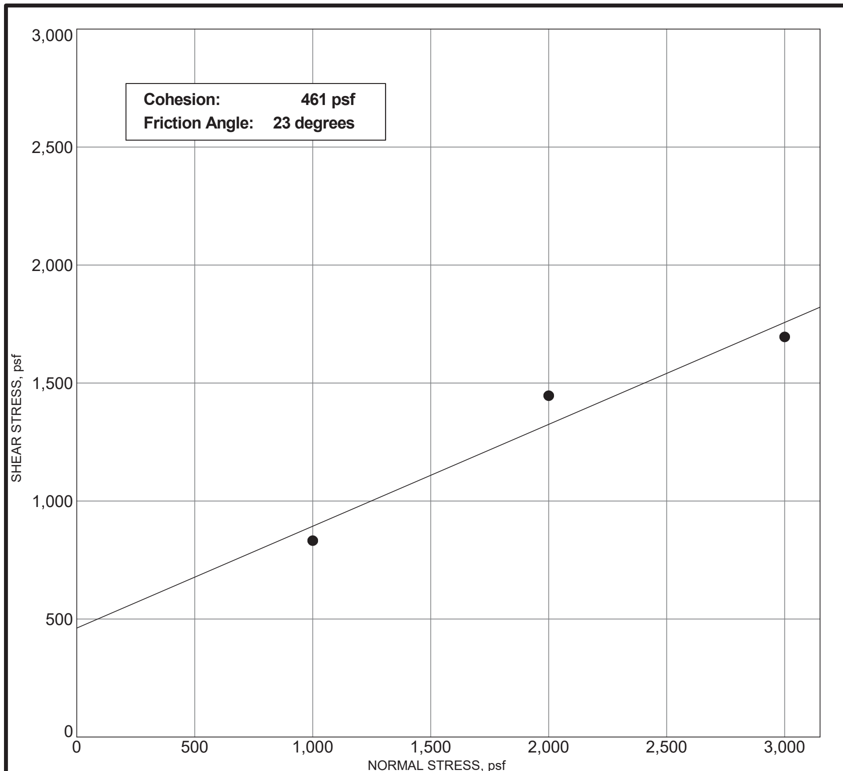
G_DIRECT_SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 11



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	22.0	22.7	23.2
	Dry Density, pcf	65.1	63.5	62.4
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	51.4	51.1	49.2
	Dry Density, pcf	63.0	66.0	64.3
	Height, inches	1.034	0.963	0.971
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0023	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**832**	**1446**	**1695**
	Shear Displacement, inches	0.43	0.42	0.42

Sample: B-1
Depth: 15.0 - 16.5 feet
Description: Light brown sandy gravel with a little silt

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

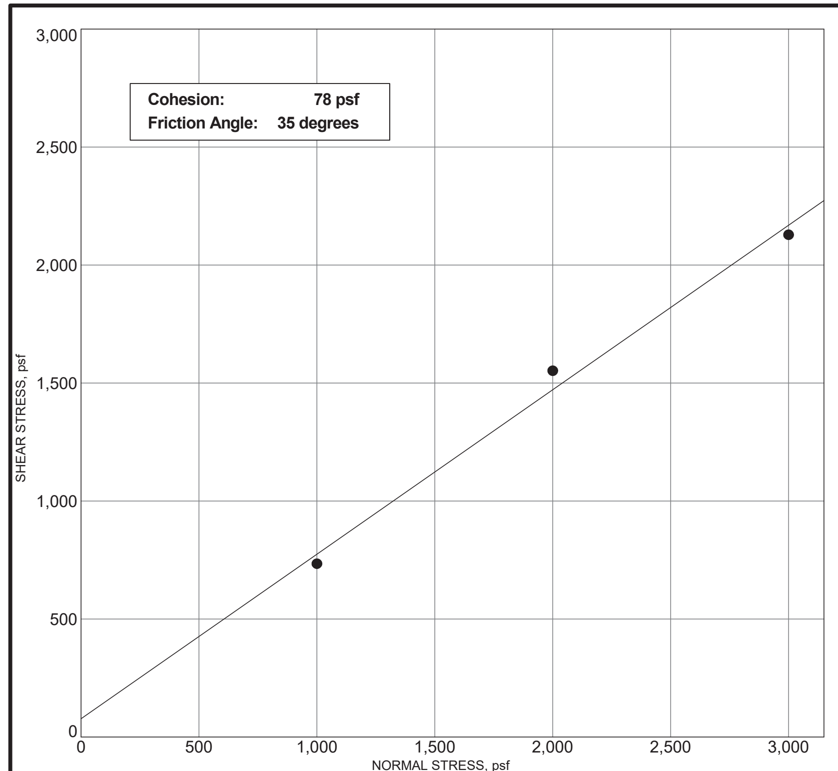
DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 12

G DIRECT SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	15.0	15.5	14.7
	Dry Density, pcf	69.1	77.9	76.2
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	40.2	36.5	35.9
	Dry Density, pcf	67.5	80.7	78.4
	Height, inches	1.023	0.966	0.971
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0024	0.0022	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**734**	**1552**	**2128**
	Shear Displacement, inches	0.43	0.41	0.42

Sample: B-2
Depth: 15.0 - 16.5 feet
Description: Brown sandy silt with some gravel

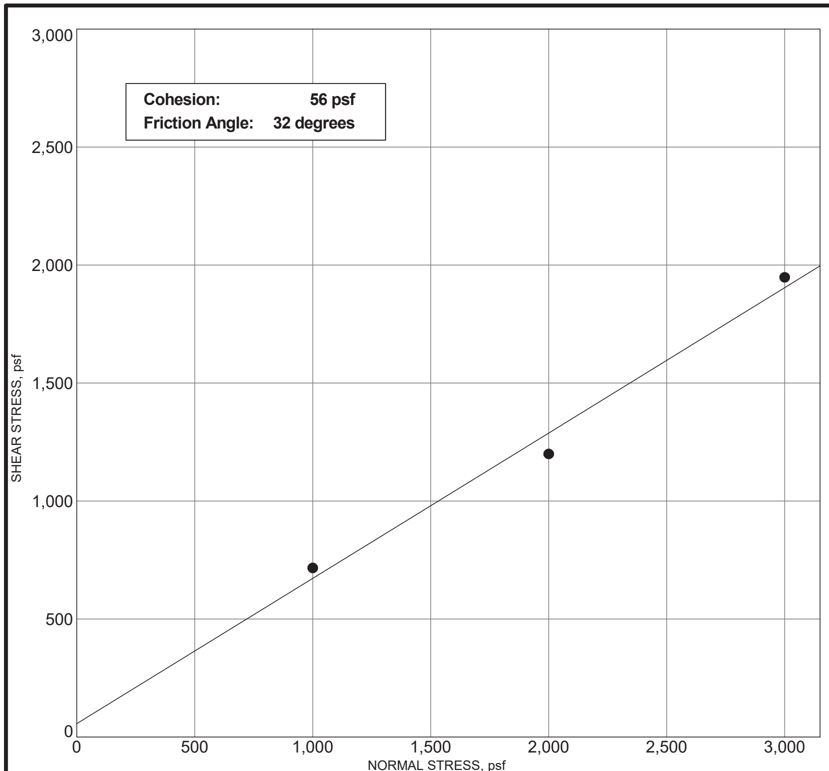
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 13

G DIRECT SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	30.5	32.0	32.8
	Dry Density, pcf	83.5	87.5	87.1
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	36.8	32.9	32.1
	Dry Density, pcf	81.5	89.8	90.2
	Height, inches	1.024	0.974	0.966
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0024	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**716**	**1199**	**1948**
	Shear Displacement, inches	0.43	0.42	0.42

Sample: P-1
Depth: 5.0 - 6.5 feet
Description: Brown sandy silt (ML)

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

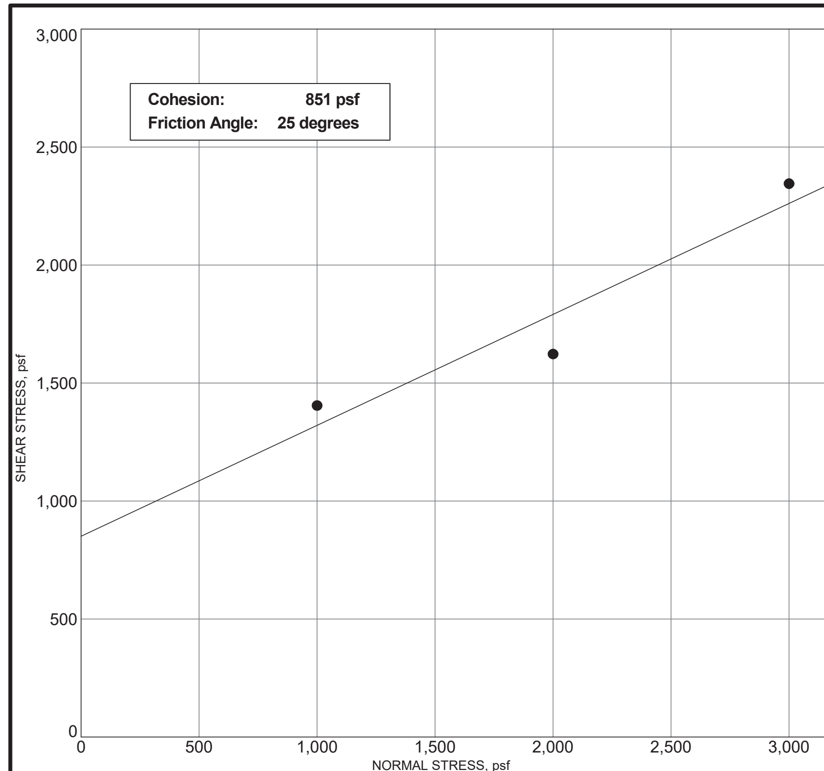
DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 14

G DIRECT SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	33.9	32.0	29.7
	Dry Density, pcf	84.5	85.5	88.7
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	41.6	38.6	35.2
	Dry Density, pcf	83.4	87.7	90.8
	Height, inches	1.013	0.974	0.977
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0024	0.0021	0.0022
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**1405**	**1623**	**2345**
	Shear Displacement, inches	0.43	0.41	0.42

Sample: P-1
Depth: 25.0 - 26.5 feet
Description: Brown silty sand with a little gravel

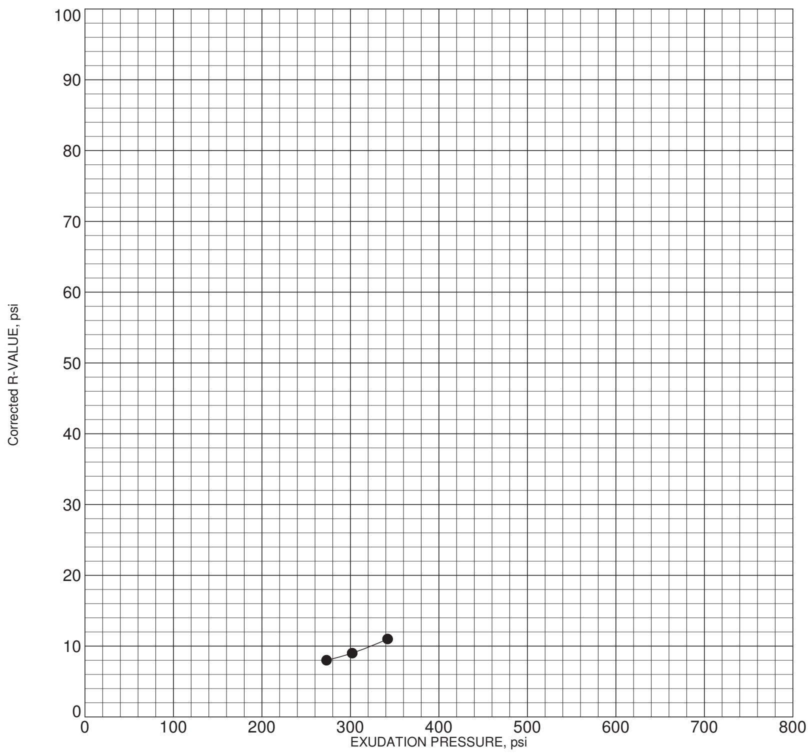
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 15

G DIRECT SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23



Sample: BULK-1
Depth: 0.5 - 1.5 feet
Description: Brown clayey sand (SC) with some gravel

R-Value at 300 psi Exudation Pressure: **9**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	106.9	23.5	127	2.49	342	11	11
2	50	105.9	24.0	132	2.44	302	9	9
3	50	102.4	24.5	136	2.44	273	8	8

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

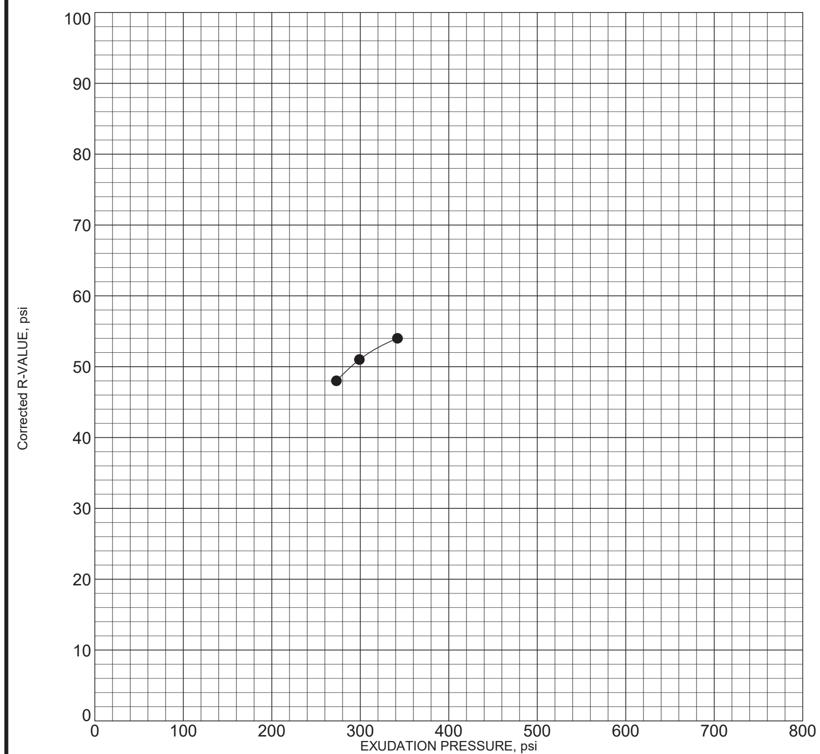
R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 16

R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 6/26/24

DRAFT Geotechnical Exploration Report - June 26, 2024



Sample: BULK-2
Depth: 0.5 - 1.5 feet
Description: Brown silty sand (SM) with some gravel

R-Value at 300 psi Exudation Pressure: **51**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	103.7	21.7	50	2.56	342	54	54
2	50	101.8	22.2	53	2.54	299	51	51
3	50	102.4	24.5	57	2.44	273	48	48

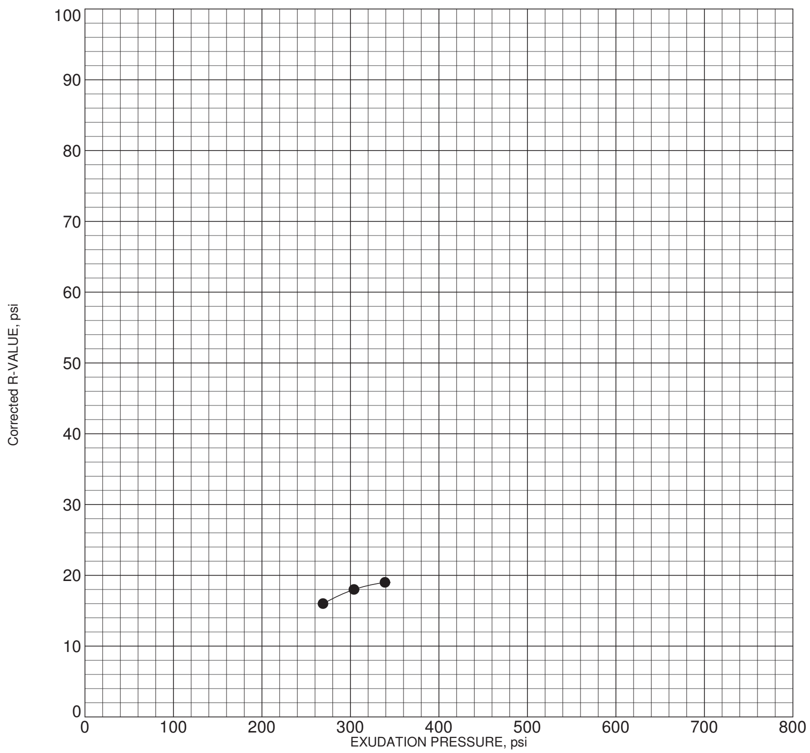
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 17

R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23



Sample: BULK-3
Depth: 0.5 - 1.5 feet
Description: Brown clayey sand (SC) with some gravel

R-Value at 300 psi Exudation Pressure:	**18**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	92.8	32.4	109	2.56	339	19	19
2	50	91.8	32.9	113	2.55	304	18	18
3	50	90.7	33.4	116	2.49	269	16	16

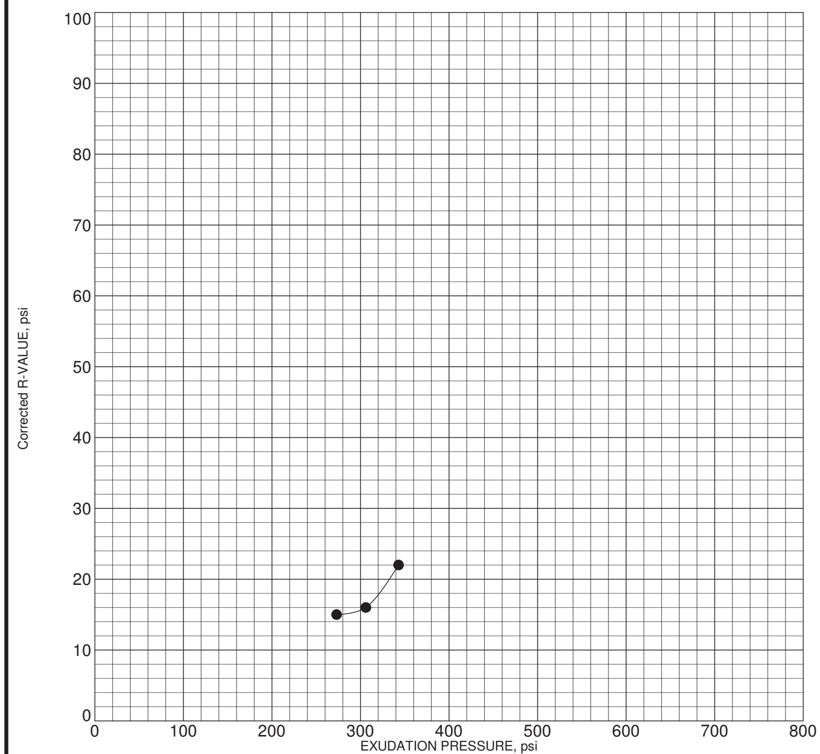
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 6/26/24

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 18



Sample: BULK-4
Depth: 0.5 - 1.5 feet
Description: Brown sandy clay (CL) with a little gravel

R-Value at 300 psi Exudation Pressure:	**16**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	99.4	29.1	105	2.52	343	22	22
2	50	96.9	29.6	116	2.55	306	16	16
3	50	96.0	30.0	119	2.51	273	15	15

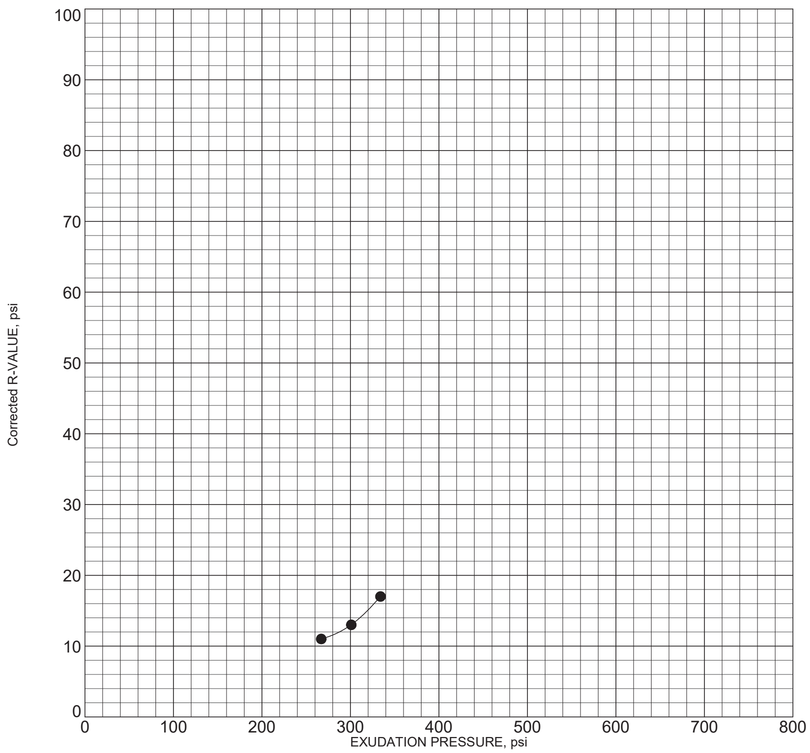
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 6/26/24

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 19



Sample: BULK-5
Depth: 0.5 - 1.5 feet
Description: Brown silty gravel (GM) with some sand

R-Value at 300 psi Exudation Pressure:	**13**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	106.0	25.6	105	2.45	334	17	17
2	50	104.7	26.1	116	2.47	301	13	13
3	50	102.0	26.9	119	2.45	267	11	11

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 20

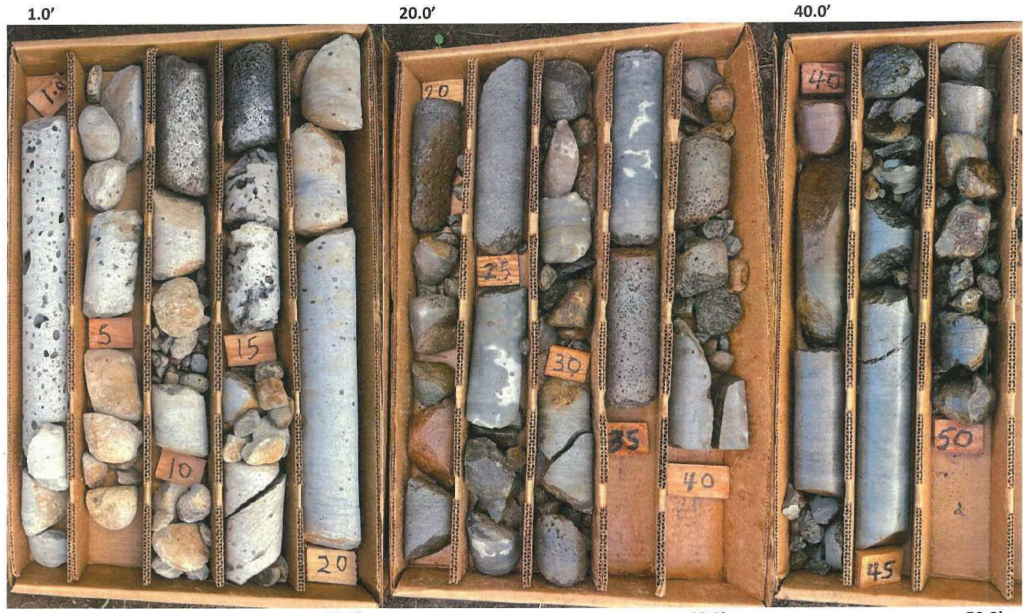
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23

DRAFT Geotechnical Exploration Report - June 26, 2024

APPENDIX C

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-8 1.0' TO 50.0'



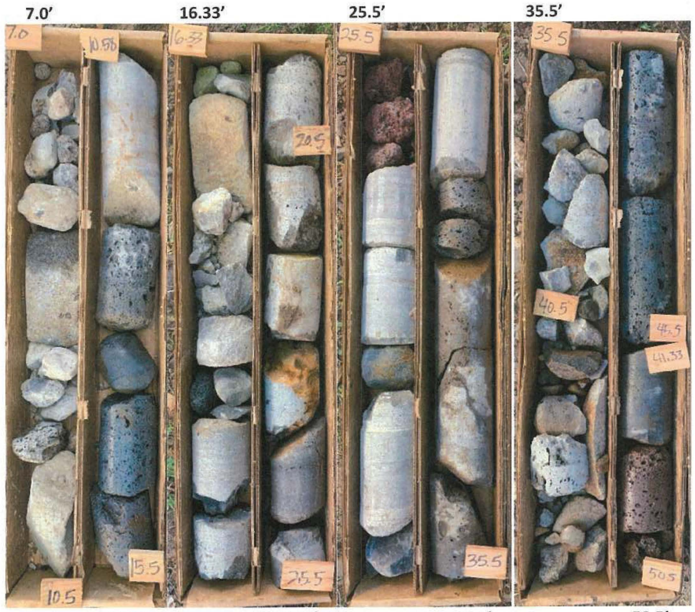
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-6 4.0' TO 11.0'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-10 7.0' TO 50.5'

7.0' 16.33' 25.5' 35.5'

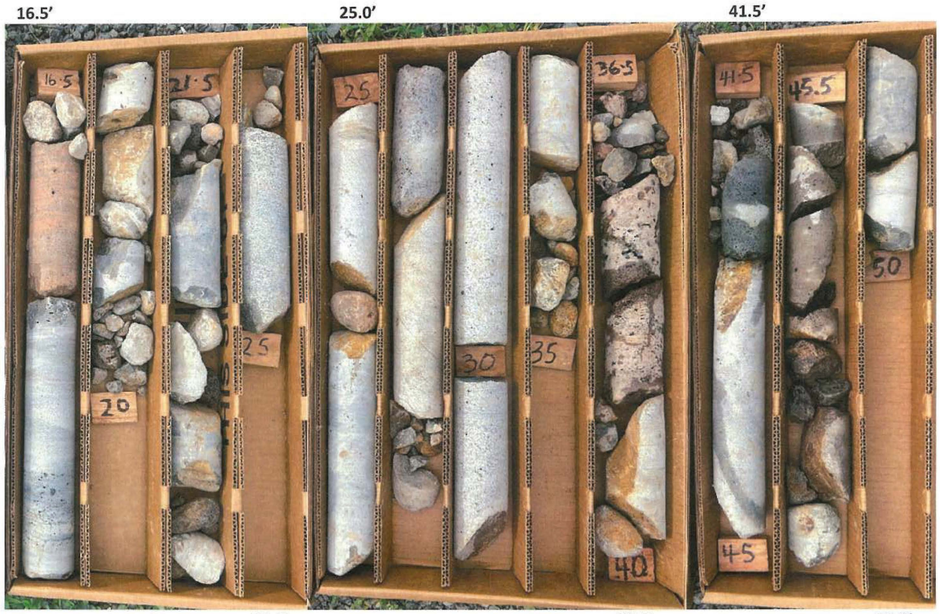


15.5' 25.5' 35.5' 50.5'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-9 16.5' TO 50.0'

16.5' 25.0' 41.5'



25.0' 40.0' 50.0'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-12 1.4' TO 30.0'

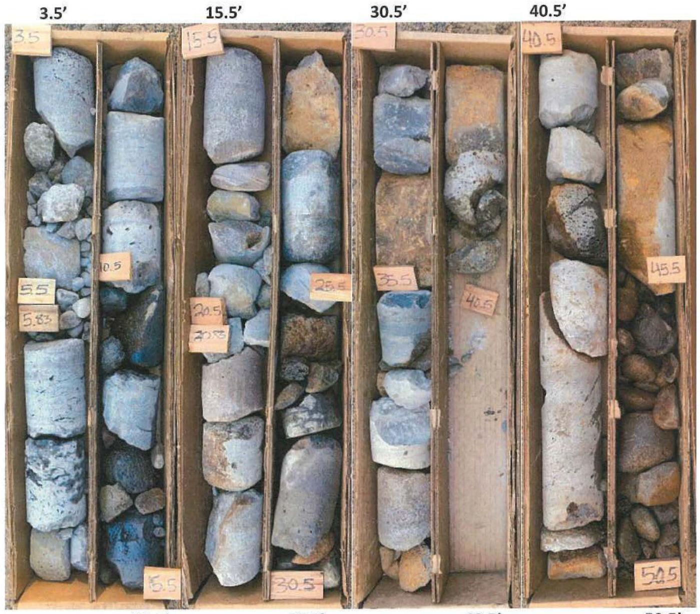
1.4' 11.5' 20.25'

10.0' 20.0' 30.0'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-11 3.5' TO 50.5'

3.5' 15.5' 30.5' 40.5'

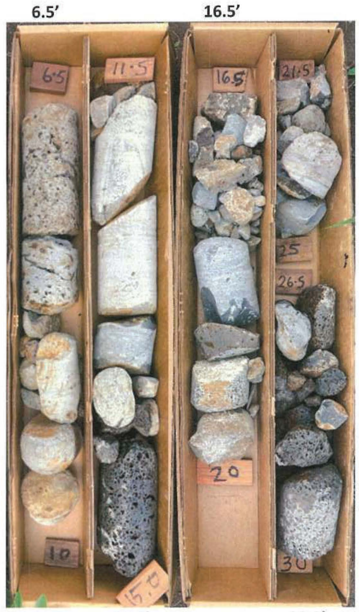


15.5' 30.5' 40.5' 50.5'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

P-4 6.5' TO 30.0'

6.5' 16.5'

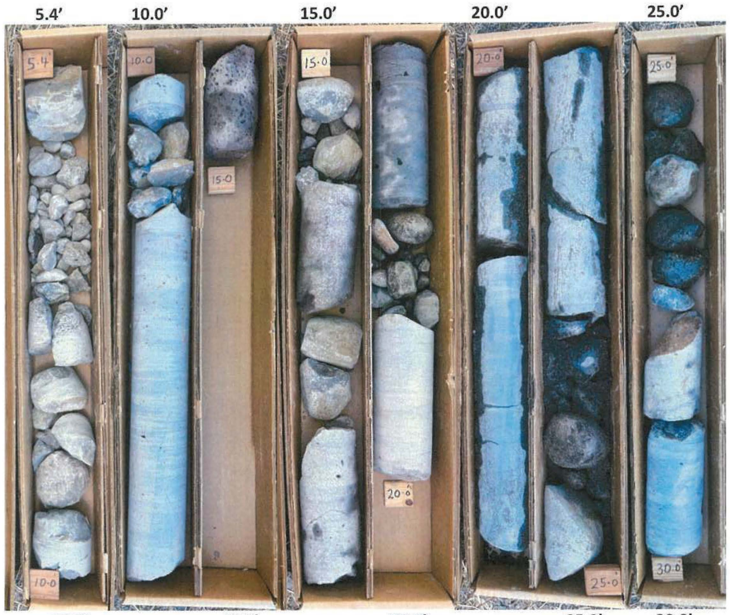


15.0' 30.0'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

B-13 5.4' TO 30.0'

5.4' 10.0' 15.0' 20.0' 25.0'

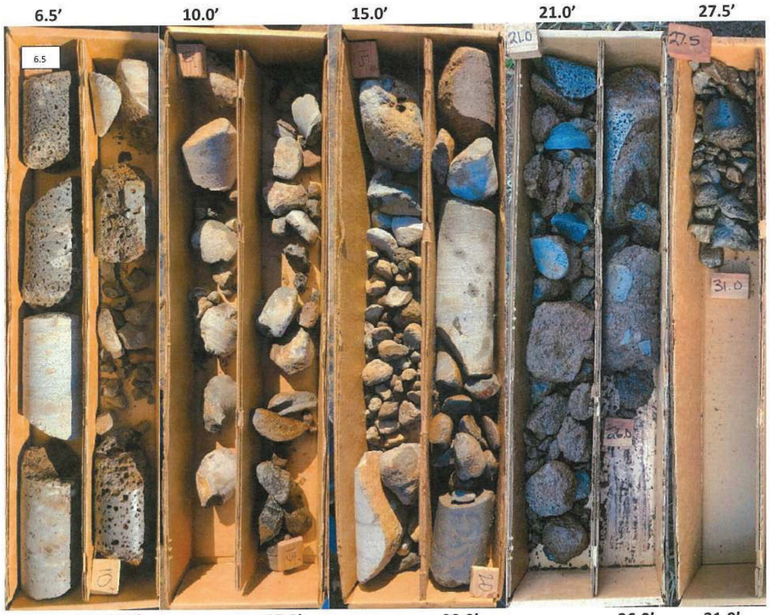


10.0' 15.0' 20.0' 25.0' 30.0'

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

P-6 6.5' TO 31.0'

6.5' **10.0'** **15.0'** **21.0'** **27.5'**



10.0' **15.0'** **20.0'** **26.0'** **31.0'**

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

P-5 5.5' TO 30.0'

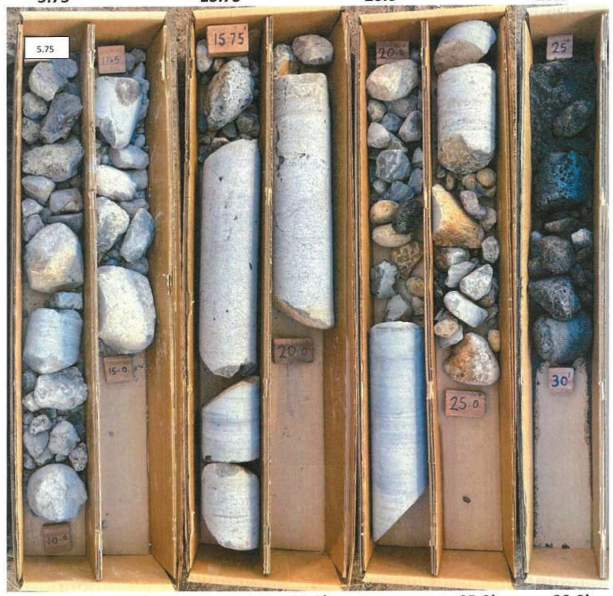
5.5' **16.5'**

15.0' **30.0'**

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

P-8 5.75' TO 30.0'

5.75' 15.75' 20.0' 25.0'



15.0' 20.0' 25.0' 30.0'

DRAFT Geotechnical Exploration Report - June 26, 2024

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

P-7 7.0' TO 30.5'

7.0' 20.5'

20.5' 30.5'

APPENDIX D

DRAFT Geotechnical Exploration Report - June 26, 2024

APPENDIX D

Field Permeability Tests

The permeability of the in-situ soils were evaluated by performing 10 constant head and 9 falling head tests in selected borings (Boring Nos. P-1 through P-8) at depths ranging from approximately 26 to 31 feet below the existing ground surface.

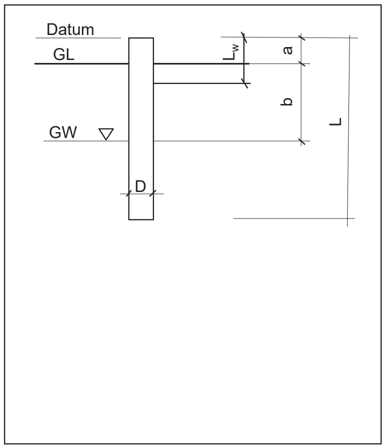
The constant head tests were performed by pumping water into the borings until the water surface stabilized and remained at equilibrium for a sufficient period of time. The water height and rate of pumping were then measured to provide data upon which to base calculation of the subsoil permeability.

After completion of the constant head test, the water inside the boring was allowed to drop for the performance of a falling head test. The time intervals and water drops were recorded to provide data upon which to base calculation of the permeability values of the subsoils.

The test results of the constant head and falling head permeability tests are presented on Plates D-1 through D-19.

INJECTION TEST CALCULATION SHEET
(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-1**	
GW table, b (from ground):	**336**	feet
Datum, a (above ground):	**3**	feet
Depth of Boring (L):	**33**	feet
Diameter of casing (D):	**4.5**	inches
Constant flow rate, Q:	**24.2**	gpm
Constant water level (L_w):	**0.0**	feet

Constant flow rate, Q =	24.2	gpm
=	3.23	$feet^3/min$
Piezometer head, H_c=	339.0	feet

Coefficient of Permeability

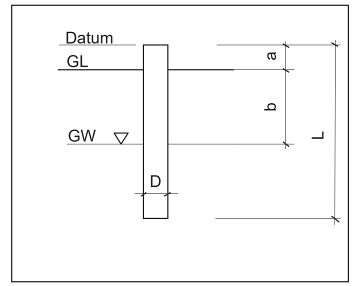
$$k = \frac{q}{2.75 \times D \times H_c}$$

9.3E-03 ft/min

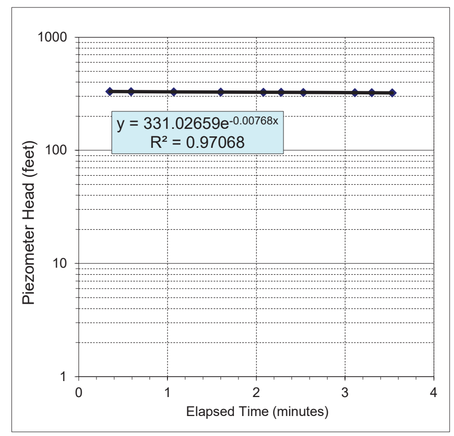
4.7E-03 cm/s

PERCOLATION TEST CALCULATION SHEET
(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-1**	
GW table, b (from ground):	**336**	feet
Datum, a (above ground):	**3**	feet
Depth of hole:	**30**	feet
Casing Length, L (from datum):	**33**	feet
Diameter of open hole (D):	**4.5**	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	**0.00**	**339.0**
0.4	**7.90**	**331.1**
0.6	**10.20**	**328.8**
1.1	**10.50**	**328.5**
1.6	**12.60**	**326.4**
2.1	**13.10**	**325.9**
2.3	**13.90**	**325.1**
2.5	**14.70**	**324.3**
3.1	**15.50**	**323.5**
3.3	**16.00**	**323.0**
3.5	**16.80**	**322.2**

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	**331.0266**
c=	**-0.0077**

Permeability, k

$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

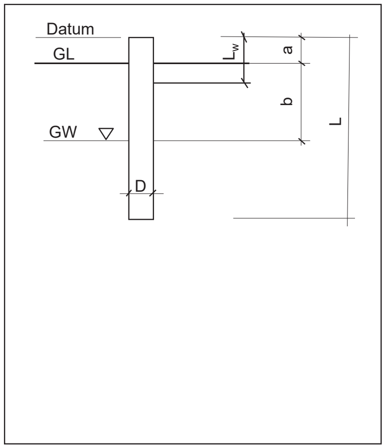
8.2E-04 ft/min

4.2E-04 cm/s

INJECTION TEST CALCULATION SHEET

(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-2	
GW table, b (from ground):	285	feet
Datum, a (above ground):	2.5	feet
Depth of Boring (L):	32.5	feet
Diameter of casing (D):	4.5	inches
Constant flow rate, Q:	4.4	gpm
Constant water level (L_w):	0.0	feet

Constant flow rate, Q	=	4.4	gpm
	=	0.58	feet³/min
Piezometer head, H_c=		287.5	feet

Coefficient of Permeability

$$k = \frac{q}{2.75 \times D \times H_c}$$

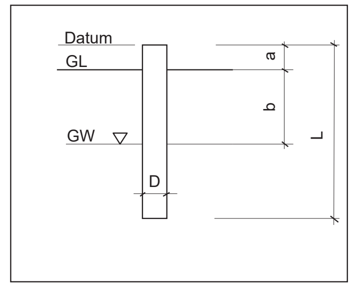
2.0E-03 ft/min

1.0E-03 cm/s

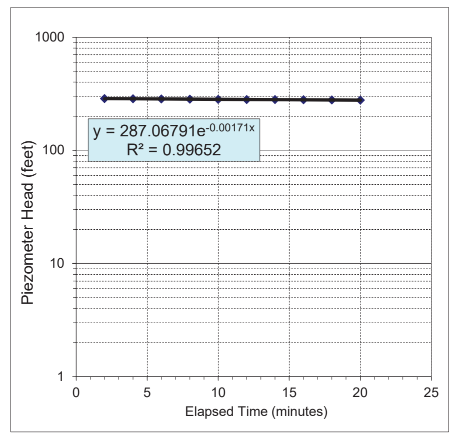
PERCOLATION TEST CALCULATION SHEET

(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-2	
GW table, b (from ground):	285	feet
Datum, a (above ground):	2.5	feet
Depth of hole:	30	feet
Casing Length, L (from datum):	32.5	feet
Diameter of open hole (D):	4.5	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	0.00	287.5
2.0	1.20	286.3
4.0	2.30	285.2
6.0	3.40	284.1
8.0	4.50	283.0
10.0	5.50	282.0
12.0	6.50	281.0
14.0	7.00	280.5
16.0	8.30	279.2
18.0	9.00	278.5
20.0	10.00	277.5

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	287.0679
c=	-0.0017

Permeability, k

$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

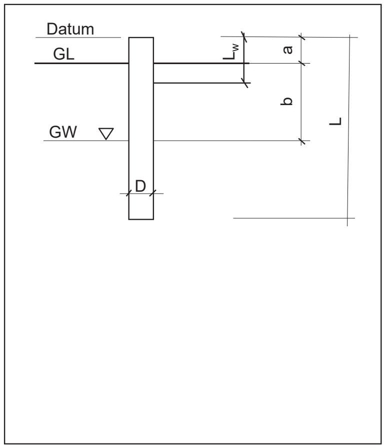
1.8E-04 ft/min

9.3E-05 cm/s

INJECTION TEST CALCULATION SHEET

(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-3**	
GW table, b (from ground):	**266**	feet
Datum, a (above ground):	**2.5**	feet
Depth of Boring (L):	**32.5**	feet
Diameter of casing (D):	**4.5**	inches
Constant flow rate, Q:	**4.0**	gpm
Constant water level (L_w):	**0.0**	feet

Constant flow rate, Q =	4.0	gpm
=	0.53	feet³/min
Piezometer head, H_c=	268.5	feet

Coefficient of Permeability

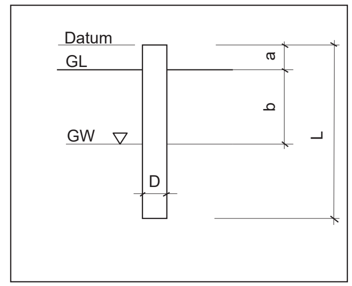
$$k = \frac{q}{2.75 \times D \times H_c}$$

1.9E-03	ft/min
9.8E-04	cm/s

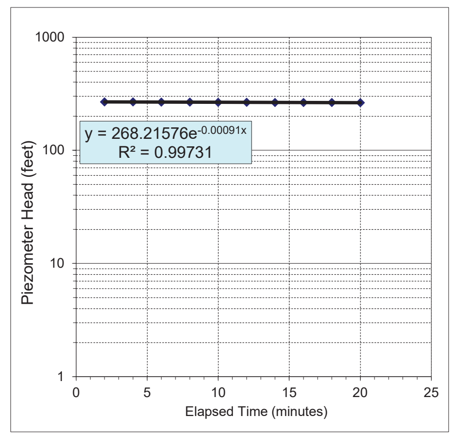
PERCOLATION TEST CALCULATION SHEET

(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-3**	
GW table, b (from ground):	**266**	feet
Datum, a (above ground):	**2.5**	feet
Depth of hole:	**30**	feet
Casing Length, L (from datum):	**32.5**	feet
Diameter of open hole (D):	**4.5**	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	**0.00**	**268.5**
2.0	**0.70**	**267.8**
4.0	**1.20**	**267.3**
6.0	**1.70**	**266.8**
8.0	**2.30**	**266.2**
10.0	**2.80**	**265.7**
12.0	**3.30**	**265.2**
14.0	**3.70**	**264.8**
16.0	**4.20**	**264.3**
18.0	**4.60**	**263.9**
20.0	**5.00**	**263.5**

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	**268.2158**
c=	**-0.0009**

Permeability, k

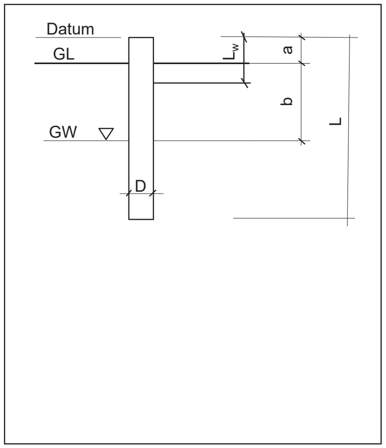
$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

9.7E-05	ft/min
4.9E-05	cm/s

INJECTION TEST CALCULATION SHEET

(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-4	
GW table, b (from ground):	256	feet
Datum, a (above ground):	2.5	feet
Depth of Boring (L):	32.5	feet
Diameter of casing (D):	4.5	inches
Constant flow rate, Q:	6.1	gpm
Constant water level (L_w):	0.0	feet

Constant flow rate, Q =	6.1	gpm
=	0.82	feet³/min
Piezometer head, H_c=	258.5	feet

Coefficient of Permeability

$$k = \frac{q}{2.75 \times D \times H_c}$$

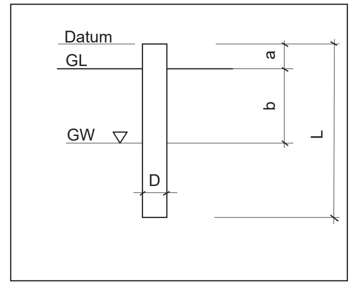
3.1E-03 ft/min

1.6E-03 cm/s

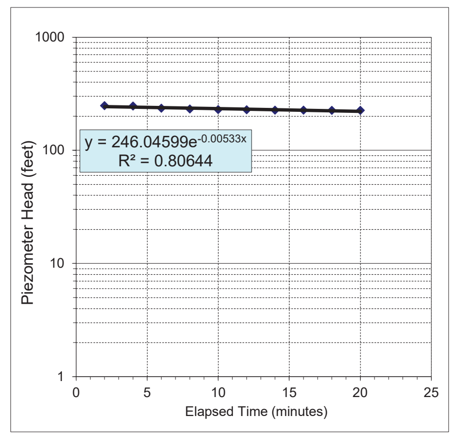
PERCOLATION TEST CALCULATION SHEET

(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-4	
GW table, b (from ground):	256	feet
Datum, a (above ground):	2.5	feet
Depth of hole:	30	feet
Casing Length, L (from datum):	32.5	feet
Diameter of open hole (D):	4.5	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	0.00	258.5
2.0	10.10	248.4
4.0	12.60	245.9
6.0	23.20	235.3
8.0	26.60	231.9
10.0	29.40	229.1
12.0	30.90	227.6
14.0	32.00	226.5
16.0	32.50	226.0
18.0	32.90	225.6
20.0	33.20	225.3

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	246.0460
c=	-0.0053

Permeability, k

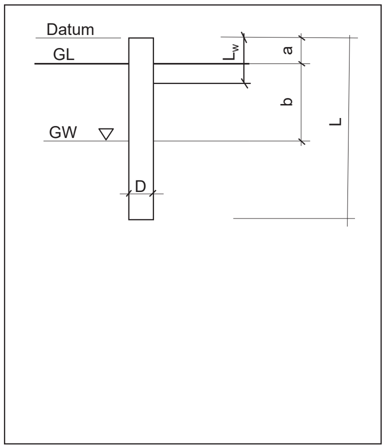
$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

5.7E-04 ft/min

2.9E-04 cm/s

INJECTION TEST CALCULATION SHEET
(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-5**	
GW table, b (from ground):	**8**	feet
Datum, a (above ground):	**2.5**	feet
Depth of Boring (L):	**32.5**	feet
Diameter of casing (D):	**4.5**	inches
Constant flow rate, Q:	**4.2**	gpm
Constant water level (L_w):	**0.0**	feet

Constant flow rate, Q =	4.2	gpm
=	0.56	feet³/min
Piezometer head, H_c=	10.8	feet

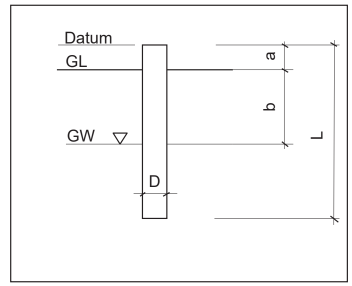
Coefficient of Permeability

$$k = \frac{q}{2.75 \times D \times H_c}$$

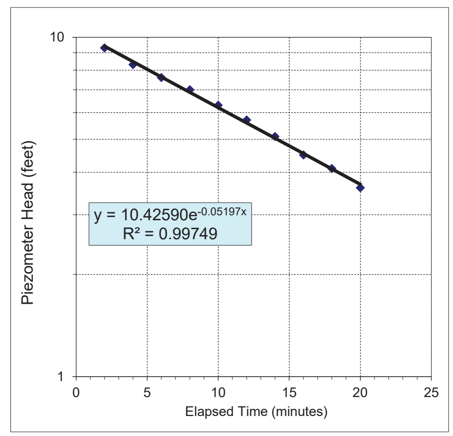
5.0E-02	ft/min
2.5E-02	cm/s

PERCOLATION TEST CALCULATION SHEET
(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-5**	
GW table, b (from ground):	**8**	feet
Datum, a (above ground):	**2.5**	feet
Depth of hole:	**30**	feet
Casing Length, L (from datum):	**32.5**	feet
Diameter of open hole (D):	**4.5**	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	**0.00**	**10.5**
2.0	**1.20**	**9.3**
4.0	**2.20**	**8.3**
6.0	**2.90**	**7.6**
8.0	**3.50**	**7.0**
10.0	**4.20**	**6.3**
12.0	**4.80**	**5.7**
14.0	**5.40**	**5.1**
16.0	**6.00**	**4.5**
18.0	**6.40**	**4.1**
20.0	**6.90**	**3.6**

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	**10.4259**
c=	**-0.0520**

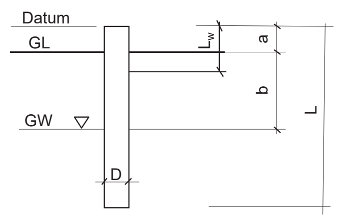
Permeability, k

$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

5.6E-03	ft/min
2.8E-03	cm/s

INJECTION TEST CALCULATION SHEET
(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-6**	
GW table, b (from ground):	**297**	feet
Datum, a (above ground):	**2.5**	feet
Depth of Boring (L):	**28.5**	feet
Diameter of casing (D):	**4.5**	inches
Constant flow rate, Q:	**4.6**	gpm
Constant water level (L_w):	**0.0**	feet

Constant flow rate, Q =	4.6	gpm
=	0.62	feet³/min
Piezometer head, H_c=	299.5	feet

Coefficient of Permeability

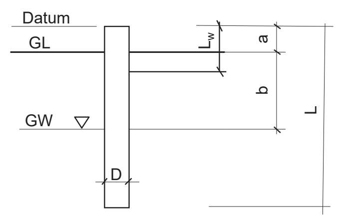
$$k = \frac{q}{2.75 \times D \times H_c}$$

2.0E-03	ft/min
1.0E-03	cm/s

DRAFT Geotechnical Exploration Report - June 26, 2024

INJECTION TEST CALCULATION SHEET
(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	**P-6**	
GW table, b (from ground):	**297**	feet
Datum, a (above ground):	**2.5**	feet
Depth of Boring (L):	**33.5**	feet
Diameter of casing (D):	**4.5**	inches
Constant flow rate, Q:	**1.9**	gpm
Constant water level (L_w):	**0.0**	feet

Constant flow rate, Q =	1.9	gpm
=	0.26	feet³/min
Piezometer head, H_c=	299.5	feet

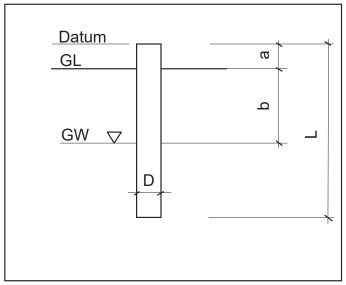
Coefficient of Permeability

$$k = \frac{q}{2.75 \times D \times H_c}$$

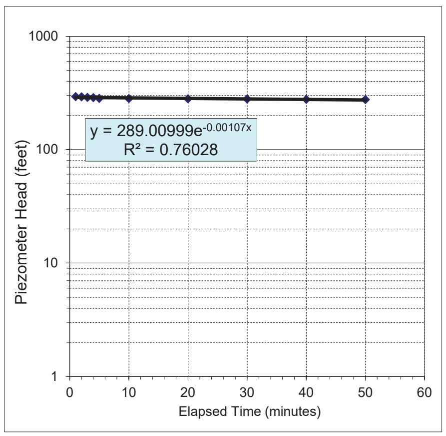
8.4E-04	ft/min
4.3E-04	cm/s

PERCOLATION TEST CALCULATION SHEET
(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-6	
GW table, b (from ground):	297	feet
Datum, a (above ground):	2.5	feet
Depth of hole:	31	feet
Casing Length, L (from datum):	33.5	feet
Diameter of open hole (D):	4.5	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	2.25	297.3
1.0	5.75	293.8
2.0	7.25	292.3
3.0	11.00	288.5
4.0	12.25	287.3
5.0	16.50	283.0
10.0	17.40	282.1
20.0	18.30	281.2
30.0	20.40	279.1
40.0	22.30	277.2
50.0	23.70	275.8
60.0	24.60	274.9

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	288.6563
c=	-0.0009

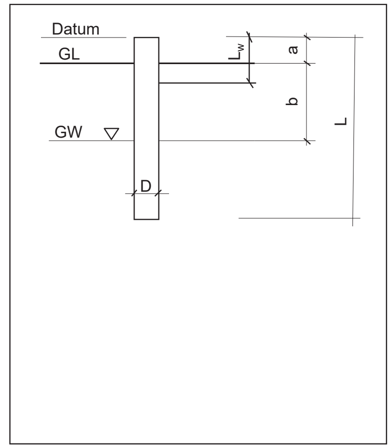
Permeability, k

$$k=\frac{\pi\times D}{11(t_2-t_1)}\ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

1.0E-04	ft/min
5.2E-05	cm/s

INJECTION TEST CALCULATION SHEET
(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-7	
GW table, b (from ground):	325	feet
Datum, a (above ground):	2.5	feet
Depth of Boring (L):	28.5	feet
Diameter of casing (D):	4.5	inches
Constant flow rate, Q:	12.6	gpm
Constant water level (L_w):	0.0	feet

Constant flow rate, Q =	12.6	gpm
=	1.68	feet³/min
Piezometer head, H_c=	327.0	feet

Coefficient of Permeability

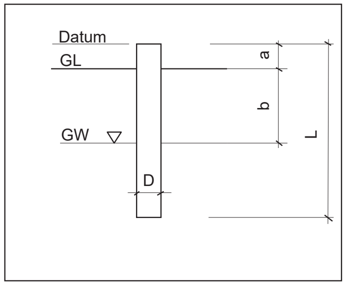
$$k = \frac{q}{2.75 \times D \times H_c}$$

5.0E-03	ft/min
2.5E-03	cm/s

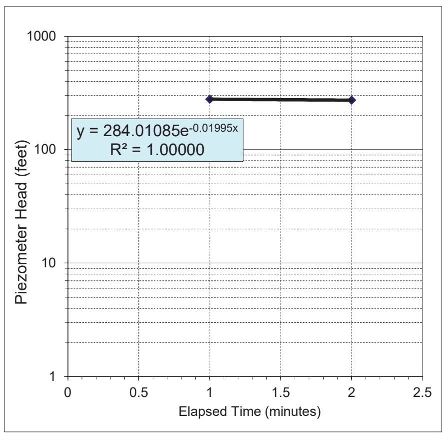
PERCOLATION TEST CALCULATION SHEET

(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-7	
GW table, b (from ground):	297	feet
Datum, a (above ground):	2.5	feet
Depth of hole:	26.0	feet
Casing Length, L (from datum):	28.5	feet
Diameter of open hole (D):	4.5	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	0.00	300.0
1.0	21.60	278.4
2.0	27.10	272.9

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	284.0108
c=	-0.0200

Permeability, k

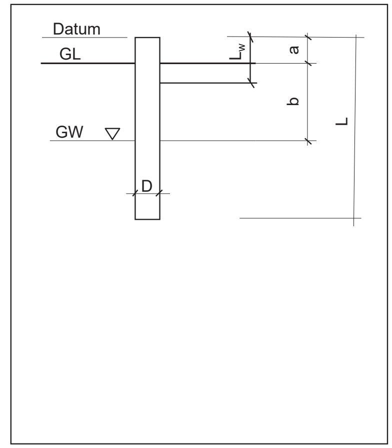
$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1c}}{H_{2c}}\right)$$

2.1E-03	ft/min
1.1E-03	cm/s

INJECTION TEST CALCULATION SHEET

(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-7	
GW table, b (from ground):	325	feet
Datum, a (above ground):	3.0	feet
Depth of Boring (L):	33.5	feet
Diameter of casing (D):	4.5	inches
Constant flow rate, Q:	8.9	gpm
Constant water level (L_w):	0.0	feet

Constant flow rate, Q =	8.9	gpm
=	1.19	feet³/min
Piezometer head, H_c=	328.0	feet

Coefficient of Permeability

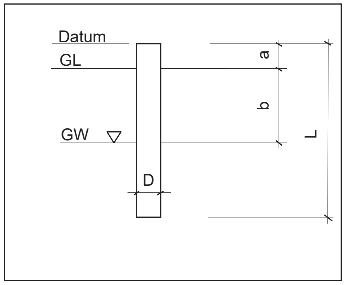
$$k = \frac{q}{2.75 \times D \times H_c}$$

3.5E-03	ft/min
1.8E-03	cm/s

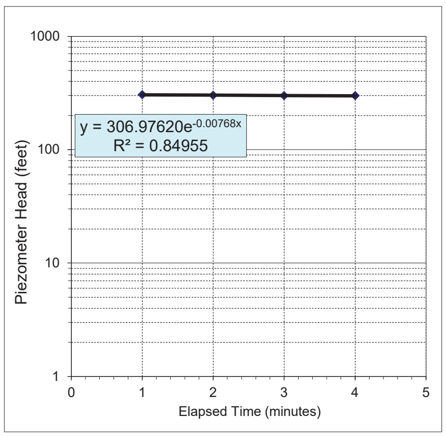
PERCOLATION TEST CALCULATION SHEET

(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-7	
GW table, b (from ground):	325	feet
Datum, a (above ground):	3	feet
Depth of hole:	30.5	feet
Casing Length, L (from datum):	33.5	feet
Diameter of open hole (D):	4.5	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	15.90	312.1
1.0	22.30	305.7
2.0	26.70	301.3
3.0	29.20	298.8
4.0	29.20	298.8

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	306.9762
c=	-0.0077

Permeability, k

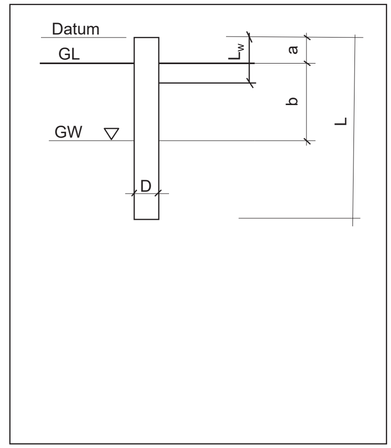
$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_{1C}}{H_{2C}}\right)$$

8.2E-04	ft/min
4.2E-04	cm/s

INJECTION TEST CALCULATION SHEET

(CONSTANT HEAD METHOD: FLUSH BOTTOM IN UNIFORM SOIL - CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-8	
GW table, b (from ground):	319	feet
Datum, a (above ground):	2.3	feet
Depth of Boring (L):	32.3	feet
Diameter of casing (D):	4.5	inches
Constant flow rate, Q:	4.0	gpm
Constant water level (L_w):	0.0	feet

Constant flow rate, Q =	4.0	gpm
=	0.53	feet³/min
Piezometer head, H_c=	320.8	feet

Coefficient of Permeability

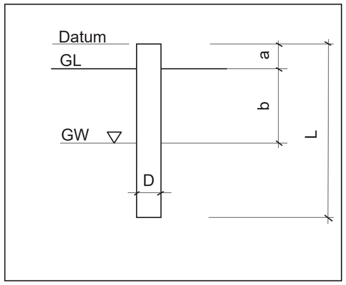
$$k = \frac{q}{2.75 \times D \times H_c}$$

1.6E-03	ft/min
8.2E-04	cm/s

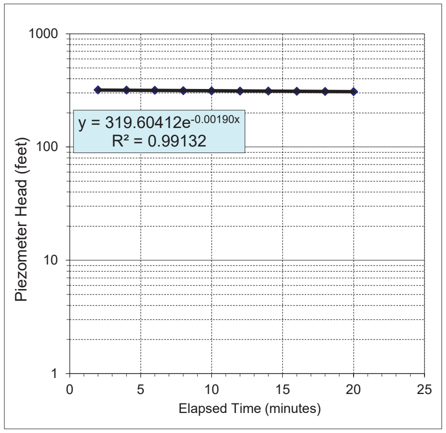
PERCOLATION TEST CALCULATION SHEET

(FALLING HEAD METHOD: FLUSHED BOTTOM-CASED HOLE)

Waiale Road Extension
Waikapu, Maui, Hawaii



Boring:	P-8	
GW table, b (from ground):	319	feet
Datum, a (above ground):	2.3	feet
Depth of hole:	30	feet
Casing Length, L (from datum):	32.3	feet
Diameter of open hole (D):	4.5	inches



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	0.00	321.3
2.0	2.40	318.9
4.0	3.90	317.4
6.0	5.40	315.9
8.0	6.80	314.5
10.0	8.10	313.2
12.0	9.30	312.0
14.0	10.40	310.9
16.0	11.30	310.0
18.0	12.20	309.1
20.0	13.20	308.1

Constant factor of the trendline $y = \lambda e^{cx}$

λ=	319.6041
c=	-0.0019

Permeability, k

$$k = \frac{\pi \times D}{11(t_2 - t_1)} \ln\left(\frac{H_1c}{H_2c}\right)$$

2.0E-04	ft/min
1.0E-04	cm/s

GEOLABS, INC.
Hawaii • California

APPENDIX B-2

Preliminary Pavement Justification Report

PAVEMENT JUSTIFICATION REPORT
COUNTY OF MAUI – DEPARTMENT OF PUBLIC WORKS
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

W.O. 8345-00 MARCH 21, 2024

Prepared for

BOWERS + KUBOTA CONSULTING

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

PAVEMENT JUSTIFICATION REPORT
COUNTY OF MAUI – DEPARTMENT OF PUBLIC WORKS
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

W.O. 8345-00 MARCH 21, 2024

Prepared for

BOWERS + KUBOTA CONSULTING

GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE 4-30-24
EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
94-429 Koaki Street, Suite 200 • Waipahu, HI 96797

Hawaii • California

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

March 21, 2024
W.O. 8345-00

Ms. Kathleen Chu
Bowers + Kubota Consulting
94-408 Akoki Street, Suite 201-A
Waipahu, HI 96797

Dear **Ms. Chu:**

Geolabs, Inc. is pleased to submit our report entitled "Pavement Justification Report, County of Maui – Department of Public Works, Waiale Road Extension, Waikapu, Maui, Hawaii," prepared for the design of this proposed project.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated August 17, 2021.

Please note that the soil and rock samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless special arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage requirements, if appropriate.

Detailed discussion and specific pavement design recommendations are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

Gerald Y. Seki, P.E.
Vice President

GS:JS:RY:sh

PAVEMENT JUSTIFICATION REPORT
COUNTY OF MAUI – DEPARTMENT OF PUBLIC WORKS
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
W.O. 8345-00 MARCH 21, 2024

TABLE OF CONTENTS

PAVEMENT JUSTIFICATION REPORT
COUNTY OF MAUI – DEPARTMENT OF PUBLIC WORKS
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
W.O. 8345-00 MARCH 21, 2024

SUMMARY OF FINDINGS AND RECOMMENDATIONS

New pavements will be constructed as part of the *Waiale Road Extension, Phase 1A* project. Based on our field exploration, we anticipate that the majority of the pavement subgrade soils for the new roadway generally will consist of loose to very dense silty sands, gravelly sands, sandy gravel, and silty gravel, medium stiff to hard sandy clay, and sandy silts. Based on the laboratory data, an R-value of 9 has been adopted for the subgrade soils in our pavement design analyses for this project.

Typically, the new Hawaii Department of Transportation (HDOT) pavements include a drainage layer to facilitate drainage and increase the pavement life. However, since the pavement section along the existing Waiale Road does not have a drainage layer, only pavement structural sections without a permeable drainage layer were considered in our pavement design.

Based on the traffic data provided by Fehr & Peers, dated October 23, 2023, the R-values obtained for the subgrade soils, and potential construction considerations, we recommend using a flexible pavement structural section consisting of 2 inches of Polymer-Modified Asphalt (PMA) concrete over 7 inches of asphaltic concrete base (ACB) over 19 inches of aggregate base course (ABC) for the new pavements at the project site. A rigid pavement structural section consisting of 9.5 inches of Portland Cement Concrete (PCC) on 12.0 inches of aggregate subbase (ASB) may be considered for the project in lieu of asphaltic concrete pavement.

By incorporating a layer of Tensar InterAx geogrid over the underlying subgrade, the thickness of the flexible and rigid pavement sections may be reduced. The geogrid should consist of Tensar InterAx FilterGrid NX850-FG or equivalent. The reinforcing geogrid would serve to enhance the R-value of the subgrade materials by providing stabilization and reinforcement to the underlying base/subbase/subgrade materials. The flexible pavement structural section with geogrid should consist of 2 inches of PMA concrete over 6 inches of ACB over 6 inches of ABC. A rigid pavement structural section with geogrid consisting of 9 inches of PCC on 6 inches of ABC may be considered for the project in lieu of asphaltic concrete pavement.

One of the primary distress mechanisms in pavement structures is pumping due to saturation of the subbase and/or subgrade soils. Therefore, the pavement surface should be sloped, and drainage gradients should be maintained to carry surface water off the pavement to appropriate drainage structures.

The text of this pavement justification report should be referred to for detailed discussion and specific design recommendations.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This pavement justification report presents the results of our analysis performed for the *Waiale Road Extension* project in the Waikapu area on the Island of Maui, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our field exploration and presents our geotechnical recommendations derived from our analyses for the design of pavements only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The project site is located in the Waikapu area on the Island of Maui, Hawaii. The project consists of the extension of Waiale Road from East Waiko Road to Honoapiilani Highway. The roadway extension will be about 8,600 linear feet in length and generally be accommodated by a future 80-foot right-of-way. We understand that a new bridge crossing will be required over the existing Waikapu Stream. In addition, new underground utilities will be installed along the roadway, and intersection improvements will be performed at the Waiale Road/East Waiko Road intersection and Waiale Road Extension/Honoapiilani Highway intersection.

This pavement justification report was prepared in support of the design of the new pavements for the project. It should be noted that a separate geotechnical engineering report will be prepared in support of the design of the new bridge crossing, site grading, underground utilities, and other elements of the project. Detailed discussion and geotechnical recommendations for the design of the other elements of the project will be presented under a separate cover in our Geotechnical Engineering Exploration report.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Maui was built by two major volcanoes, the older West Maui (Tertiary Epoch) and the more recent East Maui, also known as Haleakala (Pleistocene Epoch). The Isthmus of Maui is a narrow, gently sloping plain located between these two volcanoes. The project site is located at the central portion of this gently sloping plain.

The Isthmus of Maui was created by lava flows from Haleakala ponding on West Maui. It is comprised of alluvium washed from the slopes of West Maui and East Maui (Haleakala). The erosional processes are dominated by the detachment of soil and rock masses from the mountain walls, and the soil materials are transported downslope toward the Isthmus primarily by gravity as colluvium. Once these materials reach the stream in the central portion of a valley, alluvial processes become dominant, and the sediments are transported and deposited as alluvium.

In general, stream flows in Hawaii are intermittent and flashy, such that the stream flows transmit large volumes of water for a very short duration. Because of this, the transport of sediments is intermittent, and the bulk of the stream's hydraulic load consists of a poorly sorted mixture of boulders, cobbles, gravel, sands, and fines. When the erosional base levels change, these sediment loads are left as deposits.

When deposits are left in-place for long periods of time, chemical processes begin to alter the materials simultaneously, causing a breakdown or weathering of the materials. Chemical processes also cause induration, or cementation, of the coarse-grained portion of the sediment into a poorly-consolidated sedimentary rock or conglomerate. Simultaneously, erosion continues in the areas above the valley floors and upstream in headwaters. This continued erosion generates material, which is transported downslope, covering the older alluvial soil deposits. Depending on the local base level and rate of transport, these newer sediments are generally transient in terms of geologic time. In addition, their consistency and density are generally less than those of the older, partially consolidated deposits.

Underlying the alluvial soil deposits are overlapping lava from the West Maui and East Maui volcanoes. The bulk of the Haleakala Shield was built during the late Pliocene

and early Pleistocene Epoch by thinly bedded basaltic lava flows of the Honomanu Volcanic Series. During the Pleistocene Epoch, the characteristics of the lava changed to very hard, thickly bedded flows of andesitic composition. These lavas have been grouped as the Kula Volcanic Series.

Further complicating the stratigraphy of the Isthmus was the development of broad fringing reefs in the bay formed at the juncture between West Maui and East Maui and glacio-eustatic sea level changes that occurred during the Pleistocene Epoch in response to the advance and retreat cycles of continental glaciation. During the glacial advances, water was bound into the widespread glaciers as ice on a year-round basis, and less water was available to fill the ocean basins. As a consequence, global sea levels fell below the current sea level. During the retreats, more water was available, and sea levels rose.

When the sea levels fell, the fringing reefs, with their complement of calcium carbonate sand derived from both detrital and bioclastic sources, were exposed to the prevailing tradewinds, which blew in about the same direction as the current tradewinds but were estimated to have an average velocity of about 60 miles per hour. These winds, transporting the loose sand from the reef areas, resulted in a strip of sand dunes (aeolian deposits) that extended from the present Wailuku-Kahului area to as far as the south coast of the Maui Isthmus, blanketing the volcanic and alluvial deposits on the floor of the Isthmus. Sugar cane operations in the past decades have brought the project site to its present conditions.

2.2 Existing Site Conditions

The project site is located south of the intersection of Waiale Road and East Waiko Road, extends to the south through vacant land, and terminates at Honoapiilani Highway approximately 0.85 miles south of the entrance to the Maui Tropical Plantation in the Waikapu area on the Island of Maui, Hawaii. The approximate project area is shown on the Overall Site Plan, Plate 2.

Generally, the existing ground surface within the project area consists of vacant flat land covered with low to medium vegetation consisting of dried grasses and shrubs. A previously cleared access road was observed running in a north-south orientation located west of the proposed road extension. Based on the topographic plan provided, the project site generally slopes down towards the south with elevations ranging from +347.5 to +259 feet Mean Sea Level.

2.3 Subsurface Conditions

We explored the subsurface conditions at the project site by drilling and sampling 21 borings, designated as Boring Nos. B-1 through B-13, and P-1 through P-8, extending to depths ranging from about 10 to 51.75 feet below the existing ground surface. Permeability tests were performed on Boring Nos. P-1 through P-8 at the project site in support of the dry well design. Five bulk samples, designated as Bulk-1 through Bulk-5, were collected for laboratory R-value testing to evaluate the pavement support of the near-surface soils. The approximate boring and bulk sample locations are shown on the Overall Site Plan, Plate 2, and Site Plans, Plates 3.1 through 3.9.

The borings generally encountered a fill layer consisting of loose to very dense silty sands, silty gravel, and gravelly sand, medium stiff to hard sandy clays, and sandy silts, extending to depths of approximately 1.4 to 8 feet below the existing ground surface. The surface fills were generally underlain by alluvial soils consisting of loose to very dense silty sands, sandy gravel, and gravelly sand, medium stiff to hard sandy silts, sandy clay, and cobbles and boulders, extending to the maximum depth explored of 51.75 feet below the existing ground surface. It should be noted that alluvial deposits consisting of cobbles and boulders were encountered in Boring Nos. B-6, B-8, B-9, B-10, B-11, B-12, B-13, and P-4, P-6, P-7, and P-8 between depths of 1 to 51.75 feet below the existing ground surface. The basalt cobbles and boulders were generally moderately to slightly weathered and hard.

We encountered groundwater in Boring Nos. B-6, B-9, and P-5 at depths of about 8.3 to 48 feet below the existing ground surface at the time of our field exploration. However, it should be noted that the water levels recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site. In addition, groundwater levels may vary with seasonal rainfall, time of the year, and other factors.

Detailed descriptions of the field exploration methodology are presented in Appendix A. Descriptions and graphic representations of the materials encountered in the borings are presented on the Logs of Borings in Appendix A. Laboratory tests were performed on selected soil and basalt rock samples, and the test results are presented in Appendix B. Results of the pavement design are presented in Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

New pavements will be constructed for the *Waiale Road Extension* project. Typically, the new Hawaii Department of Transportation (HDOT) pavements include a drainage layer to facilitate drainage and increase the pavement life. However, the pavement section along the existing Waiale Road does not have a drainage layer.

Based on the traffic data provided, the R-value obtained for the subgrade soils, and potential construction considerations, we recommend using a flexible pavement structural section consisting of 2 inches of Polymer-Modified Asphalt (PMA) concrete over 7 inches of asphaltic concrete base (ACB) over 19 inches of aggregate base course (ABC) for the new pavements at the project site. A rigid pavement structural section consisting of 9.5 inches of Portland Cement Concrete (PCC) on 12.0 inches of aggregate subbase (ASB) may be considered for the project in lieu of asphaltic concrete pavement.

By incorporating a layer of Tensar InterAx geogrid over the underlying subgrade, the thickness of the flexible and rigid pavement sections may be reduced. The geogrid should consist of Tensar InterAx FilterGrid NX850-FG or equivalent. The reinforcing geogrid would serve to enhance the R-value of the subgrade materials by providing stabilization and reinforcement to the underlying base/subbase/subgrade materials.

In general, the following sections provide discussions of the areas necessary for pavement analyses and design.

3.1 Methodology of Pavement Design

Two types of pavement structural sections (flexible and rigid pavements) were determined in the pavement analyses. The flexible pavement sections presented herein generally were determined based on the methodology described in Chapter 3 of the revised Pavement Design Manual dated March 2002. The Pavement Design Manual was prepared by the State of Hawaii - Department of Transportation, Highways Division, Material Testing and Research Branch. The pavement design methodology is based on the Hveem Stabilometer method developed and used by the California Department of Transportation (Caltrans).

The design procedures for the rigid pavement sections are generally based on the design procedures described in the Portland Cement Association "Thickness Design for Concrete Highway and Street Pavements."

3.2 Design Traffic Loading Conditions/Traffic Index

Based on the design guidelines from the revised Pavement Design Manual dated March 2002, the new Waiale Road Extension may be classified as a "High-Volume Urban and Tunnels" roadway. Therefore, new pavements for this project will need to be designed for a pavement life of 50 years. Design traffic parameters were obtained from the Waiale Road Extension Transportation Impact Analysis Report by Fehr & Peers, dated October 2023. It should be noted that truck traffic and truck traffic distribution data were not available at the time this report was prepared; therefore, the truck traffic and truck traffic distribution parameters from a previous project located in Maui were utilized (Kihei Roundabout). The following tables summarize the design traffic parameters used in our pavement analyses.

DESIGN TRAFFIC PARAMETERS FOR FLEXIBLE AND RIGID PAVEMENTS	
Design Period	50 Years
Average Daily Traffic (ADT)	Vehicles per day per direction
At Project Completion	13,500
50 Years After Project Completion	13,500
24-Hour Truck Traffic	4%
Type of Axle	Truck Traffic Distribution
2-Axle	75.75%
3-Axle	3.5%
4-Axle	16.4%
5-Axle	4%
6-Axle	0.01%
7-Axle	0.34%

Based on a design period of 50 years, the traffic volume provided, and the assumed truck traffic distribution, a Traffic Index (TI) of 11.5 was determined for the project, respectively. Detailed analyses of the Traffic Index Determination are presented in Appendix C.

3.3 Design Subgrade Conditions

Based on our field exploration and the current design concept, we anticipate that the pavement subgrade soils may consist of recompacted on-site materials and/or new compacted fills needed to achieve the design finished grades. We anticipate that majority of the pavement subgrade soils generally will consist of loose to very dense silty sands, gravelly sands, sandy gravel, and silty gravel, medium stiff to hard sandy clay, and sandy silts.

Laboratory Resistance (R) value testing was performed on the near-surface soils along the proposed roadway alignment to evaluate the use of the near-surface soils as roadway fill material. The R-values obtained for the existing subgrade soils ranged from 9 to 51.

Based on the laboratory data, an R-value of 9 has been adopted for the subgrade soils in our pavement design analyses for this project. The results of the laboratory R-value tests are presented in Appendix B. If site grading exposes soils other than those assumed in the pavement design, additional tests should be performed to confirm and/or revise the recommended pavement section for actual field conditions.

3.4 Design Pavement Section

Typically, new HDOT pavements include a drainage layer to facilitate drainage and increase the pavement life. However, because the pavement section along the existing Waiale Road does not have a drainage layer, only pavement structural sections without a permeable drainage layer were considered in our pavement analyses.

Based on the results of our subsurface exploration and the R-value results obtained, a flexible pavement section was determined. Based on the relatively high traffic volumes anticipated for the new pavements, ACB should be used as the base material in permanent flexible pavement sections for the project. The HDOT Materials Testing and Research Branch indicated that the thickness of PMA concrete is equivalent to about two

times the thickness of hot mix asphaltic concrete. Detailed analyses and calculations for the flexible and rigid pavement design options are presented in Appendix C.

Flexible Pavement

2.0-Inch Polymer-Modified Asphaltic (PMA) Concrete
7.0-Inch Asphalt Concrete Base (92 Percent Max Theoretical Specific Gravity)
19.0-Inch Aggregate Subbase (95 Percent Relative Compaction)
28.0-Inch Total Pavement Thickness on Compacted Subgrade

The following rigid pavement structural section may be considered for the project in lieu of asphaltic concrete pavement.

Rigid Pavement

9.5-Inch Portland Cement Concrete (Minimum flexural strength of 650 psi)
12.0-Inch Aggregate Subbase (95 Percent Relative Compaction)
21.5-Inch Total Pavement Thickness on Compacted Subgrade

The thickness of the flexible and rigid pavement sections may be reduced by incorporating a layer of Tensar InterAx geogrid between the ASB and the underlying soil subgrade. In general, the Tensar InterAx geogrid will interlock with the aggregate subbase course, resulting in two benefits during initial construction and for the life of the project: 1) lateral confinement – increasing the modulus of the aggregate subbase course, and 2) subgrade bearing capacity enhancement.

Based on the information provided by Tensar, we believe that the R-value of the subgrade soils may be enhanced to a value of 50 with the incorporation of a layer of Tensar InterAx geogrid. Based on this enhanced R-value of the subgrade soils, we recommend using the following flexible and rigid pavement design sections for the project. Detailed calculations and analyses of the pavement design with Tensar InterAx geogrid are presented in Appendix C.

Flexible Pavement

2.0-Inch Polymer-Modified (PMA) Asphaltic Concrete
6.0-Inch Asphalt Concrete Base (92 Percent Max Theoretical Specific Gravity)
6.0-Inch Aggregate Base Course (1½" Max) (95 Percent Relative Compaction)
14.0-Inch Total Pavement Thickness on a Layer of Reinforcing Geogrid (such as Tensar InterAx NX850-FG or Equivalent) on Compacted Subgrade

Rigid Pavement

9.0-Inch Portland Cement Concrete (Minimum flexural strength of 650 psi)
6.0-Inch Aggregate Base Course (1½" Max) (95 Percent Relative Compaction)
15.0-Inch Total Pavement Thickness on a Layer of Reinforcing Geogrid (such as Tensar InterAx NX850-FG or Equivalent) on Compacted Subgrade

3.5 Subgrade Preparation Below Pavement Section

We anticipate the project pavements will be constructed in cut and fill conditions. In general, the area within the contract grading limits should be cleared and grubbed thoroughly at the on-set of earthwork. Vegetation, debris, deleterious materials, and other unsuitable materials should be removed and properly disposed of off-site or in a designated area to reduce the potential for contamination of the excavated materials.

Soft and yielding areas encountered during clearing and grubbing below areas designated to receive fill or future improvements should be over-excavated to expose stiff and/or dense materials. The resulting excavation should be backfilled with aggregate subbase materials. The excavated soft and/or organic soils should be properly disposed of off-site.

After clearing and grubbing, the future pavement areas should be excavated, where necessary, to the pavement subgrade level (i.e., bottom of the aggregate subbase layer). The pavement subgrade soils should be scarified to a depth of at least 8 inches (where possible), moisture-conditioned to at least 2 percent above optimum moisture content and compacted to no less than 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil determined in accordance with AASHTO T180 (ASTM D1557). Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Where shrinkage cracks are noted after compaction of the subgrade soils, we recommend scarifying and re-preparing the soils as recommended above. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavation of the soft areas and replacement with well-compacted fill.

3.6 Fill Materials

In general, the excavated on-site near-surface soils may be used as a source of general fill materials, provided that deleterious materials such as vegetation are removed and over-sized materials greater than 3 inches in maximum dimension are screened. Imported fill materials, if required, should consist of non-expansive select granular material, such as crushed coralline or basaltic materials. The materials should be well-graded from coarse to fine with particles no larger than 3 inches in the largest dimension and should contain between 10 and 30 percent particles passing the No. 200 sieve. The materials should have a laboratory California Bearing Ratio value of 20 or more and should have a maximum swell of 1 percent or less. Imported fill materials should be tested for conformance with these recommendations prior to delivery to the project site for the intended use.

3.7 Compaction Requirements

In general, fill and backfill materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 95 percent relative compaction. Aggregate base course (ABC) materials required for the new pavements should conform to the requirements stipulated in Subsection 703.06 of the Hawaii State Standards. The ABC should be moisture-conditioned to above the optimum moisture content, placed in 8-inch level loose lifts, and compacted to no less than 95 percent of the maximum density according to AASHTO T180 (ASTM D1557).

Asphaltic concrete base material should consist of asphalt-treated basaltic aggregate, placed in a layer not to exceed 6 inches in compacted thickness, and compacted to at least 92 percent of the maximum theoretical specific gravity determined in accordance with AASHTO T209 (ASTM D2041).

Asphaltic concrete material should be constructed in general accordance with Section 401 – Hot Mix Asphalt Pavement of the Hawaii State Standards.

Field density tests should be performed on the compacted fills and backfills in general accordance with ASTM D1556. In general, field density tests should be performed at the frequencies presented in the following table:

FIELD DENSITY TESTING FREQUENCY		
Material	Location of Material	Test Frequency
Treated Base	Pavements and Shoulders	One test per 100 linear feet of roadway per lift.
Aggregate Subbase	Pavements and Shoulders	One test per 100 linear feet of roadway per lift.
Subgrade (Sands and Gravels)	Pavements and Shoulders	One test per 100 linear feet of roadway per lift.
Trench Backfill	Utility Trenches	One test per 200 linear feet of trench per lift of backfill.

3.8 Pavement Drainage

One of the primary distress mechanisms in pavement structures is pumping due to saturation of the subbase and/or subgrade soils. Therefore, the pavement surface should be sloped, and drainage gradients should be maintained to carry surface water off the pavement to appropriate drainage structures. Surface water ponding within the roadway should not be allowed on the site during or after construction.

3.9 Design Review

Preliminary and final drawings and specifications for the proposed construction should be forwarded to Geolabs for review and written comments. This review is necessary to evaluate the general conformance of the plans and specifications with the intent of the pavement design recommendations provided herein. If this review is not made, Geolabs cannot be responsible for misinterpretation of our recommendations.

3.10 Services During Construction

Geolabs should be retained to provide geotechnical engineering services during the construction of the proposed project. The critical item of construction monitoring that requires "Special Inspection" includes observation of the subgrade preparation. This is to observe compliance with the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations provided in this report are contingent upon such observations.

If the actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate design modifications should be made.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based in part upon information obtained from the borings and bulk samples. Variations of the subsurface conditions between and beyond the field data points may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report.

The boring locations indicated in this report are approximate, having been taped from existing features shown on the drawings received from Warren S. Unemori Engineering, Inc. on September 6, 2022. Elevations shown on the logs of borings were obtained by interpolating between the spot elevations and contour lines shown on the same plan. The physical locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

The stratification breaks represented on the Logs of Borings show the approximate boundaries between soil/rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text of this report. The data has been reviewed, and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variations in seasonal rainfall and other factors.

This report has been prepared for the exclusive use of Bowers + Kubota Consulting for specific application to the proposed Waiale Road Extension, Phase 1A project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the architects and design engineers in the design of the proposed project. Therefore, this report may not contain sufficient data and/or the proper information to serve as the basis for construction cost estimates or for bidding purposes. A contractor wishing to bid on this project should retain a competent geotechnical engineer to assist in the interpretation of

this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen subsurface conditions, such as cavities, perched groundwater, soft deposits, or hard layers may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the project site. It should be noted that the equipment, techniques, and personnel used to conduct a geo-environmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

By ______________

Jason Seidman, P.E.
Project Engineer

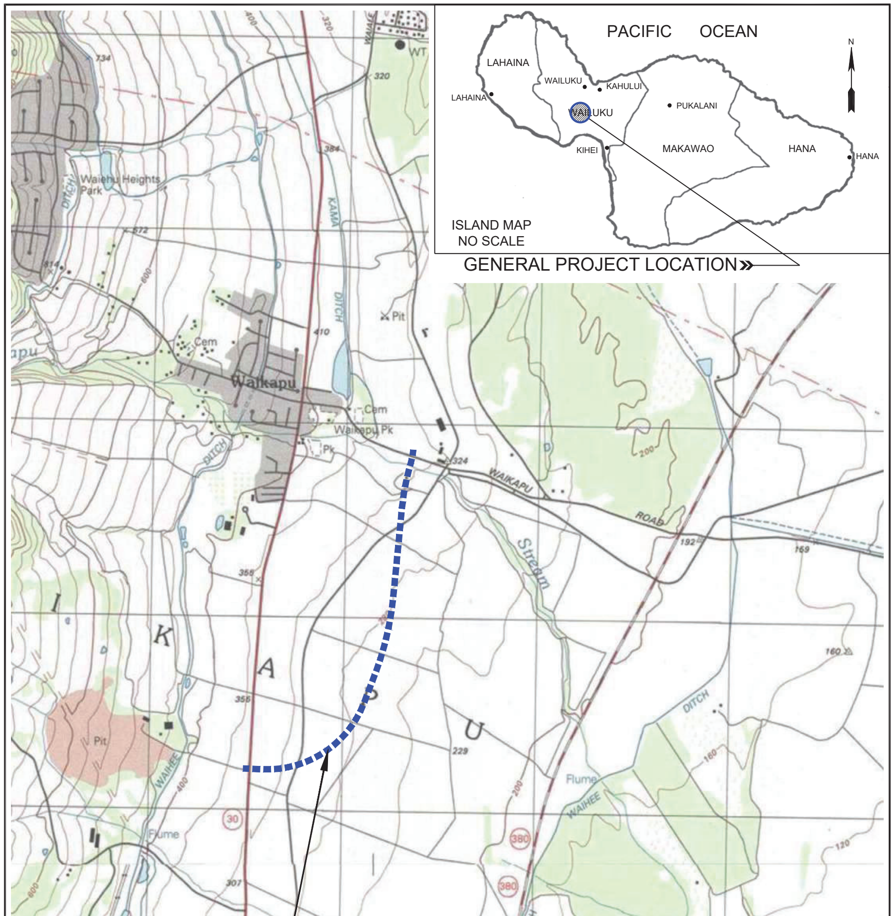
By ______________

Gerald Y. Seki, P.E.
Vice President

GS:JS:sh

h:\8300Series\8345.00.js1

PLATES



PROJECT LOCATION

PROJECT LOCATION MAP

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

2000 1000 0 2000 FT.
GRAPHIC SCALE

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	1
SCALE	W.O.	
1" = 2,000'	8345-00	

CAD User: KIM File Last Updated: June 17, 2022 5:35:02pm Plot Date: December 01, 2023 - 4:42:57pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00PLM.dwg\1
Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb

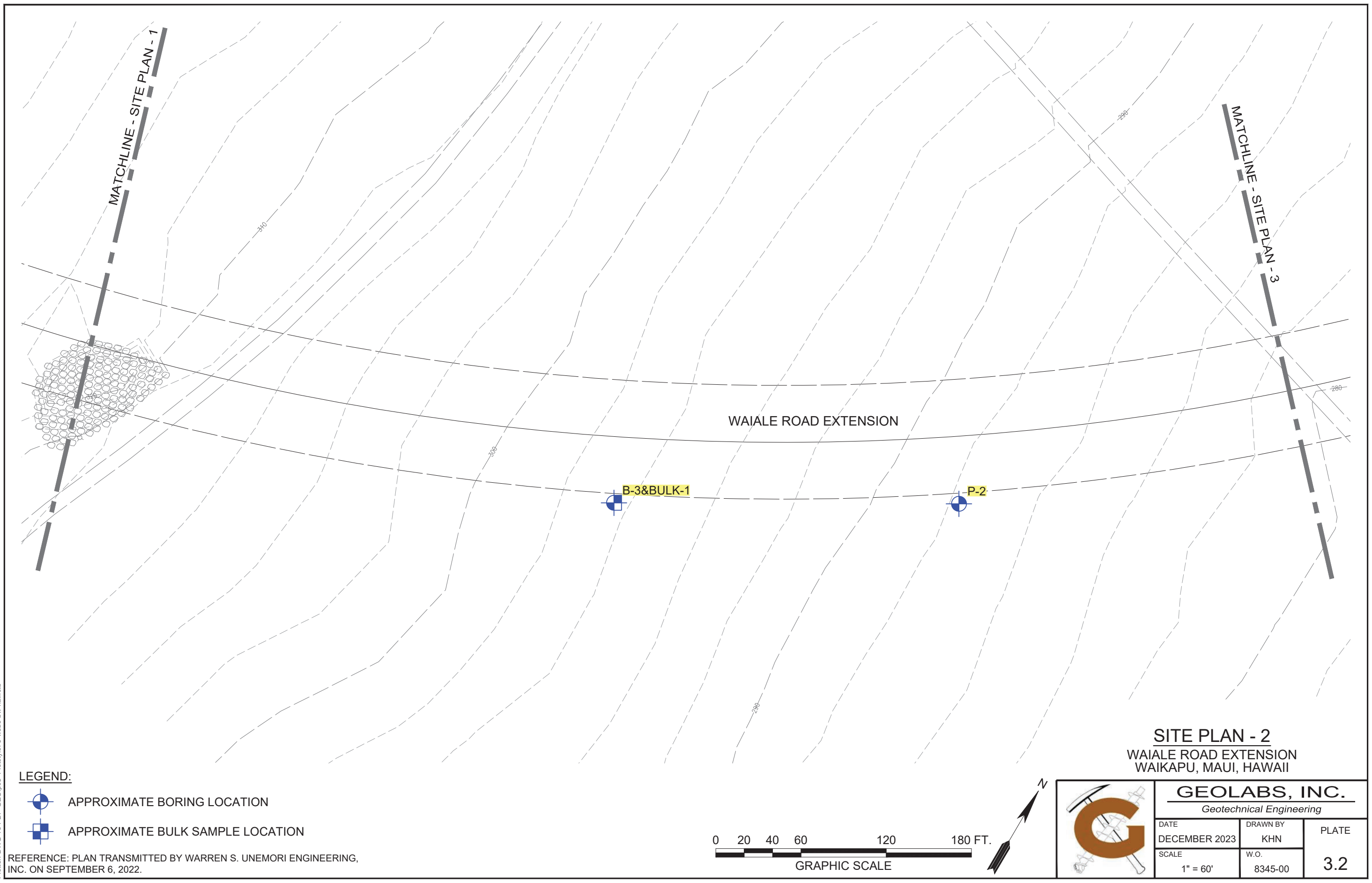
OVERALL SITE PLAN

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

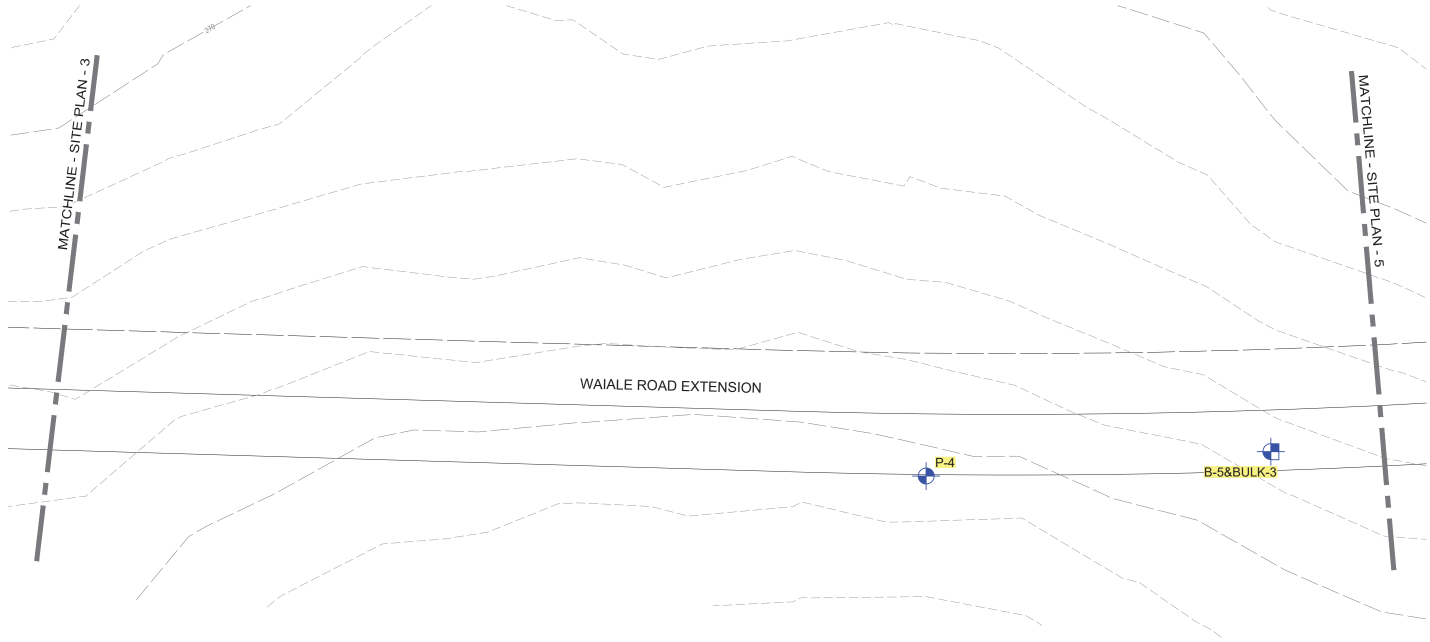
GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	2
SCALE	W.O.	
1" = 500'	8345-00	

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:45:33pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\2
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb


MATCHLINE - SITE PLAN - 1
MATCHLINE - SITE PLAN - 3
WAIALE ROAD EXTENSION
B-3&BULK-1
P-2
LEGEND:
APPROXIMATE BORING LOCATION
APPROXIMATE BULK SAMPLE LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
SITE PLAN - 2
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
PLATE
3.2
SCALE
1" = 60'
W.O.
8345-00


MATCHLINE - SITE PLAN - 2
WAIALE ROAD EXTENSION
HONOAPIILANI HIGHWAY
B-1
P-1
B-2
LEGEND:
APPROXIMATE BORING LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
SITE PLAN - 1
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
PLATE
3.1
SCALE
1" = 60'
W.O.
8345-00



LEGEND:

APPROXIMATE BORING LOCATION

APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

N

0 20 40 60 120 180 FT.
GRAPHIC SCALE

SITE PLAN - 4

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.4

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:46:31pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.4
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb

LEGEND:

APPROXIMATE BORING LOCATION

APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

N

0 20 40 60 120 180 FT.
GRAPHIC SCALE

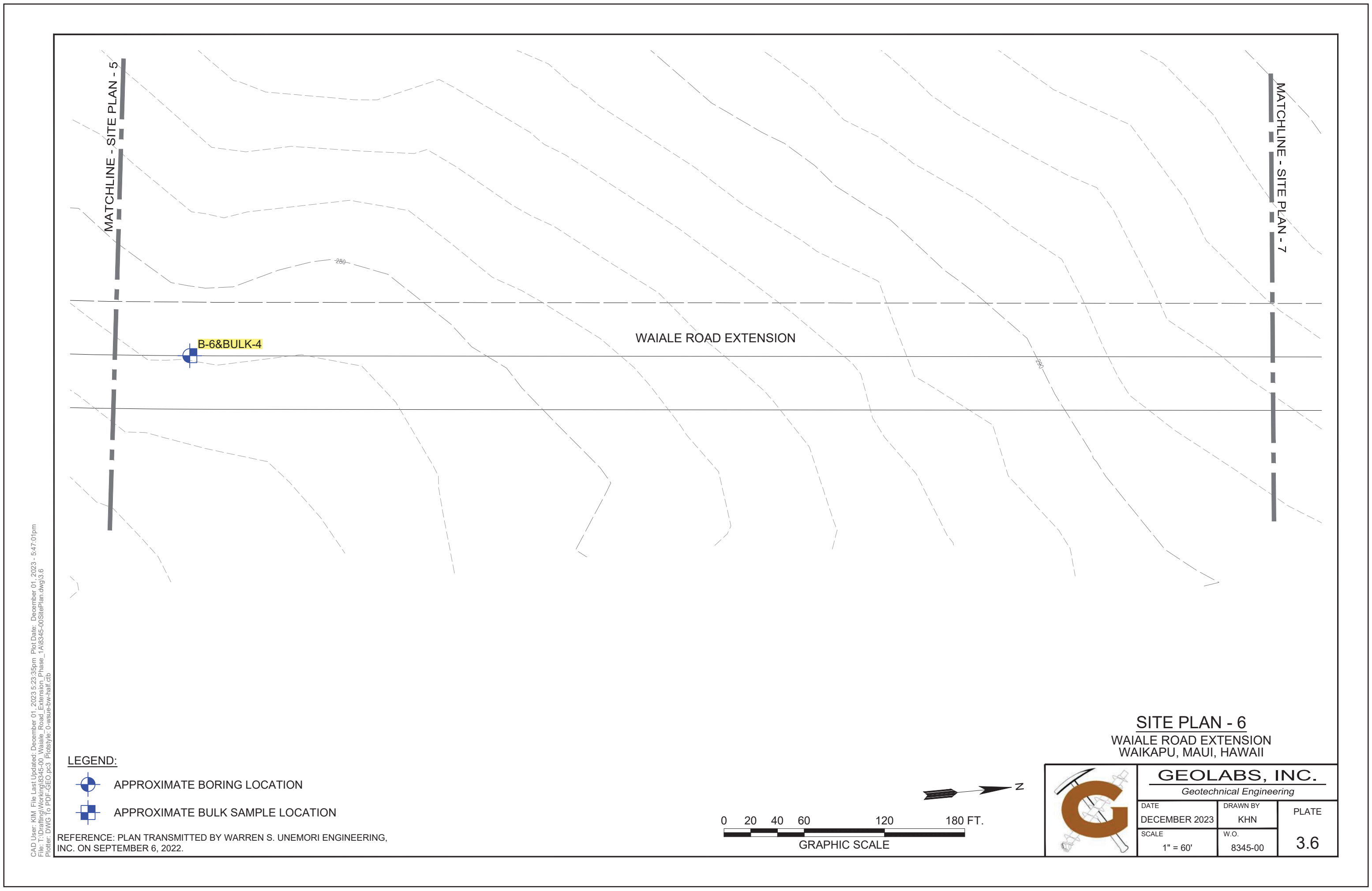
SITE PLAN - 3

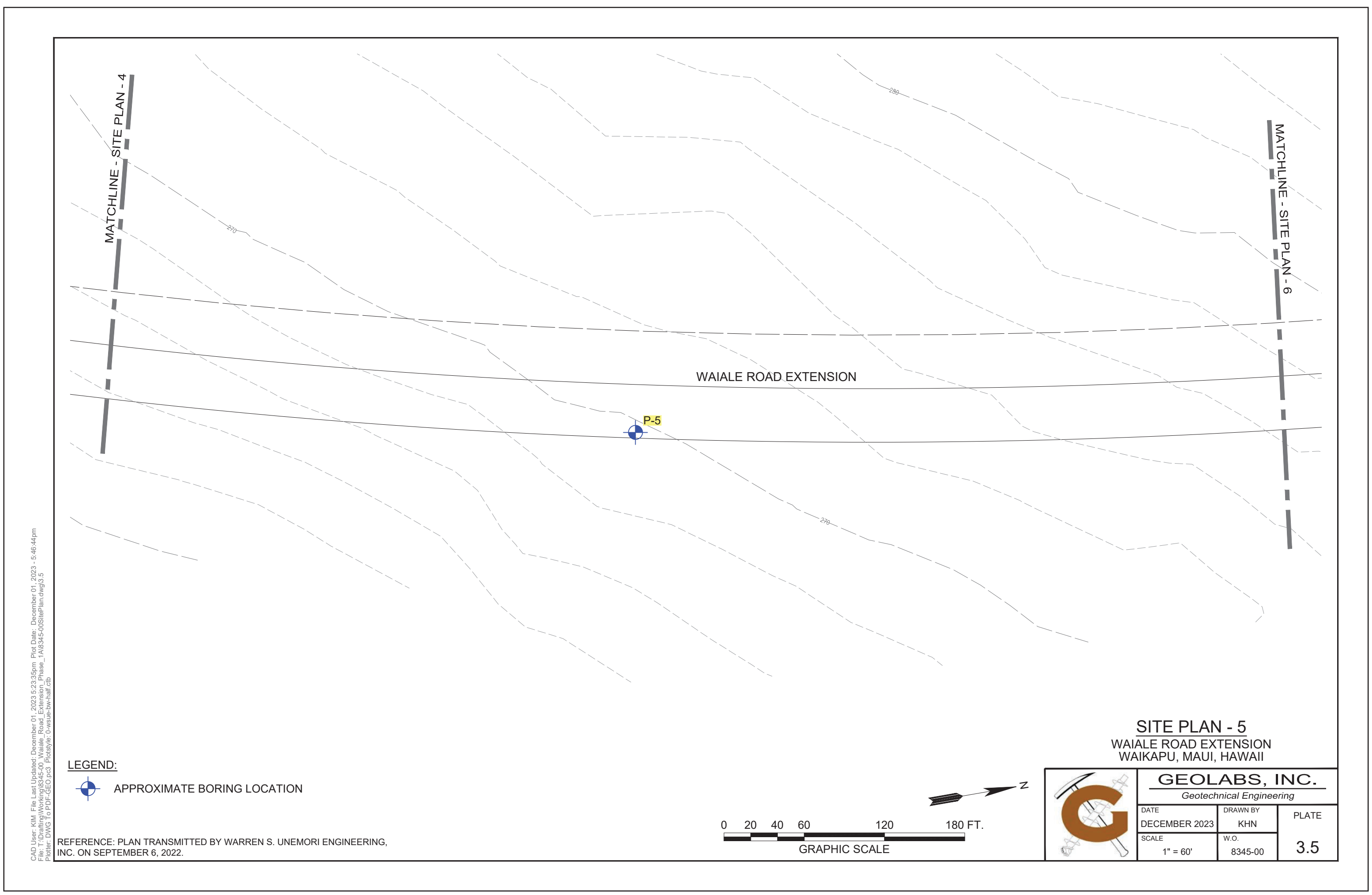
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

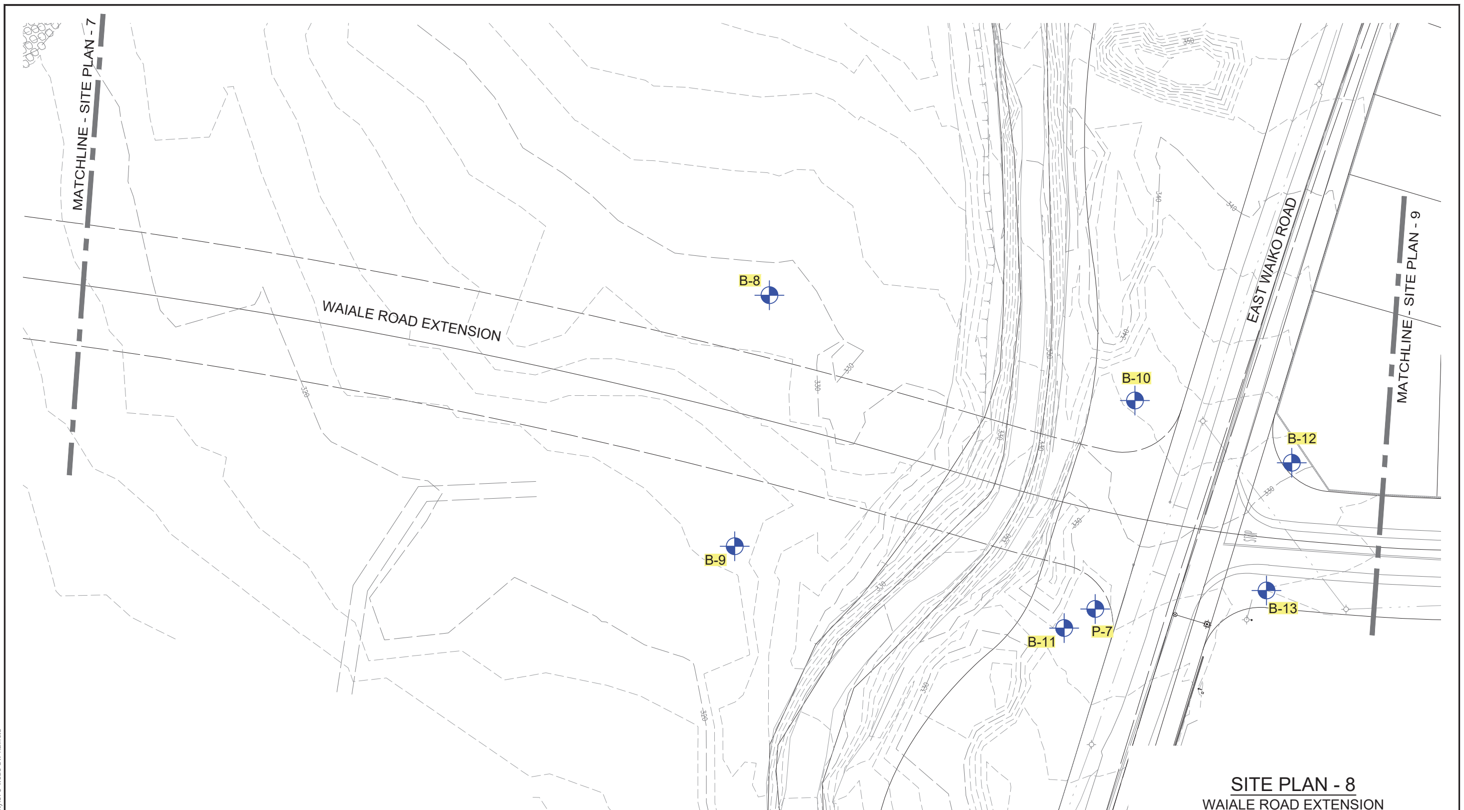
GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.3

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:46:19pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.3
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb


MATCHLINE - SITE PLAN - 5
MATCHLINE - SITE PLAN - 7
280
B-6&BULK-4
WAIALE ROAD EXTENSION
LEGEND:
APPROXIMATE BORING LOCATION
APPROXIMATE BULK SAMPLE LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
N
0 20 40 60 120 180 FT.
GRAPHIC SCALE
SITE PLAN - 6
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
PLATE
3.6
SCALE
1" = 60'
W.O.
8345-00
CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:01pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.6
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb


MATCHLINE - SITE PLAN - 4
MATCHLINE - SITE PLAN - 6
280
270
WAIALE ROAD EXTENSION
P-5
LEGEND:
APPROXIMATE BORING LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
N
0 20 40 60 120 180 FT.
GRAPHIC SCALE
SITE PLAN - 5
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
PLATE
3.5
SCALE
1" = 60'
W.O.
8345-00



SITE PLAN - 8
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

0 20 40 60 120 180 FT.
GRAPHIC SCALE

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.8

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:29pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.8
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb

SITE PLAN - 7
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

LEGEND:

APPROXIMATE BORING LOCATION

APPROXIMATE BULK SAMPLE LOCATION

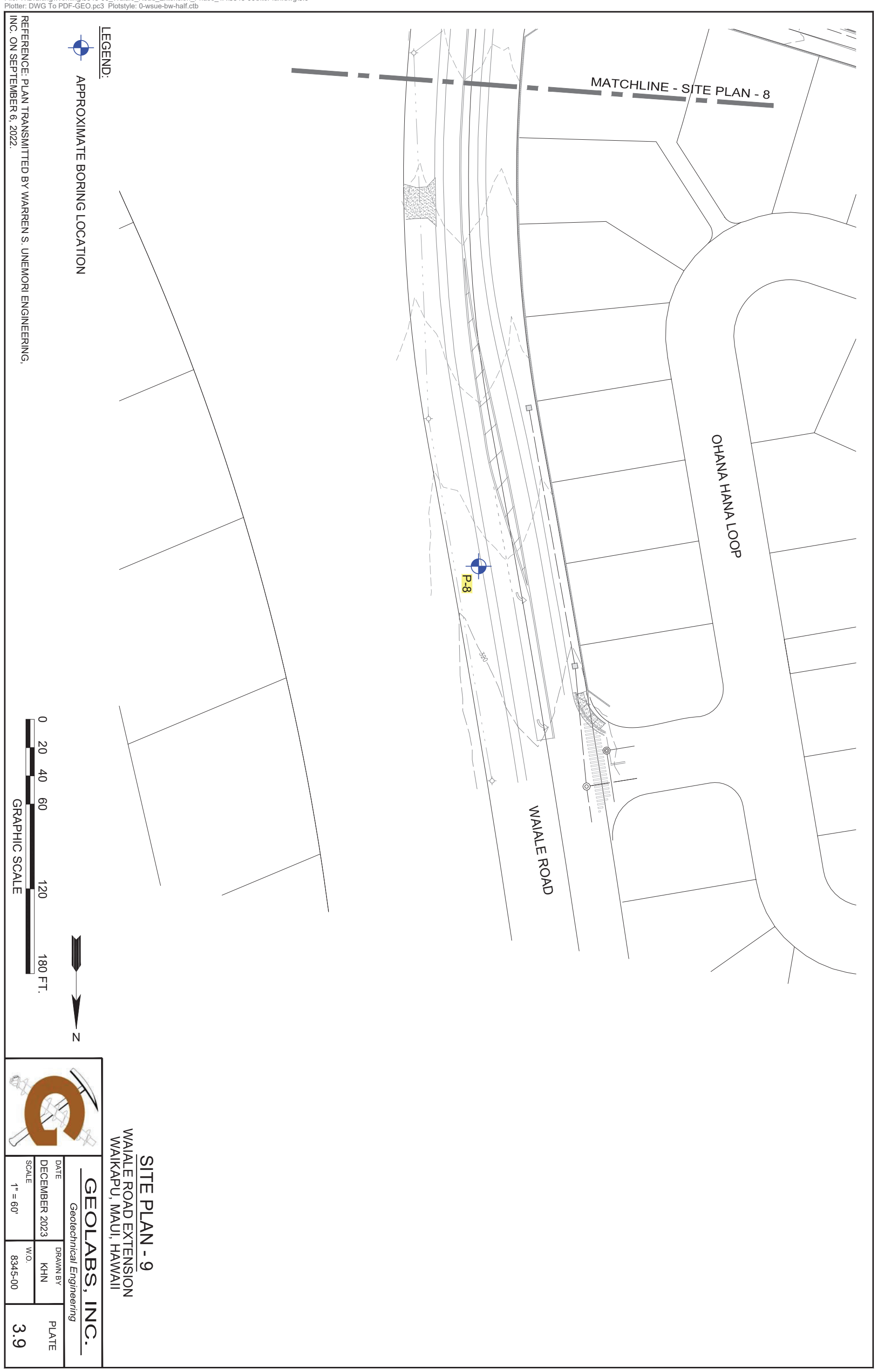
0 20 40 60 120 180 FT.
GRAPHIC SCALE

REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2023	KHN	
SCALE	W.O.	
1" = 60'	8345-00	3.7

CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:13pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.7
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb


CAD User: KIM File Last Updated: December 01, 2023 5:23:35pm Plot Date: December 01, 2023 - 5:47:39pm
File: T:\Drafting\Working\8345-00_Waiale_Road_Extension_Phase_1A\8345-00SitePlan.dwg\3.9
Plotter: DWG To PDF-GEO.pc3 Plotstyle: 0-wsue-bw-half.ctb
LEGEND:
APPROXIMATE BORING LOCATION
REFERENCE: PLAN TRANSMITTED BY WARREN S. UNEMORI ENGINEERING, INC. ON SEPTEMBER 6, 2022.
MATCHLINE - SITE PLAN - 8
OHANA HANA LOOP
P-8
WAIALE ROAD
0 20 40 60 120 180 FT.
GRAPHIC SCALE
N
SITE PLAN - 9
WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII
GEOLABS, INC.
Geotechnical Engineering
DATE
DECEMBER 2023
DRAWN BY
KHN
SCALE
1" = 60'
W.O.
8345-00
PLATE
3.9

APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions at the project site by drilling and sampling 21 borings, designated as Boring Nos. B-1 through B-13, and P-1 through P-8, extending to depths ranging from about 10 to 51.75 feet below the existing ground surface. The borings were drilled using a truck-mounted drill rig equipped with continuous flight augers and rotary coring tools. The approximate boring locations are shown on the Overall Site Plan, Plate 2, and Site Plan, Plates 3.1 through 3.9.

Our geologist classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the drilling operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), as shown on the Soil Log Legend, Plate A-0.1. Deviations made to the soil classification in accordance with ASTM D2487 are described in the Soil Classification Log Key, Plate A-0.2. Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1.1 through A-21.

Relatively "undisturbed" soil samples were obtained in general accordance with ASTM D3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. In addition, some samples were obtained from the drilled borings in general accordance with ASTM D1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the "Penetration Resistance" on the Logs of Borings at the appropriate sample depths. The penetration resistance shown on the Logs of Borings indicates the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

Core samples of the rock materials encountered at the project site were obtained by using diamond core drilling techniques in general accordance with ASTM D2113, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method that uses a hollow bit to cut into the rock formation. The rock material left in the hollow core of the bit is mechanically recovered for examination and description. Rock cores were described in general accordance with the Rock Description System, as shown on the Rock Log Legend, Plate A-0.3. The Rock Description System is based on the publication "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses" by the International Society for Rock Mechanics (March 1977). Graphical representations of the materials encountered are presented on the Logs of Borings at the appropriate depths.

Recovery (REC) may be used as a subjective guide to the interpretation of the relative quality of rock masses, where appropriate. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (RQD) is also a subjective guide to the relative quality of rock masses. RQD is defined as the percentage of the core run in rock that is sound material in excess of 4 inches in length without any discontinuities, discounting any drilling, mechanical, and handling-induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run in rock, the RQD would be 50 percent and would be shown on the Logs of Borings as RQD = 50%. Generally, the following is used to describe the relative quality of the rock based on the "Practical Handbook of Physical Properties of Rocks and Minerals" by Robert S. Carmichael (1989).

Rock Quality	RQD (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

The excavation characteristic of a rock mass is a function of the relative hardness of the rock, its relative quality, brittleness, and fissile characteristics. A dense rock formation with a high RQD value would be very difficult to excavate and probably would require more arduous methods of excavation.

GEOLABS, INC.

Geotechnical Engineering

Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS; MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE	GRAVELS; MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS; LESS THAN 5% FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES; MORE THAN 12% FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS; 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS; LESS THAN 5% FINES	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES; MORE THAN 12% FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS; 50% OR MORE OF MATERIAL PASSING THROUGH NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT 50 OR MORE	MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

- (2-INCH) O.D. STANDARD PENETRATION TEST
- (3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
- SHELBY TUBE SAMPLE
- GRAB SAMPLE
- CORE SAMPLE
- WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
- WATER LEVEL OBSERVED IN BORING AFTER DRILLING
- WATER LEVEL OBSERVED IN BORING OVERNIGHT

LL	LIQUID LIMIT (NP=NON-PLASTIC)
PI	PLASTICITY INDEX (NP=NON-PLASTIC)
TV	TORVANE SHEAR (tsf)
UC	UNCONFINED COMPRESSION OR UNIAXIAL COMPRESSIVE STRENGTH
TXUU	UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

Plate

A-0.1

LOG LEGEND FOR SOIL 8345-00.GPJ GEOLABS.GDT 7/6/23

GEOLABS, INC.

Geotechnical Engineering

Soil Classification Log Key

(with deviations from ASTM D2488)

GEOLABS, INC. CLASSIFICATION*

GRANULAR SOIL (- #200 <50%)

- **PRIMARY** constituents are composed of the largest percent of the soil mass. Primary constituents are capitalized and bold (i.e., **GRAVEL, SAND**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent. If the soil mass consists of 12 percent or more fines content, a cohesive constituent is used (**SILTY** or **CLAYEY**); otherwise, a granular constituent is used (**GRAVELLY** or **SANDY**) provided that the secondary constituent consists of 20 percent or more of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** GRAVEL, **CLAYEY** SAND) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY GRAVEL **with a little sand**)

COHESIVE SOIL (- #200 ≥ 50%)

- **PRIMARY** constituents are based on plasticity. Primary constituents are capitalized and bold (i.e., **CLAY, SILT**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent, but more than 20 percent of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** CLAY, **SILTY** CLAY, **CLAYEY** SILT) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY CLAY **with some sand**)

EXAMPLE: Soil Containing 60% Gravel, 25% Sand, 15% Fines. Described as: **SILTY GRAVEL** with some sand

RELATIVE DENSITY / CONSISTENCY

Granular Soils			Cohesive Soils			
N-Value (Blows/Foot)		Relative Density	N-Value (Blows/Foot)		PP Readings (tsf)	Consistency
SPT	MCS		SPT	MCS		
0 - 4	0 - 7	Very Loose	0 - 2	0 - 4		Very Soft
4 - 10	7 - 18	Loose	2 - 4	4 - 7	< 0.5	Soft
10 - 30	18 - 55	Medium Dense	4 - 8	7 - 15	0.5 - 1.0	Medium Stiff
30 - 50	55 - 91	Dense	8 - 15	15 - 27	1.0 - 2.0	Stiff
> 50	> 91	Very Dense	15 - 30	27 - 55	2.0 - 4.0	Very Stiff
			> 30	> 55	> 4.0	Hard

MOISTURE CONTENT DEFINITIONS

Dry: Absence of moisture, dry to the touch

Moist: Damp but no visible water

Wet: Visible free water

ABBREVIATIONS

WOH: Weight of Hammer

WOR: Weight of Drill Rods

SPT: Standard Penetration Test Split-Spoon Sampler

MCS: Modified California Sampler

PP: Pocket Penetrometer

GRAIN SIZE DEFINITION

Description	Sieve Number and / or Size
Boulders	> 12 inches (305-mm)
Cobbles	3 to 12 inches (75-mm to 305-mm)
Gravel	3-inch to #4 (75-mm to 4.75-mm)
Coarse Gravel	3-inch to 3/4-inch (75-mm to 19-mm)
Fine Gravel	3/4-inch to #4 (19-mm to 4.75-mm)
Sand	#4 to #200 (4.75-mm to 0.075-mm)
Coarse Sand	#4 to #10 (4.75-mm to 2-mm)
Medium Sand	#10 to #40 (2-mm to 0.425-mm)
Fine Sand	#40 to #200 (0.425-mm to 0.075-mm)

**Soil descriptions are based on ASTM D2488-09a, Visual-Manual Procedure, with the above modifications by Geolabs, Inc. to the Unified Soil Classification System (USCS).*

Plate

A-0.2

SOIL CLASS LOG KEY 8345-00.GPJ GEOLABS.GDT 7/6/23

GEOLABS, INC.

Geotechnical Engineering

Rock Log Legend

ROCK DESCRIPTIONS

	BASALT		CONGLOMERATE
	BOULDERS		LIMESTONE
	BRECCIA		SANDSTONE
	CLINKER		SILTSTONE
	COBBLES		TUFF
	CORAL		VOID/CAVITY

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Massive:	Greater than 24 inches apart
Slightly Fractured:	12 to 24 inches apart
Moderately Fractured:	6 to 12 inches apart
Closely Fractured:	3 to 6 inches apart
Severely Fractured:	Less than 3 inches apart

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered:	Rock shows no sign of discoloration or loss of strength.
Slightly Weathered:	Slight discoloration inwards from open fractures.
Moderately Weathered:	Discoloration throughout and noticeably weakened though not able to break by hand.
Highly Weathered:	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
Extremely Weathered:	Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard:	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
Hard:	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
Medium Hard:	Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce. Example: Porous rock such as clinker, cinder, and coral reef
Soft:	Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot. Example: Weathered rock, chalk-like coral reef
Very Soft:	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

Plate

A-0.3

LOG LEGEND FOR ROCK 8345-00.GPJ GEOLABS.GDT 7/6/23

GEOLABS, INC.

Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring

B-1

Approximate Ground Surface Elevation (feet): 347.5 *

Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0				8-inch **ASPHALTIC CONCRETE**
										GW	Gray **SANDY GRAVEL** (base material)
Sieve - #200 = 17.3%	14	98			43					SM	Brownish gray **SILTY SAND** with some gravel, medium dense, dry (fill)
	18 10				23						
Direct Shear	18	62			21		5				
											grades to light brown
										GW-GM	Light brown **SANDY GRAVEL** with a little silt, medium dense, dry (alluvium)
Sieve - #200 = 10.6%	9				30		10				
Direct Shear	22	65			42		15				
	24				42		20				grades to dense
										SM	Brown **SILTY SAND** with traces of gravel, medium dense, dry (alluvium)
Sieve - #200 = 36.3%	16	92			32		25				
					65		30				grades to very dense
							35				

Date Started: January 21, 2022	Water Level: ∇ Not Encountered		
Date Completed: January 21, 2022			
Logged By: G. Castle	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		
Total Depth: 31.5 feet	Drilling Method: 4" Solid-Stem Auger		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

Plate

A - 1.1

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-1

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											(Continued from previous plate)
											Boring terminated at 31.5 feet
											* Elevations estimated from Plan transmitted by Warren S. Unemori Engineering, Inc. on September 6, 2022.
							40				
							45				
							50				
							55				
							60				
							65				
							70				

Date Started:	January 21, 2022	Water Level: ♀	Not Encountered
Date Completed:	January 21, 2022		
Logged By:	G. Castle	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 1.2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-2

Approximate Ground Surface Elevation (feet): 337.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	18	97			9/6" +50/4"					CL	Brown **SANDY CLAY** with some gravel, hard, moist (fill)
	3				42					ML	Brown **SANDY SILT**, hard, dry to moist (alluvium)
	5	107			48		5				grades to very stiff
	11				14		10			ML	Brown **SANDY SILT** with some gravel, stiff, dry (alluvium)
Direct Shear	15	69			16		15				
Sieve - #200 = 37.5%	13				50/4"		20			SM	Brown **SILTY SAND** with traces of gravel, very dense, dry (alluvium)
	19	73			50/4"		25				
	17				39		30			GP	Brown **GRAVELLY SAND** with some clay, dense, moist (alluvium)
											Boring terminated at 31.5 feet
							35				

Date Started:	January 3, 2022	Water Level: ♀	Not Encountered
Date Completed:	January 3, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.5 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-3**

Approximate Ground Surface Elevation (feet): 296.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	CL	Brown **SANDY CLAY** with some gravel, stiff, dry (fill)
	13	104			20				
	10				16				grades to very stiff
	19	64			11		5	CL	Brown **SANDY CLAY**, medium stiff, moist (alluvium)
	16				10		10		grades to stiff
							11.5		Boring terminated at 11.5 feet

Date Started: January 3, 2022	Water Level: ⊻ Not Encountered		Plate
Date Completed: January 3, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		A - 3
Total Depth: 11.5 feet	Drilling Method: 4" Solid-Stem Auger		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-4**

Approximate Ground Surface Elevation (feet): 267.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	ML	Brown **SANDY SILT**, medium stiff, moist (fill)
Sieve - #200 = 60.4% LL=40 PI=13	29	78			10				
	10				8				
	19	80			42		5	ML	Brown **SANDY SILT**, very stiff, moist (alluvium)
	8				50/4"		10	GM	Brownish gray **SANDY GRAVEL** with some silt, very dense, dry (alluvium)
							10.83		Boring terminated at 10.83 feet

Date Started: January 3, 2022	Water Level: ⊻ Not Encountered		Plate
Date Completed: January 3, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		A - 4
Total Depth: 10.83 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.

Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring

B-5

Approximate Ground Surface Elevation (feet): 263 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
	23	90			20		0	CL	Brown **SANDY CLAY** with traces of gravel, stiff, moist (fill)
LL=48 PI=23	14				42			CL	Brown **SANDY CLAY** with traces of gravel, hard, moist (alluvium)
	27	67			50/3"		5		
	4				35/6" +50/4"		10	GM	Gray **SANDY GRAVEL**, very dense, dry (alluvium)
									Boring terminated at 11.33 feet

Date Started:	January 3, 2022	Water Level: ⊽	Not Encountered
Date Completed:	January 3, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	11.33 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 5

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.

Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring

B-6

Approximate Ground Surface Elevation (feet): 278 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
					29		0	CL	Brown **SANDY CLAY** with some gravel, very stiff, moist (fill)
	11				50/4"				Gray **COBBLES AND BOULDERS (BASALTIC)** with some sand and gravel, slightly weathered, hard, moist (alluvium)
			77				5		
			33						
	7				44		10 ⊽		
									Boring terminated at 12.5 feet

Note:
The water level recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site.

Date Started:	January 12, 2022	Water Level: ⊽	11.1 ft. 01/12/2022 1534 HRS
Date Completed:	January 12, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	12.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 6

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-7**

Approximate Ground Surface Elevation (feet): 297 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
Sieve - #200 = 45.7%	18	95			79		0	SM	Brown **SILTY SAND** with some gravel, dense, moist (fill)
	2				20/4"				grades to very dense
	3	119			36/6" +50/3"		5	GP	Grayish brown **SANDY GRAVEL**, very dense, dry (alluvium)
					50/0" Ref.		10		Boring terminated at 10 feet

Date Started:	January 6, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 6, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	10 feet	Drilling Method:	4" Solid-Stem Auger
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 7

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-8**

Approximate Ground Surface Elevation (feet): 329.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	CL	Brown **SANDY CLAY** with some gravel, moist (alluvium)
UC= 8870 psi			65						Gray **COBBLES AND BOULDERS (BASALTIC)** with some gravel, moderately weathered, hard (alluvium)
			40				5		
			27				10		
			58				15		
UC= 25320 psi			43				20		
UC= 5540 psi			42				25		
UC= 6350 psi			37				30		

Date Started:	January 4, 2022	Water Level: ⊻	Not Encountered
Date Completed:	January 4, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	50 feet	Drilling Method:	4" Solid-Stem Auger & HQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 8.1

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC. Geotechnical Engineering	WAIALE ROAD EXTENSION WAIKAPU, MAUI, HAWAII	Log of Boring	B-8

(Continued from previous plate)

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
			30						
			72				40		
UC= 7940 psi									
			33				45		
							50		Boring terminated at 50 feet
							55		
							60		
							65		
							70		

Date Started: January 4, 2022	Water Level: ⊻ Not Encountered		Plate
Date Completed: January 4, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		
Total Depth: 50 feet	Drilling Method: 4" Solid-Stem Auger & HQ Coring		A - 8.2
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

GEOLABS, INC. Geotechnical Engineering	WAIALE ROAD EXTENSION WAIKAPU, MAUI, HAWAII	Log of Boring	B-9

Approximate Ground Surface Elevation (feet): 323 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								CL	Brown **SANDY SILT** with some gravel, hard, moist (fill)
	3	87			64				
Sieve - #200 = 13.5%	4				39			GM	Brownish gray **SILTY GRAVEL** with some sand, dense, dry (alluvium)
	3	133			57		5		
									grades to very dense
	5				24/6" +50/3"		10		
	9	84			42/6" +50/3"		15		
			78						Brownish gray **COBBLES AND BOULDERS (BASALTIC)** with some sand and gravel, moderately weathered, hard, moist (alluvium)
UC= 11300 psi									
	6				58		20		
			74						
UC= 6510 psi UC= 3490 psi			87				25		
			20				30		
							35		

Date Started: January 5, 2022	Water Level: ⊻ 48.0 ft. 01/05/2022 1446 HRS		Plate
Date Completed: January 5, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		
Total Depth: 50.7 feet	Drilling Method: 4" Solid-Stem Auger & HQ Coring		A - 9.1
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-9**

(Continued from previous plate)

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
	9				35/6" +22/4"				
			45						
Sieve - #200 = 12.6%	18				57		40		grades with pockets of brown silty gravel (GM) with some sand
UC= 9790 psi			55						
			42				45		
	11				20/2"		50		
									Boring terminated at 50.7 feet

Date Started:	January 5, 2022	Water Level: ▽	48.0 ft. 01/05/2022 1446 HRS
Date Completed:	January 5, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	50.7 feet	Drilling Method:	4" Solid-Stem Auger & HQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 9.2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **B-10**

Approximate Ground Surface Elevation (feet): 332.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
Sieve - #200 = 32.7%	14	101			51			SM	Grayish brown **SILTY SAND** with a little gravel and cobbles (basaltic), medium dense, dry (fill)
	2				17/6" +25/2"				
	7	112	0		58		5		Gray **COBBLES AND BOULDERS (BASALTIC)** with a little sand and gravel, slightly weathered, hard (alluvium)
			71						
			51		25/1"		10		
	4		70		35/4"		15		
			50				20		
			45		25/0" Ref.		25		
			55				30		

Date Started:	December 13, 2021	Water Level: ▼	Not Encountered
Date Completed:	December 14, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	50.9 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 10.1

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-10

(Continued from previous plate)

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
			22								
	17				25/4"		40				grades with seams of multi-color silty sand
UC= 6290 psi			58								
			23				45				
	19				45/5"		50				Boring terminated at 50.9 feet
							55				
							60				
							65				
							70				

Date Started:	December 13, 2021	Water Level: ▼	Not Encountered
Date Completed:	December 14, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	50.9 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 10.2

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring
B-11

Approximate Ground Surface Elevation (feet): 327.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	Tannish brown **SILTY GRAVEL** with some sand, dense, dry (fill)
Sieve - #200 = 18.2%	7	114			61						
	6				35/3"						grades with a little cobbles (basaltic)
			42								Gray **COBBLES AND BOULDERS (BASALTIC)** with some gravel and sand, slightly weathered, hard, moist (alluvium)
			57		30/4"		5				
			45		20/0" Ref.		10				
			22				15				
			50		35/4"		20				
			25				25				
			38		20/0" Ref.		30				
							35				

Date Started:	December 15, 2021	Water Level: ▼	Not Encountered
Date Completed:	December 16, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	51.75 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 11.1

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring B-11

(Continued from previous plate)

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
			47					
			70		25/0" Ref.			
UC= 15220 psi								
			30					
	18				36/6" +35/3"			grades with seams of reddish brown sandy silt
								Boring terminated at 51.75 feet

Depth (feet): 40, 45, 50, 55, 60, 65, 70

Date Started: December 15, 2021	Water Level: ▼ Not Encountered		Plate
Date Completed: December 16, 2021			
Logged By: D. Gremminger	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		A - 11.2
Total Depth: 51.75 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring B-12

Approximate Ground Surface Elevation (feet): 330.5 *

Other Tests (Laboratory)	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
							SM	Tannish brown **SILTY SAND** with some gravel, very dense, dry (fill)
Sieve - #200 = 27.2%	8		35		25/5"			Gray **COBBLES AND BOULDERS (BASALTIC)**, slightly weathered, hard (alluvium)
					29			grades to medium dense
			57					grades with some brown silty sand
Sieve - #200 = 9.4%	8				38			grades with pockets of sandy gravel (GW-GM) with a little silt, dense
			57					
			28					
UC= 5790 psi	1		17		25/3"			grades to very dense
	7				72			
			71					
								Boring terminated at 30 feet

Depth (feet): 5, 10, 15, 20, 25, 30, 35

Date Started: July 29, 2022	Water Level: ▽ Not Encountered		Plate
Date Completed: July 29, 2022			
Logged By: A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*		A - 12
Total Depth: 30 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring		
Work Order: 8345-00	Driving Energy: 140 lb. wt., 30 in. drop		

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring B-13

Approximate Ground Surface Elevation (feet): 328 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	GW-GM	Tannish brown **GRAVELLY SAND** with a little silt, medium dense, dry (fill)
Sieve - #200 = 9.5%	3	88			22				
								SM	Tannish brown **SILTY SAND** with a little gravel, medium dense, dry (fill)
	6				10				
Sieve - #200 = 18.6%	22	100			21/6" +50/5"				grades to very dense
			51				5		Gray slightly vesicular **COBBLES AND BOULDERS (BASALTIC)**, slightly weathered, hard, dry (alluvium)
UC= 2740 psi			60				10		
UC= 4240 psi			88				15		
UC= 15320 psi			95				20		
									grades with some silty sand
			50				25		
UC= 2960 psi							30		Boring terminated at 30 feet

Date Started:	July 27, 2022
Date Completed:	July 27, 2022
Logged By:	A. Ayorinde
Total Depth:	30 feet
Work Order:	8345-00
Water Level:	Not Encountered
Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Drilling Method:	4" Solid-Stem Auger & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 13

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring P-1

Approximate Ground Surface Elevation (feet): 339 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	SM	Brown **SILTY SAND** with some gravel, loose, moist (fill)
Sieve - #200 = 23.1%	16	88			8				
Sieve - #200 = 65.0%	21				22			ML	Brown **SANDY SILT**, very stiff, moist (alluvium)
Direct Shear	31	84			28		5		
Sieve - #200 = 2.8%	7				26		10	GP	Brownish gray **GRAVELLY SAND** with traces of silt, medium dense, dry (alluvium)
	15	82			70		15		grades with some cobbles, dense
			29						
	12				13/6" +12/2"		20		grades to very dense
			54						
Direct Shear	34	85			20		25	SM	Brown **SILTY SAND** with a little gravel, medium dense, moist (alluvium)
			0						
Sieve - #200 = 39.9%	33				27		30		
							31.5		Boring terminated at 31.5 feet

Date Started:	January 6, 2022
Date Completed:	January 6, 2022
Logged By:	A. Ayorinde
Total Depth:	31.5 feet
Work Order:	8345-00
Water Level:	Not Encountered
Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Drilling Method:	4" Solid-Stem Auger & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 14

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-2**

Approximate Ground Surface Elevation (feet): 288 *

Other Tests (Laboratory)	Moisture Content (%) (Laboratory)	Dry Density (pcf) (Laboratory)	Core Recovery (%) (Field)	RQD (%) (Field)	Penetration Resistance (blows/foot) (Field)	Pocket Pen. (tsf) (Field)	Depth (feet)	USCS	Description
								CL	Brown **SANDY CLAY**, stiff, moist (fill)
	22	91			20				
	15				9				
	34	86			61		5	ML	Brown **SANDY SILT** with some gravel, hard, moist (alluvium)
	22				25		10		grades to very stiff
	22	87			50/5"		15		
			0					SP	Brownish gray **GRAVELLY SAND**, very dense, moist (alluvium)
	28				18		20	SM	Brown **SILTY SAND** with traces of gravel, medium dense, moist (alluvium)
			0						
					27		25		
			0						
LL=NP PI=NP Sieve - #200 = 45.8%	18	102			28		30		
									Boring terminated at 31.5 feet
							35		

Date Started:	January 10, 2022
Date Completed:	January 10, 2022
Logged By:	A. Ayorinde
Total Depth:	31.5 feet
Work Order:	8345-00
Water Level: ∇	Not Encountered
Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Drilling Method:	4" Solid-Stem Auger & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 15

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-3**

Approximate Ground Surface Elevation (feet): 269 *

Other Tests (Laboratory)	Moisture Content (%) (Laboratory)	Dry Density (pcf) (Laboratory)	Core Recovery (%) (Field)	RQD (%) (Field)	Penetration Resistance (blows/foot) (Field)	Pocket Pen. (tsf) (Field)	Depth (feet)	USCS	Description
								SP-SM	Grayish brown **GRAVELLY SAND** with a little silt, medium dense, dry (fill)
Sieve - #200 = 10.5%	8	85			33				
	14				8			SM	Brown **SILTY SAND** with traces of gravel, loose, moist (alluvium)
Sieve - #200 = 48.0%	19	89			51		5		grades to medium dense
	18				13		10		grades with some gravel
	76	57			52		15		
Sieve - #200 = 22.7%	28				16		20		
			0						
	21	89			57		25	CL	Brown **SANDY CLAY**, hard, moist (alluvium)
			0						
	41				27		30		grades to very stiff
									Boring terminated at 31.5 feet
							35		

Date Started:	January 10, 2022
Date Completed:	January 10, 2022
Logged By:	A. Ayorinde
Total Depth:	31.5 feet
Work Order:	8345-00
Water Level: ∇	Not Encountered
Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Drilling Method:	4" Solid-Stem Auger & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 16

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-4**

Approximate Ground Surface Elevation (feet): 259 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
							CL	Brown **SANDY CLAY**, very stiff, moist (fill)
	21	99			31			
							CL	Brown **SANDY CLAY** with traces of gravel, hard, moist (alluvium)
	17				34			
	22	84			24/6" +50/4"			
			45					Gray **COBBLES AND BOULDERS (BASALTIC)** with a little sand and gravel, moderately weathered, hard, moist (alluvium)
	7				45/6" +50/2"			
			61					
	13	120			45			grades to medium dense
			33					
	31				42			grades with pockets of clayey silt
			29					
								grades with brown mottling
	15	113			46/6" +50/3"			grades to very dense
			33					
					20/4"			Boring terminated at 30.3 feet

Depth (feet): 5, 10, 15, 20, 25, 30, 35

Date Started:	January 11, 2022	Water Level: ∇	Not Encountered
Date Completed:	January 11, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	30.3 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 17

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-5**

Approximate Ground Surface Elevation (feet): 269.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	USCS	Description
							CL	Brown **SANDY CLAY**, stiff, moist (fill)
	23	92			19			
					26			
	21							grades to very stiff
	20	59			50/5"			
			45					Gray **COBBLES AND BOULDERS (BASALTIC)** with a little sand and gravel, moderately weathered, hard (alluvium)
	5				55			
			38					
Sieve - #200 = 2.7%	6	112			31			grades with pockets of sandy gravel
			24					
					25/3"			
			18					
								grades with pockets of silty sand
Sieve - #200 = 47.3%	30	89			40			
			31					
					21/3"			Boring terminated at 30.3 feet

Note:
The water level recorded may be water introduced into the boring during the coring process and may not reflect the actual groundwater levels at the project site.

Depth (feet): 5, 10, 15, 20, 25, 30, 35

Date Started:	January 12, 2022	Water Level: ∇	8.3 ft. 01/12/2022 1230 HRS
Date Completed:	January 12, 2022		
Logged By:	A. Ayorinde	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	30.3 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 18

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-6**

Approximate Ground Surface Elevation (feet): 300 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	ML	Grayish brown **SANDY SILT** with traces of gravel, hard, moist (fill)
Sieve - #200 = 56.4%	17	87			17/6" +25/3"				
	3				112				
	6	140			39/6" +50/4"		5		Grayish brown subrounded **COBBLES AND BOULDERS (BASALTIC)**, moderately weathered, hard, moist (alluvium)
			89						
			65		10/0" Ref.		10		
			100		10/0" Ref.		15		
			61		10/0" Ref.		20		
							25	SM	Brown **SILTY SAND (BASALTIC)** with some gravel and traces of cobbles, medium dense, moist (alluvium)
	11				20				
			24						
Sieve - #200 = 18.1%	29				13		30		grades to brownish gray
									Boring terminated at 32.5 feet
							35		

Date Started:	January 21, 2022	Water Level: ▽	Not Encountered
Date Completed:	January 28, 2022		
Logged By:	Castle & Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	32.5 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 19

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
Geotechnical Engineering

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Log of Boring **P-7**

Approximate Ground Surface Elevation (feet): 327.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	SM	Brownish tan **SILTY SAND** with some gravel, dense, dry (fill)
Sieve - #200 = 26.7%	19	82			70				
	4				15				grades with a little cobbles, medium dense
			0						Gray **COBBLES AND BOULDERS (BASALTIC)** with some sand and gravel, moderately weathered, hard, moist (alluvium)
	8	113			39		5		
			38						
	36		24		25/2"		10		
			39		65/6"		15		
UC= 3960 psi			64		30/2"		20		
			45				25		
	7				30/3"		30		
									Boring terminated at 31.25 feet
							35		

Date Started:	December 16, 2021	Water Level: ▼	Not Encountered
Date Completed:	December 17, 2021		
Logged By:	D. Gremminger	Drill Rig:	CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*
Total Depth:	31.25 feet	Drilling Method:	4" Solid-Stem Auger & PQ Coring
Work Order:	8345-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate A - 20

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC. Geotechnical Engineering	WAIALE ROAD EXTENSION WAIKAPU, MAUI, HAWAII	Log of Boring **P-8**

Approximate Ground Surface Elevation (feet): 321.5 *

Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
							0	SM	Tannish brown **SILTY SAND** with a little gravel, medium dense, dry (fill)
Sieve - #200 = 38.9%	11	87			27				
	11				20				grades with some cobbles
	10	94			50/4"		5		grades to very dense
			48						Gray slightly vesicular **COBBLES AND BOULDERS (BASALTIC)**, slightly weathered, hard, moist (alluvium)
	9				27		10		
			40						
	5	91			50/3"		15		
			90						
UC= 8080 psi									
			78				20		
UC= 22670 psi									
			25				25		
Sieve - #200 = 5.2%	23				35		30		grades with pockets of brown sand (SP-SM) with a little silt and traces of gravel, dense
									Boring terminated at 31.5 feet
							35		

Date Started:	July 28, 2022	Water Level: ▽ Not Encountered	Plate
Date Completed:	July 28, 2022		
Logged By:	A. Ayorinde	Drill Rig: CME-45C TRUCK *(Energy Transfer Ratio = 86.4%)*	A - 21
Total Depth:	31.5 feet	Drilling Method: 4" Solid-Stem Auger & PQ Coring	
Work Order:	8345-00	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 8345-00.GPJ GEOLABS.GDT 12/1/23

APPENDIX B

APPENDIX B

Laboratory Tests

Moisture Content (ASTM D2216) and Unit Weight (ASTM D2937) determinations were performed on selected samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Borings at the appropriate sample depths.

Three Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits and to aid in soil classification. The test results are summarized on the Logs of Borings at the appropriate sample depths. A graphic presentation of the test results is provided on Plate B-1.

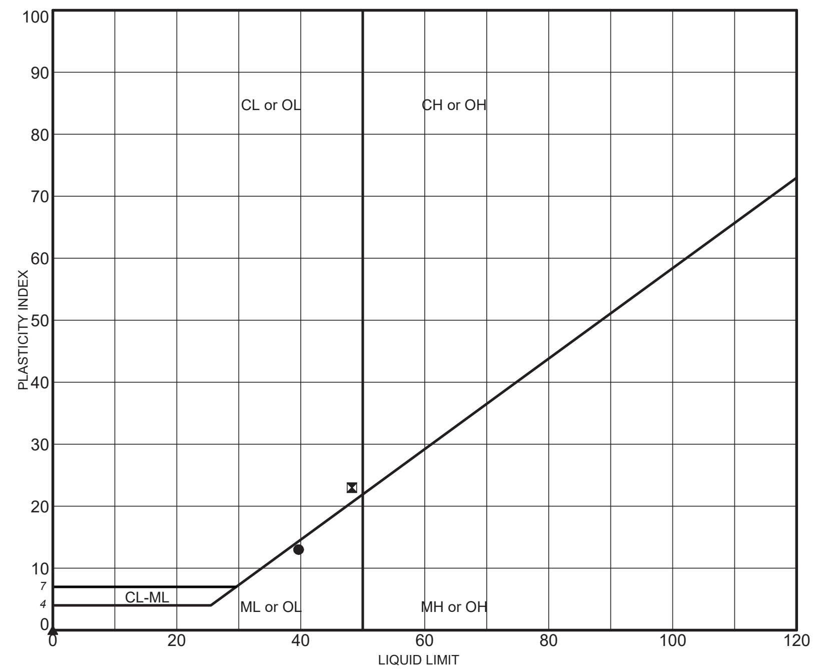
Thirty-four Sieve Analysis tests (ASTM D6913) were performed on selected samples of the soils to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic representations of the grain size distributions are provided on Plates B-2 through B-8.

Six one-inch Ring Swell tests were performed on relatively undisturbed and remolded samples to evaluate the swelling potential of the on-site materials under surcharge pressures. The test results are presented on Plate B-9.

Nineteen Uniaxial Compression tests (ASTM D7012, Method C) were performed on selected intact core samples to evaluate the uniaxial compressive strength of the rock cores tested. The test results are presented on Plate B-10.

Five Direct Shear tests (ASTM D3080) were performed on selected samples to evaluate the undrained shear strength of the in-situ soils. The approximate in-situ effective overburden pressure was used as the applied confining pressure for relatively “undisturbed” soil sample. The test results and the stress-strain curves are presented on Plates B-11 through B-15.

Five laboratory Resistance (R) Value tests (ASTM D2844) were performed by Ninyo & Moore on bulk samples of the near-surface soils to evaluate the pavement support characteristics of the soils. The test results are presented on Plates B-16 through B-20.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-4	3.0-4.5	40	27	13	Brown sandy silt (ML)
⧗	B-5	3.0-4.5	48	25	23	Brown sandy clay (CL)
▲	P-2	30.0-31.5	NP	NP	NP	Brown silty sand (SM) with traces of gravel

NP = NON-PLASTIC

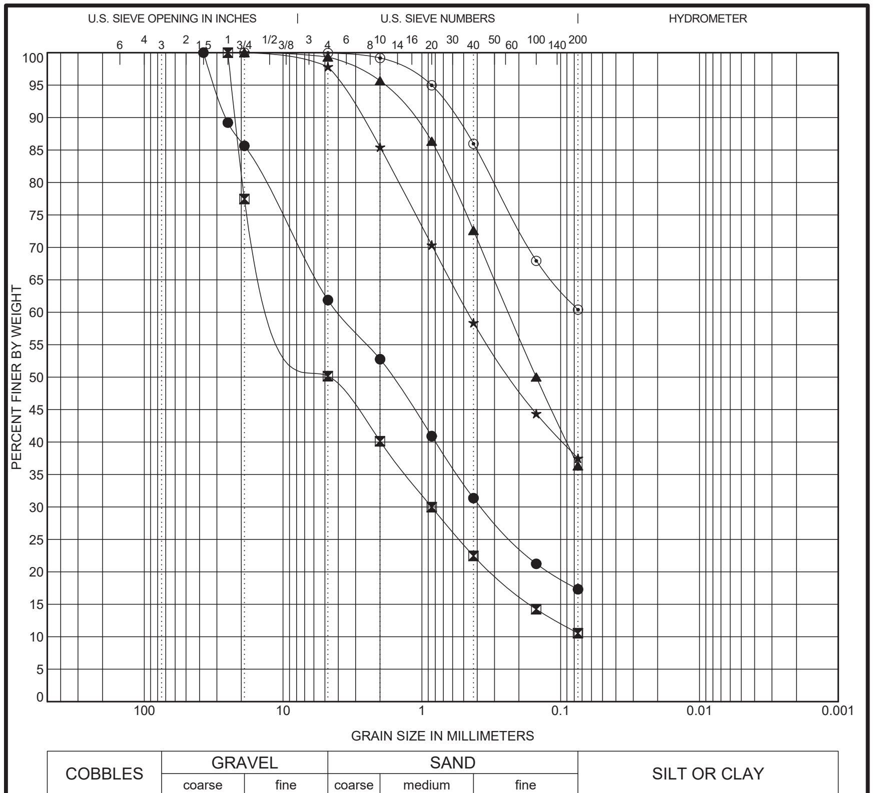
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 1

G_ATTERBERG PI-100 LL-120 8345-00.GPJ GEOLABS.GDT 12/1/23



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-1	1.0-2.5	Brownish gray silty sand (SM) with some gravel					
⧗	B-1	10.0-11.5	Light brown sandy gravel (GW-GM) with a little silt				1.4	115.9
▲	B-1	25.0-26.5	Brown silty sand (SM) with traces of gravel					
★	B-2	20.0-20.8	Brown silty sand (SM) with traces of gravel					
⊙	B-4	1.0-2.5	Brown sandy silt (ML)					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-1	1.0-2.5	37.5	3.977	0.37		38.1	44.6	17.3
⧗	B-1	10.0-11.5	25	7.835	0.853		49.9	39.6	10.6
▲	B-1	25.0-26.5	19	0.238			0.7	63.0	36.3
★	B-2	20.0-20.8	19	0.467			2.2	60.3	37.5
⊙	B-4	1.0-2.5	19				0.1	39.5	60.4

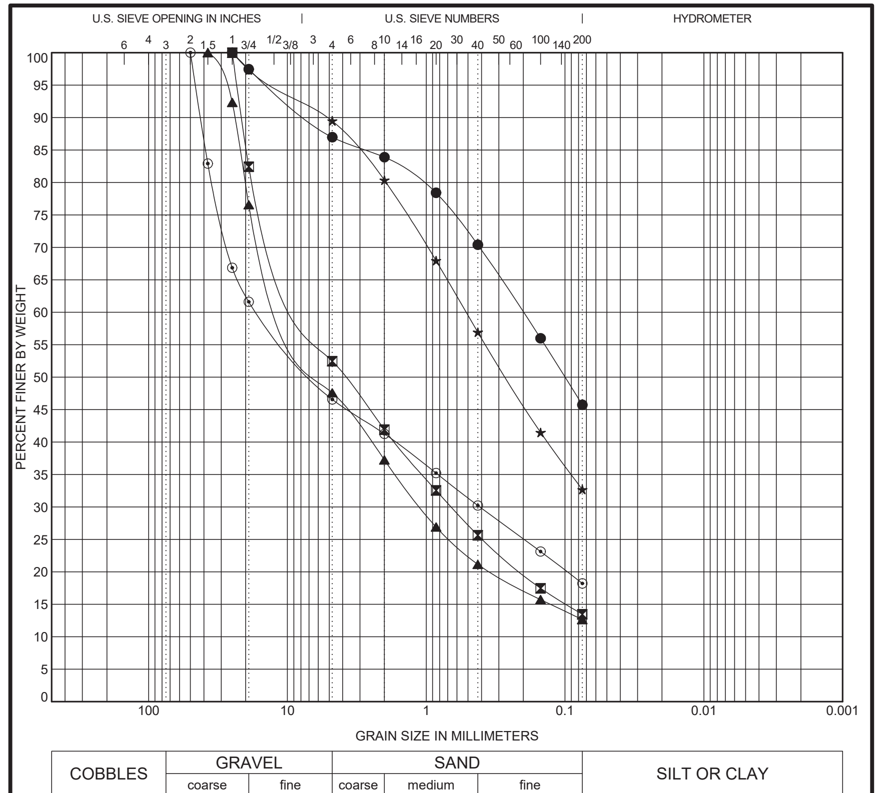
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 2



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-7	1.0-2.5	Brown silty sand (SM) with some gravel					
⧗	B-9	3.0-4.5	Brownish gray silty gravel (GM) with some sand					
▲	B-9	40.0-41.5	Brown silty gravel (GM) with some sand					
★	B-10	1.0-2.5	Grayish brown silty sand (SM) with a little gravel					
⊙	B-11	1.0-2.5	Tannish brown silty gravel (GM) with some sand					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-7	1.0-2.5	25	0.201			13.0	41.2	45.7
⧗	B-9	3.0-4.5	25	6.737	0.66		47.6	39.0	13.5
▲	B-9	40.0-41.5	37.5	8.603	1.099		52.4	35.0	12.6
★	B-10	1.0-2.5	25	0.516			10.5	56.8	32.7
⊙	B-11	1.0-2.5	50	16.393	0.412		53.4	28.4	18.2

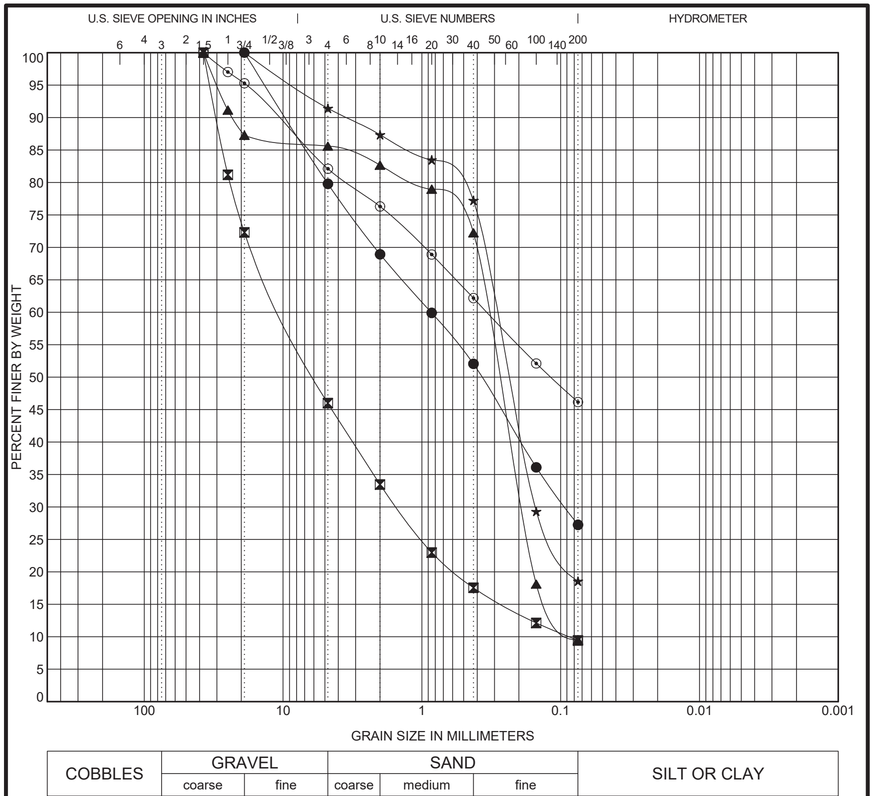
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 3



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-12	1.0-1.4	Tannish brown silty sand (SM) with some gravel					
⧗	B-12	10.0-11.5	Gray sandy gravel (GW-GM) with a little silt				2.6	114.3
▲	B-13	1.0-2.5	Tannish brown gravelly sand (GW-GM) with a little silt				1.4	4.3
★	B-13	2.5-4.0	Tannish brown silty sand (SM) with a little gravel					
⊙	BULK-1	0.5-1.5	Brown silty sand (SM) with some gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-12	1.0-1.4	19	0.858	0.093		20.2	52.5	27.2
⧗	B-12	10.0-11.5	37.5	9.935	1.508	0.087	54.0	36.6	9.4
▲	B-13	1.0-2.5	37.5	0.336	0.189	0.078	14.4	76.1	9.5
★	B-13	2.5-4.0	19	0.292	0.152		8.6	72.9	18.6
⊙	BULK-1	0.5-1.5	37.5	0.339			17.9	35.9	46.2

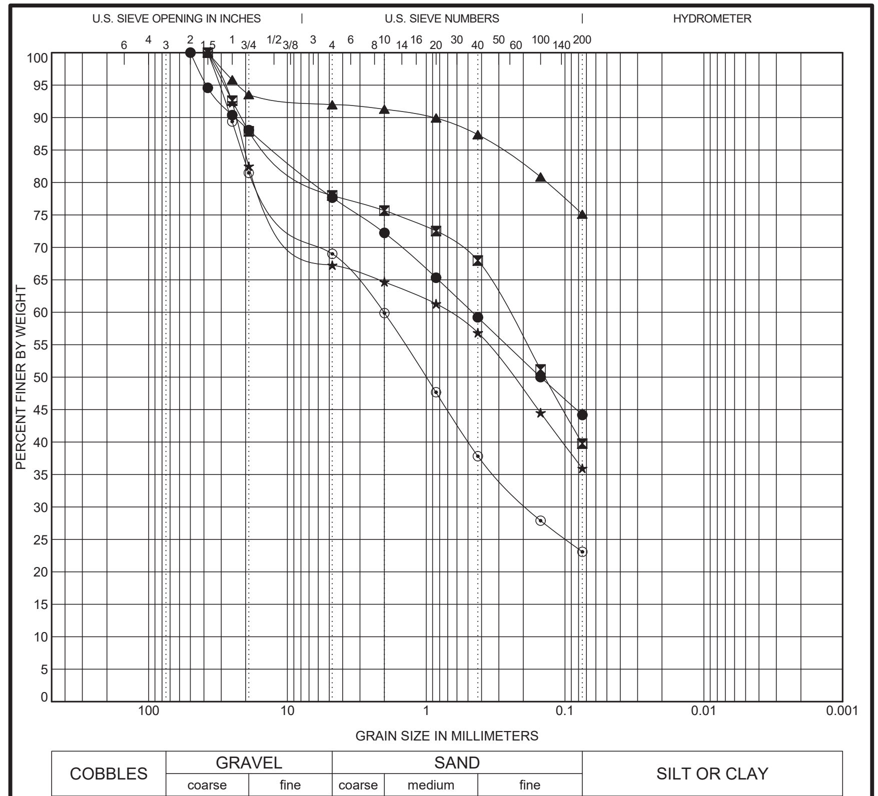
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 4



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	BULK-2	0.5-1.5	Brown silty sand (SM) with some gravel					
⧗	BULK-3	0.5-1.5	Brown silty sand (SM) with some gravel					
▲	BULK-4	0.5-1.5	Brown sandy silt (ML) with a little gravel					
★	BULK-5	0.5-1.5	Brown silty gravel (GM) with some sand					
⊙	P-1	1.0-2.5	Brown silty sand (SM) with some gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	BULK-2	0.5-1.5	50	0.465			22.3	33.5	44.2
⧗	BULK-3	0.5-1.5	37.5	0.259			22.0	38.2	39.8
▲	BULK-4	0.5-1.5	37.5				8.0	16.9	75.1
★	BULK-5	0.5-1.5	37.5	0.694			32.8	31.3	35.9
⊙	P-1	1.0-2.5	37.5	2.025	0.187		31.0	45.9	23.1

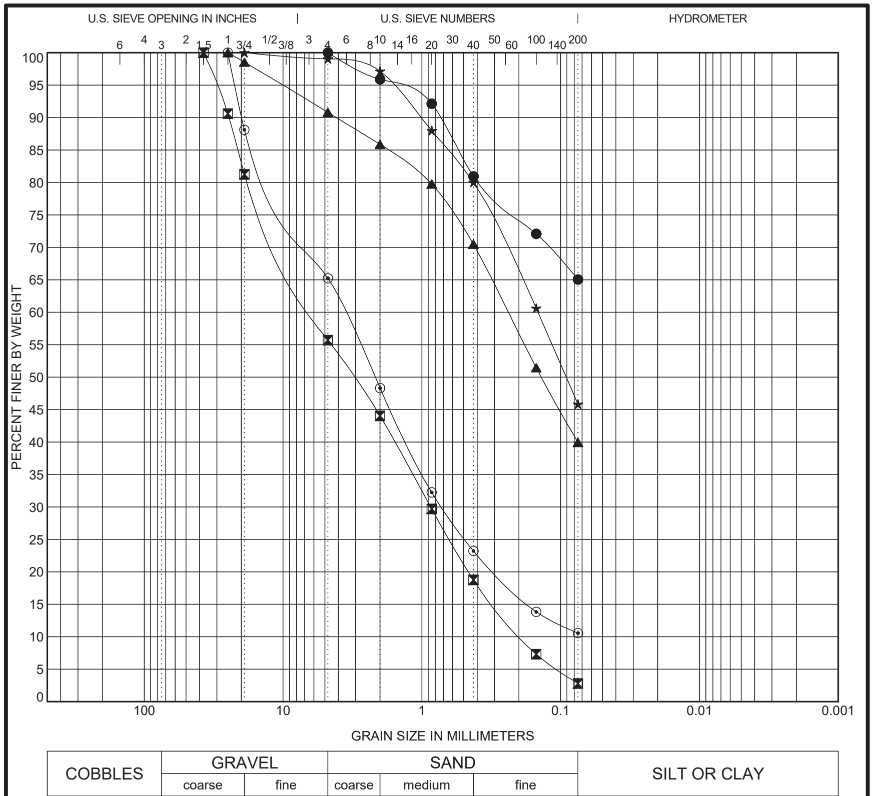
G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 5



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	P-1	3.0-4.5	Brown sandy silt (ML)					
⧗	P-1	10.0-11.5	Brownish gray gravelly sand (SP) with traces of silt				0.7	31.3
▲	P-1	30.0-31.5	Brown silty sand (SM) with a little gravel					
★	P-2	30.0-31.5	Brown silty sand (SM) with traces of gravel	NP	NP	NP		
⊙	P-3	1.0-2.5	Grayish brown gravelly sand (SW-SM) with a little silt				2.1	54.4

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	P-1	3.0-4.5	4.75				0.0	35.0	65.0
⧗	P-1	10.0-11.5	37.5	5.999	0.865	0.192	44.3	52.9	2.8
▲	P-1	30.0-31.5	25	0.24			9.2	50.9	39.9
★	P-2	30.0-31.5	19	0.146			1.0	53.2	45.8
⊙	P-3	1.0-2.5	25	3.636	0.716		34.8	54.7	10.5

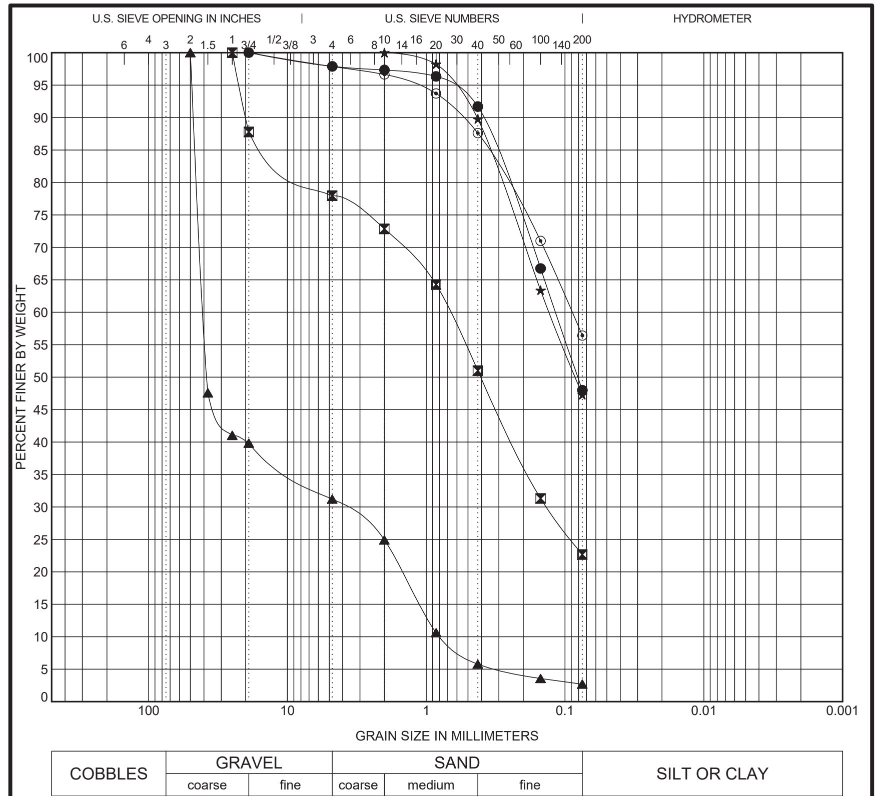
G GRAIN SIZE MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 6



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	P-3	5.0-6.5	Brown silty sand (SM) with traces of gravel					
⧗	P-3	20.0-21.5	Brown silty sand (SM) with some gravel					
▲	P-5	15.0-16.5	Brown sandy gravel (GP) with traces of silt				0.5	51.5
★	P-5	25.0-26.5	Brown silty sand (SM)					
⊙	P-6	1.0-2.3	Grayish brown sandy silt (ML) with traces of gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	P-3	5.0-6.5	19	0.117			2.1	49.9	48.0
⧗	P-3	20.0-21.5	25	0.68	0.135		22.0	55.3	22.7
▲	P-5	15.0-16.5	50	40.147	4.03	0.779	68.8	28.5	2.7
★	P-5	25.0-26.5	2	0.13			0.0	52.7	47.3
⊙	P-6	1.0-2.3	19	0.089			2.1	41.5	56.4

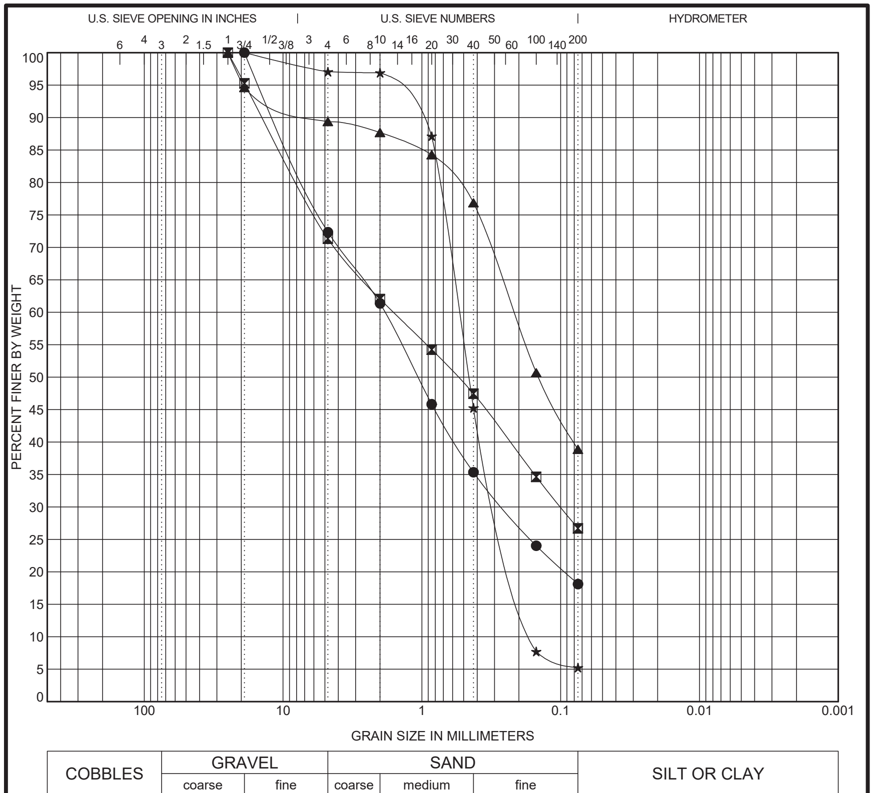
G GRAIN SIZE MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 7



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	P-6	31.0-32.5	Brown silty sand (SM) with some gravel					
⧗	P-7	1.0-2.5	Brownish tan silty sand (SM) with some gravel					
▲	P-8	1.0-2.5	Tannish brown silty sand (SM) with a little gravel					
★	P-8	30.0-31.5	Brown sand (SP-SM) with a little silt and traces of gravel				0.9	3.4

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	P-6	31.0-32.5	19	1.856	0.26		27.7	54.2	18.1
⧗	P-7	1.0-2.5	25	1.602	0.1		28.7	44.6	26.7
▲	P-8	1.0-2.5	25	0.217			10.6	50.5	38.9
★	P-8	30.0-31.5	19	0.542	0.278	0.16	2.9	91.8	5.2

G_GRAIN_SIZE_MOD 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

GRAIN SIZE DISTRIBUTION - ASTM D6913

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 8

Location	Depth	Soil Description	Dry Density	Moisture Contents			Ring Swell
				Initial	Air-Dried	Final	
	(feet)		(pcf)	(%)	(%)	(%)	(%)
B-3*	5.0 - 6.5	Brown sandy clay with some gravel	67.9	17.2	13.0	50.6	0.7
B-3**	5.1 - 6.5	Brown sandy clay	87.2	24.0	19.0	35.9	6.8
B-5*	1.0 - 2.5	Brown sandy clay with traces of gravel	104.1	22.1	18.1	23.6	1.8
B-5**	1.0 - 2.5	Brown sandy clay with traces of gravel	104.2	22.2	18.1	23.1	1.8
P-2**	1.0 - 2.5	Brown sandy clay	106.9	24.9	19.1	25.0	2.5
P-4**	1.0 - 2.5	Brown sandy clay	107.5	23.5	17.8	25.0	5.1

NOTE: Samples tested were either relatively undisturbed or remolded in 2.4-inch diameter by 1-inch high rings. They were air-dried overnight and then saturated for 24 hours under a surcharge pressure of 55 psf.
* Relatively Undisturbed
** Remolded

G_RING_SWELL_TEST 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

SUMMARY OF RING SWELL TESTS

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 9

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs)	(psi)
B-8	1 - 2.8	4.810	2.400	2.00	154.1	40,145	8,870
B-8	19 - 19.4	4.820	2.420	1.99	172.6	116,445	25,320
B-8	24 - 24.4	4.820	2.410	2.00	163.6	25,255	5,540
B-8	30.5 - 30.9	4.840	2.420	2.00	165.3	29,210	6,350
B-8	41.75 - 42.15	4.810	2.400	2.00	163.1	35,940	7,940
B-9	16.75 - 17.16	4.880	2.430	2.01	163.5	52,420	11,300
B-9	24.5 - 24.9	4.830	2.400	2.01	165.6	29,465	6,510
B-9	26 - 26.4	4.830	2.410	2.00	187.1	15,935	3,490
B-9	43 - 43.4	4.820	2.400	2.01	167.1	44,280	9,790
B-10	41.33 - 41.33	6.550	3.270	2.00	143.7	52,785	6,290
B-11	42.5 - 43.05	6.540	3.280	1.99	153.7	128,585	15,220
B-12	19.5 - 2	6.500	3.250	2.00	169.1	48,065	5,790
B-13	10.75 - 11.29	6.500	3.250	2.00	179.6	22,710	2,740
B-13	17 - 17.5	6.500	3.250	2.00	173.4	35,150	4,240
B-13	20.25 - 20.79	6.500	3.250	2.00	183.2	127,080	15,320
B-13	29.5 - 30	6.480	3.240	2.00	172.8	24,365	2,960
P-7	21 - 21.55	6.546	3.280	2.00	172.1	33,440	3,960
P-8	16.25 - 16.79	6.480	3.240	2.00	180.8	66,650	8,080
P-8	21.5 - 22	6.500	3.250	2.00	187.5	188,025	22,670

ASTM D7012 (METHOD C)

Note: Samples were not prepared in accordance with ASTM D4543. Therefore, results reported may differ from results obtained from a test specimen that meets the requirements of Practice D4543

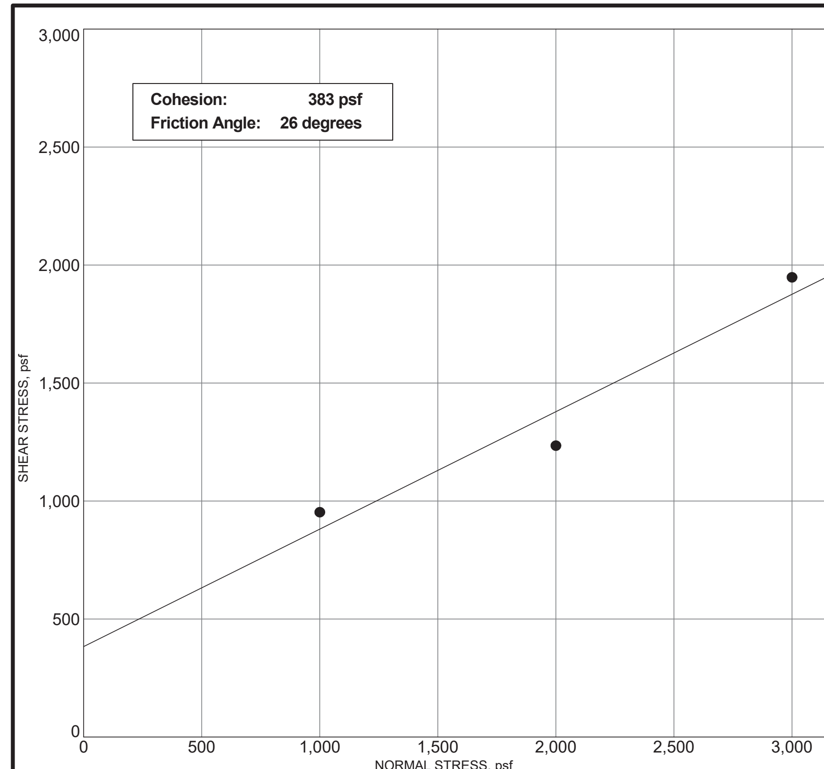
G_ROCK_UC_TEST_PORTRAIT 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

UNIAXIAL COMPRESSIVE STRENGTH TEST

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 10



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	17.7	20.3	14.3
	Dry Density, pcf	62.1	66.3	80.1
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	48.4	44.0	31.3
	Dry Density, pcf	59.7	70.1	84.4
	Height, inches	1.041	0.946	0.949
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0024	0.0023	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**953**	**1235**	**1948**
	Shear Displacement, inches	0.43	0.41	0.42

Sample: B-1
Depth: 5.0 - 6.5 feet
Description: Brownish gray silty sand with some gravel

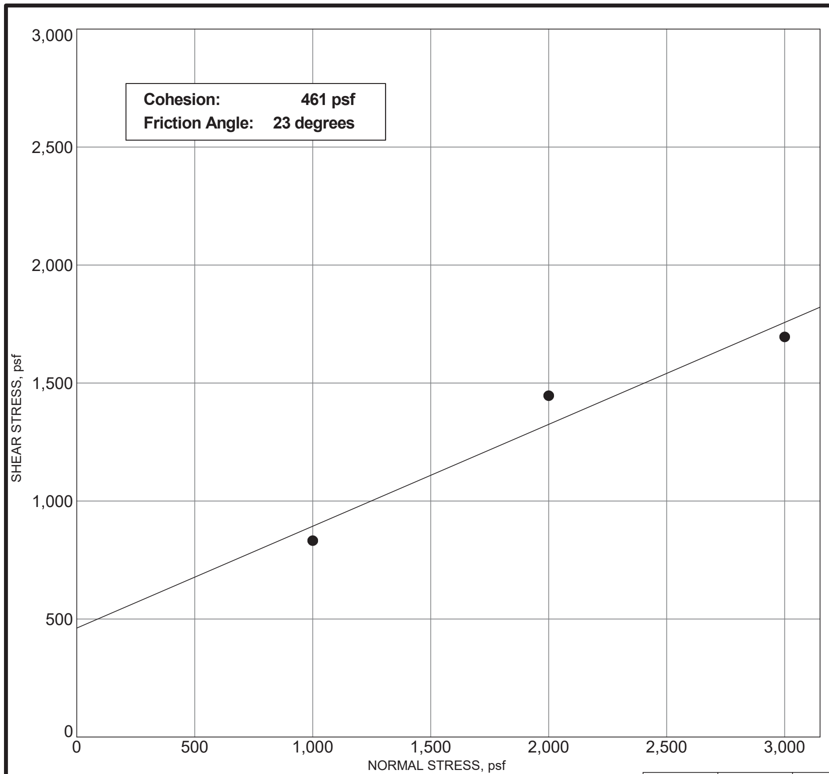
G_DIRECT_SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 11



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	22.0	22.7	23.2
INITIAL	Dry Density, pcf	65.1	63.5	62.4
INITIAL	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	51.4	51.1	49.2
FINAL	Dry Density, pcf	63.0	66.0	64.3
FINAL	Height, inches	1.034	0.963	0.971
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0023	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**832**	**1446**	**1695**
	Shear Displacement, inches	0.43	0.42	0.42

Sample: B-1
Depth: 15.0 - 16.5 feet
Description: Light brown sandy gravel with a little silt

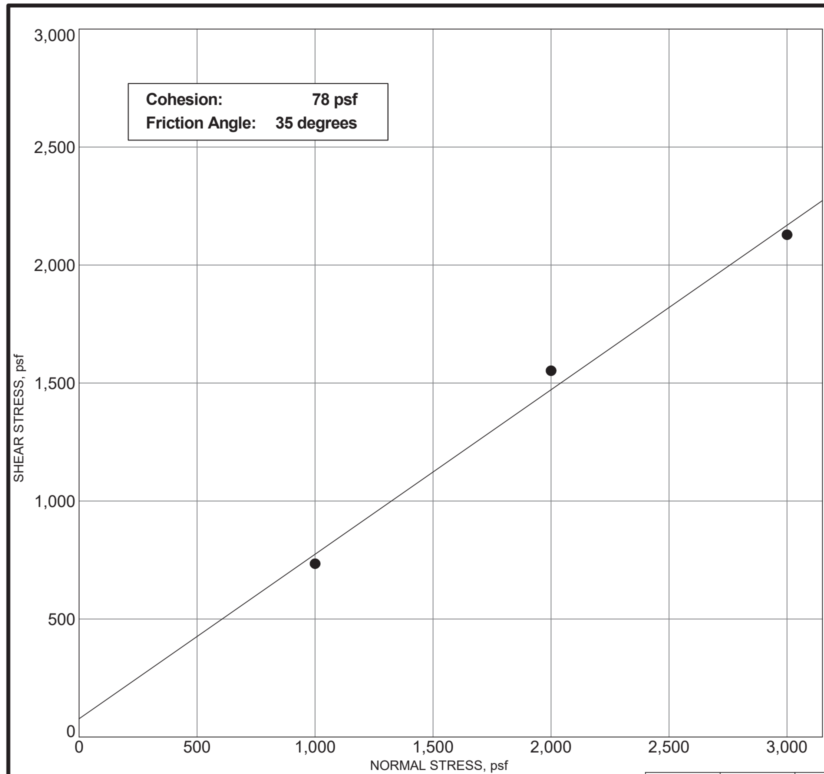
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 12

G_DIRECT_SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	15.0	15.5	14.7
INITIAL	Dry Density, pcf	69.1	77.9	76.2
INITIAL	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	40.2	36.5	35.9
FINAL	Dry Density, pcf	67.5	80.7	78.4
FINAL	Height, inches	1.023	0.966	0.971
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0024	0.0022	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**734**	**1552**	**2128**
	Shear Displacement, inches	0.43	0.41	0.42

Sample: B-2
Depth: 15.0 - 16.5 feet
Description: Brown sandy silt with some gravel

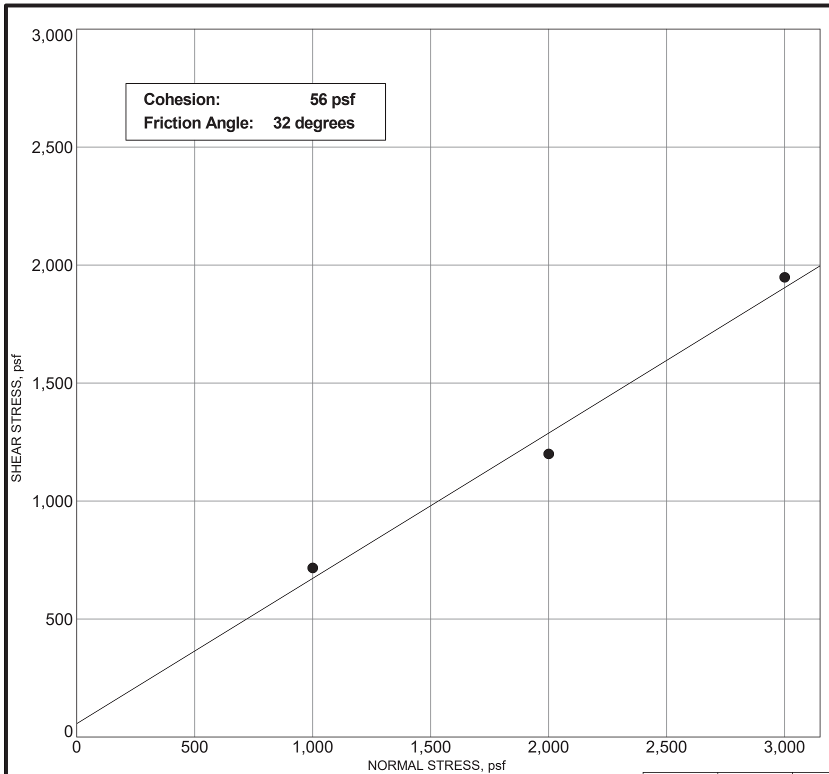
GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate B - 13

G_DIRECT_SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	30.5	32.0	32.8
	Dry Density, pcf	83.5	87.5	87.1
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	36.8	32.9	32.1
	Dry Density, pcf	81.5	89.8	90.2
	Height, inches	1.024	0.974	0.966
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0025	0.0024	0.0023
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**716**	**1199**	**1948**
	Shear Displacement, inches	0.43	0.42	0.42

Sample: P-1
Depth: 5.0 - 6.5 feet
Description: Brown sandy silt (ML)

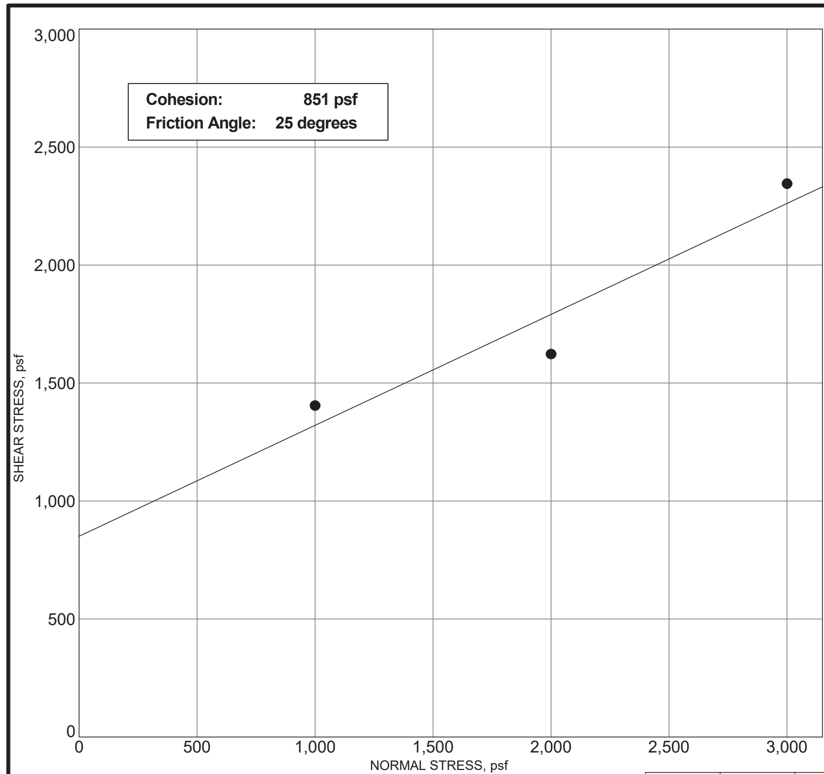
G DIRECT SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 14



		Sample #1	Sample #2	Sample #3
INITIAL	Moisture Content, %	33.9	32.0	29.7
	Dry Density, pcf	84.5	85.5	88.7
	Height, inches	1.00	1.00	1.00
FINAL	Moisture Content, %	41.6	38.6	35.2
	Dry Density, pcf	83.4	87.7	90.8
	Height, inches	1.013	0.974	0.977
	Diameter, inches	2.42	2.42	2.42
	Deformation Rate, inch/minute	0.0024	0.0021	0.0022
	Normal Stress, psf	**1000**	**2000**	**3000**
	Peak Shear Stress, psf	**1405**	**1623**	**2345**
	Shear Displacement, inches	0.43	0.41	0.42

Sample: P-1
Depth: 25.0 - 26.5 feet
Description: Brown silty sand with a little gravel

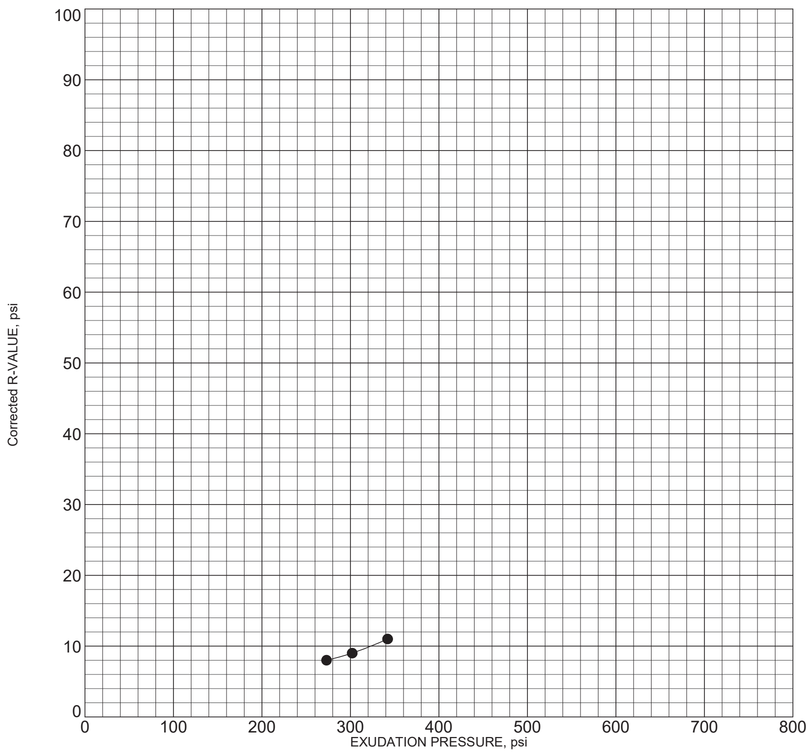
G DIRECT SHEAR 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

DIRECT SHEAR TEST - ASTM D3080

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 15



Sample: BULK-1
Depth: 0.5 - 1.5 feet
Description: Brown silty sand (SM) with some gravel

R-Value at 300 psi Exudation Pressure:	**9**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	106.9	23.5	127	2.49	342	11	11
2	50	105.9	24.0	132	2.44	302	9	9
3	50	102.4	24.5	136	2.44	273	8	8

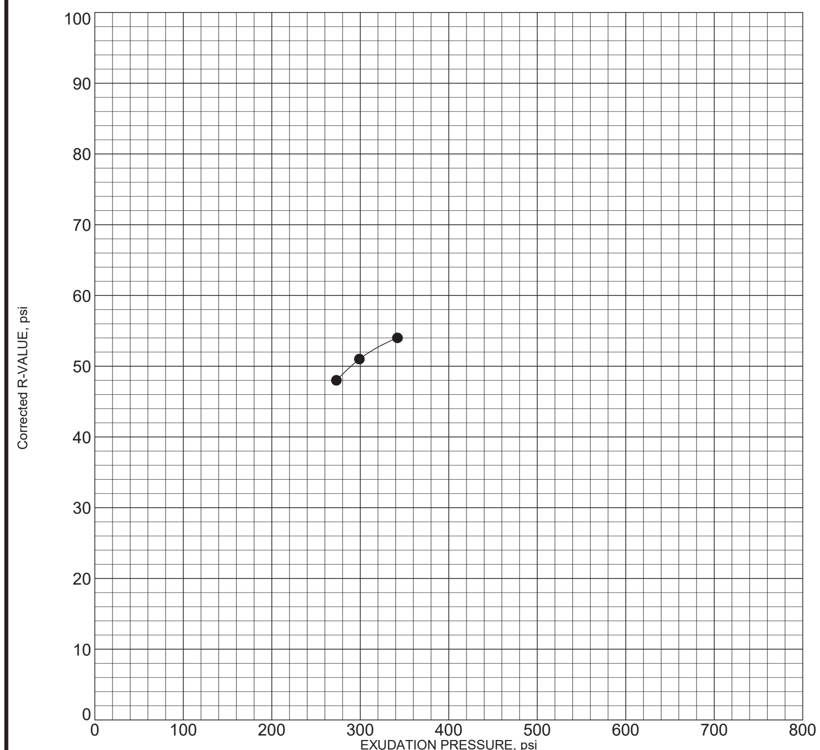
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 16



Sample: BULK-2
Depth: 0.5 - 1.5 feet
Description: Brown silty sand (SM) with some gravel

R-Value at 300 psi Exudation Pressure:	**51**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	103.7	21.7	50	2.56	342	54	54
2	50	101.8	22.2	53	2.54	299	51	51
3	50	102.4	24.5	57	2.44	273	48	48

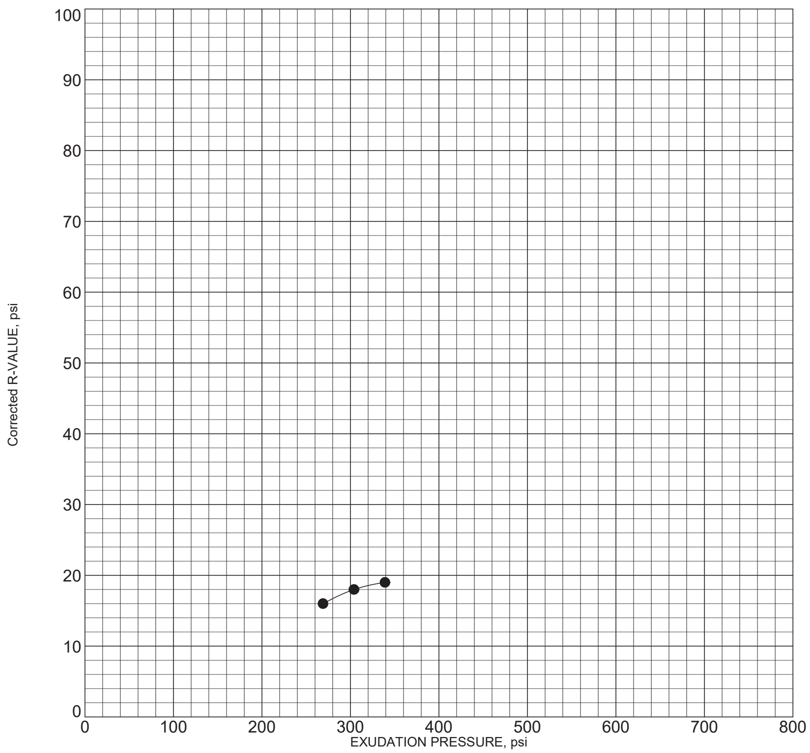
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 17



Sample: BULK-3
Depth: 0.5 - 1.5 feet
Description: Brown silty sand (SM) with some gravel

R-Value at 300 psi Exudation Pressure:	**18**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	92.8	32.4	109	2.56	339	19	19
2	50	91.8	32.9	113	2.55	304	18	18
3	50	90.7	33.4	116	2.49	269	16	16

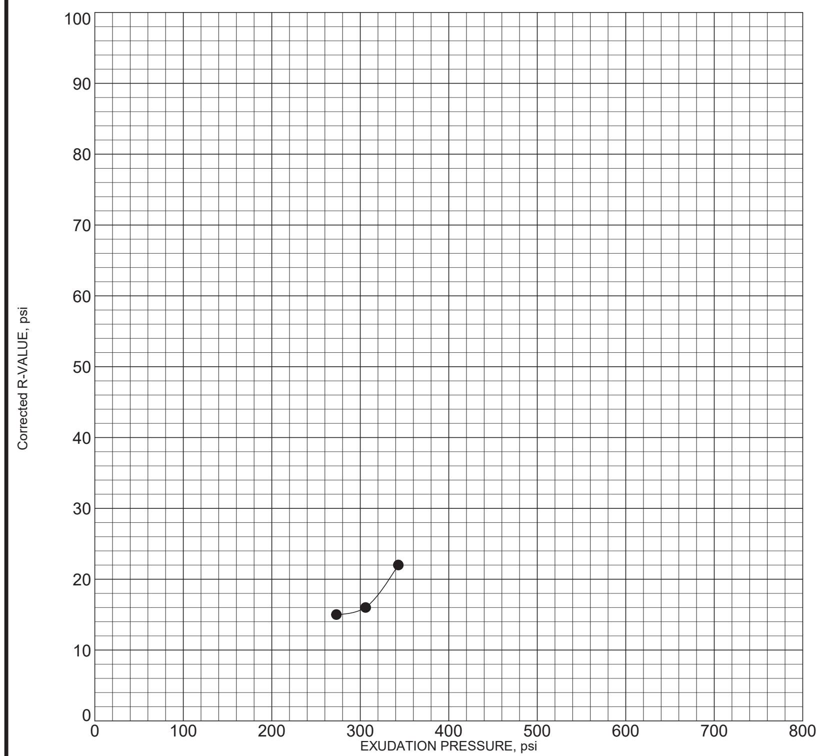
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 18



Sample: BULK-4
Depth: 0.5 - 1.5 feet
Description: Brown sandy silt (ML) with a little gravel

R-Value at 300 psi Exudation Pressure:	**16**

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	99.4	29.1	105	2.52	343	22	22
2	50	96.9	29.6	116	2.55	306	16	16
3	50	96.0	30.0	119	2.51	273	15	15

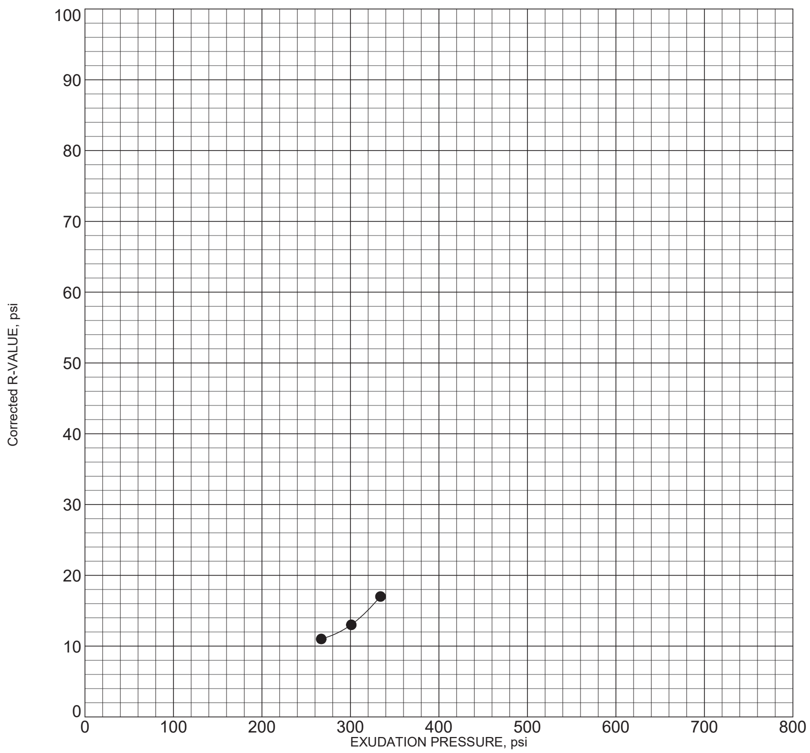
R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 19



Sample: BULK-5
Depth: 0.5 - 1.5 feet
Description: Brown silty gravel (GM) with some sand

R-Value at 300 psi Exudation Pressure:	13

R-Value Test Performed by Ninyo & Moore

No.	Compaction Pressure	Density	Moisture Content	Horizontal Pressure @160 psi	Sample Height	Exudation Pressure	R-Value	Corrected R-Value
	(psi)	(pcf)	(%)	(psi)	(in)	(psi)		
1	50	106.0	25.6	105	2.45	334	17	17
2	50	104.7	26.1	116	2.47	301	13	13
3	50	102.0	26.9	119	2.45	267	11	11

R-VALUE TEST-NINYO&MOORE 8345-00.GPJ GEOLABS.GDT 12/1/23

GEOLABS, INC.
GEOTECHNICAL ENGINEERING
W.O. 8345-00

R-VALUE AND EXPANSION PRESSURE - ASTM D2844

WAIALE ROAD EXTENSION
WAIKAPU, MAUI, HAWAII

Plate
B - 20

APPENDIX C

TRAFFIC INDEX DETERMINATION

Project: Waiale Road Extension
Waikapu, Maui, Hawaii

Street Name: Waiale Road Extension

(1)	Design Period (years)	50
(2)	Average Daily Traffic (ADT) Per Direction at Project Completion	13500
(3)	Future Average Daily Traffic (ADT) Per Direction	13500
(4)	Average ADT Per Direction Over Design Period	13500
(5)	Design Lane Factor	1

Number of Lanes In One Direction	Design Lane Factor
1	1
2	1
3	0.8
4	0.75

(6) 24-Hour Truck Traffic, T_{24} (%) 4

Truck Traffic Distribution :

2-axle	=	75.75%
3-axle	=	3.50%
4-axle	=	16.40%
5-axle	=	4.00%
6-axle	=	0.01%
7-axle	=	0.34%

(7) Average Daily Truck Traffic Per Direction, ADTT 540

(8) Equivalent 18-kip Single Axle Loads, ESAL

2-axle : % of 2-axle trucks x No. trucks x 65	=	26588
3-axle : % of 3-axle trucks x No. trucks x 525	=	9923
4-axle : % of 4-axle trucks x No. trucks x 1162	=	102907
5-axle : % of 5-axle trucks x No. trucks x 1462	=	31579
6-axle : % of 6-axle trucks x No. trucks x 968	=	1830
Annual ESAL :	=	172826
Total ESAL For Design Period	=	8641310
TRAFFIC INDEX (TI) = 9 (ESAL/1,000,000)EXP(0.119)		11.6
	SAY	11.5

Project: Waiale Road Extension
Waikapu, Maui, Hawaii

Street: Waiale Road Extension

Design Parameters

Traffic Index	11.5
R value of ACB	90
R value of ASB	60
R value of Subgrade	9

Pavement Section using Asphalt Concrete Base and Aggregate Subbase

Trial Thickness of AC + ACB 11 Inches

(1)	**Asphalt Concrete (AC)**							
	GE required						0.368	
	GE with Tolerance =	0.368	+	0.240	=		0.608	
	Gf of AC						2.006	
	GE/Gf	=	3.64			SAY	4.000	Inches
						USE	4.000	Inches
(2)	**Asphalt Concrete Base (ACB)**							
	GE required	=					1.472	
	GE of AC	=					0.429	
	GE required of ACB	=					1.043	
	Gf of ACB						1.905	
	GE/Gf	=	6.57			SAY	7.00	Inches
						USE	7.00	Inches
(3)	**Calculate New Gf of AC**							
	Thickness of AC + Thickness of ACB						0.917	
	New Gf of AC						2.006	
(4)	**Aggregate Subbase (ASB)**							
	GE required	=					3.349	
	GE of AC	=					0.429	
	GE of ACB	=					1.112	
	GE required of ASB	=					1.809	
	GE less tolerance	=					1.569	
	Gf of ASB	=					1.000	
	GE/Gf	=	18.82			SAY	19.00	Inches
						USE	19.00	Inches

Design Pavement Section

4.0	**Inches**	**AC**
7.0	**Inches**	**ACB**
19.0	**Inches**	**ASB**
30.0	**Inches**	**Total Thickness**

Project: Waiale Road Extension
Waikapu, Maui, Hawaii

Street: Waiale Road Extension

Design Parameters

Traffic Index	11.5	
R value of ACB	90	
R value of AB	80	
R value of Subgrade	50	(Enhanced R-value with Tensar NX850 or Equal Geogrid)

Pavement Section using Asphalt Concrete Base and Aggregate Base

Trial Thickness of AC + ACB 8 Inches

(1)	**Asphalt Concrete (AC)**								
	GE required							0.368	
	GE with Tolerance =	0.368	+		0.240	=		0.608	
	Gf of AC							1.806	
	GE/Gf		=	4.04			SAY	4.500	Inches
							USE	4.000	Inches
(2)	**Asphalt Concrete Base (ACB)**								
	GE required		=					0.736	
	GE of AC		=					0.362	
	GE required of ACB		=					0.374	
	Gf of ACB							1.715	
	GE/Gf		=	2.62			SAY	3.00	Inches
							USE	6.00	Inches
(3)	**Calculate New Gf of AC**								
	Thickness of AC + Thickness of ACB							0.833	
	New Gf of AC							1.944	
(4)	**Aggregate Base (AB)**								
	GE required		=					1.840	
	GE of AC		=					0.362	
	GE of ACB		=					0.858	
	GE required of AB		=					0.620	
	GE less tolerance		=					0.380	
	Gf of AB		=					1.000	
	GE/Gf		=	4.56			SAY	6.00	Inches
							USE	6.00	Inches

Design Pavement Section

4.0	**Inches**	**AC**
6.0	**Inches**	**ACB**
6.0	**Inches**	**AB**
16.0	**Inches**	**Total Thickness on a Layer of Reinforcing Geogrid (such as Tensar InterAx NX850-FG or Equivalent) on Recompacted Subgrade**

Waiale Road Extension
Waikapu, Maui, Hawaii

Design Period = 50 years (One-Way Traffic)

	2 Axles		3 Axles		4 Axles		5 Axles		6 Axles		TOTAL
Single Axle Loads (kips)	ADTT= 409		ADTT= 19		ADTT= 89		ADTT= 22		ADTT= 4		ADTT= 543
	Factors	Repetition	Factors	Repetition	Factors	Repetition	Factors	Repetition	Factors	Repetition	REPETITIONS
20-22	172.5	70553	306.25	5819	1773	157797	3,788.50	83347	3221.75	12887	330402
22-24	120.25	49182	44.75	850	2232.5	198693	1077.25	23700	5773.5	23094	295519
24-26	87	35583	18.75	356	1515.75	134902	85	1870	1085.25	4341	177052
26-28	16.75	6851	14	266	575.25	51197.3	15	330			58644
28-30	16.75	6851	13.5	257	573	50997	15	330			58434
30-32			12.25	233	107	9523					9756
32-34			12.25	233	105	9345					9578
34-36			12.25	233	105	9345					9578
Tandem Axle Loads (kips)											
30-32			1268.5	24102	1015.25	90357.3	454.75	10005	1085.25	4341	128804
32-34			926	17594	733	65237	520.25	11446			94277
34-36			261.5	4969	935.25	83237.3	332.75	7321			95526
36-38			261.5	4969	313.5	27901.5	464.5	10219			43089
38-40			167	3173	209.75	18667.8	188.25	4142			25982
40-42			74	1406	139.5	12415.5	100.25	2206			16027
42-44					139.5	12415.5	64	1408			13824
44-46					68	6052	82.75	1821			7873
46-48			9.5	181			62.5	1375			1556
48-50			9.5	181			62.5	1375			1556

CONCRETE PAVEMENT CALCULATION

```
15:54:32                    PCAPAV(TM) 2.10                        Page 2 of 2
10-26-<3   Proprietary Software of PORTLAND CEMENT ASSOCIATION
                           Pavement  Design  Data
Modulus of Subg/Subb K  200.0 PCI    |Axle Load Cat.  1.Light
Modulus of Rupture  MR  650.0 PSI    |                2.Medium
                                     |                3.Heavy
A D T T    543.00                    |                4.Very Heavy
                                     |                5.Input Axles
Design Life  50 Years                |  Maximum Single axle load   36  KIPS
                                     |  Maximum Tandem axle load   48  KIPS
Load Transfer:                       |      A X L E   L O A D S
  At Joint        1.Dowel            | SAL     Axles    TAL     Axles
                  2.Agg. Interlock   | KIPS   /1000     KIPS   /1000
                                     | 36       0.97    48       1.11
  At Shoulder     1.Conc. Shoulder   | 34       0.97    44       3.01
                  2.No Conc. Shoulder| 32       0.98    40       6.97
                                     | 30       5.90    36      19.15
 Load Safety Factor   1. 1.0         | 28       5.92    32      13.00
                      2. 1.1         | 26      17.87    28       0.00
                      3. 1.2         | 24      29.82    24       0.00
                      4. 1.3         | 22      33.34    20       0.00
                                     | 20       0.00    16       0.00
 Estimated Pavement Thickness 9.5  IN| 18       0.00    12       0.00
```

SINGLE AXLE LOAD COMPUTATIONS

Design Thickness = 9.5 Inches

		Load Repetitions		---Fatigue Analysis-----			----Erosion Analysis---		
SAL	*LSF	Axle/ 1000	Expected Reps	Stress Ratio	Allowable Reps	Fatigue Consump	Power	Allowable Reps	Erosion
36	46.8	0.97	4806.	0.592	38913.	12.35	39.553	82220.	5.85
34	44.2	0.97	4806.	0.561	92042.	5.22	35.280	115722.	4.15
32	41.6	0.98	4856.	0.530	230639.	2.11	31.252	167778.	2.89
30	39.0	5.90	29234.	0.499	815278.	3.59	27.467	252481.	11.58
28	36.4	5.92	29333.	0.467	6635234.	0.44	23.927	398819.	7.35
26	33.8	17.87	88544.	0.436	***********	0.00	20.631	673156.	13.15
24	31.2	29.82	147754.	0.404	***********	0.00	17.579	1252360.	11.80
22	28.6	33.34	165196.	0.373	***********	0.00	14.771	2733267.	6.04
20	26.0	0.00	0.	0.341	***********	0.00	12.208	***********	0.00
18	23.4	0.00	0.	0.308	***********	0.00	9.888	***********	0.00

TANDEM AXLE LOAD COMPUTATIONS

Design Thickness = 9.5 Inches

		Load Repetitions		---Fatigue Analysis-----			----Erosion Analysis---		
TAL	*LSF	Axle/ 1000	Expected Reps	Stress Ratio	Allowable Reps	Fatigue Consump	Power	Allowable Reps	Erosion
48	62.4	1.11	5500.	0.353	***********	0.00	24.568	364649.	1.51
44	57.2	3.01	14914.	0.325	***********	0.00	20.644	671571.	2.22
40	52.0	6.97	34535.	0.297	***********	0.00	17.061	1418574.	2.43
36	46.8	19.15	94886.	0.269	***********	0.00	13.820	3857720.	2.46
32	41.6	13.00	64413.	0.241	***********	0.00	10.919	20450346.	0.31
28	36.4	0.00	0.	0.212	***********	0.00	8.360	***********	0.00
24	31.2	0.00	0.	0.184	***********	0.00	6.142	***********	0.00
20	26.0	0.00	0.	0.155	***********	0.00	4.265	***********	0.00
16	20.8	0.00	0.	0.126	***********	0.00	2.730	***********	0.00
12	15.6	0.00	0.	0.096	***********	0.00	1.536	***********	0.00

TOTAL FATIGUE USED = 23.71   EROSION DAMAGE = 71.76

9.0 Inch Thickness Inadequate, Fatigue Used= 88.12   Erosion Damage = 115.71

CONCRETE PAVEMENT CALCULATION (ENHANCED K-VALUE WITH GEOGRID)

```
16:54:10                    PCAPAV(TM) 2.10                        Page 2 of 2
10-26-<3   Proprietary Software of PORTLAND CEMENT ASSOCIATION
                           Pavement  Design  Data
Modulus of Subg/Subb K _275.0 PCI    |Axle Load Cat.  1.Light
Modulus of Rupture  MR  650.0 PSI    |                2.Medium
                                     |                3.Heavy
A D T T    543.00                    |                4.Very Heavy
                                     |                5.Input Axles
Design Life  50 Years                |  Maximum Single axle load   36  KIPS
                                     |  Maximum Tandem axle load   48  KIPS
Load Transfer:                       |      A X L E   L O A D S
  At Joint        1.Dowel            | SAL     Axles    TAL     Axles
                  2.Agg. Interlock   | KIPS   /1000     KIPS   /1000
                                     | 36       0.97    48       1.11
  At Shoulder     1.Conc. Shoulder   | 34       0.97    44       3.01
                  2.No Conc. Shoulder| 32       0.98    40       6.97
                                     | 30       5.90    36      19.15
 Load Safety Factor   1. 1.0         | 28       5.92    32      13.00
                      2. 1.1         | 26      17.87    28       0.00
                      3. 1.2         | 24      29.82    24       0.00
                      4. 1.3         | 22      33.34    20       0.00
                                     | 20       0.00    16       0.00
 Estimated Pavement Thickness 9.0  IN| 18       0.00    12       0.00
```

SINGLE AXLE LOAD COMPUTATIONS

Design Thickness = 9.0 Inches

		Load Repetitions		---Fatigue Analysis-----			----Erosion Analysis---		
SAL	*LSF	Axle/ 1000	Expected Reps	Stress Ratio	Allowable Reps	Fatigue Consump	Power	Allowable Reps	Erosion
36	46.8	0.97	4806.	0.604	27475.	17.49	43.385	63011.	7.63
34	44.2	0.97	4806.	0.573	66181.	7.26	38.699	88233.	5.45
32	41.6	0.98	4856.	0.541	161527.	3.01	34.280	127024.	3.82
30	39.0	5.90	29234.	0.509	502675.	5.82	30.129	189262.	15.45
28	36.4	5.92	29333.	0.477	2932008.	1.00	26.245	294689.	9.95
26	33.8	17.87	88544.	0.445	***********	0.00	22.630	486698.	18.19
24	31.2	29.82	147754.	0.413	***********	0.00	19.282	874130.	16.90
22	28.6	33.34	165196.	0.380	***********	0.00	16.203	1789501.	9.23
20	26.0	0.00	0.	0.348	***********	0.00	13.391	***********	0.00
18	23.4	0.00	0.	0.315	***********	0.00	10.846	***********	0.00

TANDEM AXLE LOAD COMPUTATIONS

Design Thickness = 9.0 Inches

		Load Repetitions		---Fatigue Analysis-----			----Erosion Analysis---		
TAL	*LSF	Axle/ 1000	Expected Reps	Stress Ratio	Allowable Reps	Fatigue Consump	Power	Allowable Reps	Erosion
48	62.4	1.11	5500.	0.352	***********	0.00	24.133	389949.	1.41
44	57.2	3.01	14914.	0.324	***********	0.00	20.279	722640.	2.06
40	52.0	6.97	34535.	0.297	***********	0.00	16.759	1543734.	2.24
36	46.8	19.15	94886.	0.269	***********	0.00	13.575	4304256.	2.20
32	41.6	13.00	64413.	0.240	***********	0.00	10.726	25078387.	0.26
28	36.4	0.00	0.	0.212	***********	0.00	8.212	***********	0.00
24	31.2	0.00	0.	0.183	***********	0.00	6.033	***********	0.00
20	26.0	0.00	0.	0.155	***********	0.00	4.190	***********	0.00
16	20.8	0.00	0.	0.125	***********	0.00	2.681	***********	0.00
12	15.6	0.00	0.	0.096	***********	0.00	1.508	***********	0.00

TOTAL FATIGUE USED = 34.58   EROSION DAMAGE = 94.80

8.5 Inch Thickness Inadequate, Fatigue Used= 136.89   Erosion Damage = 156.11

APPENDIX C

Traffic Impact and Analysis Report

Waiale Road Extension

Transportation Impact Analysis Report

Prepared for:
Bowers & Kubota

October 2023

SD21-0409

FEHR PEERS

Table of Contents

Appendices

List of Figures

List of Tables

Executive Summary

The County of Maui, Department of Public Works (DPW) is planning to construct the Waiale Road Extension (project). It would extend the existing portion of Waiale Road, which currently terminates at East Waiko Road, approximately 8,600 feet south to Honoapiilani Highway. The planned extension will be designed to support all transportation modes. Currently, there is an existing 80'-0" easement for the roadway extension (Subdivision File No. 3.2278). This will need to be subdivided to create a roadway lot (in favor of County of Maui), which would also need to be widened at each of the intersections to accommodate the proposed roundabouts associated with the project. The right-of-way will provide two through lanes, shoulder bikeways, pedestrian sidewalks, a shared-use path, and grassy swales. It will improve local access and provide travelers with an alternate route in and around the urban areas of Kahului and Wailuku.

For this transportation impact analysis report (TIAR), long-term traffic forecasts were prepared with the project in place and for the No Project Alternative. Traffic operations with both traditional intersection control and modern roundabouts at intersections along the Waiale Road Extension were analyzed to determine the effects of the project.

The following scenarios were evaluated to assess the transportation benefits and impacts associated with the project.

- Existing (2022) Conditions
- Future (2045) No Project Conditions
    - This scenario assumes proposed signalized intersections at Waiale Road/Main Street and Honoapiilani Highway/Waiale Road.
- Future (2045) With Project Conditions
    - This scenario assumes proposed roundabout intersections at Waiale Road/East Waiko Road, Waiale Road/Main Street, Waiale Road/Makai Parkway Street and Honoapiilani Highway/Waiale Road.
    - A second with project scenario was analyzed which assumes proposed signalized intersections at Waiale Road/East Waiko Road and Honoapiilani Highway/Waiale Road, and roundabouts at Waiale Road/Main Street and Waiale Road/Makai Parkway.

A total of twelve (12) study intersections were analyzed in the project study area during the weekday morning (AM) and evening (PM) peak hours for Existing (2022) conditions, Future (2045) No Project conditions, and Future (2045) With Project conditions.

Construction of the proposed Waiale Road Extension would reduce total vehicle miles of travel in Central Maui and reduce delays and improve levels of service at intersections along Honoapiilani Highway. Minor

delay increases are projected at some other intersections. The reduction in delays at most of the analyzed intersections in the study area is due to the fact that the proposed project would provide additional roadway capacity in Central Maui. In particular, delay at intersections along Honoapiilani Highway will be reduced relative to No Project conditions because the Waiale Road Extension will provide a new parallel route.

Single-lane roundabouts will operate acceptably at all intersections where roundabouts are proposed. Multi-lane approaches to these roundabouts should be considered at Honoapiilani Highway/Waiale Road and Waiale Road/East Waiko Road if additional land use growth is anticipated beyond what was assumed in this study or to accommodate future roadway widening to further improve projected traffic operations.

If signalized, the Waiale Road/Waiko Road intersection would need one dedicated left-turn lane and one shared through/right-turn lane on all approaches. At Honoapiilani Highway/Waiale Road, the Waiale Road approaches would provide a single shared lane and the Honoapiilani Highway approaches would provide one left-turn lane and one shared through/right-turn lane.

Fehr & Peers recommends roundabout configurations for Waiale Road/Honoapiilani Highway, Waiale Road/Mauka Parkway, Waiale Road/Main Street and Waiale Road/Waiko Road. Not only are they projected to operate acceptably in 2045 with single-lane approaches but, relative to traditional intersection design, roundabouts have the potential to reduce both the number and severity of crashes since they reduce the number of conflict points and act as a traffic calming measure. Maui County and the State of Hawaii will ultimately determine the type of intersection control and roadway configuration at these intersections.

1. Introduction and Methodologies

This report documents a study conducted by Fehr & Peers of the planned extension of Waiale Road between East Waiko Road and Honoapiilani Highway in Waikapu on the island of Maui (both East Waiko Road and West Waiko Road will be referred to as Waiko Road for the remainder of this report). The Waiale Road Extension will be okuikwned, operated, and maintained by the County of Maui. This TIAR was conducted in accordance with the standard procedures and practices of the affected government agencies and addresses the potential impact of the project on all modes of travel. Traffic operations at selected intersections in the study area were analyzed under Existing (2022) conditions, Future (2045) No Project conditions, and Future (2045) With Project conditions, and a multi-modal assessment of mobility along the Waiale Road Extension was conducted. The location of the project and study intersections in the vicinity is shown in **Figure 1**.

1.1 Project Description and Background

The County of Maui, Department of Public Works (DPW) is planning to construct the Waiale Road Extension (project). It would extend the existing portion of Waiale Road, which currently terminates at East Waiko Road, approximately 8,600 feet south to Honoapiilani Highway. The planned extension will be designed to support all transportation modes. Currently, there is an existing 80'-0" easement for the roadway extension (Subdivision File No. 3.2278). This will need to be subdivided to create a roadway lot (in favor of County of Maui), which would also need to be widened at each of the intersections to accommodate the potential for roundabouts associated with the project. The right-of-way will provide two through lanes, shoulder bikeways, pedestrian sidewalks, a shared-use path, and grassy swales. It will improve local access and provide travelers with an alternate route in and around the urban areas of Kahului and Wailuku.

Honoapiilani Highway in Waikapu and Wailuku is expected to experience increased traffic congestion as additional land development occurs. Long-range plans, such as the 2002 Wailuku-Kahului Community Plan and the Hele Mai Maui Long-Range Transportation Plan 2040 (completed in 2019), have included support for the proposed extension of Waiale Road south to Honoapiilani Highway. The ongoing *I Mua Central Maui* long-range plan *(Draft Plan June 2023)* also anticipates construction of the Waiale Road Extension. Studies for individual development projects have assumed that the Waiale Road Extension would be constructed. In 2014, the County completed an Environmental Assessment (EA) for the construction of the Waiale Road Extension and to also make improvements to Waiko Road. The project, which is the subject of this study, is limited to construction of the proposed Waiale Road Extension. Conceptual designs for roundabouts at the four intersections on the project are shown in **Appendix A**.

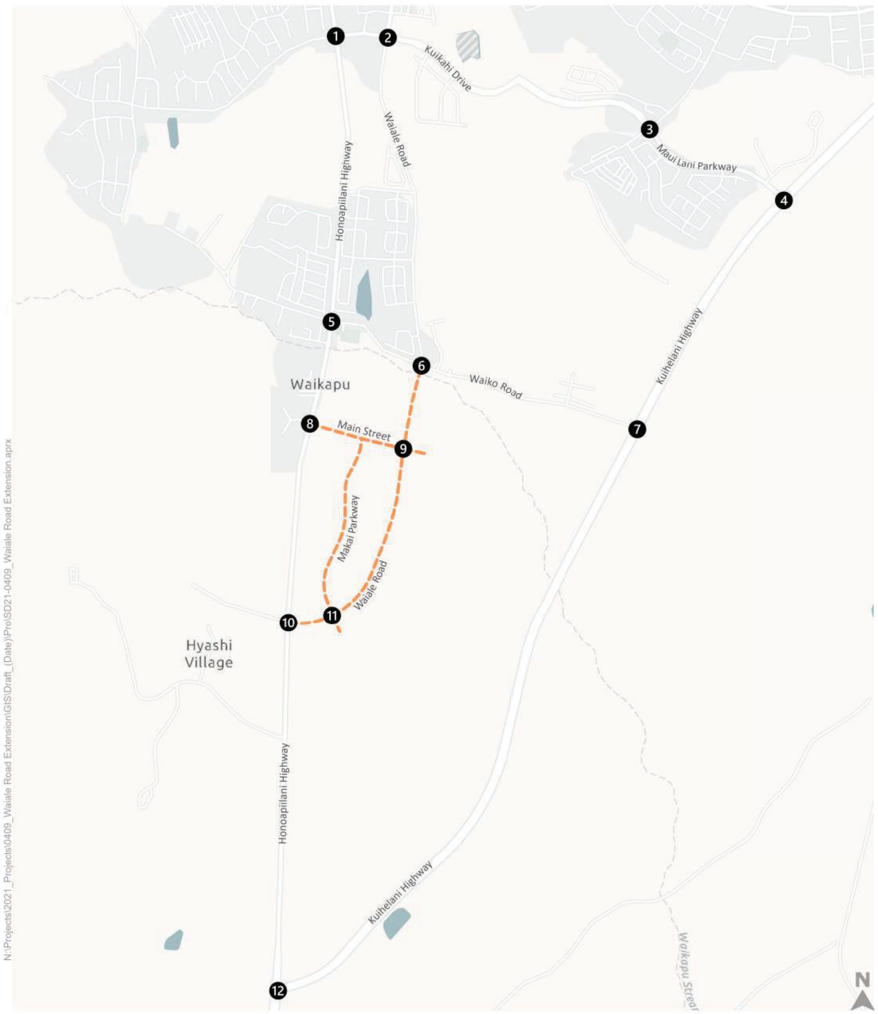
One alternative is fully analyzed in this report. This alternative assumes that the intersections at the northern and southern termini of the project would be constructed as signalized intersections rather than as roundabouts. A conceptual design for the Waiko Road/Waiale Road intersection with signalization is shown in **Appendix A**. Other project alternatives, such as widening Honoapiilani Highway through Central

Maui, were considered but not carried forward for detailed analysis because they would not align with the purpose and need statement for the project. In addition, a Travel Demand Management (TDM) alternative was considered but not studied further because that would involve access management through roadway pricing, providing preferential treatment for high-occupancy vehicles or express buses (which would require widening at intersections and/or an additional lane on the highway), encouraging traditional TDM measures at employment centers, and improving operations of parallel facilities.

1.2 Study Area

The following analysis focused on evaluating the Future Year (2045) transportation operations for the No Project and With Project alternatives. The analyzed intersections are listed below and shown on **Figure 1**:

1. Honoapiilani Highway/Kuikahi Drive
2. Waiale Road/Kuikahi Drive
3. South Kamehameha Avenue/Maui Lani Parkway
4. Kuihelani Highway/Maui Lani Parkway
5. Honoapiilani Highway/Waiko Road
6. Waiale Road/Waiko Road
7. Kuihelani Highway/Waiko Road
8. Honoapiilani Highway/Maui Tropical Plantation Driveway/Main Street
9. Waiale Road/Main Street (future intersection)
10. Honoapiilani Highway/Waiale Road (future intersection)
11. Waiale Road/Makai Parkway (future intersection)
12. Honoapiilani Highway/Kuihelani Highway



Study Intersections
New Roads

Figure 1
Study Area

This study analyzes the changes in traffic operations for the alternatives under typical weekday AM and PM peak hour traffic conditions. The AM and PM peak hours for each intersection are defined as the highest one-hour totals of traffic at each intersection during the commute peak periods from 6:00 AM to 9:00 AM and from 3:00 PM to 6:00 PM on a weekday.

1.3 Study Scenarios

The operations of the study intersections and corridor were evaluated during the weekday AM and PM peak hours for the following study scenarios:

- **Existing (2022) Conditions** – Traffic counts at study intersections were collected in May 2022. Given the ongoing COVID-19 pandemic, traffic counts may not reflect typical levels of peak hour volumes. Counts were compared to historic data for intersections in the study area. Differences at the time of counts were determined to be nominal and no adjustments to counts were made. Counts collected in 2022 are provided in **Appendix B**.
- **Future (2045) No Project Conditions** – Existing peak hour counts were used as the basis for applying the estimated future traffic growth as forecast by the Maui Travel Demand Model through 2045. A list of relevant proposed land use projects was compiled and approved by Maui County to be added to the model. Projects were only added if land use growth in the model's transportation analysis zones (TAZ) did not already account for the projects. A full list of land use projects and transportation projects included in the model is provided in **Appendix C**.

  Adjustments to the model roadway network were also made to better reflect roadway conditions in the study area. Consistent with the approved development plans for the Waikapu County Town project, the model network was modified to reflect the new roadway connections it will construct. While the entire Waiale Road Extension would not be constructed, the southernmost segment would be constructed by the Waikapu Country Town project to provide local access. The following improvements are consistent with the Waikapu Country Town project and assumed for this study scenario:

  - A new four-legged signalized intersection at the existing intersection of Honoapiilani Highway/Maui Tropical Plantation Driveway. While the makai leg is not yet formally named, this study uses the name Main Street which was used in the TIAR for that project.
  - A new three-legged roundabout intersection at Waiale Road/Makai Parkway.
  - A new signalized intersection at Honoapiilani Highway/Waiale Road. This new segment of Waiale Road will run only between Honoapiilani Highway and Waikapu Country Town's Makai Parkway and will not connect to Waiko Road.
- **Future (2045) With Project Conditions** – In addition to the assumed No Build land uses and roadway network changes, this scenario assumes construction of Waiale Road between Waiko Road and Makai Parkway with four (4) roundabout intersections. The Maui Travel Demand Model was used to forecast Future (2045) With Project volumes and determine how volumes would shift given the opening of the proposed roadway extension.

- **Future (2045) With Project Signal Alternative Conditions** – This scenario assumes Future (2045) With Project land uses, network, and volumes described above but with two of the four intersections along the Waiale Road Extension constructed as signalized intersections rather than as roundabout intersections (at Waiko Road and at Honoapiilani Highway).

1.4 Analysis Methodology

The analysis of roadway operations performed for this study is based on procedures presented in the *Highway Capacity Manual 6th Edition* (HCM 6), published by the Transportation Research Board in 2016. The operations of roadway facilities are described with the term "level of service" (LOS). LOS is a qualitative description of traffic flow based on factors such as speed, travel time, delay, and freedom to maneuver. Six levels are defined, from LOS A, with the least congested operating conditions, to LOS F, with the most congested operating conditions. LOS E represents "at-capacity" operations. Operations are designated as LOS F when volumes exceed capacity, resulting in stop-and-go conditions.

1.4.1 Signalized Intersections

The methodology described in "Chapter 19: Signalized Intersections" of the *HCM 6* was used to prepare the LOS calculations for the signalized study intersections. This LOS method analyzes a signalized intersection's operation based on the average control delay per vehicle. Control delay alone is used to characterize LOS for the entire intersection or for an approach. Control delay includes the initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. The average control delay for signalized intersections is calculated using Synchro 11.0 analysis software and is correlated to a LOS designation, as shown in **Table 1**.

Table 1: Signalized Intersection LOS Definitions

Level of Service	Description	Delay in Seconds
A	Progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.	≤ 10.0
B	Progression is good, cycle lengths are short, or both. More vehicles stop than with LOS A, causing higher levels of average delay.	> 10.0 to 20.0
C	Higher congestion may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level, though many still pass through the intersection without stopping.	> 20.0 to 35.0
D	The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.	> 35.0 to 55.0
E	This level is considered by many agencies to be the limit of desirable delay. These high-delay values generally indicate poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences.	> 55.0 to 80.0
F	This level is considered undesirable with oversaturation, which is when arrival flow rates exceed the capacity of the intersection. This level may also occur at high V/C ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be contributing factors to such delay levels.	> 80.0

Source: *Highway Capacity Manual 6th Edition*, Transportation Research Board, 2016.

1.4.2 Stop-Controlled Intersections and Roundabouts

The operation of the unsignalized intersections were evaluated using the methodology contained in "Chapter 20: Two-Way Stop-Controlled Intersections" and "Chapter 22: Roundabouts" of the *HCM 6*. LOS ratings for stop-sign-controlled and roundabout intersections are based on the average control delay expressed in seconds per vehicle. At a two-way- or side-street-stop-controlled (SSSC) intersection, the average control delay is calculated for the minor-street stopped movement and the major-street left turns, not for the overall intersection. For approaches composed of a single lane, the control delay is computed as the average of all movements in that lane. At a roundabout intersection, the average control delay is calculated for the entire intersection. As shown in **Table 2**, LOS F is assigned to the movement if the volume-to-capacity (V/C) ratio for the movement exceeds 1.0, regardless of control delay. The average control delay for unsignalized intersections is calculated using Synchro 11.0 analysis software and is correlated to a LOS designation, as shown in **Table 2**.

Table 2: Unsignalized Intersection LOS Definition

Level of Service (V/C ≤ 1.0)	Level of Service (V/C > 1.0)[1]	Description	Delay in Seconds
A	F	Little or no delay	≤ 10.0
B	F	Short traffic delay	> 10.0 to 15.0
C	F	Average traffic delays	> 15.0 to 25.0
D	F	Long traffic delays	> 25.0 to 35.0
E	F	Very long traffic delays	> 35.0 to 50.0
F	F	Extreme traffic delays with intersection capacity exceeded	> 50.0

Source: *Highway Capacity Manual 6th Edition*, Transportation Research Board, 2016.
Notes:
[1] For approach-based and intersection-wide assessments, such as that used for all-way stop controlled intersections, LOS is defined solely by control delay.

1.4.3 Evaluation of Changes in Roadway Operations

The analysis of 2045 conditions compares No Project operations with conditions when the project has been constructed to determine whether project implementation is expected to degrade or improve operations in the study area. Based on previous studies conducted for the County of Maui and the Hawaii Department of Transportation (HDOT), the minimum desired operating standard for a signalized intersection is LOS D. HDOT and the County acknowledge that some facilities may operate at worse levels during peak hours. When evaluating intersection operations at any location, other factors are considered in the analysis, such as traffic volumes and potential secondary impacts to pedestrian, bicycle, and transit travel.

Undesirable changes in roadway operations are categorized as either project-specific or cumulative. Changes are considered project-specific at a signalized study intersection if a change in traffic operations resulting from the project alone would degrade LOS D or better operations to LOS E or F operations. Changes are considered cumulative at a signalized intersection if a change in traffic operations resulting from the project would exacerbate projected LOS E or F operations and would increase the intersection delay by more than five seconds. Desirable changes to traffic operations can also occur where a study alternative reduces intersection or corridor delay and may improve the LOS grade.

For unsignalized intersections, the criterion for undesirable changes is the same as for signalized intersections, as described above (i.e., LOS D or better to E or F). However, the project is determined to have a significant impact if a change in traffic operations resulting from the project worsens delay at an intersection with a controlled approach operating at an undesirable level (i.e., LOS E or F) and one or more volume-based signal warrants are met. Similar to signalized intersections, a study alternative may result in operations benefits by reducing the intersection or corridor delay, potentially improving the LOS.

HDOT and the County have not approved detailed criteria for significant pedestrian, bicycle, and transit impacts. However, these impacts are generally evaluated based on whether a project would: 1) conflict with existing or planned pedestrian, bicycle, or transit facilities and services; or, 2) create substantive walking, bicycling, or transit use demand without providing adequate and appropriate facilities for non-motorized mobility. Existing facilities for pedestrians, bicycles, and transit users were inventoried to evaluate the quality and scope of facilities and services currently in place. The assessments of planned pedestrian, bicycle, and transit facilities were conducted using information in planning documents, such as the Hele Mai Maui Long-Range Transportation Plan 2040. For these modes, if the project is expected to conflict with existing or planned improvements to pedestrian and bicycle facilities, or if the project is expected to generate a substantial demand that could warrant additional transit service, then the project would be determined to have a project-specific effect on non-motorized modes of transportation.

2. Existing Conditions

This section describes the existing pedestrian, bicycle, and transit facilities, as well as the roadway network located within the project study area. A discussion of the existing intersection LOS operation results is also included in this section.

2.1 Local Roadway Network

The key roadways providing vehicular access in the vicinity of the study corridor are described below:

Waiale Road (Route 3180) is a north-south, undivided collector road that starts as an extension of Lower Main Street and terminates at Waiko Road. The roadway provides two travel lanes (one in each direction) and serves as the only access road for residents of the Waikapu Gardens neighborhood located between Kuikahi Drive and Waiko Road. The posted speed limit is 20 mph. Striped shoulders are used by bicyclists.

Honoapiilani Highway (Route 30) provides regional access between West Maui and Central Maui. The roadway is initially classified as a principal arterial in downtown Wailuku and where it extends south to Waikapu and Maalaea. As the roadway runs through Lahaina in West Maui, it transitions into a minor arterial. Through the regions of Kapalua and Honolua, it is classified as a collector roadway, and ends near Honokohau Bay, where it becomes Kahekili Highway. In the project area, it is an undivided arterial which runs north-south and provides two travel lanes (one in each direction) with separate lanes for left and right turns at several intersections. Parking is not permitted on most segments of Honoapiilani Highway, and sidewalks are not provided. The posted speed limit ranges between 30 to 45 miles per hour (mph). Striped shoulders are used by bicyclists.

Kuihelani Highway (Route 380) is a north-south, four-lane divided arterial with a posted speed limit of 45 or 55 mph in the study area. The roadway begins at its intersection with Puunene Avenue and Dairy Road in Kahului and extends southward until it terminates at its intersection with Honoapiilani Highway north of Maalaea Harbor.

Kuikahi Drive (Route 3210*)* is an east-west, undivided collector road with two travel lanes (one in each direction). West of its intersection with Honoapiilani Highway, Kuikahi Drive passes through the Wailuku Heights Development until it terminates at a cul-de-sac. East of Honoapiilani Highway, Kuikahi Drive provides access to retail and commercial land uses. East of Paa Drive, Kuikahi Drive terminates and transitions to Maui Lani Parkway. The posted speed limit is 20 to 30 mph in the study area.

South Kamehameha Avenue is a north-south collector road with two travel lanes (one in each direction). Kamehameha Avenue begins at its intersection of Hana Highway and extends southward through the Maui Lani development until it terminates just south of Pomaikai Elementary School. In the project study area, sidewalks are provided along most segments and the posted speed limit is 20 mph.

Maui Lani Parkway is an east-west, divided collector road with two travel lanes (one in each direction) and a raised median. West of Amoa Street, Maui Lani Parkway terminates and transitions to Kuikahi Drive. The posted speed limit is 20 mph.

Waiko Road (Route 3185) is an east-west, undivided collector road with two travel lanes (one in each direction). It is signed as "West Waiko Road" west of Honoapiilani Highway and "East Waiko Road" east of Honoapiilani highway. Waiko Road begins in a residential neighborhood west of Honoapiilani Highway and traverses through mostly residential and industrial uses until it terminates at its intersection with Kuihelani Highway. In the project area, Waiko Road is a narrow, gently curving 20 to 30 mph road with no sidewalks provided and limited street parking opportunities.

Tropical Plantation Driveway is an east-west, two lane driveway serving the Maui Tropical Plantation. Upon buildout of Waikapu Country Town, this driveway will be reconstructed as a part of the planned "Main Street" and will have a signalized intersection at Honoapiilani Highway. Main Street will continue further west and connect with the Waiale Road Extension at a roundabout intersection.

Makai Parkway is a planned two-lane roadway running through the planned Waikapu Country Town community east of Honoapiilani Highway. It will intersect both Main Street and the Waiale Road Extension to the south. This was referred to as the north south collector street in the Waikapu Country Town TIAR.

2.2 Existing Transit Facilities and Services

The Maui Bus service, operated by Roberts Hawaii, provides public transit service around the island with thirteen (13) bus routes. Each route operates seven days a week, including holidays.

The Lahaina Islander Route (#20) is the only Maui Bus that serves the Waikapu area, which provides hourly service between the Wharf Cinema Center in Lahaina, Ma'alaea Harbor Village, and Waikapu. It originates and terminates at the Queen Ka'ahumanu Center in Kahului. In the study area, this route operates along Honoapiilani Highway with a bus stop near the intersection of Honoapiilani Highway and Waiko Road.

2.3 Existing Pedestrian Facilities and Activity

Pedestrian facilities consist of sidewalks, crosswalks, and pedestrian signals at signalized intersections. Pedestrian facilities do not currently exist at either end of the planned Waiale Road Extension and existing pedestrian facilities are limited along the major roadways that serve the project study area. For example, sidewalks are not provided on either side of Honoapiilani Highway, Kuihelani Highway, Waiko Road, and most of Waiale Road, while sidewalks are provided only on one side of Kuikahi Drive and most portions of Maui Lani Parkway.

Most signalized intersections along the study corridor have marked crosswalks on intersection legs where pedestrian crossings are allowed. Most of the study intersections serve minimal amounts of pedestrian activity. Maui Lani Parkway/South Kamehameha Avenue had the highest number of pedestrians crossings with over 28 total crossings on all intersection legs during the AM peak hour because of its proximity to Pomaikai Elementary School.

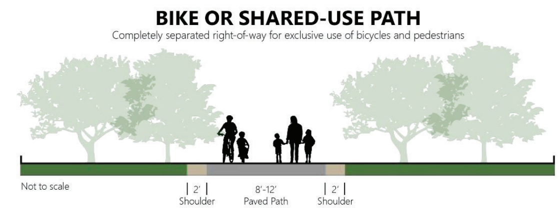
Existing pedestrian facilities at the existing study intersections are described below:

- Intersection 1: Honoapiilani Highway (Highway 30) & Kuikahi Drive
    - Signalized with marked crosswalks and pedestrian signals on three legs
- Intersection 2: Waiale Road & Kuikahi Drive
    - Signalized with marked crosswalks and pedestrian signals on all four legs
- Intersection 3: S. Kamehameha Avenue & Maui Lani Parkway
    - Roundabout with marked crosswalks on all legs
- Intersection 4: Kuihelani Parkway (Highway 380) & Maui Lani Parkway
    - Signalized with no marked crosswalks or pedestrian signals
- Intersection 5: Honoapiilani Highway (Highway 30) & Waiko Road
    - Signalized with marked crosswalks and pedestrian signals on three legs
- Intersection 6: Waiale Road & Waiko Road
    - Side-street stop-controlled with no marked crosswalks on all legs
- Intersection 8: Kuihelani Highway (Highway 380) & Waiko Road
    - Signalized with marked crosswalks and pedestrian signals on two legs
- Intersection 14: Honoapiilani Highway (Highway 30) & Kuihelani Highway (Highway 380)
    - Signalized with no marked crosswalks or pedestrian signals

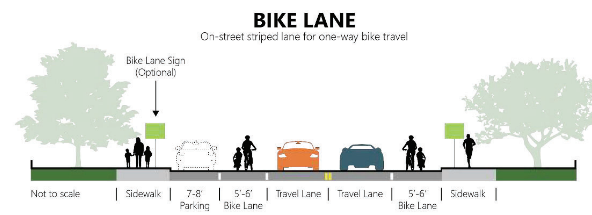
2.4 Existing Bicycle Facilities and Activity

Bicycle facilities generally consist of four types of facilities, which are outlined below:

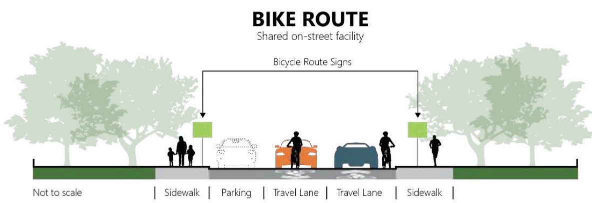
- _Bike or Shared Use Paths_ provide a separate right-of-way and are designated for the exclusive use of bicycles and pedestrians (or exclusively bicycles) with vehicle and pedestrian cross-flow minimized. Generally, the minimum pavement width for a two-directional bike or multi-use path is eight (8) feet plus graded shoulders, but a ten (10) foot or wider path is desirable.



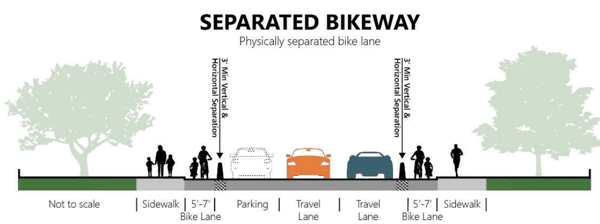
- _Bike Lanes_ provide a restricted right-of-way and are designated for the use of bicycles with a striped lane on a street or highway. Bicycle lanes are generally five (5) feet wide. Adjacent vehicle parking and vehicle/pedestrian cross-flow are permitted.



- *Bike Route or Signed Shared Roadways* provide for a right-of-way designated by signs or shared lane pavement markings, or "sharrows," for shared use with pedestrians or motor vehicles.



- *Separated Bikeways or Cycle Tracks* provide a restricted right-of-way with physical separation and are designated for the use of bicycles in or directly adjacent to a roadway with a raised barrier, such as curbs or bollards. Separated bikeways are typically at least five (5) feet wide with a minimum three (3) foot minimum horizontal separation from an adjacent vehicle parking or travel lane [although a two (2) foot median could be used next to a travel lane with lower vehicle speeds]. Adjacent vehicle parking is permitted and vehicle/pedestrian cross-flow is restricted to selected locations (e.g., driveways) indicated by breaks in the barrier and buffer.



In the project study area, there are limited existing bicycle facilities. Bicycle lanes exist along some north and south segments of Honoapiilani Highway and Waiale Road. Roadway shoulders are wide enough on some segments to act as de facto bicycle lanes. Maui Lani Parkway provides a bicycle lane between Kamehameha Avenue and Kuihelani Highway.

Most of the study intersections serve minimal amounts of bicycle activity. Maui Lani Parkway/South Kamehameha Avenue had the highest number of bicyclists with 21 total crossings on all intersection legs during the AM peak hour because of its proximity to Pomaikai Elementary School.

2.5 Crash History

HDOT provides a summary of fatal crashes across the state for 2012 through 2021 on their online Fatal Crash Dashboard and webmap. In the study area, only two fatal crashes were recorded, both at the Waiko Road/Kuihelani Highway intersection in 2016 and 2017. Both had drugs or alcohol as the primary contributing factor to the crash.

2.6 Existing Traffic Volumes, Lane Configurations, and Operations

Existing intersection turning movement counts and lane configurations are shown on **Figure 2**. This data was used to quantify traffic operations at each of the study intersections. **Table 3** shows current operations at the study intersections. Detailed LOS worksheets showing input data and calculations for each turning movement and for the intersection as a whole are included in **Appendix D**. Traffic count data sheets are provided in **Appendix B**.

All intersections operate at acceptable levels of service (LOS D or better), with the exception of one location:

- Intersection 8: Honoapiilani Highway/Maui Tropical Plantation Driveway (LOS F in the PM peak hour). This intersection is currently controlled by a stop sign on the minor (makai-bound) approach. During the PM peak period, side street delay exceeds 50 seconds per vehicle and the intersection operates at LOS F during the PM peak hour.

There are limitations to the HCM 6th Edition analysis approach and Synchro 11 software that do not capture some aspects of observed congestion in the study area. Southbound delays at Waiale Road/Kuikahi Drive were observed to be higher than reported. The analysis methodology does not capture the effects of queue spillback from turn pockets, in this case the southbound left turn pocket, which may exacerbate average vehicle delays beyond what is reported.

Table 3: Existing (2022) Intersection Levels of Service

	Intersection	Control	Peak Hour	Intersection Delay (sec/veh)[1]	Intersection LOS[1]
1	Honoapiilani Highway/Kuikahi Drive	Signal	AM	21.8	C
			PM	19.5	B
2	Waiale Road/Kuikahi Drive	Signal	AM	25.7	C
			PM	23.9	C
3	South Kamehameha Avenue/Maui Lani Parkway	Roundabout	AM	30.0	D
			PM	21.8	C
4	Kuihelani Highway/Maui Lani Parkway	Signal	AM	18.3	B
			PM	23.5	C
5	Honoapiilani Highway/Waiko Road	Signal	AM	11.0	B
			PM	23.6	C
6	Waiale Road/Waiko Road	Side Street Stop Controlled	AM	16.0	C
			PM	17.9	C
7	Kuihelani Highway/Waiko Road	Signal	AM	13.5	B
			PM	10.8	B
8	Honoapiilani Highway/Maui Tropical Plantation/Main Street	Side Street Stop Controlled	AM	33.2	D
			PM	**52.5**	**F**
9	Waiale Road/Main Street	Future Intersection	AM		
			PM		
10	Honoapiilani Highway/Waiale Road	Future Intersection	AM		
			PM		
11	Waiale Road/Makai Parkway	Future Intersection	AM		
			PM		
12	Honoapiilani Highway/Kuihelani Highway	Signal	AM	15.1	B
			PM	17.4	B

Source: Fehr & Peers, 2023 using Synchro 11.
Notes:
[1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.

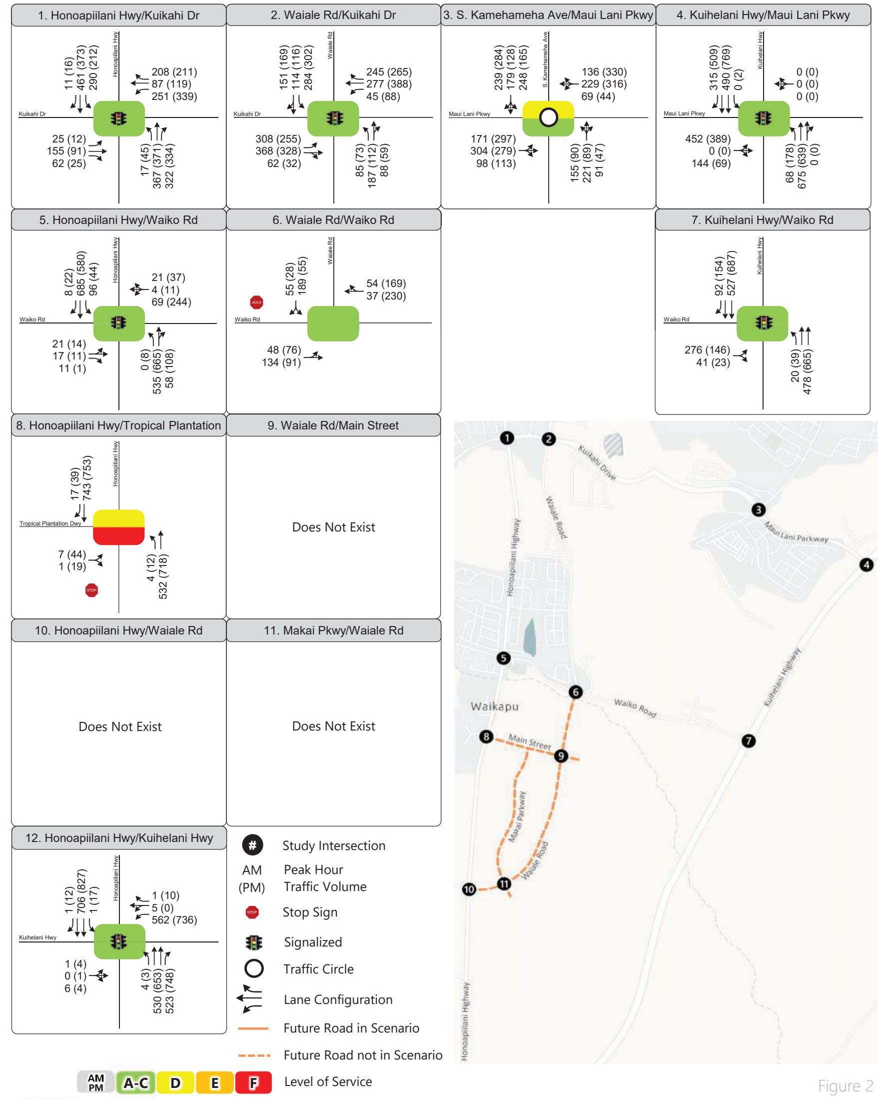


Figure 2
Peak Hour Data and Operations - Existing (2022) Conditions

3. Future (2045) No Project Conditions

To evaluate the potential effects of the planned project, it was necessary to first develop estimates of future traffic conditions in the area without any project improvements. Future (2045) No Project traffic conditions reflect traffic increases based on regional growth and development near the study site by the time the project would be expected to be fully implemented, serving both existing and planned development.

No roadway network changes were assumed in the study area compared to existing conditions except for two locations:

- The Honoapiilani Highway/Maui Tropical Plantation Driveway/Main Street intersection will be signalized and a fourth leg will be added as part of the construction of the Waikapu Country Town project.
- Honoapiilani Highway/Waiale Road is a new intersection that will be constructed with the Waikapu Country Town project. This portion of Waiale Road would not connect to the northern section of Waiale Road and would only serve as the southern access to Waikapu Country Town and future development on County land to the east, as shown in Figure 3. In this scenario, the intersection would be signalized. The Waikapu Country Town project EIS documents were referenced to obtain the anticipated lane configurations and intersection control for this intersection without the full extension of Waiale Road in place.

3.1 Future (2045) No Project Traffic Projections

Growth in traffic was forecast using the Maui Travel Demand Model. Fehr & Peers coordinated with County of Maui staff to determine specific projects to add to the future year model near the project to better reflect expected land use conditions near the project site upon completion of the project. This list, including project size, is shown in **Appendix C**. Notable projects assumed include Maui Lani, Waikapu Affordable Housing, Valley Isle Fellowship, and Emmanuel Lutheran Campus. Outside of the vicinity of the project in the Wailuku-Kahului area, all growth assumptions in the model between its base year (2019) and future year (2045) were held constant. The model used a blanket growth rate for land uses between the base and future year based on Hawaii Department of Business, Economic Development and Tourism (DBEDT) Data.

Traffic volume outputs from the base and future year models were used to determine growth in volumes on roadway links and at each intersection. Analysis of future signalized Intersection operations assumed optimization of cycle lengths and traffic signal phasing splits.

3.2 Future (2045) No Project Intersection Level of Service

Figure 3 illustrates the forecasted peak hour traffic volumes and lane configurations for Future (2045) No Project Traffic Conditions.

Levels of service (LOS) calculations were conducted to evaluate the operating levels of the study intersections under Future (2045) No Project conditions with the forecasted growth in traffic. The results of the LOS analysis for the study intersections under this scenario are presented in **Table 4.** The corresponding LOS calculation sheets are included in **Appendix D**.

Five (5) of the 12 study intersections are projected to continue operating at acceptable levels of service (LOS D or better). Seven (7) intersections are projected to operate at levels of service E or F in the Future (2045) No Project scenario:

- Intersection 1: Honoapiilani Highway/Kuikahi Drive (LOS F in the AM peak hour, LOS E in the PM peak hour).
- Intersection 2: Waiale Road/Kuikahi Drive (LOS F in the AM and PM peak hours).
- Intersection 3: South Kamehameha Avenue/Maui Lani Parkway (LOS F in the AM peak hour, LOS E in the PM peak hour).
- Intersection 4: Honoapiilani Highway/Kuikahi Drive (LOS F in the AM and PM peak hours).
- Intersection 5: Honoapiilani Highway/Waiko Road (LOS F in the AM and PM peak hours).
- Intersection 6: Waiale Road/Waiko Road (LOS F in the AM and PM peak hours).
- Intersection 8: Honoapiilani Highway/Maui Tropical Plantation Driveway (LOS E in the AM peak hour).

The changes in operations from Existing (2022) Conditions are the result of regional and local land use growth. Large increases in delay are expected due to increases in peak hour traffic volumes with minor changes at certain study intersections but no substantial physical capacity improvements are planned across the study area. Some peak hour volumes, in particular along Honoapiilani Highway and Waiko Road, are expected to more than double over the 23-year study period. Seven (7) of the eleven (11) study intersections that exist in this scenario are projected to operate at LOS E or F in one or both peak hours.

Similar to what is noted in the discussion of Existing Conditions, southbound delays at Waiale Road/Kuikahi Drive may be higher in the field than shown in the level of service worksheet in Appendix D. The southbound left-turn movement is projected to experience a delay in excess of 120 seconds, which is expected to continue to impede the ability of other southbound traffic to pass through the intersection.

Table 4: Future (2045) No Project Intersection Levels of Service

	Intersection	2045 Intersection Control	Peak Hour	Existing Conditions Intersection Delay (sec/veh)[1]	Existing Conditions Intersection LOS[1]	Future No Project Intersection Delay (sec/veh)[1]	Future No Project Intersection LOS[1]	Change
1	Honoapiilani Highway/Kuikahi Drive	Signal	AM	21.8	C	**84.7**	**F**	62.9
			PM	19.5	B	**70.6**	**E**	51.1
2	Waiale Road/Kuikahi Drive	Signal	AM	25.7	C	**94.8**	**F**	69.1
			PM	23.9	C	**83.2**	**F**	59.3
3	South Kamehameha Avenue/Maui Lani Parkway	Roundabout	AM	30.0	D	**>120**[2]	**F**	>120.0
			PM	21.8	C	**>120**[2]	**F**	>120.0
4	Kuihelani Highway/Maui Lani Parkway	Signal	AM	18.3	B	50.4	D	32.1
			PM	23.5	C	**64.5**	**E**	41.0
5	Honoapiilani Highway/Waiko Road	Signal	AM	11.0	B	**118.2**	**F**	107.2
			PM	23.6	C	**>120**[2]	**F**	>120
6	Waiale Road/Waiko Road	Side Street Stop Controlled	AM	16.0	C	**>120**[2]	**F**	>120.0
			PM	17.9	C	**>120**[2]	**F**	>120.0
7	Kuihelani Highway/Waiko Road	Signal	AM	13.5	B	32.4	C	18.9
			PM	10.8	B	27.1	C	16.3
8	Honoapiilani Highway /Main Street	Signal[3]	AM	33.2	D	**62.5**	**E**	29.3
			PM	**52.5**	**F**	52.8	D	0.3
9	Waiale Road/Main Street	NA	AM	-	-	-	-	-
			PM	-	-	-	-	-
10	Honoapiilani Highway/Waiale Road	Signal	AM	-	-	20.6	C	-
			PM	-	-	18.0	B	-
11	Waiale Road/Makai Parkway	Roundabout	AM	-	-	3.8	A	-
			PM	-	-	3.9	A	-
12	Honoapiilani Highway/Kuihelani Highway	Signal	AM	15.1	B	23.6	C	8.5
			PM	17.4	B	29.8	C	12.4

Source: Fehr & Peers, 2023 using Synchro 11.
Notes:
[1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.
[2] Average delay per vehicle exceeds 120 seconds.
[3] Future No Project intersection control differs from Existing intersection control

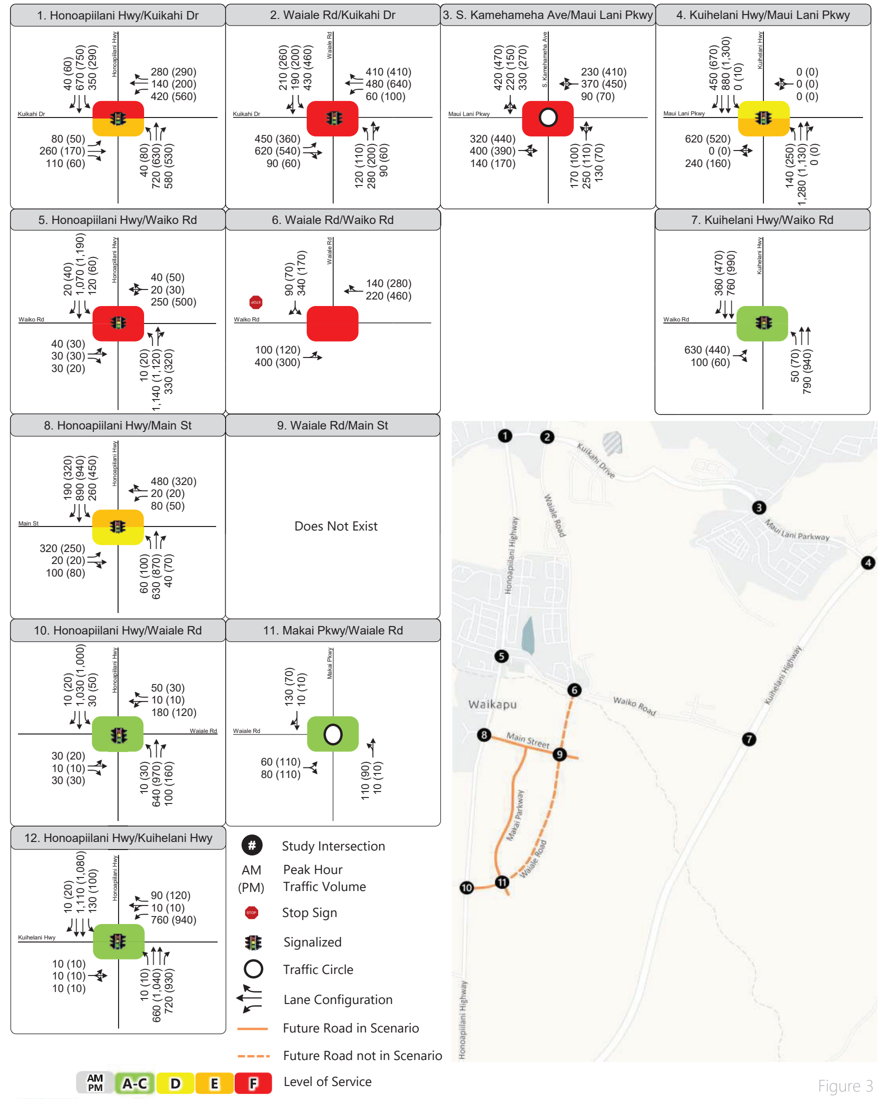


Figure 3
Peak Hour Data and Operations - Future (2045) No Project

4. Future (2045) With Project Conditions

This section describes the analysis conditions in 2045 with the extension of Waiale Road between Waiko Road and Honoapiilani Highway complete as well as how this network addition changes transportation operations compared to Future (2045) No Project conditions. The roadway network is the same network assumed under Future (2045) No Project conditions except for the addition of the Waiale Road Extension (including the Waiale Road/Main Street roundabout intersection), construction of four-leg roundabouts at Waiko Road/Waiale Road and Honoapiilani Highway/Waiale Road and the addition of the fourth leg of the Waiale Road/Makai Parkway intersection. All roundabout intersections were assumed to have one-lane approaches.

4.1 Future (2045) With Project Traffic Projections

Shifts in traffic compared to Future (2045) No Project conditions were forecast using the Maui Travel Demand Model. The forecast land use growth in this scenario includes all of the anticipated land use growth in the area through 2045, similar to the No Project scenario. Traffic volume outputs from the future year model scenarios with and without the project were used to determine shifts in volumes on roadway links and at each intersection.

Figure 4 illustrates the forecasted peak hour traffic volumes and lane configurations for Future (2045) With Project Traffic Conditions.

4.1.1 Vehicle Miles Traveled

The Maui Travel Demand model outputs were used to calculate daily vehicle miles traveled (VMT) on roadways within three (3) miles of the Waiale Road Extension project site under Future (2045) No Project and Future (2045) With Project conditions. VMT decreases by 0.7%, indicating that the Waiale Road Extension provides a more direct route for vehicle trips:

- Future (2045) No Project VMT: 542,500
- Future (2045) With Project VMT: 534,200
- Reduction in VMT associated with Waiale Road Extension: 8,300 (1.5%)

Benefits associated with reductions in VMT included reduced GHG emissions, improved air quality, and shorter travel times.

4.1.2 Average Daily Traffic

Average Daily Traffic (ADT) was forecast along the Waiale Road Extension under Future (2045) With Project Conditions:

- Waiale Road between Waiko Road and Main Street: 13,500 ADT
- Waiale Road between Main Street and Makai Parkway: 3,700 ADT
- Waiale Road between Makai Parkway and Honoapiilani Highway: 4,200 ADT

The northern portion of the extension serves the highest number of trips. It provides the quickest path for much Waikapu Country Town and the adjacent County development towards both Wailuku and Kahului.

The middle portion of the extension has the lowest ADT, indicating that the Waiale Road extension is utilized more by future residents living along the corridor than by pass-through trips.

4.2 Future (2045) With Project Intersection Level of Service

Level of service (LOS) calculations were conducted to evaluate the operating levels of the study intersections under Future (2045) With Project conditions. The results of the LOS analysis for the study intersections under this scenario are presented in **Table 5.** The corresponding LOS calculation sheets are included in **Appendix D**. All roundabout intersections are projected to operate acceptably (LOS D or better) with only a single lane on each approach.

Eight (8) of the 12 study intersections are projected to operate at acceptable levels of service (LOS D or better) following construction of the Waiale Road Extension as proposed. Four (4) intersections are projected to operate at levels of service E or F in the Future (2045) No Project scenario:

- Intersection 1: Honoapiilani Highway/Kuikahi Drive (LOS E in the AM peak hour).
- Intersection 2: Waiale Road/Kuikahi Drive (LOS F in the AM and PM peak hours).
- Intersection 3: South Kamehameha Avenue/Maui Lani Parkway (LOS F in the AM and PM peak hours).
- Intersection 4: Honoapiilani Highway/Kuikahi Drive (LOS E in the PM peak hour).

Large decreases in delay are expected along Honoapiilani Highway due traffic shifting to Waiale Road. Trips to and from Waikapu Country Town and the County parcels along Waiale Road account for the largest changes in intersection volumes. The Waiale Road Extension provides these neighborhoods with additional routes in and out, in particular those trips to/from Kuihelani Highway. Trips to and from these neighborhoods are projected to represent the majority of trips using the Waiale Road Extension. While the project does increase delay at some intersections, the only substantial increase in delay is at Waiale Road/Kuikahi Drive, where delays are projected to increase by nine (9) seconds per vehicle in the AM peak hour and seven (7) seconds per vehicle in the PM peak hour, respectively. Operations at this intersection may be worse than calculated due to queue spillback from the southbound left-turn lane. As part of a separate effort, Maui County is preparing a comprehensive study of transportation projects and programs across the entire Central Maui area for all travel modes, including construction of the Waiale Road Extension. Additional near- and long-term strategies in *I Mua Central Maui (Draft Plan June 2023)* include complete streets and transit-supportive projects (e.g., transit hubs) that will minimize future vehicle demand and help to reduce traffic delays within the Waiale Road corridor and at this affected intersection.

Table 5: Future (2045) With Project Intersection Levels of Service

	Intersection	Control	Peak Hour	Future No Project		Future With Project		Change
				Intersection Delay (sec/veh)[1]	Intersection LOS[1]	Intersection Delay (sec/veh)[1]	Intersection LOS[1]	
1	Honoapiilani Highway/Kukahi Drive	Signal	AM	**84.7**	**F**	**73.2**	**E**	-11.5
			PM	**70.6**	**E**	50.6	D	-20.0
2	Waiale Road/Kuikahi Drive	Signal	AM	**94.8**	**F**	**104.0**	**F**	9.2
			PM	**83.2**	**F**	**90.0**	**F**	6.8
3	South Kamehameha Avenue/Maui Lani Parkway	Roundabout	AM	**>120**[2]	**F**	**>120**[2]	**F**	<5.0
			PM	**>120**[2]	**F**	**>120**[2]	**F**	<5.0
4	Kuihelani Highway/Maui Lani Parkway	Signal	AM	50.4	D	46.3	D	-4.1
			PM	**64.5**	**E**	**66.6**	**E**	2.1
5	Honoapiilani Highway/Waiko Road	Signal	AM	**118.2**	**F**	21.4	C	-- [4]
			PM	**>120**[2]	**F**	52.4	D	-- [4]
6	Waiale Road/Waiko Road	Roundabout[3]	AM	**>120**[2]	**F**	27.8	D	-- [4]
			PM	**>120**[2]	**F**	22.9	C	-- [4]
7	Kuihelani Highway/Waiko Road	Signal	AM	32.4	C	51.5	D	19.1
			PM	27.1	C	31.8	C	4.7
8	Honoapiilani Highway /Main Street	Signal	AM	62.5	E	25.5	C	-37.0
			PM	52.8	D	28.6	C	-24.2
9	Waiale Road/Main Street	Roundabout	AM	-	-	7.6	A	-
			PM	-	-	7.6	A	-
10	Honoapiilani Highway/Waiale Road	Roundabout[3]	AM	20.6	C	30.9	D	10.3
			PM	18.0	B	29.5	D	11.5
11	Waiale Road/Makai Parkway	Roundabout	AM	3.8	A	4.0	A	0.2
			PM	3.9	A	4.2	A	0.3
12	Honoapiilani Highway/Kuihelani Highway	Signal	AM	23.6	C	22.3	C	-1.3
			PM	29.8	C	25.5	C	-4.3

Source: Fehr & Peers, 2023 using Synchro 11.
Notes: [1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.
[2] Average delay per vehicle exceeds 120 seconds.
[3] Future With Project intersection control differs from Future No Project intersection control.
[4] With the proposed extension of Waiale Road overall delay at this intersection projected to substantially decrease.

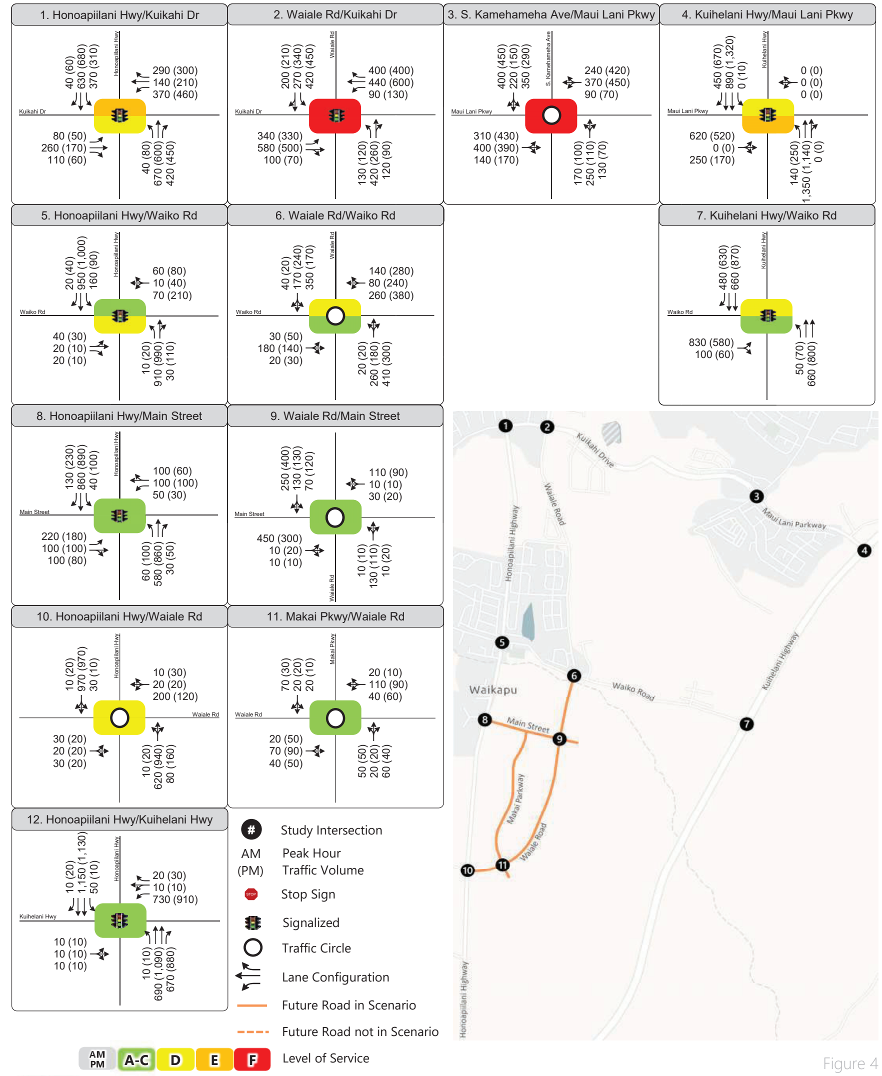


Figure 4
Peak Hour Data and Operations - Future (2045) With Project

4.2.1 Future Considerations

All roundabout intersections are projected to operate acceptably (LOS D or better) with only a single lane on each approach.

Operations beyond 2045 are outside the scope of this project. The following assessment of operations beyond 2045 is provided for information purposes only and may be considered by Maui County and the State of Hawaii as the design of these intersections proceeds. At the Waiale Road/Waiko Road intersection and at the Honoapiilani Highway/Waiale Road intersection, the addition of relatively few additional peak hour trips (e.g. 50 trips on the heaviest approach) beyond 2045 would cause the operations to decline to LOS E.

- To allow for potential future expansion of the roundabout at this location, construction of the second northbound lane at Waiale Road & Waiko Road should be considered as the design of these intersections proceeds.
- To allow for potential future expansion of Honoapiilani Highway, right-of-way to construct a second lane on both the northbound and southbound approaches at Honoapiilani Highway & Waiale Road should be considered as the design of these intersections proceeds.

4.3 Future (2045) With Project Signal Alternative

An alternative Future (2045) With Project scenario assumes the same peak hour traffic volumes and network/lane configurations assumed under Future (2045) With Project conditions except it assumes that the Waiko Road/Waiale Road and Waiale Road/Honoapiilani Highway intersections are signalized.

The results of the LOS analysis for the signal configuration at Waiale Road/Waiko Road and Honoapiilani Highway/Waiale Road are presented in **Table 6.** The LOS calculation sheets are included in **Appendix D**.

To achieve LOS D or better operations at Waiale Road/Waiko Road, the signalized intersection configuration requires a dedicated left-turn lane and shared through-right-turn lane on all approaches. At Honoapiilani Highway/Waiale Road, single-lane approaches are needed on Waiale Road, and a dedicated left turn lane and a shared through-right turn lane are needed on the north and south approaches.

Table 6: Future (2045) With Project Signal Alternative Intersection Levels of Service

	Intersection	Control	Peak Hour	Intersection Delay (sec/veh)[1]	Intersection LOS[1]
6	Waiale Road/Waiko Road	Side Street Stop Controlled	AM	43.8	D
			PM	24.7	C
10	Honoapiilani Highway/Waiale Road	Future Intersection	AM	12.2	B
			PM	11.6	B

Source: Fehr & Peers, 2023 using Synchro 11.
Notes:
[1] The weighted average stopped delay and LOS for the whole intersection is reported for signalized intersections. The average stopped delay and LOS for the worst movement is reported for side-street stop-controlled intersections.

4.4 Future (2045) With Project Multimodal Analysis

Consistent with State of Hawaii and County of Maui policies on Complete Streets, the Waiale Road Extension, as well as new roadways connecting to it as a part of the Waikapu Country Town development, are planned to form a balanced multi-modal network designed to provide mobility choices and to meet the needs of the community and all roadway users.

Approximately eight (8) miles of hiking, biking and walking trails are planned to be incorporated into the Waikapu Country Town project site. A multi-use path is planned along the entire length of the Waiale Road Extension, including on a bridge over Waikapu Stream at the northern end. The entire existing length of Waiale Road is designated as the Waiale Road Complete Street project in the Hele Mai Maui Long-Range Transportation Plan 2040, and these improvements along the Waiale Road Extension will connect to any future improvements to the north to support a more complete multi-modal corridor and network.

The Waiale Road Extension will also emphasize traffic calming and streetscape beautification. The use of roundabouts at intersections, landscape planting strips to buffer pedestrians from traffic, and linear greenways will serve to beautify the corridor while providing motivation for residents to walk and bike more.

Under existing conditions, the Honoapiilani Highway & Waiko Road bus stop is the only bus stop located in the project vicinity. While the Maui Bus has no immediate plans to expand service in this area, the Waiale Road Extension could facilitate additional transit routes as land is developed alongside it. Right-of-way is available for enhancements and amenities (i.e., benches or covered shelter) to be installed at any new bus stops along the extension to support future transit riders in this area.

While no fatal collisions were noted in the immediate vicinity of the project between 2012 and 2021, the reduction in congestion in the study area will reduce the likelihood of severe crashes. This would also benefit transit along Honoapiilani Highway by reducing travel time and increasing reliability.

Roundabouts have the potential to reduce both the number and severity of crashes since they reduce the number of conflict points and act as a traffic calming measure. Roundabouts slow traffic speeds through the intersection, reducing the potential for fatal collisions. For pedestrians and bicyclists, design treatments such as rectangular rapid flashing beacons (RRFBs) or pedestrian hybrid beacons (PHBs) would enhance pedestrian and bicycle safety at the roundabout crossings, particularly if any multi-lane approaches are implemented.

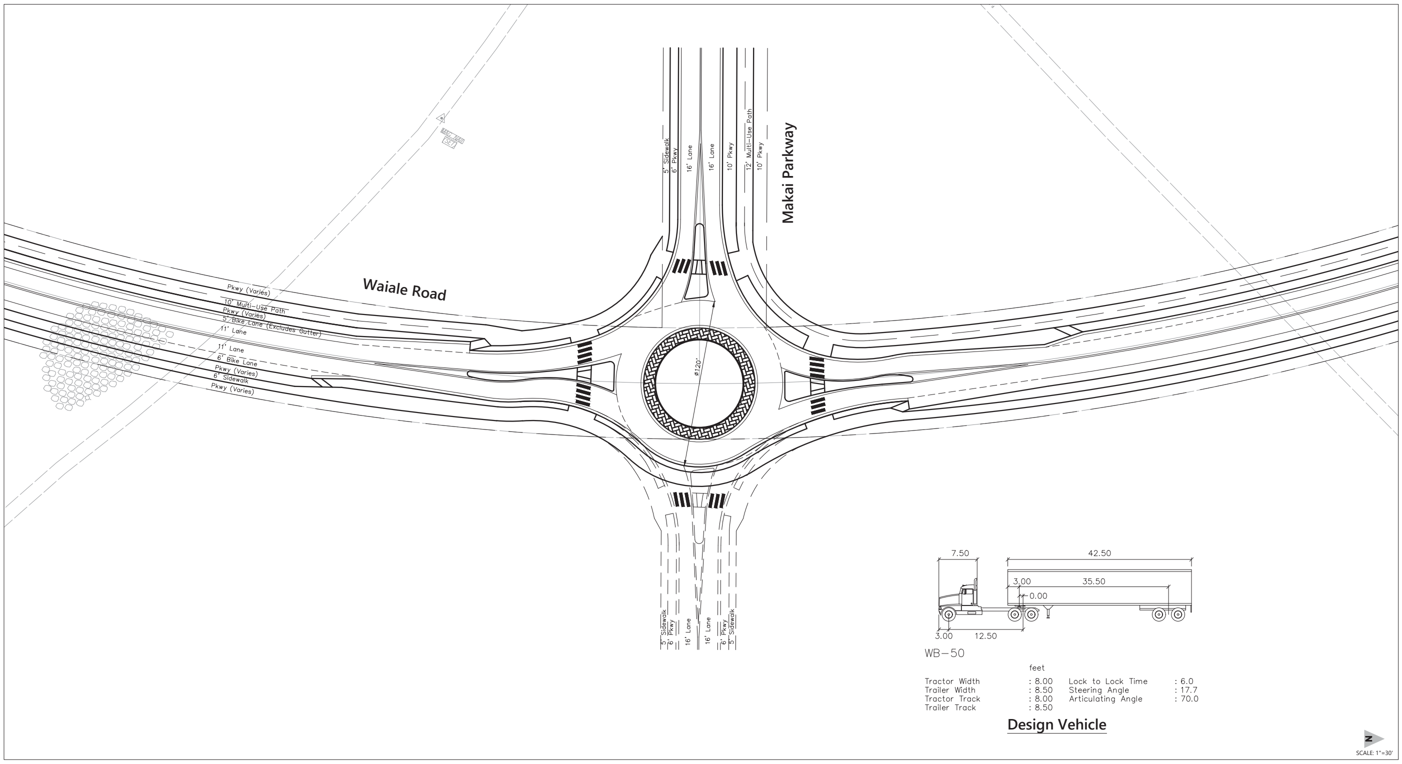
5. Conclusions

Construction of the proposed Waiale Road Extension would reduce total vehicle miles of travel in Central Maui and reduce delays at intersections along Honoapiilani Highway. Intersection delays would be reduced or only minimally increased most intersections in the project area. An exception is the intersection of Waiale Road/Kuikahi Drive, where the projected shift in traffic volumes would exacerbate projected LOS F conditions.

New intersections along the Waiale Road Extension will operate acceptably in 2045 as either roundabouts or signalized intersections. Roundabout configurations would only require one approach lane on all legs and one circulating lane to provide the desired level of service (LOS D). If signalized, the Waiale Road/Waiko Road intersection would need one dedicated left-turn lane and one shared through/right-turn lane on all approaches. At Honoapiilani Highway/Waiale Road, the Waiale Road approaches would provide a single shared lane and the Honoapiilani Highway approaches would provide one left-turn lane and one shared through/right-turn lane.

Fehr & Peers recommends roundabout configurations for Waiale Road/Honoapiilani Highway, Waiale Road/Mauka Parkway, Waiale Road/Main Street and Waiale Road/Waiko Road. Not only are they projected to operate acceptably in 2045 with single-lane approaches but, relative to traditional intersection design, roundabouts have the potential to reduce both the number and severity of crashes since they reduce the number of conflict points and act as a traffic calming measure. Maui County and the State of Hawaii will ultimately determine the type of intersection control and roadway configuration at these intersections.

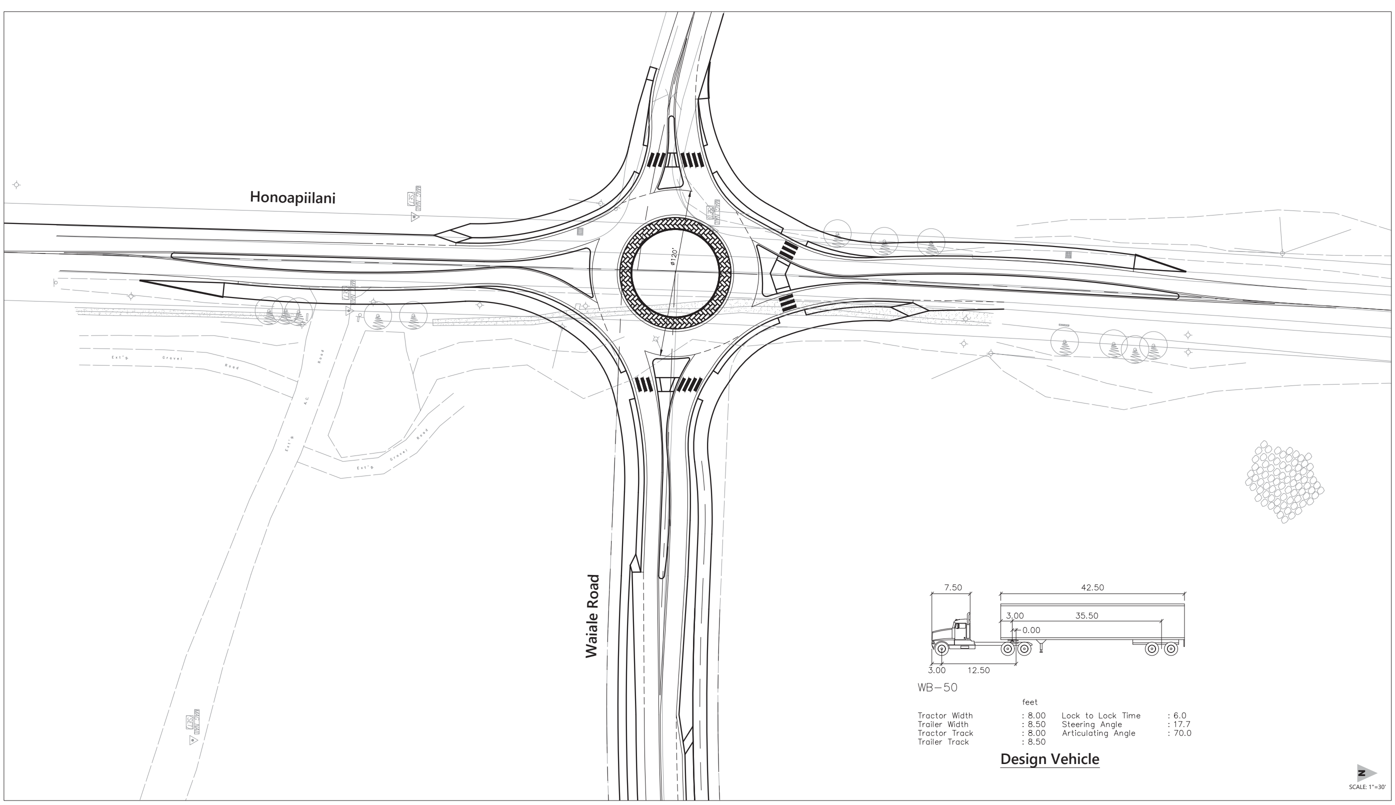
Appendix A: Conceptual Design of Intersections on the Waiale Road Extension



CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Waiale Road & Makai Parkway
Roundabout Concept

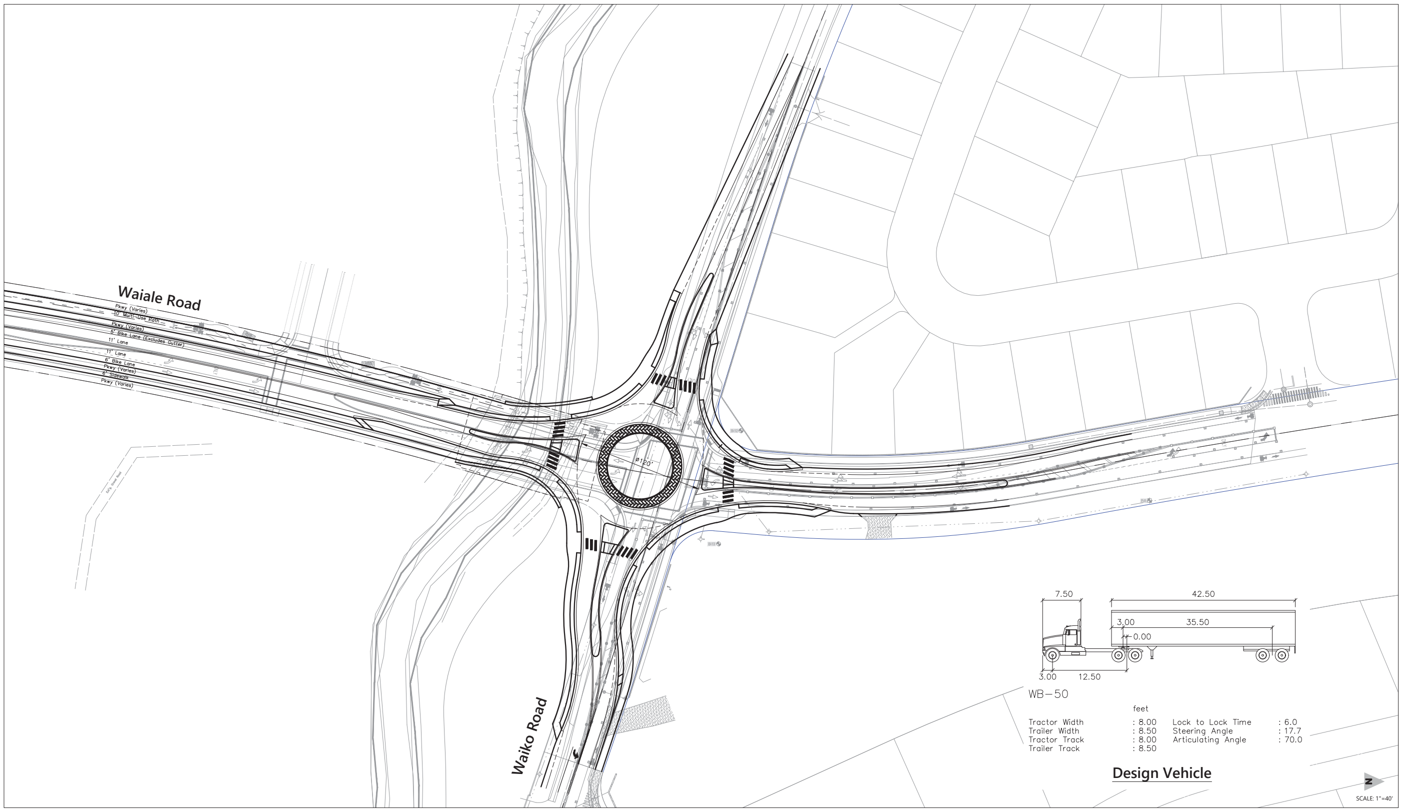
5/9/23



CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

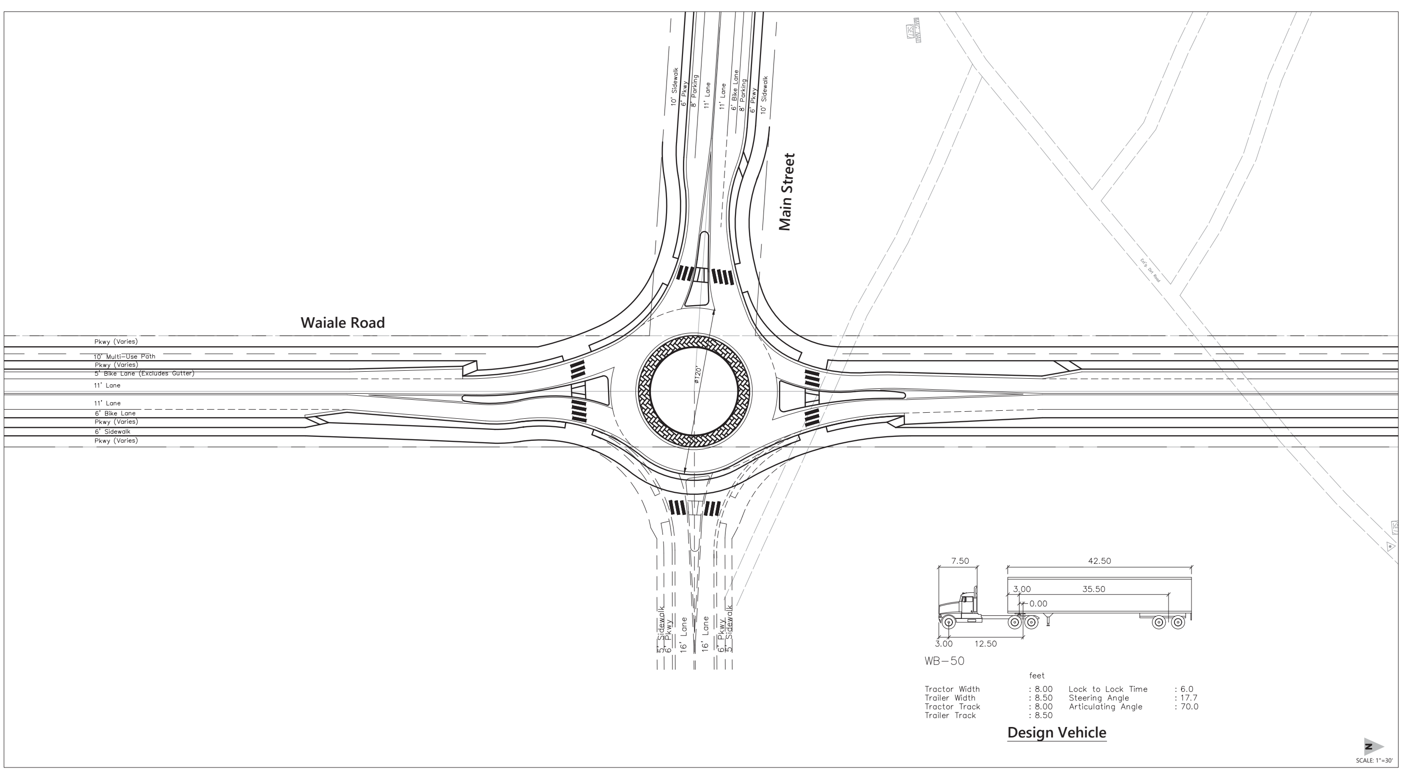
Honoapiilani & Waiale Road
Roundabout Concept

5/9/23



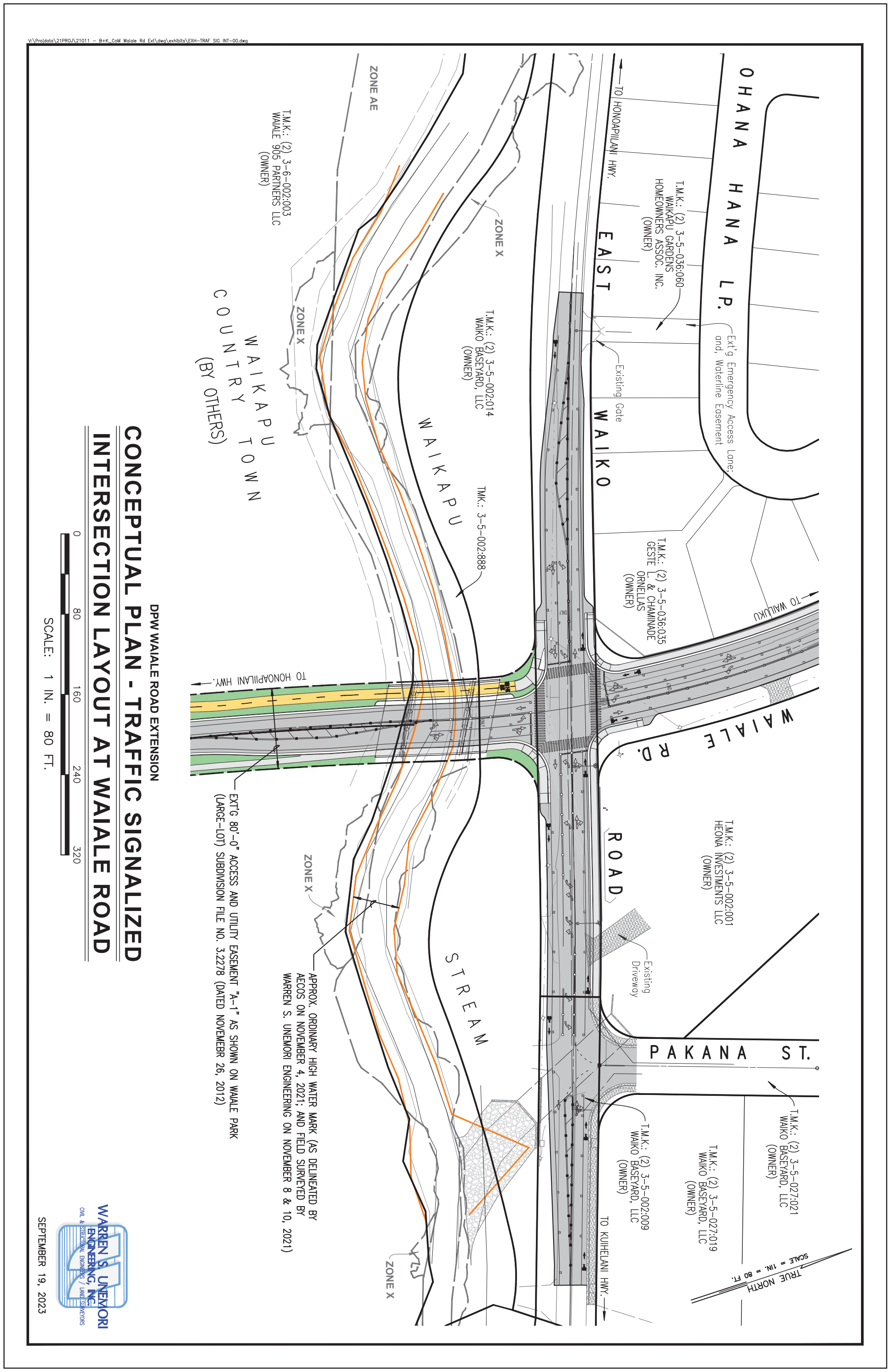
CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Waiko Road & Waiale Road
Roundabout Concept
5/9/23



CONCEPTUAL - NOT FOR CONSTRUCTION. ADDITIONAL
DETAILED ANALYSIS AND ENGINEERING DESIGN REQUIRED.

Waiale Road & Main Street
Roundabout Concept
5/9/23



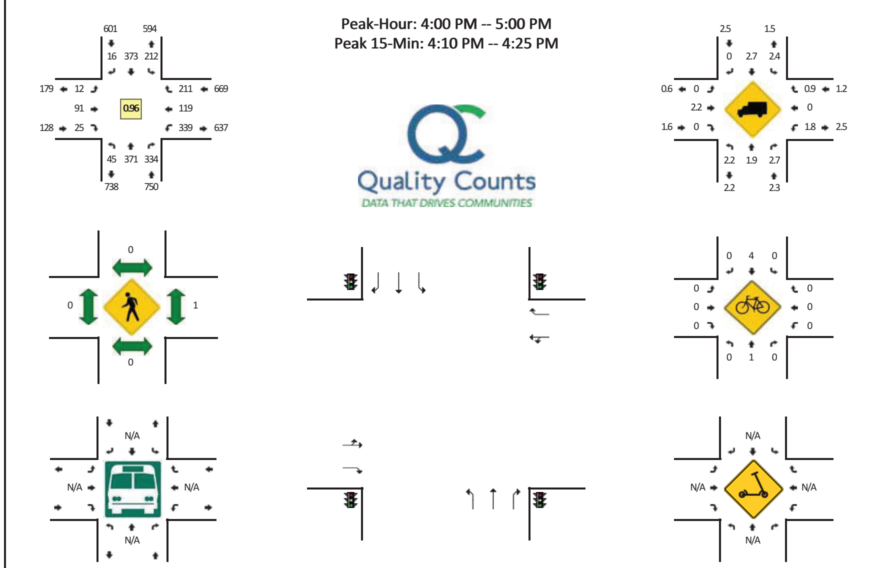
Appendix B: Traffic Count Data

FEHR PEERS

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuikahi Dr | **QC JOB #:** 15812104
CITY/STATE: Wailuku, HI | **DATE:** Thu, May 12 2022

Peak-Hour: 4:00 PM -- 5:00 PM
Peak 15-Min: 4:10 PM -- 4:25 PM



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Kuikahi Dr (Eastbound)				Kuikahi Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	4	33	27	0	17	31	2	0	1	5	1	0	30	15	13	0	179	
4:05 PM	1	32	32	0	10	40	1	0	0	10	5	0	29	10	14	0	184	
4:10 PM	6	20	28	0	20	29	0	0	4	6	2	0	32	8	24	0	179	
4:15 PM	2	40	29	0	20	33	1	0	1	11	1	0	27	6	21	0	192	
4:20 PM	3	32	28	0	14	38	1	0	0	1	3	0	39	12	19	0	190	
4:25 PM	3	33	26	0	11	29	2	0	0	11	1	0	26	13	22	0	177	
4:30 PM	4	23	26	1	24	29	1	0	2	9	1	0	27	13	15	0	175	
4:35 PM	10	30	28	0	22	34	2	0	0	5	0	0	27	5	18	0	181	
4:40 PM	1	41	29	0	24	29	2	0	1	7	2	0	24	10	17	0	187	
4:45 PM	2	30	27	0	22	21	1	0	0	13	3	0	29	13	19	0	180	
4:50 PM	4	26	31	0	12	28	2	0	2	8	2	0	28	7	13	0	163	
4:55 PM	4	31	23	0	16	32	1	0	1	5	4	0	21	7	16	0	161	2148
5:00 PM	3	32	13	0	12	17	1	0	1	7	1	0	18	12	19	0	136	2105
5:05 PM	4	35	31	0	13	12	3	0	0	9	0	0	21	6	17	0	151	2072
5:10 PM	6	13	11	0	23	31	0	0	0	11	5	0	29	14	13	0	156	2049
5:15 PM	3	30	20	0	14	24	3	0	0	8	3	0	21	13	18	0	157	2014
5:20 PM	2	27	28	0	14	19	2	0	1	13	4	0	23	11	21	0	165	1989
5:25 PM	3	32	16	0	10	25	4	0	0	9	5	0	22	3	16	0	145	1957
5:30 PM	1	16	13	0	11	10	2	0	1	10	0	0	23	12	16	0	115	1897
5:35 PM	4	34	25	0	11	19	3	0	3	6	1	0	18	11	18	0	153	1869
5:40 PM	2	27	10	0	12	25	2	0	0	6	0	0	20	9	15	0	128	1810
5:45 PM	4	36	21	0	12	18	1	0	0	6	1	0	17	11	8	0	135	1765
5:50 PM	4	25	36	0	16	23	1	0	0	6	0	0	19	10	13	0	153	1755
5:55 PM	1	12	11	0	13	11	1	0	0	7	1	0	23	18	14	0	112	1706

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	44	368	340	0	216	400	8	0	20	72	24	0	392	104	256	0	2244
Heavy Trucks	4	8	8		4	16	0		0	4	0		4	0	4		52
Buses																	
Pedestrians		0				0				0				4			4
Bicycles	0	0	0		0	4	0		0	0	0		0	0	0		4
Scooters																	

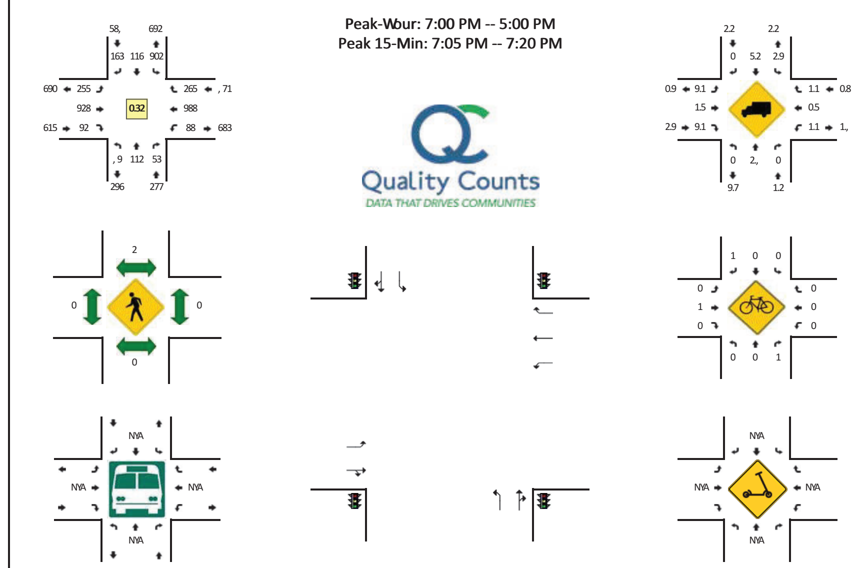
Comments:

Report generated on 6/15/2022 2:34 PM | SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- Kuikahi Dr | **QC JOB #:** 15812108
CIT4Y/TATE: KahuluiSW | **DATE:** ThuSMay 12 2022

Peak-Wour: 7:00 PM -- 5:00 PM
Peak 15-Min: 7:05 PM -- 7:20 PM



5-Min Count Period Beginning At	H aiale wd (Northbound)				H aiale wd (/outhbound)				Kuikahi Dr (Eastbound)				Kuikahi Dr (H estbound)				Total	Wourly Totals
	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R		
7:00 PM	10	6	9	0	27	8	6	0	22	90	1	0	15	95	1,	0	1, ,	
7:05 PM	,	1,	6	0	18	17	27	0	23	22	2	0	10	27	27	0	13,	
7:10 PM	16	16	10	0	20	10	17	0	20	29	6	0	,	99	16	0	131	
7:15 PM	10	19	8	0	20	3	10	0	26	97	1	0	7	93	97	0	208	
7:20 PM	6	3	5	0	2,	12	18	0	26	90	9	0	8	25	27	0	139	
7:25 PM	8	5	5	0	15	3	19	0	1,	26	0	0	,	75	26	0	1, 6	
7:90 PM	9	8	6	0	28	19	18	0	17	27	6	0	7	98	99	0	135	
7:95 PM	1	3	7	0	20	6	8	0	25	90	9	0	5	98	15	0	167	
7:70 PM	0	8	7	0	92	15	18	0	21	23	7	0	10	2,	16	0	187	
7:75 PM	6	10	9	0	95	3	1,	0	25	92	9	0	7	25	20	0	183	
7:50 PM	1	8	9	0	29	,	16	0	20	29	2	0	5	26	22	0	156	
7:55 PM	5	9	2	0	70	7	,	0	10	25	1	0	3	99	18	0	15,	218,
5:00 PM	1	11	5	0	91	11	17	0	3	16	1	0	,	25	29	0	157	2167
5:05 PM	7	8	,	0	18	10	,	0	22	29	0	0	5	23	16	0	173	2116
5:10 PM	5	3	5	0	23	3	16	0	6	98	9	0	5	26	21	0	1, 2	203,
5:15 PM	2	6	2	0	26	3	10	0	12	90	1	0	8	9,	18	0	161	2050
5:20 PM	2	7	7	0	28	,	11	0	1,	26	,	0	7	95	22	0	16,	2027
5:25 PM	1	,	11	0	27	6	20	0	19	15	2	0	9	96	28	0	166	2017
5:90 PM	7	8	,	0	29	7	11	0	19	20	7	0	9	92	2,	0	156	13, 5
5:95 PM	0	8	7	0	19	,	16	0	19	1,	9	0	8	99	13	0	171	1352
5:70 PM	7	,	6	0	21	10	16	0	11	1,	2	0	7	1,	1,	0	192	1300
5:75 PM	9	7	2	0	29	3	3	0	11	1,	7	0	7	25	20	0	191	1872
5:50 PM	0	10	5	0	17	9	12	0	23	22	7	0	5	99	22	0	153	1875
5:55 PM	9	7	2	0	20	7	11	0	6	1,	2	0	9	2,	19	0	112	1800

Peak 15-Min UoF rates	Northbound				/outhbound				Eastbound				H estbound				Total
	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	
All Vehicles	192	187	36	0	292	192	132	0	900	916	96	0	87	987	236	0	2987
Weavy Trucks	0	8	0		0	7	0		8	8	0		0	0	7		92
Buses																	
Pedestrians		0				7				0				0			7
Bicycles	0	0	0		0	0	7		0	7	0		0	0	0		8
/cooters																	

Comments:

weport generated on 6Y15Y2022 2:97 PM | /ORwCE: Quality CountsSLLC (http:YYF F F .qualitycounts.net) 1-8, , -580-2212

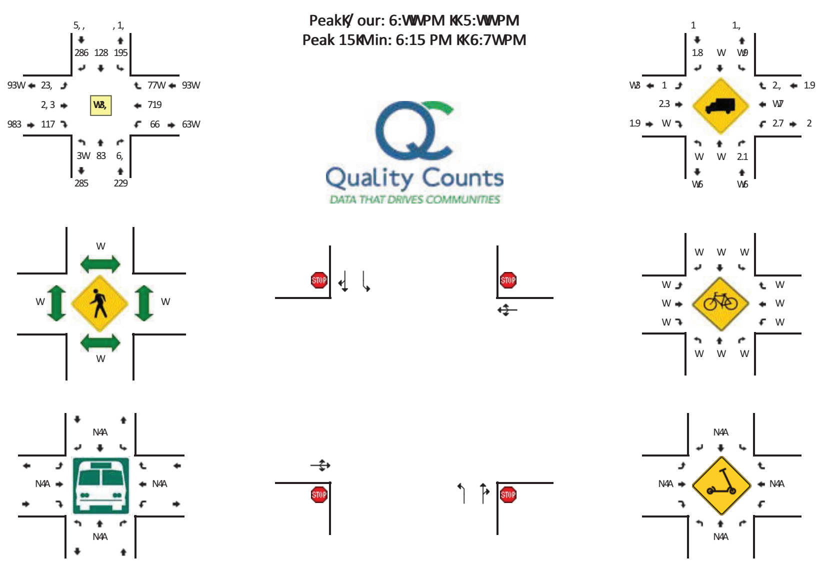
Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Hwamehameha A- e KKMaui Lani PkDy | **QC JOB #:** 15812112

CIT04HTATE: wahuluiY/ I | **SATE:** ThuYMay 12 2W22

Peak// our: 6:WWPM KK5:WWPM

Peak 15KMin: 6:15 PM KK6:7WPM



5KMin Count Period Beginning At	Hwamehameha A- e (Northbound)				Hwamehameha A- e (Houthbound)				Maui Lani PkDy (Eastbound)				Maui Lani PkDy (R estbound)				Total	/ ourly Totals
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F		
6:WWPM	16	11	8	W	11	18	22	W	28	15	18	W	7	2,	26	W	133	
6:W5 PM	19	12	6	W	8	17	22	W	22	2W	6	W	7	26	27	W	1, 1	
6:1WPM	17	5	5	W	1,	16	22	W	26	21	8	W	8	25	26	W	189	
6:15 PM	1	1W	5	W	1,	8	29	W	29	13	8	W	2	77	23	W	186	
6:2WPM	1W	5	1	W	16	11	26	1	28	7W	9	W	W	7W	29	W	189	
6:25 PM	,	6	7	W	12	11	7W	W	26	27	15	W	1	75	2,	W	132	
6:7WPM	6	8	7	W	17	1W	2,	W	2W	13	9	W	5	2,	72	W	1, 6	
6:75 PM	,	9	9	W	15	8	27	W	71	2,	3	W	7	21	25	W	181	
6:6WPM	2	8	2	W	1,	8	28	W	18	26	3	W	11	27	72	W	182	
6:65 PM	9	9	,	W	12	,	1,	W	21	2,	12	W	7	22	71	W	1, 1	
6:5WPM	9	8	2	W	17	3	13	W	76	7W	1W	W	1	22	26	W	1, 8	
6:55 PM	6	9	1	W	15	11	26	W	21	26	8	W	6	2,	77	W	1, 8	2182
5:WWPM	6	11	2	W	17	12	1,	W	25	75	1W	W	9	26	28	W	18,	21, W
5:W5 PM	,	7	7	W	8	9	17	W	22	25	8	W	3	13	21	W	166	2167
5:1WPM	2	6	2	W	15	3	18	W	1,	28	9	W	5	28	13	W	157	211W
5:15 PM	6	6	6	W	,	1W	2W	W	25	27	12	W	8	79	2,	W	18W	21W9
5:2WPM	3	11	7	W	11	9	7W	W	27	77	9	W	1	26	27	W	18W	21WW
5:25 PM	,	9	6	W	16	5	27	W	18	2,	8	W	5	75	1,	W	193	2W,
5:7WPM	12	17	15	W	15	5	28	W	27	13	8	W	,	26	16	W	187	2W89
5:75 PM	11	11	6	W	3	,	19	W	21	13	9	W	1	29	2W	W	151	2W59
5:6WPM	6	12	5	W	17	3	18	W	19	19	5	W	6	12	21	W	175	2WW3
5:65 PM	3	6	5	W	17	9	2W	W	21	17	9	W	6	12	7W	W	167	1381
5:5WPM	6	6	5	W	12	5	16	W	1,	13	1W	W	1	71	13	W	161	1366
5:55 PM	5	2	1	W	16	3	2W	W	18	12	7	W	6	1,	11	W	119	1882

Peak 15KMin vloDrates	Northbound				Houthbound				Eastbound				R estbound				Total
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	
All Vehicles	, 2	, 9	79	W	1, 2	12W	72W	6	712	288	119	W	12	732	728	W	2268
/ ea- y Trucks	W	W	W		W	W	8		6	12	W		W	W	W		26
Buses																	
Pedestrians		W				W				W				W			W
Bicycles	W	W	W		W	W	W		W	W	W		W	W	W		W
Hcooters																	

Comments:

Ueport generated on 941542W22 2:76 PM | HOF UCE: Quality CountsYLLC (http:44DDD.qualitycounts.net) 1K8, , K58W2212

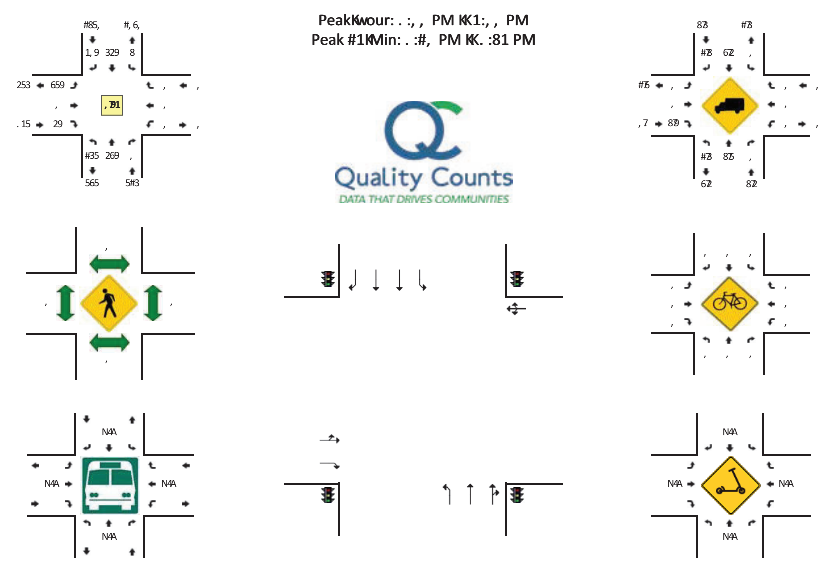
Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKMaui Lani Pk- y | **DC ODJ B:** #15#8##2

CIT04YTATE: Hahului/wl | **SATE:** Wed/May 81 8, 88

PeakKwour: . :, , PM KK1:, , PM

Peak #1KMin: . :#, PM KK. :81 PM



1KMin Count Period J eginning At	Huihelani w- y (Northbound)				Huihelani w- y (Youthbound)				Maui Lani Pk- y (Eastbound)				Maui Lani Pk- y (Westbound)				Total	wourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
. :, , PM	2	. 8	,	,	,	13	. 8	,	. 6	,	5	,	,	,	,	,	#95	
. :, 1 PM	8#	2,	,	,	,	15	1,	#	6,	,	.	,	,	,	,	,	88.	
. :#, PM	.	1#	,	,	,	52	19	,	6,	,	3	,	,	,	,	,	863	
. :#1 PM	#6	69	,	,	,	18	6,	,	. 2	,	9	,	,	,	,	,	#59	
. :8, PM	#5	2.	,	,	,	9,	. #	,	6,	,	2	,	,	,	,	,	8. 9	
. :81 PM	88	1,	,	,	,	23	62	,	8,	,	1	,	,	,	,	,	8, ,	
. :6, PM	86	2#	,	,	,	13	65	,	68	,	2	,	,	,	,	,	8#3	
. :61 PM	#1	. 8	,	,	,	1#	12	,	81	,	.	,	,	,	,	,	#96	
. :. , PM	#8	2.	,	,	,	18	63	#	68	,	2	,	,	,	,	,	8, .	
. :. 1 PM	#6	. 3	,	,	,	25	. .	,	65	,	3	,	,	,	,	,	8#3	
. :1, PM	#9	1#	,	,	,	3.	. .	,	83	,	6	,	,	,	,	,	8#5	
. :11 PM	#8	25	,	,	,	13	68	,	62	,	.	,	,	,	,	,	8, 9	8111
1:, , PM	2	89	,	,	,	36	. 9	,	6#	,	5	,	,	,	,	,	#92	8116
1:, 1 PM	81	1.	#	,	,	82	. 8	,	. 8	,	9	,	,	,	,	,	#99	8185
1:#, PM	8,	11	,	,	,	25	. 1	,	85	,	.	,	#	,	,	,	88#	81#8
1:#1 PM	##	66	,	,	,	19	. .	,	. 6	,	6	,	,	,	,	,	#96	81#2
1:8, PM	8#	. 2	,	,	,	23	61	,	6,	,	1	,	,	,	,	,	8, .	8. 3#
1:81 PM	#2	. .	,	,	,	81	#9	,	. 6	,	3	,	,	,	,	,	#1.	8. 81
1:6, PM	88	62	,	,	,	13	. 2	,	86	,	1	,	,	,	,	,	#59	8693
1:61 PM	#8	. 2	,	,	#	1,	89	,	82	,	.	,	,	,	#	,	#29	8636
1:. , PM	#2	11	,	,	,	. #	81	,	66	,	##	,	,	,	,	,	#5#	861,
1:. 1 PM	#1	69	,	,	,	62	. 5	,	65	,	3	,	,	,	,	,	#56	86#2
1:1, PM	5	85	,	,	,	15	82	,	6,	,	2	,	,	,	,	,	#12	881.
1:11 PM	#6	69	,	,	,	. 8	89	#	83	,	#	,	,	,	,	,	#18	8#93

Peak #1KMin Flo- rates	Northbound				Youthbound				Eastbound				Westbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	#. ,	2#2	,	,	,	9#8	18,	,	. 8.	,	55	,	,	,	,	,	83, ,
weavy Trucks	.	#8	,		,	85	5		,	,	,		,	,	,		18
J uses																	
Pedestrians		,				,				,				,			,
J icycles	,	,	,		,	,	,		,	,	,		,	,	,		,
Ycooters																	

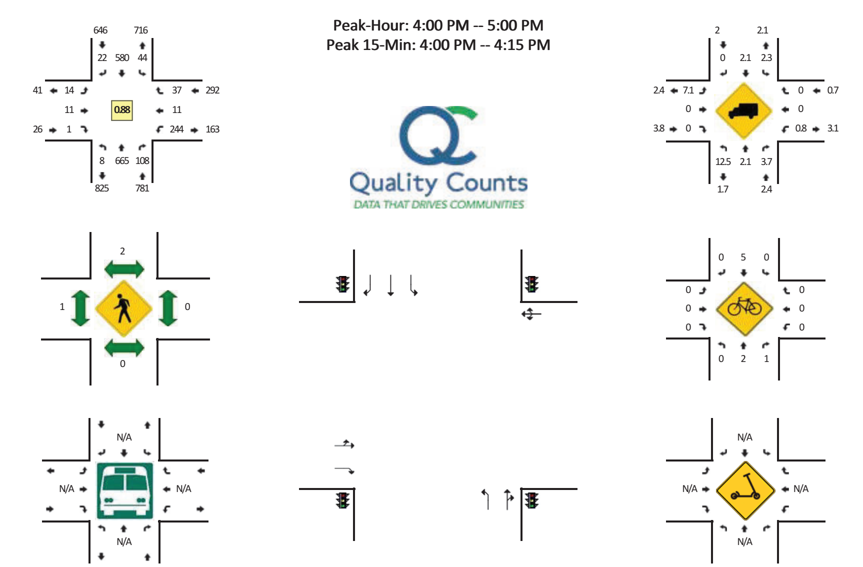
Comments:

Report generated on 24#148, 88 8:6. PM | YOURCE: Duality Counts/ LLC (http:44- - - 7qualitycounts7net) #K533K15, K88#8

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Waiko Rd | **QC JOB #:** 15812120
CITY/STATE: Waikapu, HI | **DATE:** Thu, May 12 2022

Peak-Hour: 4:00 PM -- 5:00 PM
Peak 15-Min: 4:00 PM -- 4:15 PM



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Waiko Rd (Eastbound)				Waiko Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	1	57	9	0	7	62	3	0	1	3	0	0	23	0	2	0	168	
4:05 PM	1	61	17	0	3	52	3	0	0	0	0	0	30	0	1	0	168	
4:10 PM	2	55	9	0	3	50	2	0	3	3	0	0	30	1	2	0	160	
4:15 PM	0	58	5	0	2	48	0	0	1	3	0	0	29	1	2	0	149	
4:20 PM	0	51	14	0	3	48	2	0	3	0	0	0	30	1	2	0	154	
4:25 PM	0	58	13	0	4	59	2	0	0	0	0	0	24	0	1	0	161	
4:30 PM	2	45	7	0	2	40	2	0	3	0	1	0	24	4	10	0	140	
4:35 PM	0	57	5	0	2	56	3	0	1	0	0	0	14	0	6	0	144	
4:40 PM	1	82	7	0	5	43	1	0	0	0	0	0	6	0	1	0	146	
4:45 PM	1	37	9	0	2	44	2	0	1	1	0	0	14	2	4	0	117	
4:50 PM	0	67	4	0	4	33	0	0	1	1	0	0	9	2	2	0	123	
4:55 PM	0	37	9	0	7	45	2	0	0	0	0	0	11	0	4	0	115	1745
5:00 PM	1	60	4	0	5	36	2	0	4	1	0	0	15	1	2	0	131	1708
5:05 PM	0	61	9	0	1	32	0	0	2	0	0	0	20	1	1	0	127	1667
5:10 PM	1	33	9	0	2	33	1	0	0	1	0	0	21	2	5	0	108	1615
5:15 PM	1	58	3	0	4	49	2	0	2	1	0	0	5	0	3	0	128	1594
5:20 PM	2	35	3	0	5	40	1	0	0	1	0	0	8	0	5	0	100	1540
5:25 PM	1	38	8	0	4	40	2	0	1	1	1	0	1	0	2	0	99	1478
5:30 PM	1	52	3	0	2	34	2	0	1	0	0	0	4	1	1	0	101	1439
5:35 PM	0	49	5	0	0	21	1	0	0	0	2	0	4	1	3	0	86	1381
5:40 PM	1	49	2	0	2	33	2	0	1	0	0	0	3	4	3	0	100	1335
5:45 PM	1	52	9	0	0	32	2	0	0	1	1	0	1	0	5	0	104	1322
5:50 PM	1	38	5	0	5	39	1	0	0	0	0	0	5	0	0	0	94	1293
5:55 PM	2	29	6	0	3	25	2	0	1	0	0	0	9	2	4	0	83	1261

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	692	140	0	52	656	32	0	16	24	0	0	332	4	20	0	1984
Heavy Trucks	4	24	0		4	28	0		0	0	0		4	0	0		64
Buses																	
Pedestrians		0				0				0				0			0
Bicycles	0	0	0		0	4	0		0	0	0		0	0	0		4
Scooters																	

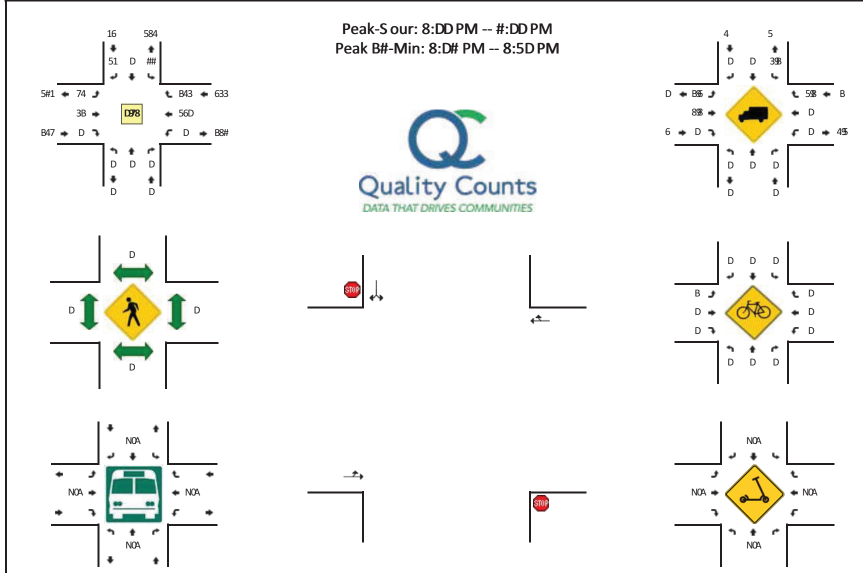
Comments:

Report generated on 6/15/2022 2:34 PM | SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-877-580-2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- H aiko wd | **WC ROQJ :** B#1B5B58
CIT20YTATE: H aikapu/S I | **, ATE:** Thu/May B5 5D55

Peak-S our: 8:DD PM -- #:DD PM
Peak B#-Min: 8:D# PM -- 8:5D PM



#-Min Count Period Qeginning At	H aiale wd .Northbound(				H aiale wd .Youthbound(				H aiko wd .Eastbound(				H aiko wd .H estbound(				Total	S ourly Totals
	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)		
8:DD PM	D	D	D	D	5	D	5	D	3	7	D	D	D	53	B7	D	44	
8:D# PM	D	D	D	D	6	D	#	D	1	BB	D	D	D	5D	B#	D	45	
8:BD PM	D	D	D	D	8	D	5	D	3	BD	D	D	D	67	54	D	11	
8:B# PM	D	D	D	D	5	D	8	D	4	BD	D	D	D	54	55	D	7D	
8:5D PM	D	D	D	D	8	D	6	D	7	1	D	D	D	55	B4	D	4D	
8:5# PM	D	D	D	D	3	D	B	B	4	7	D	D	D	B6	B5	D	83	
8:6D PM	D	D	D	D	6	D	8	D	1	8	D	D	D	B4	BD	D	8#	
8:6# PM	D	D	D	D	1	D	5	D	8	7	D	D	D	BD	3	D	8D	
8:8D PM	D	D	D	D	7	D	B	D	1	5	D	D	D	BD	B4	D	88	
8:8# PM	D	D	D	D	7	D	B	D	#	7	D	D	D	B8	BB	D	8#	
8:#D PM	D	D	D	D	6	D	B	D	6	7	D	D	D	B8	BD	D	61	
8:## PM	D	D	D	D	5	D	5	D	6	BB	D	D	D	B3	#	D	85	483
#:DD PM	D	D	D	D	7	D	D	D	8	3	D	D	D	B7	BD	D	87	46D
#:D# PM	D	D	D	D	8	D	6	D	4	4	D	D	D	B4	1	D	86	4BB
#:BD PM	D	D	D	D	#	D	6	D	8	#	D	D	D	5D	3	D	84	#43
#:B# PM	D	D	D	D	#	D	D	D	7	#	D	D	D	BD	6	D	6D	#53
#:5D PM	D	D	D	D	6	D	6	D	#	#	D	D	D	3	1	D	66	#D5
#:5# PM	D	D	D	D	8	D	D	D	7	6	D	D	D	3	#	D	51	81B
#:6D PM	D	D	D	D	5	D	6	D	7	#	D	D	D	6	B6	D	66	843
#:6# PM	D	D	D	D	6	D	5	D	6	6	D	D	D	7	3	D	57	8#4
#:8D PM	D	D	D	D	8	D	5	D	5	B	D	D	D	BD	3	D	51	88D
#:8# PM	D	D	D	D	5	D	B	D	5	4	D	D	D	#	8	D	5D	8B#
#:#D PM	D	D	D	D	8	D	6	D	#	8	D	D	D	B	BD	D	57	8D8
#:## PM	D	D	D	D	6	D	8	D	6	4	D	D	D	1	4	D	6D	635

Peak B#-Min UoF rates	Northbound				Youthbound				Eastbound				H estbound				Total
	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	Left	Thru	wight	)	
All Vehicles	D	D	D	D	64	D	88	D	35	B58	D	D	D	665	5#5	D	11D
S eavy Trucks	D	D	D		8	D	D		D	8	D		D	D	1		B4
Quses																	
Pedestrians		D				D				D				D			D
Qicycles	D	D	D		D	D	D		D	D	D		D	D	D		D
Ycooters																	

Comments:

weport generated on 40B#05D55 5:68 PM | YO) wCE: Wuality Counts/LLC .http:00F F F 9qualitycounts9net(B-177-#1D-55B5

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKE D aiko Qd

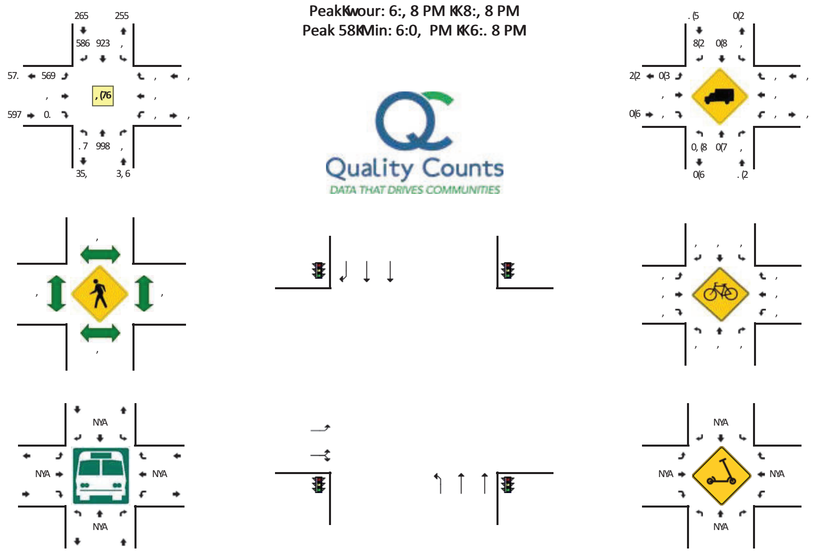
J C BO# 1: 58250502

CIT4Y/TATE: HahuluiSwl

WATE: D edSMay 08 0, 00

PeakKwour: 6:, 8 PM KK8:, 8 PM

Peak 58KMin: 6:0, PM KK6:. 8 PM



8KMin Count Period #eginning At	Huihelani w- y)NorthboundR Left	Thru	Qight	U	Huihelani w- y)/outhboundR Left	Thru	Qight	U	E D aiko Qd)EastboundR Left	Thru	Qight	U	E D aiko Qd)D estboundR Left	Thru	Qight	U	Total	wourly Totals
6:, , PM	5	. 7	,	,	,	80	5.	,	53	,	.	,	,	,	,	,	508	
6:, 8 PM	6	3,	,	,	,	97	55	,	8	,	5	,	,	,	,	,	59,	
6:5, PM	0	8,	,	,	,	86	52	,	58	,	8	,	,	,	,	,	566	
6:58 PM	.	67	,	,	,	88	55	,	56	,	5	,	,	,	,	,	5. .	
6:0, PM	6	86	,	,	,	39	5.	,	55	,	5	,	,	,	,	,	587	
6:08 PM	0	96	,	,	,	82	00	,	56	,	8	,	,	,	,	,	598	
6:. , PM	5	3,	,	,	,	65	7	,	50	,	5	,	,	,	,	,	5. 6	
6:. 8 PM	.	8.	,	,	,	95	56	,	5,	,	,	,	,	,	,	,	565	
6:6, PM	9	86	,	,	,	89	5.	,	58	,	,	,	,	,	,	,	566	
6:68 PM	6	87	,	,	,	65	55	,	55	,	5	,	,	,	,	,	503	
6:8, PM	8	62	,	,	,	99	55	,	56	,	,	,	,	,	,	,	566	
6:88 PM	8	80	,	,	,	85	55	,	58	,	5	,	,	,	,	,	5. 8	5355
8:, , PM	,	60	,	,	,	87	5,	,	5,	,	3	,	,	,	,	,	502	5356
8:, 8 PM	5	93	,	,	,	85	2	,	5,	,	,	,	,	,	,	,	5. 3	5975
8:5, PM	,	95	,	,	,	95	58	,	7	,	5	,	,	,	,	,	563	5976
8:58 PM	0	65	,	,	,	60	50	,	50	,	,	,	,	,	,	,	5, 7	593,
8:0, PM	5	80	,	,	,	60	56	,	2	,	0	,	,	,	,	,	557	59. ,
8:08 PM	5	66	,	,	,	85	8	,	2	,	,	,	,	,	,	,	5, 7	5836
8:. , PM	5	80	,	,	,	6,	9	,	5,	,	5	,	,	,	,	,	55,	588,
8:. 8 PM	5	86	,	,	,	. 9	3	,	2	,	5	,	,	,	,	,	5, 3	5859
8:6, PM	5	63	,	,	,	87	59	,	5,	,	,	,	,	,	,	,	5. .	58, 8
8:68 PM	5	8,	,	,	,	06	5,	,	3	,	.	,	,	,	,	,	78	563.
8:8, PM	5	. ,	,	,	,	60	56	,	5,	,	5	,	,	,	,	,	72	5603
8:88 PM	5	. 7	,	,	,	. 6	5.	,	3	,	0	,	,	,	,	,	79	5. 22

Peak 58KMin Flo- rates	Northbound Left	Thru	Qight	U	/outhbound Left	Thru	Qight	U	Eastbound Left	Thru	Qight	U	D estbound Left	Thru	Qight	U	Total
All Vehicles	02	380	,	,	,	3, ,	539	,	562	,	02	,	,	,	,	,	52. 0
weavy Trucks	,	06	,		,	0,	59		,	,	,		,	,	,		9,
#uses																	
Pedestrians		,				,				,				,			,
#icycles	,	,	,		,	,	,		,	,	,		,	,	,		,
/cooters																	

Comments:

Qeport generated on 9Y58Y0, 00 0:. 6 PM

/OUQCE: J uality CountsSLLC)http:YY- - - (qualitycounts(netR5K233K82, K0050

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Maui Tropical Plantation WriReway

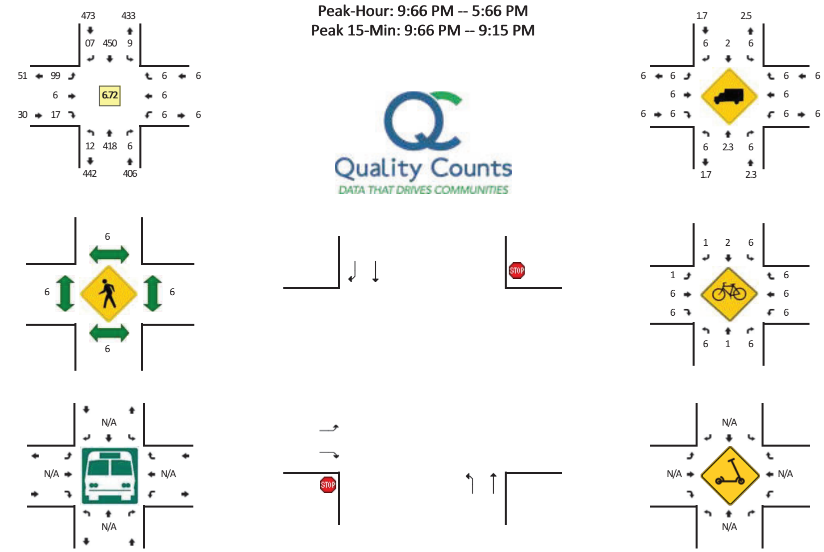
QC JOB #: 15812102

CITY/STATE: , aikapuDHI

WATE: ThuDMay 12 2622

Peak-Hour: 9:66 PM -- 5:66 PM

Peak 15-Min: 9:66 PM -- 9:15 PM



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound) Left	Thru	Uight	F	Honoapiilani Hwy (Southbound) Left	Thru	Uight	F	Maui Tropical Plantation WriReway (Eastbound) Left	Thru	Uight	F	Maui Tropical Plantation WriReway (, estbound) Left	Thru	Uight	F	Total	Hourly Totals
9:66 PM	6	36	6	6	6	40	9	6	6	6	2	6	6	6	6	6	107	
9:65 PM	2	35	6	6	6	48	0	6	9	6	6	6	6	6	6	6	152	
9:16 PM	1	35	6	6	6	35	9	6	5	6	2	6	6	6	6	6	192	
9:15 PM	1	51	6	6	6	46	0	1	5	6	6	6	6	6	6	6	101	
9:26 PM	1	55	6	6	6	49	9	6	4	6	2	6	6	6	6	6	190	
9:25 PM	1	58	6	6	6	34	0	1	0	6	1	6	6	6	6	6	109	
9:06 PM	1	33	6	6	6	86	9	6	9	6	1	6	6	6	6	6	153	
9:05 PM	2	33	6	6	6	53	0	1	0	6	2	6	6	6	6	6	100	
9:96 PM	6	39	6	6	6	93	5	1	0	6	9	6	6	6	6	6	120	
9:95 PM	6	54	6	6	6	55	0	6	3	6	1	6	6	6	6	6	122	
9:56 PM	2	56	6	6	6	50	2	6	0	6	2	6	6	6	6	6	112	
9:55 PM	1	31	6	6	6	03	1	6	1	6	2	6	6	6	6	6	162	1587
5:66 PM	6	54	6	6	6	95	5	6	1	6	0	6	6	6	6	6	111	1531
5:65 PM	2	32	6	6	6	93	0	6	0	6	9	6	6	6	6	6	126	1527
5:16 PM	6	97	6	6	6	90	9	6	1	6	0	6	6	6	6	6	166	1984
5:15 PM	1	98	6	6	6	99	0	1	6	6	1	6	6	6	6	6	78	1959
5:26 PM	1	92	6	6	6	98	1	6	6	6	1	6	6	6	6	6	70	1969
5:25 PM	2	98	6	6	6	99	6	6	2	6	1	6	6	6	6	6	74	1034
5:06 PM	6	05	6	6	6	08	2	6	2	6	1	6	6	6	6	6	48	1287
5:05 PM	6	31	6	6	6	03	6	6	3	6	6	6	6	6	6	6	160	1257
5:96 PM	6	93	6	6	6	28	6	6	2	6	1	6	6	6	6	6	44	1210
5:95 PM	2	56	6	1	6	09	1	6	1	6	1	6	6	6	6	6	76	1181
5:56 PM	9	35	6	6	6	01	1	6	2	6	2	6	6	6	6	6	165	1149
5:55 PM	0	21	6	6	6	07	0	6	2	6	6	6	6	6	6	6	38	1196

Peak 15-Min vlowrates	Northbound Left	Thru	Uight	F	Southbound Left	Thru	Uight	F	Eastbound Left	Thru	Uight	F	, estbound Left	Thru	Uight	F	Total
All Vehicles	12	436	6	6	6	839	99	6	03	6	13	6	6	6	6	6	1402
HeaRy Trucks	6	28	6		6	02	6		6	6	6		6	6	6		36
Buses																	
Pedestrians		6				6				6				6			6
Bicycles	6	6	6		6	6	6		6	6	6		6	6	6		6
Scooters																	

Comments:

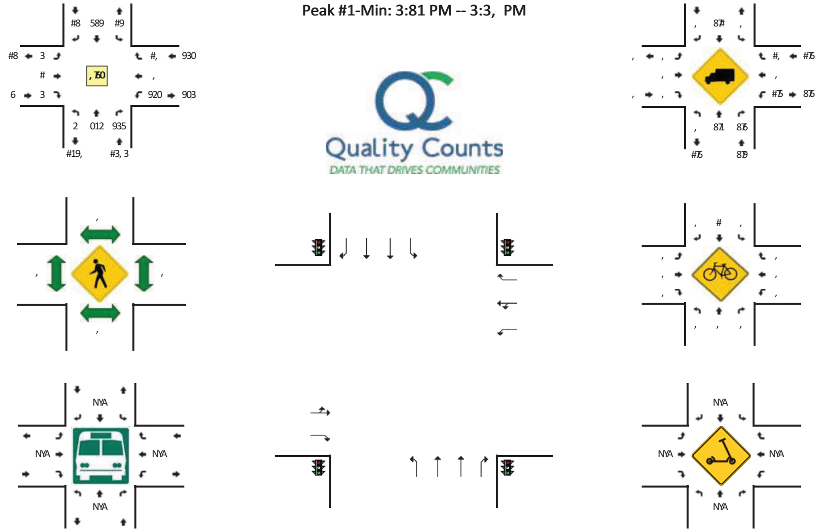
Ueport generated on 3/15/2622 2:09 PM

SOF UCE: Quality CountsDLLC (http://www.qualitycounts.net) 1-844-586-2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuihelani Hwy | DC QDJ B: #15#8#20
CIT4Y/TATE: MaalaeaSHI | WATE: ThuSMay #8 8, 88

Peak-Hour: 3:#, PM -- 1:#, PM
Peak #1-Min: 3:81 PM -- 3:3, PM



1-Min Count Period J eginning At	Honoapiilani Hwy .Northbound(				Honoapiilani Hwy ./outhbound(				Kuihelani Hwy .Eastbound(				Kuihelani Hwy .) estbound(				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
3:, , PM	,	12	0#	,	,	10	#	,	,	,	,	,	98	,	2	,	830	
3:, 1 PM	,	19	00	,	,	0,	,	,	,	,	,	,	9,	#	2	,	819	
3:#, PM	,	1,	13	,	,	59	2	,	,	,	,	,	10	,	8	,	818	
3:#1 PM	,	9,	9#	,	2	06	,	#	,	,	,	,	93	,	,	,	855	
3:8, PM	,	39	0,	,	,	38	2	,	,	,	#	,	11	,	,	,	8, 5	
3:81 PM	,	02	58	#	#	05	,	#	,	,	,	,	11	,	,	,	89#	
3:2, PM	,	91	19	,	,	95	#	,	,	,	,	,	00	,	#	,	895	
3:21 PM	,	36	08	#	8	58	,	,	,	,	,	,	38	,	#	,	826	
3:3, PM	,	30	05	,	#	12	,	,	8	,	,	,	9#	,	#	,	838	
3:31 PM	,	35	16	#	2	1,	#	,	,	,	#	,	08	,	#	,	880	
3:1, PM	,	03	11	,	,	69	,	,	,	,	,	,	21	,	8	,	812	
3:11 PM	,	19	36	,	#	59	#	,	,	,	,	,	11	,	,	,	81,	2, #,
1:, , PM	,	26	00	,	,	18	,	,	,	#	#	,	51	,	#	,	831	2, , 6
1:, 1 PM	,	31	01	,	3	08	2	,	8	,	#	,	5,	,	#	,	802	2, #1
1:#, PM	,	31	18	8	1	03	#	,	#	,	#	,	09	,	,	,	825	2, , #
1:#1 PM	,	30	3,	,	,	30	#	,	,	,	#	,	19	,	#	,	#68	86, 1
1:8, PM	,	25	3#	,	8	36	,	,	,	,	#	,	3,	,	#	,	#98	8506
1:81 PM	,	19	33	,	,	80	,	,	,	,	,	,	16	,	#	,	#59	8951
1:2, PM	,	32	25	#	#	36	,	,	,	,	,	,	35	,	,	,	#5,	8059
1:21 PM	,	12	36	,	#	89	,	,	,	,	,	,	1,	,	,	,	#5,	8085
1:3, PM	,	06	33	,	,	22	#	,	,	,	,	,	39	,	8	,	#60	8158
1:31 PM	,	8,	80	,	2	22	,	,	#	,	,	,	9,	,	#	,	#13	81#,
1:1, PM	,	33	35	,	#	28	,	,	,	,	,	,	38	,	8	,	#06	8380
1:11 PM	,	3#	2#	#	#	86	,	,	,	,	,	,	23	,	,	,	#29	82#2

Peak #1-Min Flowrates	Northbound				/outhbound				Eastbound				) estbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	,	935	5, 3	5	#8	6#8	3	3	,	,	,	,	018	,	5	,	2#18
Heavy Trucks	,	#8	85		,	3,	,		,	,	,		8,	,	,		#, ,
J uses																	
Pedestrians		,				,				,				,			,
J icycles	,	,	,		,	,	,		,	,	,		,	,	,		,
/cooters																	

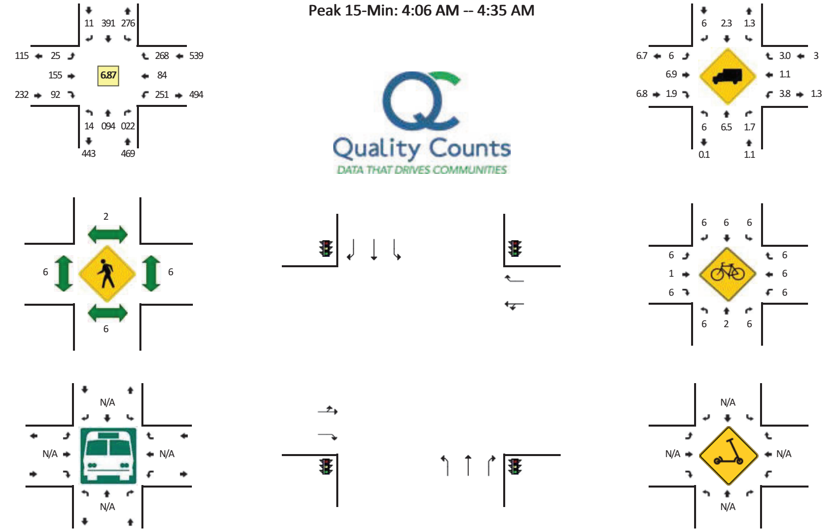
Comments:

Report generated on 0Y#1Y8, 88 8:23 PM | /OURCE: Duality CountsSLLC .http:YYwww7qualitycounts7net(#-599-15, -88#8

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuikahi Dr | QC JOB #: 15812104
CITY/STATE: Wailuku, HI | DATE: Thu, May 12 2622

Peak-Hour: 4:66 AM -- 8:66 AM
Peak 15-Min: 4:06 AM -- 4:35 AM



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Kuikahi Dr (Eastbound)				Kuikahi Dr (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:66 AM	1	25	29	6	14	03	6	6	1	16	4	6	10	5	10	6	152	
4:65 AM	2	29	27	6	14	04	6	6	1	21	4	6	10	8	13	6	145	
4:16 AM	2	06	02	6	03	03	1	6	1	11	4	6	20	4	14	6	177	
4:15 AM	1	28	02	6	24	03	1	6	0	13	7	6	20	7	19	6	174	
4:26 AM	6	04	25	6	23	08	1	6	0	10	0	6	20	4	18	6	172	
4:25 AM	6	26	28	6	18	32	2	6	2	19	9	6	24	3	06	6	175	
4:06 AM	2	04	25	6	21	07	6	6	0	17	5	6	14	16	29	6	263	
4:05 AM	0	03	02	6	27	30	2	6	6	7	3	6	24	8	22	6	210	
4:36 AM	0	04	28	6	21	59	1	6	0	18	0	6	29	9	13	6	219	
4:35 AM	1	09	25	6	27	07	6	6	1	8	5	6	26	5	13	6	180	
4:56 AM	2	00	18	6	24	03	0	6	2	9	0	6	12	9	10	6	157	
4:55 AM	6	23	22	6	29	01	6	6	5	16	0	6	24	12	11	6	141	2259
8:66 AM	1	15	17	6	16	06	6	6	1	11	5	6	27	4	19	6	133	2238
8:65 AM	6	14	26	6	11	23	6	6	2	4	2	6	26	0	10	6	117	2172
8:16 AM	1	03	24	6	19	17	6	6	0	8	5	6	10	4	16	6	130	2109
8:15 AM	0	22	18	6	15	14	1	6	1	8	9	6	26	11	13	6	109	2645
8:26 AM	2	18	14	6	13	21	1	6	3	8	2	6	26	5	11	6	120	2669
8:25 AM	6	23	27	6	15	10	6	6	2	16	3	6	23	3	8	6	100	1733
8:06 AM	1	20	26	6	4	29	6	6	6	16	9	6	12	5	4	6	114	1854
8:05 AM	1	14	27	6	12	14	1	6	6	4	9	6	18	4	4	6	122	1499
8:36 AM	2	14	17	6	7	29	6	6	0	7	3	6	14	2	7	6	114	1994
8:35 AM	0	24	23	6	8	21	6	6	6	11	1	6	11	5	11	6	122	1969
8:56 AM	1	22	29	6	11	14	1	6	6	11	2	6	7	5	9	6	111	1558
8:55 AM	5	20	15	6	16	12	0	6	6	5	2	6	20	4	11	6	119	1560

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	02	302	036	6	283	552	12	6	23	183	38	6	286	79	238	6	2502
Heavy Trucks	6	3	6		3	12	6		6	3	6		12	3	8		38
Buses																	
Pedestrians		6				6				6				6			6
Bicycles	6	3	6		6	6	6		6	6	6		6	6	6		3
Scooters																	

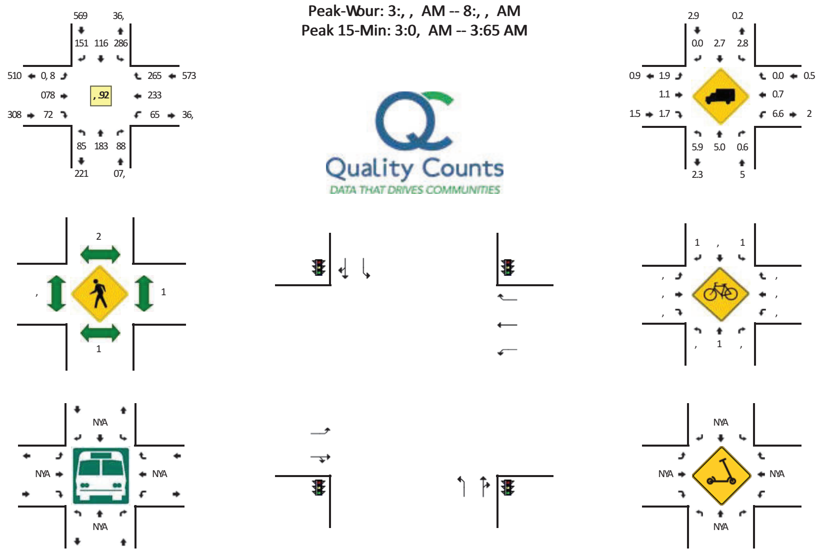
Comments:

Report generated on 9/15/2622 2:03 PM | SOURCE: Quality Counts, LLC (http://www.qualitycounts.net) 1-844-586-2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- Kuikahi Dr | **QC JOB #:** 15812108
CIT4Y/TATE: KahuluiSW | **DATE:** ThuSMay 12 2, 22

Peak-Wour: 3:, , AM -- 8:, , AM
Peak 15-Min: 3:0, AM -- 3:65 AM



5-Min Count Period Beginning At	H aiale wd (Northbound)				H aiale wd (/outhbound)				Kuikahi Dr (Eastbound)				Kuikahi Dr (H estbound)				Total	Wourly Totals
	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R		
3:, , AM	3	2,	11	,	20	8	12	,	21	21	,	,	1	16	18	,	157	
3:, 5 AM	3	11	9	,	27	17	3	,	25	00	0	,	1	17	25	,	139	
3:1, AM	3	18	7	,	17	11	16	,	06	69	0	,	2	28	22	,	21,	
3:15 AM	5	11	3	,	25	3	16	,	06	06	3	,	5	2,	10	,	182	
3:2, AM	11	13	9	,	29	3	13	,	19	21	2	,	0	27	28	,	189	
3:25 AM	1,	22	8	,	2,	7	1,	,	07	23	7	,	6	15	25	,	189	
3:0, AM	17	18	7	,	20	1,	1,	,	26	07	16	,	0	0,	22	,	212	
3:05 AM	9	22	5	,	21	12	13	,	28	19	5	,	5	20	13	,	180	
3:6, AM	6	15	1,	,	22	7	17	,	02	61	7	,	0	26	25	,	2, 6	
3:65 AM	5	8	5	,	29	15	9	,	18	28	8	,	1,	13	2,	,	132	
3:5, AM	2	11	6	,	22	8	11	,	20	26	5	,	5	02	16	,	171	
3:55 AM	2	16	8	,	28	8	16	,	16	05	0	,	0	02	17	,	133	2216
8:, , AM	1	7	2	,	13	5	16	,	2,	27	2	,	6	26	19	,	16,	2198
8:, 5 AM	6	3	0	,	26	9	9	,	10	19	1	,	0	2,	13	,	129	2168
8:1, AM	6	3	0	,	19	3	8	,	23	25	1	,	5	18	15	,	109	2, 33
8:15 AM	0	1,	3	,	13	5	16	,	13	16	1	,	5	28	18	,	109	2, 06
8:2, AM	1	12	5	,	10	1,	5	,	17	22	1	,	2	20	2,	,	10,	1935
8:25 AM	6	7	5	,	21	0	1,	,	2,	18	2	,	0	20	17	,	101	1913
8:0, AM	,	7	7	,	22	6	5	,	20	18	,	,	2	20	11	,	12,	1825
8:05 AM	0	6	0	,	2,	0	12	,	21	15	,	,	1	17	9	,	1, 3	1369
8:6, AM	0	6	1	,	27	5	3	,	20	19	1	,	0	10	17	,	121	1777
8:65 AM	2	5	1	,	22	6	3	,	13	15	2	,	6	15	21	,	115	17, 9
8:5, AM	2	3	0	,	27	5	1,	,	22	2,	1	,	1	18	28	,	160	1591
8:55 AM	1	3	5	,	22	5	3	,	10	18	2	,	2	20	16	,	119	1500

Peak 15-Min UoF rates	Northbound				/outhbound				Eastbound				H estbound				Total
	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	Left	Thru	wight	R	
All Vehicles	117	22,	86	,	276	112	132	,	007	086	1, ,	,	66	0, 8	257	,	2097
Weavy Trucks	,	12	6		17	8	6		6	,	6		,	17	8		37
Buses																	
Pedestrians		6				8				,				6			17
Bicycles	,	,	,		,	,	6		,	,	,		,	,	,		6
/cooters																	

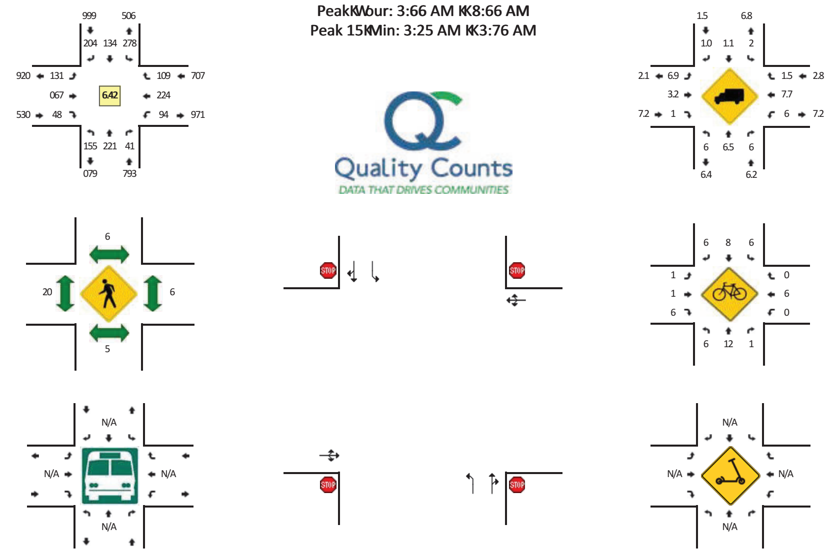
Comments:

weport generated on 7Y15Y2, 22 2:06 PM | /ORwCE: Quality CountsSLLC (http:YF F F .qualitycounts.net) 1-833-58, -2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Hwamehameha A- e KKMaui Lani PkDy | **QC JOB #:** 15812104
CITY/HTATE: wahuluiSW | **, ATE:** ThuSMay 12 2622

PeakKWour: 3:66 AM KK8:66 AM
Peak 15KMin: 3:25 AM KK3:76 AM



5KMin Count Period Beginning At	Hwamehameha A- e (Northbound)				Hwamehameha A- e (Houthbound)				Maui Lani PkDy (Eastbound)				Maui Lani PkDy (R estbound)				Total	Wourly Totals
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F		
3:66 AM	16	10	7	6	27	8	15	6	15	20	9	6	2	20	4	6	152	
3:65 AM	8	22	8	6	06	5	21	6	16	27	11	6	4	18	11	6	133	
3:16 AM	4	3	10	6	25	25	15	6	15	20	4	6	5	14	8	6	130	
3:15 AM	22	8	5	6	23	17	18	6	17	27	0	6	10	11	3	6	199	
3:26 AM	26	14	4	6	17	14	18	1	26	22	4	6	8	22	11	6	142	
3:25 AM	18	28	8	6	21	22	17	6	16	21	18	6	5	13	8	6	146	
3:06 AM	4	21	11	6	14	14	27	1	15	20	10	6	7	18	17	6	141	
3:05 AM	12	14	8	6	13	26	24	6	13	27	11	6	3	14	14	6	262	
3:76 AM	17	27	3	6	10	14	14	6	21	29	3	6	8	13	16	6	185	
3:75 AM	11	25	7	6	21	16	20	6	17	04	7	6	0	13	10	6	187	
3:56 AM	18	29	4	6	19	16	13	6	11	23	7	6	0	21	17	6	139	
3:55 AM	7	4	5	6	14	8	29	6	4	28	0	6	2	23	12	6	152	2176
8:66 AM	0	0	1	6	15	0	27	6	14	29	4	6	0	19	4	6	101	2114
8:65 AM	16	9	2	6	14	6	17	6	12	20	2	6	2	20	11	6	127	2699
8:16 AM	7	7	9	6	19	7	15	6	4	14	7	6	1	11	9	6	44	1442
8:15 AM	8	5	2	6	11	2	13	6	11	21	0	6	7	21	15	6	126	1479
8:26 AM	7	0	7	6	15	0	18	6	4	29	1	6	1	23	3	6	118	1832
8:25 AM	7	2	2	6	4	2	19	6	17	19	0	6	6	17	3	6	84	1331
8:06 AM	0	2	2	6	16	7	13	6	16	27	2	6	0	10	3	6	43	1933
8:05 AM	6	7	1	6	9	2	14	6	8	27	1	6	2	17	3	6	88	1590
8:76 AM	2	1	0	6	4	1	15	6	8	19	6	6	1	21	5	6	82	1796
8:75 AM	7	0	6	6	10	1	18	6	17	25	6	6	1	18	5	6	162	1038
8:56 AM	2	1	7	6	4	1	13	6	12	23	2	6	1	20	11	1	111	1010
8:55 AM	1	2	2	6	2	0	17	6	19	13	5	6	6	26	4	6	41	1252

Peak 15KMin vloDrates	Northbound				Houthbound				Eastbound				R estbound				Total
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	
All Vehicles	159	232	168	6	228	277	298	7	198	232	198	6	97	219	197	6	2002
Wea- y Trucks	6	7	6		7	6	7		6	77	7		6	8	8		39
Buses																	
Pedestrians		8				6				76				6			78
Bicycles	6	12	7		6	6	6		6	7	6		6	6	7		27
Hcooters																	

Comments:

Ueport generated on 9/15/2622 2:07 PM | HOF UCE: Quality CountsSLLC (http://DDD.qualitycounts.net) 1K833K586K2212

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKMaui Lani Pk- y

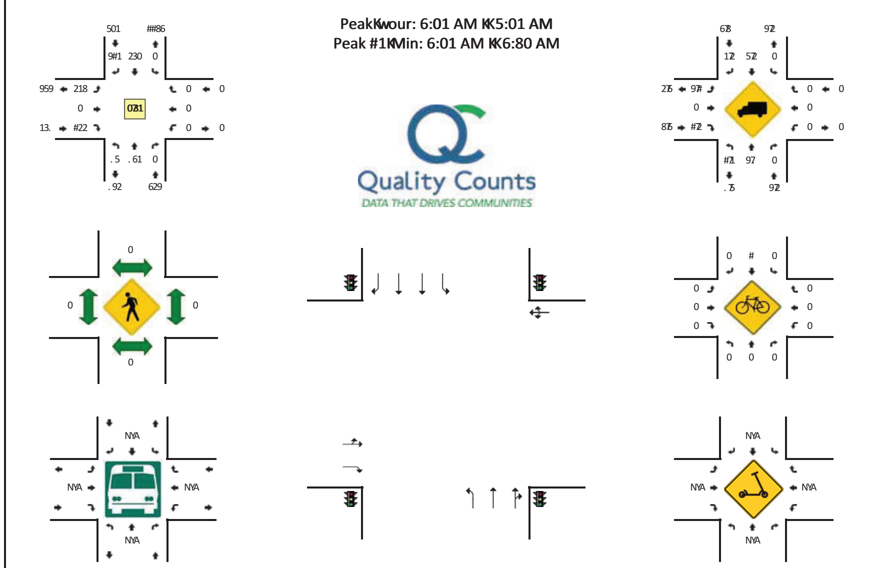
DC QJ B: #15#8#20

CIT4Y/TATE: HahuluiSwl

WATE: , edSMay 81 8088

Peak Kwour: 6:01 AM KK5:01 AM

Peak #1KMin: 6:01 AM KK6:80 AM



1KMin Count Period J eginning At	Huihelani w- y (Northbound)				Huihelani w- y (/outhbound)				Maui Lani Pk- y (Eastbound)				Maui Lani Pk- y (, estbound)				Total	wourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
6:00 AM	2	98	0	0	0	99	98	0	19	0	#6	0	0	0	0	0	#6#	
6:01 AM	2	. 2	0	0	0	95	81	0	93	0	#6	0	0	0	0	0	#56	
6:#0 AM	9	12	0	0	0	1.	98	0	95	0	#.	0	0	0	0	0	#33	
6:#1 AM	6	. #	0	0	0	93	8.	0	9.	0	#8	0	0	0	0	0	#5#	
6:80 AM	.	18	0	0	0	20	88	0	95	0	#6	0	0	0	0	0	#61	
6:81 AM	.	16	0	0	0	91	98	0	95	0	#2	0	0	0	0	0	#58	
6:90 AM	2	. 5	0	0	0	10	83	0	20	0	#9	0	0	0	0	0	802	
6:91 AM	6	16	0	0	0	9#	82	0	2#	0	#0	0	0	0	0	0	#60	
6:20 AM	1	19	0	0	0	28	86	0	9#	0	3	0	0	0	0	0	#. 6	
6:21 AM	5	22	0	0	0	29	8#	0	99	0	#0	0	0	0	0	0	#13	
6:10 AM	6	. 6	0	0	0	99	85	0	1#	0	5	0	0	0	0	0	#32	
6:11 AM	.	9.	0	0	0	9.	88	0	92	0	#9	0	0	0	0	0	#26	8#9.
5:00 AM	1	. 8	0	0	0	26	86	0	99	0	1	0	0	0	0	0	#63	8#22
5:01 AM	2	16	0	0	0	25	98	0	81	0	#0	0	0	0	0	0	#6.	8#99
5:#0 AM	2	. 0	0	0	0	99	80	0	83	0	#0	0	0	0	0	0	#1.	8030
5:#1 AM	2	95	0	0	0	99	83	0	10	0	#9	0	0	0	0	0	#. 6	806.
5:80 AM	2	. 2	0	0	0	22	90	0	89	0	#0	0	0	0	0	0	#61	806.
5:81 AM	9	. 8	0	0	0	23	98	0	89	0	.	0	0	0	0	0	#61	80. 3
5:90 AM	8	9.	0	0	0	99	#3	0	81	0	6	0	0	0	0	0	#88	#356
5:91 AM	#	19	0	0	0	8.	#3	0	83	0	5	0	0	0	0	0	#9.	#319
5:20 AM	6	21	0	0	0	86	8#	0	86	0	#0	0	0	0	0	0	#96	#389
5:21 AM	.	2#	0	0	0	93	81	0	83	0	.	0	0	0	0	0	#2.	#3#0
5:10 AM	6	66	0	0	0	9#	83	0	98	0	5	0	0	0	0	0	#52	#300
5:11 AM	9	6#	0	0	0	86	86	0	#3	0	6	0	0	0	0	0	#12	#306

Peak #1KMin Flo- rates	Northbound				/outhbound				Eastbound				, estbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	1.	6#.	0	0	0	198	998	0	218	0	#50	0	0	0	0	0	88. 5
weavy Trucks	0	85	0		0	1.	80		2	0	2		0	0	0		##8
J uses																	
Pedestrians		0				0				0				0			0
J icycles	0	0	0		0	0	0		0	0	0		0	0	0		0
/cooters																	

Comments:

Report generated on . Y#1Y8088 8:92 PM

/OURCE: Duality CountsSLLC (http:YY- - - 7qualitycounts7net) #K566K150K88#8

Type of peak hour being reported: Intersection Peak

Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Waiko Rd

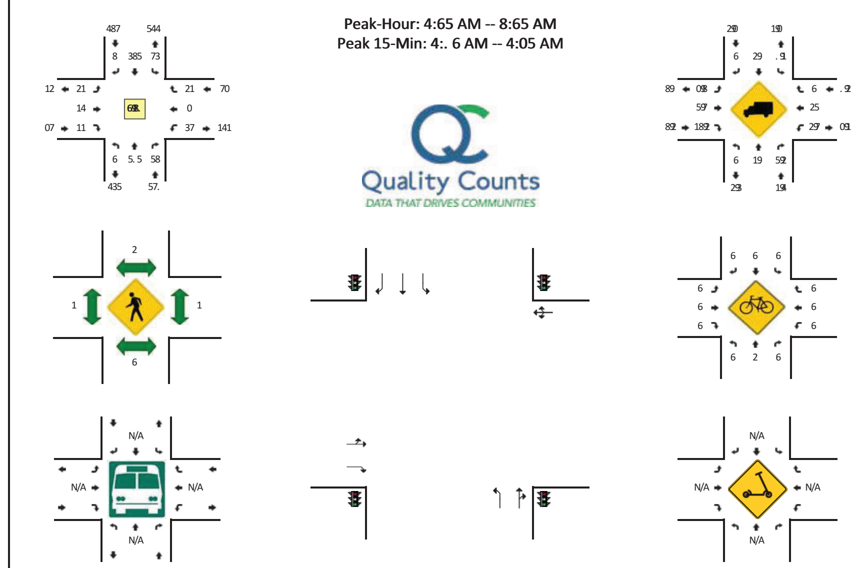
QC JOB #: 15812101

CITY/STATE: Waikapu, HI

DATE: Thu, May 12 2622

Peak-Hour: 4:65 AM -- 8:65 AM

Peak 15-Min: 4:. 6 AM -- 4:05 AM



5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Waiko Rd (Eastbound)				Waiko Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:66 AM	6	. 0	1	6	1	32	6	6	2	2	6	6	1	6	2	6	165	
4:65 AM	6	02	2	6	3	54	6	6	1	2	1	6	8	6	.	6	122	
4:16 AM	6	02	1	6	3	52	2	6	5	0	6	6	5	2	1	6	126	
4:15 AM	6	03	5	6	16	55	2	6	2	1	1	6	8	6	6	6	1. 6	
4:26 AM	6	0.	0	6	2	36	1	6	1	1	.	6	2	6	2	6	117	
4:25 AM	6	. 2	4	6	12	. 7	6	6	.	.	6	6	8	6	.	6	164	
4:. 6 AM	6	56	16	6	15	34	1	6	2	2	2	6	5	6	.	6	154	
4:. 5 AM	6	50	2	6	10	50	1	6	1	1	.	6	16	6	2	6	102	
4:06 AM	6	30	4	6	1.	37	6	6	2	6	6	6	0	1	1	6	131	
4:05 AM	6	08	5	6	5	38	6	6	2	1	6	6	.	6	1	6	1. .	
4:56 AM	6	03	4	6	5	08	1	6	6	1	1	6	2	6	1	6	112	
4:55 AM	6	28	0	6	4	02	6	6	6	1	6	6	8	6	.	6	7.	1561
8:66 AM	6	06	0	6	1	40	6	6	2	6	6	6	3	1	1	6	127	1525
8:65 AM	1	. 3	6	6	2	. 3	2	6	2	1	1	6	3	6	6	6	84	1076
8:16 AM	6	54	5	6	2	06	1	6	1	6	6	6	2	1	2	6	111	1081
8:15 AM	6	. .	1	6	6	. .	1	6	1	1	6	6	8	1	1	6	86	10. 1
8:26 AM	6	. 4	.	6	6	02	.	6	6	6	6	6	8	1	6	6	70	1063
8:25 AM	6	. 0	.	6	.	28	1	6	6	1	6	6	7	2	2	6	8.	1. 82
8:. 6 AM	1	02	.	6	0	07	6	6	1	1	6	6	2	6	1	6	160	1. 27
8:. 5 AM	6	. 7	0	6	.	. 1	1	6	2	2	6	6	8	2	2	6	70	1281
8:06 AM	6	00	2	6	0	56	6	6	1	1	6	6	5	6	.	6	116	12. 6
8:05 AM	1	. 3	5	6	3	. 6	6	6	2	1	6	6	2	2	2	6	84	1180
8:56 AM	6	. 0	5	6	1	. 4	6	6	2	1	6	6	.	6	0	6	84	1157
8:55 AM	6	. .	1	6	.	20	6	6	6	1	1	6	3	6	0	6	4.	11. 7

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	6	342	43	6	138	436	8	6	26	12	26	6	43	0	20	6	1806
Heavy Trucks	6	0	6		12	13	6		6	6	0		6	6	6		. 3
Buses																	
Pedestrians		6				0				6				0			8
Bicycles	6	0	6		6	6	6		6	6	6		6	6	6		0
Scooters																	

Comments:

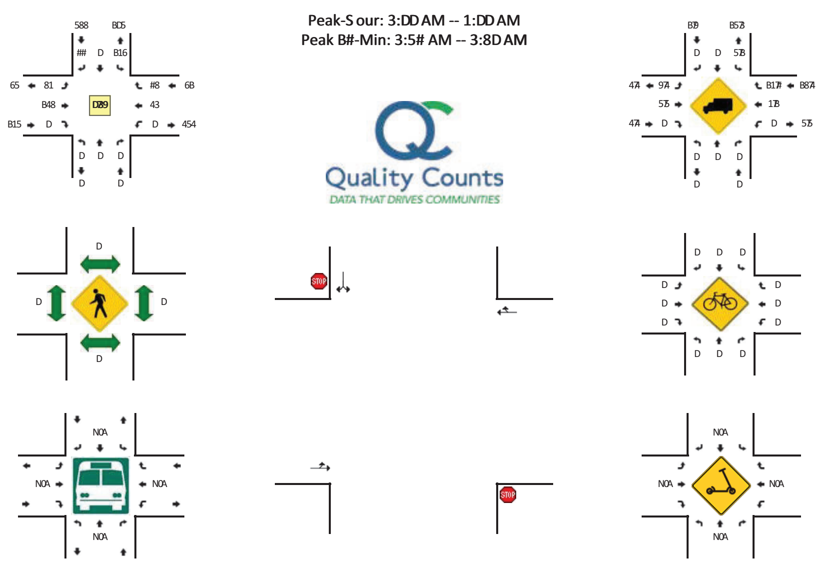
Report generated on 3/15/2622 2:. 0 PM

SOURCE: Quality Counts, LLC (http://www9qualitycounts9net) 1-844-586-2212

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: H aiale wd -- H aiko wd | **WC ROQJ :** B#1B5B85
CIT20YTATE: H aikapu/S I | **, ATE:** Thu/May B5 5D55

Peak-S our: 3:DD AM -- 1:DD AM
Peak B#-Min: 3:5# AM -- 3:8D AM



#-Min Count Period Qeginning At	H aiale wd .Northbound(Left	Thru	wight	)	H aiale wd .Youthbound(Left	Thru	wight	)	H aiko wd .Eastbound(Left	Thru	wight	)	H aiko wd .H estbound(Left	Thru	wight	)	Total	S ourly Totals
3:DD AM	D	D	D	D	B5	D	5	D	4	9	D	D	D	B	#	D	56	
3:D# AM	D	D	D	D	6	D	3	D	B	9	D	D	D	5	4	D	51	
3:BD AM	D	D	D	D	B4	D	9	D	B	9	D	D	D	#	8	D	4#	
3:B# AM	D	D	D	D	5D	D	1	D	5	B8	D	D	D	D	4	D	83	
3:5D AM	D	D	D	D	59	D	4	D	3	6	D	D	D	8	6	D	#1	
3:5# AM	D	D	D	D	5#	D	3	D	8	B5	D	D	D	4	5	D	#4	
3:4D AM	D	D	D	D	B3	D	8	D	B4	B8	D	D	D	3	8	D	#6	
3:4# AM	D	D	D	D	B#	D	3	D	4	59	D	D	D	5	9	D	#6	
3:8D AM	D	D	D	D	B9	D	4	D	9	BD	D	D	D	4	4	D	8B	
3:8# AM	D	D	D	D	B8	D	5	D	8	B9	D	D	D	5	9	D	88	
3:#D AM	D	D	D	D	B5	D	B	D	B	8	D	D	D	4	9	D	53	
3:## AM	D	D	D	D	BD	D	#	D	4	BB	D	D	D	#	4	D	43	#B3
1:DD AM	D	D	D	D	#	D	9	D	4	#	D	D	D	8	#	D	51	#B9
1:D# AM	D	D	D	D	3	D	D	D	4	4	D	D	D	8	#	D	55	#BD
1:BD AM	D	D	D	D	#	D	5	D	B	9	D	D	D	#	BD	D	56	#D8
1:B# AM	D	D	D	D	3	D	9	D	5	4	D	D	D	5	8	D	58	81B
1:5D AM	D	D	D	D	8	D	4	D	B	5	D	D	D	5	BD	D	55	88#
1:5# AM	D	D	D	D	9	D	1	D	4	B	D	D	D	B	4	D	55	8B8
1:4D AM	D	D	D	D	9	D	9	D	5	8	D	D	D	#	BD	D	44	411
1:4# AM	D	D	D	D	5	D	9	D	B	1	D	D	D	5	3	D	59	4##
1:8D AM	D	D	D	D	9	D	8	D	4	9	D	D	D	3	8	D	4D	488
1:8# AM	D	D	D	D	3	D	8	D	4	1	D	D	D	5	9	D	4D	44D
1:#D AM	D	D	D	D	#	D	4	D	B	5	D	D	D	B	5	D	B8	4B3
1:## AM	D	D	D	D	8	D	5	D	B	3	D	D	D	9	8	D	58	4D8

Peak B#-Min UoF rates	Northbound Left	Thru	wight	)	Youthbound Left	Thru	wight	)	Eastbound Left	Thru	wight	)	H estbound Left	Thru	wight	)	Total
All Vehicles	D	D	D	D	551	D	35	D	1D	5D1	D	D	D	81	81	D	918
S eavy Trucks	D	D	D		8	D	D		B5	1	D		D	D	1		45
Quses																	
Pedestrians		D				D				D				D			D
Qicycles	D	D	D		D	D	D		D	D	D		D	D	D		D
Ycooters																	

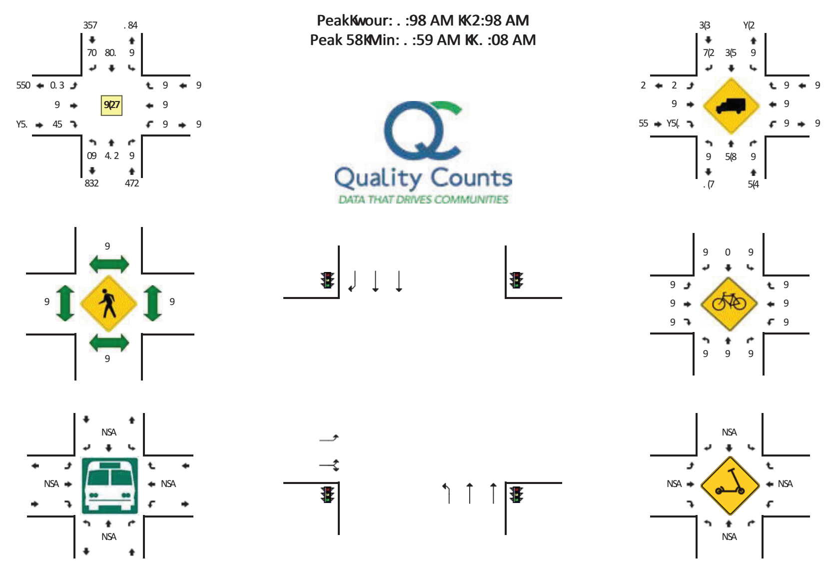
Comments:

weport generated on 90B#05D55 5:48 PM | YO) wCE: Wuality Counts/LLC .http:0F F F 7qualitycounts7net(B-133-#1D-55B5

Type of peak hour being reported: Intersection Peak | Method for determining peak hour: Total Entering Volume

LOCATION: Huihelani w- y KKE D aiko Qd | **J C BD# 1:** 5825054Y
CIT/SWATE: Hahului, wl | **6ATE:** D ed, May 08 0900

PeakKwour: . :98 AM KK2:98 AM
Peak 58KMin: . :59 AM KK. :08 AM



8KMin Count Period #eginning At	Huihelani w- y)NorthboundR Left	Thru	Qight	U	Huihelani w- y)WouthboundR Left	Thru	Qight	U	E D aiko Qd)EastboundR Left	Thru	Qight	U	E D aiko Qd)D estboundR Left	Thru	Qight	U	Total	wourly Totals
. :99 AM	0	Y9	9	9	9	4.	59	9	05	9	4	9	9	9	9	9	554	
. :98 AM	5	Y.	9	9	9	Y8	2	9	58	9	3	9	9	9	9	9	590	
. :59 AM	4	Y2	9	9	9	8Y	.	9	08	9	8	9	9	9	9	9	5Y0	
. :58 AM	0	Y.	9	9	9	8.	54	9	Y4	9	5	9	9	9	9	9	548	
. :09 AM	0	Y8	9	9	9	47	7	9	08	9	8	9	9	9	9	9	508	
. :08 AM	5	5.	9	9	9	Y8	0	9	Y0	9	0	9	9	9	9	9	27	
. :Y9 AM	5	42	9	9	9	85	59	9	04	9	4	9	9	9	9	9	5Y2	
. :Y8 AM	Y	4.	9	9	9	4Y	8	9	08	9	8	9	9	9	9	9	502	
. :49 AM	9	40	9	9	9	89	.	9	05	9	0	9	9	9	9	9	500	
. :48 AM	0	03	9	9	9	Y0	3	9	09	9	8	9	9	9	9	9	75	
. :89 AM	9	42	9	9	9	44	3	9	Y5	9	Y	9	9	9	9	9	5Y0	
. :88 AM	0	49	9	9	9	Y3	2	9	2	9	5	9	9	9	9	9	78	545Y
2:99 AM	0	3Y	9	9	9	40	59	9	53	9	0	9	9	9	9	9	5Y8	54Y4
2:98 AM	0	Y2	9	9	9	Y3	55	9	59	9	8	9	9	9	9	9	590	54Y4
2:59 AM	5	80	9	9	9	42	7	9	.	9	8	9	9	9	9	9	500	5404
2:58 AM	9	80	9	9	9	49	2	9	7	9	Y	9	9	9	9	9	550	5Y75
2:09 AM	0	45	9	9	9	49	50	9	.	9	8	9	9	9	9	9	59.	5Y. Y
2:08 AM	9	84	9	9	9	YY	54	9	2	9	9	9	9	9	9	9	597	5Y7Y
2:Y9 AM	0	0.	9	9	9	4Y	7	9	55	9	3	9	9	9	9	9	72	5Y8Y
2:Y8 AM	Y	43	9	9	9	Y9	4	9	7	9	5	9	9	9	9	9	7Y	5Y52
2:49 AM	5	80	9	9	9	07	3	9	3	9	0	9	9	9	9	9	73	5070
2:48 AM	Y	4Y	9	9	9	YY	55	9	2	9	5	9	9	9	9	9	77	5Y99
2:89 AM	3	. 4	9	9	9	04	55	9	59	9	Y	9	9	9	9	9	502	5073
2:88 AM	0	8Y	9	9	9	Y9	2	9	55	9	5	9	9	9	9	9	598	5Y93

Peak 58KMin Flo- rates	Northbound Left	Thru	Qight	U	Wouthbound Left	Thru	Qight	U	Eastbound Left	Thru	Qight	U	D estbound Left	Thru	Qight	U	Total
All Vehicles	Y0	449	9	9	9	3Y3	509	9	YY3	9	44	9	9	9	9	9	5392
weavy Trucks	9	4	9		9	Y3	4		04	9	53		9	9	9		24
#uses																	
Pedestrians		9				9				9				9			9
#icycles	9	9	9		9	9	9		9	9	9		9	9	9		9
Wooters																	

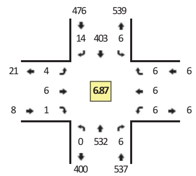
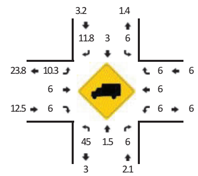
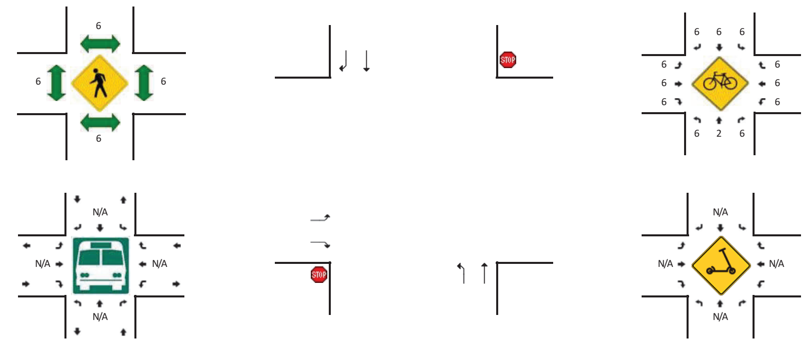
Comments:

Qeport generated on 3S58S0900 0:Y4 PM | WOUQCE: J uality Counts, LLC)http:SS- - - (qualitycounts(netR5K2. . K829K0050

Type of peak hour being reported: Intersection Peak — Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Maui Tropical Plantation WiReway — **QC JOB #:** 15812100
CITY/STATE: , aikapuDHI — **WATE:** ThuDMay 12 2622

Peak-Hour: 4:66 AM -- 8:66 AM
Peak 15-Min: 4:35 AM -- 4:56 AM

5-Min Count Period Beginning At	Honoapiilani Hwy (Northbound)				Honoapiilani Hwy (Southbound)				Maui Tropical Plantation WiReway (Eastbound)				Maui Tropical Plantation WiReway (, estbound)				Total	Hourly Totals
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F		
4:66 AM	6	03	6	6	6	73	1	6	1	6	6	6	6	6	6	6	168	
4:65 AM	1	35	6	6	6	74	6	6	6	6	6	6	6	6	6	6	163	
4:16 AM	6	30	6	6	6	74	6	6	6	6	6	6	6	6	6	6	161	
4:15 AM	6	30	6	6	6	58	6	6	6	6	6	6	6	6	6	6	92	
4:26 AM	2	07	6	6	6	59	3	6	6	6	6	6	6	6	6	6	116	
4:25 AM	6	31	6	6	6	75	2	6	2	6	6	6	6	6	6	6	166	
4:36 AM	6	55	6	6	6	05	3	6	1	6	6	6	6	6	6	6	160	
4:35 AM	6	07	6	6	6	46	3	6	1	6	6	6	6	6	6	6	126	
4:06 AM	1	76	6	6	6	71	2	6	6	6	6	6	6	6	6	6	120	
4:05 AM	6	58	6	6	6	43	1	6	1	6	1	6	6	6	6	6	130	
4:56 AM	6	02	6	6	6	58	2	6	1	6	6	6	6	6	6	6	163	
4:55 AM	6	08	6	6	6	54	6	6	6	6	6	6	6	6	6	6	165	1360
8:66 AM	6	27	6	6	6	04	2	6	1	6	6	6	6	6	6	6	47	1242
8:65 AM	1	06	6	6	6	43	1	6	1	6	6	6	6	6	6	6	117	1285
8:16 AM	6	03	6	6	6	38	2	6	1	6	6	6	6	6	6	6	80	1278
8:15 AM	1	56	6	6	6	06	6	6	6	6	6	6	6	6	6	6	91	1274
8:26 AM	6	31	6	6	6	39	6	6	6	6	6	6	6	6	6	6	46	1224
8:25 AM	2	05	6	6	6	04	3	6	6	6	1	6	6	6	6	6	98	1225
8:36 AM	1	38	6	6	6	31	5	6	2	6	6	6	6	6	6	6	44	1198
8:35 AM	2	35	6	6	6	05	5	6	2	6	6	6	6	6	6	6	89	1174
8:06 AM	1	02	6	6	6	33	3	6	1	6	6	6	6	6	6	6	86	1123
8:05 AM	1	03	6	6	6	53	1	6	1	6	3	6	6	6	6	6	162	1691
8:56 AM	3	39	6	6	6	32	1	6	2	6	6	6	6	6	6	6	44	1675
8:55 AM	1	35	6	6	6	39	2	6	6	6	6	6	6	6	6	6	44	1634

Peak 15-Min vlowrates	Northbound				Southbound				Eastbound				, estbound				Total
	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	Left	Thru	Uight	F	
All Vehicles	0	757	6	6	6	817	20	6	8	6	0	6	6	6	6	6	1512
HeaRy Trucks	0	12	6		6	20	6		6	6	6		6	6	6		06
Buses																	
Pedestrians		6				6				6				6			6
Bicycles	6	0	6		6	6	6		6	6	6		6	6	6		0
Scooters																	

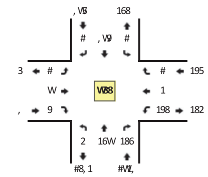
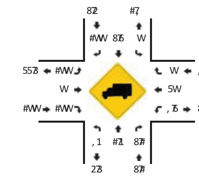
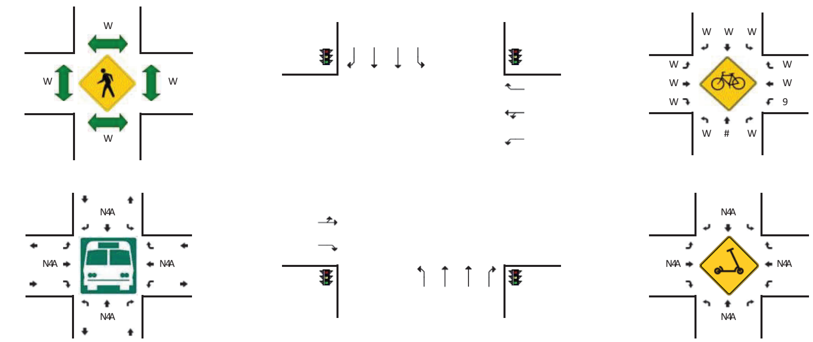
Comments:

Ueport generated on 7/15/2622 2:30 PM — SOF UCE: Quality CountsDLLC (http://www.qualitycounts.net) 1-844-586-2212

Type of peak hour being reported: Intersection Peak — Method for determining peak hour: Total Entering Volume

LOCATION: Honoapiilani Hwy -- Kuihelani Hwy — **DC ⓄJ B:** #15#8#21
CIT04YTATE: Maalaea/HI — **SATE:** Thu/May #8 8W88

Peak-Hour: , :W1 AM -- 5:W1 AM
Peak #1-Min: , :61 AM -- , :1WAM

1-Min Count Period J eginning At	Honoapiilani Hwy .Northbound(				Honoapiilani Hwy .Youthbound(				Kuihelani Hwy .Eastbound(				Kuihelani Hwy .) estbound(				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
, :WWAM	W	62	89	8	W	, W	W	W	W	W	W	W	2#	W	W	W	#, 6	
, :W1 AM	W	6,	69	W	W	96	W	W	W	W	W	W	15	#	W	W	#31	
, :#WAM	W	29	26	W	W	12	W	W	W	W	W	W	6,	W	W	W	#5W	
, :#1 AM	W	63	23	#	W	1,	W	W	#	W	W	W	15	8	W	W	8W	
, :8WAM	W	26	29	W	W	9#	W	W	W	W	W	W	11	W	#	W	8W9	
, :81 AM	#	2,	6W	W	W	16	W	W	W	W	W	W	12	W	W	W	#51	
, :6WAM	W	9,	63	W	W	98	#	W	W	W	#	W	62	W	W	W	8W2	
, :61 AM	#	13	12	W	W	91	W	W	W	W	#	W	18	W	W	W	868	
, :2WAM	W	26	2#	W	#	19	W	W	W	W	W	W	21	W	W	W	#59	
, :21 AM	#	25	23	W	W	95	W	W	W	W	#	W	25	#	W	W	8#9	
, :1WAM	W	8#	63	W	W	9#	W	W	W	W	8	W	21	#	W	W	#93	
, :11 AM	W	65	15	W	W	2#	W	W	W	W	#	W	25	W	W	W	#59	8663
5:WWAM	W	28	63	W	W	91	W	W	W	W	W	W	85	W	W	W	#, 2	862W
5:W1 AM	W	23	23	W	W	65	#	W	W	W	#	W	1#	#	W	W	#3W	8661
5:#WAM	#	69	29	W	#	25	W	W	W	W	W	W	63	W	W	W	#, #	8689
5:#1 AM	W	2,	2,	W	#	2#	W	W	W	W	W	W	65	#	#	W	#, 9	8831
5:8WAM	#	2W	65	W	8	2W	W	W	W	#	W	W	2#	W	W	W	#96	8818
5:81 AM	W	6,	19	W	#	66	W	W	W	6	W	W	6W	8	#	W	#96	886W
5:6WAM	W	28	62	W	8	63	W	W	W	#	#	W	62	W	#	W	#12	8#5W
5:61 AM	8	1W	16	W	W	69	W	W	W	W	W	W	81	#	W	W	#9,	8##1
5:2WAM	#	2W	19	W	W	1W	W	W	W	W	W	W	61	W	W	W	#58	8###
5:21 AM	W	6#	2#	W	8	63	W	W	#	W	#	W	61	W	W	W	#1W	8W21
5:1WAM	W	82	96	W	#	6W	W	W	W	W	#	W	62	W	W	W	#16	8W83
5:11 AM	W	26	65	W	W	83	W	W	W	W	W	W	61	#	W	W	#29	#353

Peak #1-Min Flowrates	Northbound				Youthbound				Eastbound				) estbound				Total
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	
All Vehicles	5	9WW	1, 9	W	2	, 19	W	W	W	W	5	W	15W	2	W	W	8169
Heavy Trucks	5	2	5		W	#9	W		W	W	5		18	W	W		39
J uses																	
Pedestrians		W				W				W				W			W
J icycles	W	W	W		W	W	W		W	W	W		8W	W	W		8W
Ycooters																	

Comments:

Report generated on 94#148W88 8:62 PM — YOURCE: Duality Counts/ LLC .http:44www7qualitycounts7net(#-5, , -15W88#8

Appendix B: Land Use Projects Assumed Complete by 2045

Portal ProjNum[1]	ProjName	DevStage	TMKS	Developer	Multi-Family Units	Single-Family Units	Other Units	Acres	Land Use Description	Est Emp Floor Area Ratio	Est KSF	Est Sq Ft per Emp	Est Emp	Students
592	Maui Lani	1: Conceptual or Proposed	38007159	DR Horton; Schuler homes		120		21.7	Mostly residential					
638	Maui Lani	1: Conceptual or Proposed	38007109	D.R.Horton Schuler Homes	238			16.7	Mostly residential					
677	Waikapu Mauka Rural Lots	1: Conceptual or Proposed	236004004	THP Assoc., Waikapu Mauka Partners		304		281.5	Mostly residential					
723	Maui Lani	1: Conceptual or Proposed	38007159	Maui Lani 100				1.5	Low employment					
724	Maui Lani	1: Conceptual or Proposed	38007159	Maui Lani 100	68			5.1	Mostly residential					
725	Maui Lani	1: Conceptual or Proposed	38007159	Maui Lani 100				2.4	Other Retail Trade and Strip Commercial	0.35	37	450	82	
726	Maui Lani	1: Conceptual or Proposed	38007130	Maui Lani 100		240		46.0	Mostly residential					
501	Kehalani	2: Pending Approvals (Discretionary)	35001113	RCFC Kehalani LLC		138		38.6	Mostly residential					
585	Pu`unani Homestead	2: Pending Approvals (Discretionary)	35002002	Endurance Investors LLC		161		60.3	Mostly residential					
688	Waikapu Light Industrial Park	2: Pending Approvals (Discretionary)	38007105	ABC Development Comp LLC, Munekiyo & Hiraga, Weinberg				8.3	Industrial Park	0.35	126	600	210	
721	Wai'ale Affordable Homes	2: Pending Approvals (Discretionary)	38007101	A & B Properties	300			34.1	Mostly residential					
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	141	231			Mixed Use		58	400	146	
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	37	188			Mostly residential					
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	243	216			Mixed Use		111	450	247	
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC	108	415			Mostly residential					
872	Waikapu Country Town	2: Pending Approvals (Discretionary)	36004003	Mike Atherton, MTP, Waikapu Properties LLC					School					1200
888	Kuikahi	2: Pending Approvals (Discretionary)	35002003	Alaula Builders Lawrence Carnicelli		204		0.0	Mostly residential					
492	Wai'olu	3: Approved (Discretionary)	35001075	Kehalani Mauka LLC		60		24.9	Mostly residential					
587	Maui Lani	3: Approved (Discretionary)	38096001	Maui Lani Homes, LLC; DR Horton/Schuller Homes		50		12.7	Mostly residential					
651	Valley Isle Fellowship	3: Approved (Discretionary)	35002012	Wayne Arakaki Eng, LLC				14.7	Mostly residential					
655	Emmanuel Lutheran Campus	3: Approved (Discretionary)	35002011	CHP				25.2	School					450
660	Maui Lani Gentry	3: Approved (Discretionary)	38007151	GENTRY MAUI DEVELOPMENT LLC	200	185		46.7	Mostly residential					
775	Waiko Baseyard	3: Approved (Discretionary)	238007102	Vincent Bagoyo				30.5	Industrial Park	0.35	465	600	774	
825	Wailuku Rental Housing	3: Approved (Discretionary)	35001064	Legacy Wailuku LLC	324			14.4	Mostly residential					
854	Waikapu Affordable Housing	3: Approved (Discretionary)	35002011	Waikapu Development Venture	12	68		12.5	Mostly residential					
500	Kehalani[2]	4: Under Construction	35001108	HBT Of Anuhea LLC		131		39.2	Mostly residential					
503	Kehalani	4: Under Construction	35040001	RCFC Kehalani LLC	25			14.2	Mostly residential					
815	Maui Lani Village[2]	4: Under Construction	38097001	Maui Lani 100 LLC		40	40	58.1	Industrial Park	0.35	443	600	738	
787	County Facilities	99: Need More Info	36002004	County of Maui		250		100.5	No info provided					
787	County Facilities	99: Need More Info	36002004	County of Maui		250		100.5	No info provided					
810	County Facilities	99: Need More Info	38005023	County of Maui				212.0	No info provided					

[1] Project number in Maui County Planning Department Project Status Viewer https://mauicounty.maps.arcgis.com/apps/webappviewer/index.html?id=0a7b91b1265045608c91e48902dced18

[2] Development partially complete. Land uses in table are estimated remaining land use to be developed

Appendix C: Land Use Projects included in 2045 Forecasts

FEHR PEERS

Appendix D: LOS Worksheets

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	155	62	251	87	208	17	367	322	290	461	11
Future Volume (veh/h)	25	155	62	251	87	208	17	367	322	290	461	11
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		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	1826	1870	1841	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	28	174	0	282	98	0	19	412	0	326	518	0
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	2	2	2	5	2	4	2	2	2	2	2	2
Cap, veh/h	308	235		431	497		321	552		463	790	
Arrive On Green	0.02	0.13	0.00	0.16	0.27	0.00	0.02	0.29	0.00	0.15	0.42	0.00
Sat Flow, veh/h	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	28	174	0	282	98	0	19	412	0	326	518	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	0.9	6.2	0.0	9.2	2.8	0.0	0.5	13.9	0.0	8.2	15.4	0.0
Cycle Q Clear(g_c), s	0.9	6.2	0.0	9.2	2.8	0.0	0.5	13.9	0.0	8.2	15.4	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	308	235		431	497		321	552		463	790	
V/C Ratio(X)	0.09	0.74		0.65	0.20		0.06	0.75		0.70	0.66	
Avail Cap(c_a), veh/h	636	537		508	537		665	1128		580	1128	
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	25.6	29.3	0.0	19.9	19.8	0.0	16.7	22.2	0.0	14.5	16.1	0.0
Incr Delay (d2), s/veh	0.1	3.4	0.0	2.3	0.1	0.0	0.0	4.3	0.0	1.8	2.0	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	0.4	2.9	0.0	3.7	1.2	0.0	0.2	6.0	0.0	2.9	5.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	25.7	32.7	0.0	22.3	20.0	0.0	16.8	26.5	0.0	16.3	18.0	0.0
LnGrp LOS	C	C		C	B		B	C		B	B	
Approach Vol, veh/h		202	A		380	A		431	A		844	A
Approach Delay, s/veh		31.8			21.7			26.1			17.4	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	14.4	25.5	15.9	13.8	5.5	34.4	6.2	23.5
Change Period (Y+Rc), s	4.0	5.0	4.5	5.0	4.0	5.0	4.5	5.0
Max Green Setting (Gmax), s	15.0	42.0	14.5	20.0	15.0	42.0	14.5	20.0
Max Q Clear Time (g_c+I1), s	10.2	15.9	11.2	8.2	2.5	17.4	2.9	4.8
Green Ext Time (p_c), s	0.2	4.7	0.3	0.5	0.0	6.1	0.0	0.3

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)	308	368	62	45	277	245	85	187	88	284	114	151
Future Volume (veh/h)	308	368	62	45	277	245	85	187	88	284	114	151
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		0.98	1.00		0.98
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	1841	1841	1856	1811	1826	1856	1856	1856	1856
Adj Flow Rate, veh/h	335	400	64	49	301	67	92	203	83	309	124	129
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	4	4	3	6	5	3	3	3	3
Cap, veh/h	449	530	85	266	386	328	394	255	104	424	253	263
Arrive On Green	0.17	0.34	0.34	0.04	0.21	0.21	0.06	0.21	0.21	0.16	0.31	0.31
Sat Flow, veh/h	1781	1573	252	1753	1841	1565	1725	1222	500	1767	823	856
Grp Volume(v), veh/h	335	0	464	49	301	67	92	0	286	309	0	253
Grp Sat Flow(s),veh/h/ln	1781	0	1825	1753	1841	1565	1725	0	1721	1767	0	1680
Q Serve(g_s), s	10.8	0.0	17.7	1.7	12.1	2.8	3.2	0.0	12.3	10.1	0.0	9.6
Cycle Q Clear(g_c), s	10.8	0.0	17.7	1.7	12.1	2.8	3.2	0.0	12.3	10.1	0.0	9.6
Prop In Lane	1.00		0.14	1.00		1.00	1.00		0.29	1.00		0.51
Lane Grp Cap(c), veh/h	449	0	614	266	386	328	394	0	360	424	0	516
V/C Ratio(X)	0.75	0.00	0.76	0.18	0.78	0.20	0.23	0.00	0.80	0.73	0.00	0.49
Avail Cap(c_a), veh/h	718	0	1144	440	824	701	580	0	881	487	0	902
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.9	0.0	23.1	22.9	29.2	25.5	22.2	0.0	29.3	19.4	0.0	22.1
Incr Delay (d2), s/veh	0.9	0.0	1.9	0.1	3.5	0.3	0.1	0.0	4.0	3.6	0.0	0.7
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	4.3	0.0	7.6	0.7	5.6	1.0	1.3	0.0	5.4	4.4	0.0	3.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	19.8	0.0	25.0	23.1	32.6	25.8	22.3	0.0	33.3	23.0	0.0	22.8
LnGrp LOS	B	A	C	C	C	C	C	A	C	C	A	C
Approach Vol, veh/h		799			417			378			562	
Approach Delay, s/veh		22.8			30.4			30.7			22.9	
Approach LOS		C			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.2	21.3	8.3	31.3	9.6	29.0	18.2	21.4
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	15.0	40.0	11.0	49.0	13.0	42.0	25.0	35.0
Max Q Clear Time (g_c+I1), s	12.1	14.3	3.7	19.7	5.2	11.6	12.8	14.1
Green Ext Time (p_c), s	0.2	1.9	0.0	3.4	0.1	1.8	0.4	2.1

Intersection Summary	
HCM 6th Ctrl Delay	25.7
HCM 6th LOS	C

Intersection	
Intersection Delay, s/veh	30.0
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	623	472	507	725
Demand Flow Rate, veh/h	652	486	517	739
Vehicles Circulating, veh/h	550	606	818	506
Vehicles Exiting, veh/h	695	729	384	586
Ped Vol Crossing Leg, #/h	28	5	28	23
Ped Cap Adj	0.996	0.999	0.996	0.997
Approach Delay, s/veh	27.9	17.2	37.9	34.6
Approach LOS	D	C	E	D

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	652	486	517	739
Cap Entry Lane, veh/h	787	744	599	824
Entry HV Adj Factor	0.955	0.971	0.981	0.981
Flow Entry, veh/h	623	472	507	725
Cap Entry, veh/h	749	722	586	806
V/C Ratio	0.831	0.654	0.866	0.900
Control Delay, s/veh	27.9	17.2	37.9	34.6
LOS	D	C	E	D
95th %tile Queue, veh	9	5	10	12

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	452	0	144	0	0	0	68	675	0	0	490	315
Future Volume (veh/h)	452	0	144	0	0	0	68	675	0	0	490	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		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	1870	1870	1870	1870	1870	1870	1841	1870	1870	1781	1826
Adj Flow Rate, veh/h	476	0	0	0	0	0	72	711	0	0	516	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, %	3	2	2	2	2	2	2	4	2	2	8	5
Cap, veh/h	642	0		0	704	0	92	1497	0	3	1018	
Arrive On Green	0.38	0.00	0.00	0.00	0.00	0.00	0.05	0.43	0.00	0.00	0.30	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3589	0	1781	3385	1547
Grp Volume(v), veh/h	476	0	0	0	0	0	72	711	0	0	516	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1749	0	1781	1692	1547
Q Serve(g_s), s	21.0	0.0	0.0	0.0	0.0	0.0	2.7	9.7	0.0	0.0	8.4	0.0
Cycle Q Clear(g_c), s	21.0	0.0	0.0	0.0	0.0	0.0	2.7	9.7	0.0	0.0	8.4	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	642	0		0	704	0	92	1497	0	3	1018	
V/C Ratio(X)	0.74	0.00		0.00	0.00	0.00	0.78	0.47	0.00	0.00	0.51	
Avail Cap(c_a), veh/h	1047	0		0	1294	0	348	2368	0	80	1782	
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	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	19.5	0.0	0.0	0.0	0.0	0.0	31.1	13.6	0.0	0.0	19.2	0.0
Incr Delay (d2), s/veh	0.6	0.0	0.0	0.0	0.0	0.0	5.2	0.5	0.0	0.0	0.8	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	6.5	0.0	0.0	0.0	0.0	0.0	1.1	3.0	0.0	0.0	2.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.1	0.0	0.0	0.0	0.0	0.0	36.4	14.1	0.0	0.0	20.0	0.0
LnGrp LOS	C	A		A	A	A	D	B	A	A	C	
Approach Vol, veh/h		476	A		0			783			516	A
Approach Delay, s/veh		20.1			0.0			16.2			20.0	
Approach LOS		C						B			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	0.0	35.4	31.0	8.4	27.0	31.0
Change Period (Y+Rc), s	5.0	7.0	6.0	5.0	7.0	* 6
Max Green Setting (Gmax), s	3.0	45.0	44.0	13.0	35.0	* 46
Max Q Clear Time (g_c+I1), s	0.0	11.7	23.0	4.7	10.4	0.0
Green Ext Time (p_c), s	0.0	9.2	2.1	0.0	5.7	0.0

Intersection Summary	
HCM 6th Ctrl Delay	18.3
HCM 6th LOS	B

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
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)	21	17	11	69	4	21	0	535	58	96	685	8
Future Volume (veh/h)	21	17	11	69	4	21	0	535	58	96	685	8
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.99	0.99		0.99	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	1826	1811	1633	1870	1530	1870	1870	1870	1826	1856	1870	1870
Adj Flow Rate, veh/h	25	20	1	83	5	14	0	645	68	116	825	0
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Percent Heavy Veh, %	5	6	18	2	25	2	2	2	5	3	2	2
Cap, veh/h	192	125	181	213	16	19	382	894	94	393	1232	
Arrive On Green	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.54	0.54	0.05	0.66	0.00
Sat Flow, veh/h	748	953	1374	788	123	145	1781	1659	175	1767	1870	1585
Grp Volume(v), veh/h	45	0	1	102	0	0	0	0	713	116	825	0
Grp Sat Flow(s),veh/h/ln	1700	0	1374	1055	0	0	1781	0	1834	1767	1870	1585
Q Serve(g_s), s	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	17.4	1.6	16.0	0.0
Cycle Q Clear(g_c), s	1.3	0.0	0.0	5.8	0.0	0.0	0.0	0.0	17.4	1.6	16.0	0.0
Prop In Lane	0.56		1.00	0.81		0.14	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	318	0	181	249	0	0	382	0	989	393	1232	
V/C Ratio(X)	0.14	0.00	0.01	0.41	0.00	0.00	0.00	0.00	0.72	0.30	0.67	
Avail Cap(c_a), veh/h	666	0	496	526	0	0	559	0	1911	598	2074	
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	1.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	23.0	0.0	22.5	25.2	0.0	0.0	0.0	0.0	10.3	8.3	6.2	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.0	2.1	0.2	1.4	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	0.5	0.0	0.0	1.4	0.0	0.0	0.0	0.0	6.1	0.4	4.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.1	0.0	22.5	25.6	0.0	0.0	0.0	0.0	12.5	8.4	7.6	0.0
LnGrp LOS	C	A	C	C	A	A	A	A	B	A	A	
Approach Vol, veh/h		46			102			713			941	A
Approach Delay, s/veh		23.1			25.6			12.5			7.7	
Approach LOS		C			C			B			A	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	7.1	38.1	14.3	0.0	45.2	14.3
Change Period (Y+Rc), s	4.0	6.0	6.5	4.0	6.0	* 6.5
Max Green Setting (Gmax), s	10.0	62.0	21.5	6.0	66.0	* 22
Max Q Clear Time (g_c+I1), s	3.6	19.4	3.3	0.0	18.0	7.8
Green Ext Time (p_c), s	0.1	12.6	0.1	0.0	16.5	0.3

Intersection Summary	
HCM 6th Ctrl Delay	11.0
HCM 6th LOS	B

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	8.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	48	134	37	54	189	55
Future Vol, veh/h	48	134	37	54	189	55
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	76	76	76	76	76	76
Heavy Vehicles, %	6	2	8	19	2	2
Mvmt Flow	63	176	49	71	249	72

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	120	0	-	0	387	85
Stage 1	-	-	-	-	85	-
Stage 2	-	-	-	-	302	-
Critical Hdwy	4.16	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.254	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1443	-	-	-	616	974
Stage 1	-	-	-	-	938	-
Stage 2	-	-	-	-	750	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1443	-	-	-	586	974
Mov Cap-2 Maneuver	-	-	-	-	586	-
Stage 1	-	-	-	-	893	-
Stage 2	-	-	-	-	750	-

Approach	EB	WB	SB
HCM Control Delay, s	2	0	16
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1443	-	-	-	644
HCM Lane V/C Ratio	0.044	-	-	-	0.499
HCM Control Delay (s)	7.6	0	-	-	16
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0.1	-	-	-	2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	276	41	20	478	527	92
Future Volume (veh/h)	276	41	20	478	527	92
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	1767	1455	1870	1870	1811	1752
Adj Flow Rate, veh/h	310	42	22	537	592	0
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	9	30	2	2	6	10
Cap, veh/h	362	49	46	1745	1280	
Arrive On Green	0.25	0.25	0.03	0.49	0.37	0.00
Sat Flow, veh/h	1456	197	1781	3647	3532	1485
Grp Volume(v), veh/h	353	0	22	537	592	0
Grp Sat Flow(s),veh/h/ln	1658	0	1781	1777	1721	1485
Q Serve(g_s), s	10.9	0.0	0.7	4.9	7.0	0.0
Cycle Q Clear(g_c), s	10.9	0.0	0.7	4.9	7.0	0.0
Prop In Lane	0.88	0.12	1.00			1.00
Lane Grp Cap(c), veh/h	412	0	46	1745	1280	
V/C Ratio(X)	0.86	0.00	0.47	0.31	0.46	
Avail Cap(c_a), veh/h	864	0	497	2843	1472	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	19.3	0.0	25.8	8.2	12.8	0.0
Incr Delay (d2), s/veh	2.0	0.0	2.8	0.1	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.0	0.0	0.3	1.3	2.1	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	21.3	0.0	28.6	8.3	13.1	0.0
LnGrp LOS	C	A	C	A	B	
Approach Vol, veh/h	353			559	592	A
Approach Delay, s/veh	21.3			9.1	13.1	
Approach LOS	C			A	B	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		33.4		20.4	6.4	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		43.0		28.0	15.0	23.0
Max Q Clear Time (g_c+I1), s		6.9		12.9	2.7	9.0
Green Ext Time (p_c), s		3.5		0.5	0.0	3.1

Intersection Summary			
HCM 6th Ctrl Delay			13.5
HCM 6th LOS			B

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	7	1	4	532	743	17
Future Vol, veh/h	7	1	4	532	743	17
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	250	-	-	250
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	86	86	86	86	86	86
Heavy Vehicles, %	14	2	75	2	3	12
Mvmt Flow	8	1	5	619	864	20

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1493	864	884	0	-	0
Stage 1	864	-	-	-	-	-
Stage 2	629	-	-	-	-	-
Critical Hdwy	6.54	6.22	4.85	-	-	-
Critical Hdwy Stg 1	5.54	-	-	-	-	-
Critical Hdwy Stg 2	5.54	-	-	-	-	-
Follow-up Hdwy	3.626	3.318	2.875	-	-	-
Pot Cap-1 Maneuver	127	354	531	-	-	-
Stage 1	393	-	-	-	-	-
Stage 2	509	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	126	354	531	-	-	-
Mov Cap-2 Maneuver	126	-	-	-	-	-
Stage 1	389	-	-	-	-	-
Stage 2	509	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	33.2	0.1	0
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	531	-	137	-	-
HCM Lane V/C Ratio	0.009	-	0.068	-	-
HCM Control Delay (s)	11.8	-	33.2	-	-
HCM Lane LOS	B	-	D	-	-
HCM 95th %tile Q(veh)	0	-	0.2	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	0	6	562	5	1	4	530	523	1	706	1
Future Volume (veh/h)	1	0	6	562	5	1	4	530	523	1	706	1
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	418	1870	418	1796	714	1870	788	1870	1870	1870	1870	418
Adj Flow Rate, veh/h	1	0	0	615	0	0	4	576	0	1	767	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	100	2	100	7	80	2	75	2	2	2	2	100
Cap, veh/h	3	0		853	0		4	1366		3	1352	
Arrive On Green	0.00	0.00	0.00	0.25	0.00	0.00	0.01	0.38	0.00	0.00	0.38	0.00
Sat Flow, veh/h	1781	0	0	3421	0	1585	751	3554	1585	1781	3554	354
Grp Volume(v), veh/h	1	0	0	615	0	0	4	576	0	1	767	0
Grp Sat Flow(s),veh/h/ln	1781	0	0	1711	0	1585	751	1777	1585	1781	1777	354
Q Serve(g_s), s	0.0	0.0	0.0	8.6	0.0	0.0	0.3	6.2	0.0	0.0	8.9	0.0
Cycle Q Clear(g_c), s	0.0	0.0	0.0	8.6	0.0	0.0	0.3	6.2	0.0	0.0	8.9	0.0
Prop In Lane	1.00		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	3	0		853	0		4	1366		3	1352	
V/C Ratio(X)	0.29	0.00		0.72	0.00		0.99	0.42		0.29	0.57	
Avail Cap(c_a), veh/h	170	0		2946	0		86	3740		204	3740	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	26.1	0.0	0.0	18.0	0.0	0.0	26.0	11.8	0.0	26.1	12.8	0.0
Incr Delay (d2), s/veh	41.9	0.0	0.0	1.2	0.0	0.0	122.9	0.3	0.0	16.7	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	0.1	0.0	0.0	3.1	0.0	0.0	0.2	2.1	0.0	0.0	3.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	67.9	0.0	0.0	19.1	0.0	0.0	148.9	12.1	0.0	42.8	13.3	0.0
LnGrp LOS	E	A		B	A		F	B		D	B	
Approach Vol, veh/h		1	A		615	A		580	A		768	A
Approach Delay, s/veh		67.9			19.1			13.1			13.4	
Approach LOS		E			B			B			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	4.1	25.1		18.0	4.3	24.9		5.1
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0
Max Green Setting (Gmax), s	6.0	55.0		45.0	6.0	55.0		5.0
Max Q Clear Time (g_c+I1), s	2.0	8.2		10.6	2.3	10.9		2.0
Green Ext Time (p_c), s	0.0	6.3		2.4	0.0	9.0		0.0

Intersection Summary	
HCM 6th Ctrl Delay	15.1
HCM 6th LOS	B

Notes

User approved volume balancing among the lanes for turning movement.
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)	12	91	25	339	119	211	45	371	334	212	373	16
Future Volume (veh/h)	12	91	25	339	119	211	45	371	334	212	373	16
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	1870	1870	1870	1870	1870	1856	1870	1856	1870
Adj Flow Rate, veh/h	12	95	0	353	124	0	47	386	0	221	389	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, %	2	2	2	2	2	2	2	2	3	2	3	2
Cap, veh/h	240	156		519	513		405	587		443	703	
Arrive On Green	0.01	0.08	0.00	0.20	0.27	0.00	0.04	0.31	0.00	0.11	0.38	0.00
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Grp Volume(v), veh/h	12	95	0	353	124	0	47	386	0	221	389	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Q Serve(g_s), s	0.4	3.1	0.0	10.7	3.3	0.0	1.1	11.4	0.0	4.9	10.5	0.0
Cycle Q Clear(g_c), s	0.4	3.1	0.0	10.7	3.3	0.0	1.1	11.4	0.0	4.9	10.5	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	240	156		519	513		405	587		443	703	
V/C Ratio(X)	0.05	0.61		0.68	0.24		0.12	0.66		0.50	0.55	
Avail Cap(c_a), veh/h	624	587		563	587		745	1233		668	1223	
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	26.3	28.2	0.0	18.8	18.0	0.0	13.8	18.9	0.0	12.6	15.5	0.0
Incr Delay (d2), s/veh	0.1	2.8	0.0	3.0	0.2	0.0	0.0	2.7	0.0	0.3	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	0.2	1.5	0.0	4.5	1.3	0.0	0.4	4.6	0.0	1.6	3.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	26.3	31.1	0.0	21.8	18.2	0.0	13.9	21.6	0.0	12.9	17.0	0.0
LnGrp LOS	C	C		C	B		B	C		B	B	
Approach Vol, veh/h		107	A		477	A		433	A		610	A
Approach Delay, s/veh		30.5			20.8			20.7			15.5	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	11.0	25.0	17.4	10.3	6.8	29.2	5.3	22.5
Change Period (Y+Rc), s	4.0	5.0	4.5	5.0	4.0	5.0	4.5	5.0
Max Green Setting (Gmax), s	15.0	42.0	14.5	20.0	15.0	42.0	14.5	20.0
Max Q Clear Time (g_c+I1), s	6.9	13.4	12.7	5.1	3.1	12.5	2.4	5.3
Green Ext Time (p_c), s	0.2	4.4	0.2	0.3	0.0	4.5	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	19.5
HCM 6th LOS	B

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
2: Waiale Rd & Kuikahi Dr

Existing (2022)
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑	↱	↰	↑↱		↰	↑↱	
Traffic Volume (veh/h)	255	328	32	88	388	265	73	112	59	302	116	169
Future Volume (veh/h)	255	328	32	88	388	265	73	112	59	302	116	169
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		1.00	1.00		0.98	1.00		0.98
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	1870	1856	1841	1841	1856	1870	1856	1870	1870	1826	1870
Adj Flow Rate, veh/h	277	357	34	96	422	92	79	122	49	328	126	143
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	3	2	3	4	4	3	2	3	2	2	5	2
Cap, veh/h	395	600	57	380	517	440	321	169	68	465	199	226
Arrive On Green	0.14	0.36	0.36	0.06	0.28	0.28	0.05	0.14	0.14	0.18	0.26	0.26
Sat Flow, veh/h	1767	1678	160	1753	1841	1567	1781	1250	502	1781	771	875
Grp Volume(v), veh/h	277	0	391	96	422	92	79	0	171	328	0	269
Grp Sat Flow(s),veh/h/ln	1767	0	1838	1753	1841	1567	1781	0	1751	1781	0	1646
Q Serve(g_s), s	7.6	0.0	12.8	2.8	15.8	3.3	2.8	0.0	6.9	11.0	0.0	10.7
Cycle Q Clear(g_c), s	7.6	0.0	12.8	2.8	15.8	3.3	2.8	0.0	6.9	11.0	0.0	10.7
Prop In Lane	1.00		0.09	1.00		1.00	1.00		0.29	1.00		0.53
Lane Grp Cap(c), veh/h	395	0	657	380	517	440	321	0	237	465	0	426
V/C Ratio(X)	0.70	0.00	0.59	0.25	0.82	0.21	0.25	0.00	0.72	0.71	0.00	0.63
Avail Cap(c_a), veh/h	755	0	1220	539	873	743	538	0	949	510	0	937
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.5	0.0	19.3	17.4	24.8	20.3	25.4	0.0	30.6	20.4	0.0	24.2
Incr Delay (d2), s/veh	0.9	0.0	0.9	0.1	3.2	0.2	0.1	0.0	4.1	3.1	0.0	1.6
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	5.4	1.1	7.1	1.2	1.2	0.0	3.1	4.8	0.0	4.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	17.4	0.0	20.2	17.6	28.0	20.5	25.5	0.0	34.7	23.5	0.0	25.8
LnGrp LOS	B	A	C	B	C	C	C	A	C	C	A	C
Approach Vol, veh/h		668			610			250			597	
Approach Delay, s/veh		19.0			25.2			31.8			24.6	
Approach LOS		B			C			C			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	18.1	15.0	9.3	31.4	9.0	24.1	15.0	25.7
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	15.0	40.0	11.0	49.0	13.0	42.0	25.0	35.0
Max Q Clear Time (g_c+I1), s	13.0	8.9	4.8	14.8	4.8	12.7	9.6	17.8
Green Ext Time (p_c), s	0.1	1.1	0.1	2.8	0.0	1.9	0.4	2.9

Intersection Summary		
HCM 6th Ctrl Delay		23.9
HCM 6th LOS		C

HCM 6th Roundabout
3: S. Kamehameha Ave & Maui Lani Pkwy

Existing (2022)
PM Peak Hour

Intersection	
Intersection Delay, s/veh	21.8
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	710	711	233	595
Demand Flow Rate, veh/h	727	729	238	607
Vehicles Circulating, veh/h	354	501	782	474
Vehicles Exiting, veh/h	727	519	299	756
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	18.4	31.9	11.4	17.8
Approach LOS	C	D	B	C

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	727	729	238	607
Cap Entry Lane, veh/h	962	828	622	851
Entry HV Adj Factor	0.977	0.976	0.980	0.981
Flow Entry, veh/h	710	711	233	595
Cap Entry, veh/h	940	808	609	835
V/C Ratio	0.756	0.881	0.383	0.713
Control Delay, s/veh	18.4	31.9	11.4	17.8
LOS	C	D	B	C
95th %tile Queue, veh	7	11	2	6

4: Kuihelani Hwy & Maui Lani Pkwy

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	389	0	69	0	0	0	178	639	0	2	769	509
Future Volume (veh/h)	389	0	69	0	0	0	178	639	0	2	769	509
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	1856	1870	1870	1870	1870	1856	1870	1870	1841	1870
Adj Flow Rate, veh/h	409	0	0	0	0	0	187	673	0	2	809	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, %	2	2	3	2	2	2	2	3	2	2	4	2
Cap, veh/h	546	0		0	601	0	227	1590	0	3	1137	
Arrive On Green	0.32	0.00	0.00	0.00	0.00	0.00	0.13	0.45	0.00	0.00	0.33	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3618	0	1781	3497	1585
Grp Volume(v), veh/h	409	0	0	0	0	0	187	673	0	2	809	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1763	0	1781	1749	1585
Q Serve(g_s), s	21.9	0.0	0.0	0.0	0.0	0.0	8.2	10.3	0.0	0.1	16.2	0.0
Cycle Q Clear(g_c), s	21.9	0.0	0.0	0.0	0.0	0.0	8.2	10.3	0.0	0.1	16.2	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	546	0		0	601	0	227	1590	0	3	1137	
V/C Ratio(X)	0.75	0.00		0.00	0.00	0.00	0.82	0.42	0.00	0.69	0.71	
Avail Cap(c_a), veh/h	873	0		0	1080	0	514	2433	0	67	1536	
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	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	25.8	0.0	0.0	0.0	0.0	0.0	33.9	14.8	0.0	39.8	23.6	0.0
Incr Delay (d2), s/veh	0.8	0.0	0.0	0.0	0.0	0.0	2.9	0.4	0.0	72.5	1.9	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	7.2	0.0	0.0	0.0	0.0	0.0	3.4	3.5	0.0	0.1	6.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	26.6	0.0	0.0	0.0	0.0	0.0	36.7	15.2	0.0	112.3	25.5	0.0
LnGrp LOS	C	A		A	A	A	D	B	A	F	C	
Approach Vol, veh/h		409	A		0			860			811	A
Approach Delay, s/veh		26.6			0.0			19.9			25.7	
Approach LOS		C						B			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	5.1	42.9	31.6	15.2	32.9	31.6
Change Period (Y+Rc), s	5.0	7.0	6.0	5.0	7.0	* 6
Max Green Setting (Gmax), s	3.0	55.0	44.0	23.0	35.0	* 46
Max Q Clear Time (g_c+I1), s	2.1	12.3	23.9	10.2	18.2	0.0
Green Ext Time (p_c), s	0.0	9.2	1.7	0.2	7.7	0.0

Intersection Summary	
HCM 6th Ctrl Delay	23.5
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

5: Honoapiilani Hwy & Waiko Rd

PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	14	11	1	244	11	37	8	665	108	44	580	22
Future Volume (veh/h)	14	11	1	244	11	37	8	665	108	44	580	22
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		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	1796	1870	1870	1870	1870	1870	1722	1870	1841	1870	1870	1870
Adj Flow Rate, veh/h	16	12	-10	277	12	32	9	756	121	50	659	0
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	7	2	2	2	2	2	12	2	4	2	2	2
Cap, veh/h	274	190	375	369	13	34	339	881	141	218	1084	
Arrive On Green	0.24	0.24	0.00	0.24	0.24	0.24	0.01	0.56	0.56	0.02	0.58	0.00
Sat Flow, veh/h	903	805	1585	1255	54	145	1640	1567	251	1781	1870	1585
Grp Volume(v), veh/h	28	0	-10	321	0	0	9	0	877	50	659	0
Grp Sat Flow(s),veh/h/ln	1708	0	1585	1455	0	0	1640	0	1818	1781	1870	1585
Q Serve(g_s), s	0.0	0.0	0.0	19.0	0.0	0.0	0.2	0.0	38.0	1.1	21.3	0.0
Cycle Q Clear(g_c), s	1.1	0.0	0.0	20.1	0.0	0.0	0.2	0.0	38.0	1.1	21.3	0.0
Prop In Lane	0.57		1.00	0.86		0.10	1.00		0.14	1.00		1.00
Lane Grp Cap(c), veh/h	465	0	375	416	0	0	339	0	1022	218	1084	
V/C Ratio(X)	0.06	0.00	-0.03	0.77	0.00	0.00	0.03	0.00	0.86	0.23	0.61	
Avail Cap(c_a), veh/h	465	0	375	416	0	0	434	0	1211	366	1326	
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	27.6	0.0	0.0	34.7	0.0	0.0	10.8	0.0	17.2	16.6	12.7	0.0
Incr Delay (d2), s/veh	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	6.8	0.2	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	0.5	0.0	0.0	7.9	0.0	0.0	0.1	0.0	16.2	0.4	8.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.6	0.0	0.0	42.6	0.0	0.0	10.8	0.0	24.0	16.8	13.9	0.0
LnGrp LOS	C	A	A	D	A	A	B	A	C	B	B	
Approach Vol, veh/h		18			321			886			709	A
Approach Delay, s/veh		42.9			42.6			23.9			14.1	
Approach LOS		D			D			C			B	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	6.3	58.3	28.5	4.6	60.0	28.5
Change Period (Y+Rc), s	4.0	6.0	6.5	4.0	6.0	* 6.5
Max Green Setting (Gmax), s	10.0	62.0	21.5	6.0	66.0	* 22
Max Q Clear Time (g_c+I1), s	3.1	40.0	3.1	2.2	23.3	22.1
Green Ext Time (p_c), s	0.0	12.3	0.0	0.0	11.1	0.0

Intersection Summary	
HCM 6th Ctrl Delay	23.6
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	76	91	230	169	55	28
Future Vol, veh/h	76	91	230	169	55	28
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	2	4	2	2	9	2
Mvmt Flow	103	123	311	228	74	38

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	539	0	-	0	754	425
Stage 1	-	-	-	-	425	-
Stage 2	-	-	-	-	329	-
Critical Hdwy	4.12	-	-	-	6.49	6.22
Critical Hdwy Stg 1	-	-	-	-	5.49	-
Critical Hdwy Stg 2	-	-	-	-	5.49	-
Follow-up Hdwy	2.218	-	-	-	3.581	3.318
Pot Cap-1 Maneuver	1029	-	-	-	367	629
Stage 1	-	-	-	-	645	-
Stage 2	-	-	-	-	714	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1029	-	-	-	328	629
Mov Cap-2 Maneuver	-	-	-	-	328	-
Stage 1	-	-	-	-	576	-
Stage 2	-	-	-	-	714	-

Approach	EB	WB	SB
HCM Control Delay, s	4	0	17.9
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1029	-	-	-	391
HCM Lane V/C Ratio	0.1	-	-	-	0.287
HCM Control Delay (s)	8.9	0	-	-	17.9
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0.3	-	-	-	1.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	146	23	39	665	687	154
Future Volume (veh/h)	146	23	39	665	687	154
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	1856	1870	1604	1856	1856	1811
Adj Flow Rate, veh/h	155	17	41	707	731	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	3	2	20	3	3	6
Cap, veh/h	283	31	66	1906	1402	
Arrive On Green	0.18	0.18	0.04	0.54	0.40	0.00
Sat Flow, veh/h	1565	172	1527	3618	3618	1535
Grp Volume(v), veh/h	173	0	41	707	731	0
Grp Sat Flow(s),veh/h/ln	1746	0	1527	1763	1763	1535
Q Serve(g_s), s	4.5	0.0	1.3	5.8	7.9	0.0
Cycle Q Clear(g_c), s	4.5	0.0	1.3	5.8	7.9	0.0
Prop In Lane	0.90	0.10	1.00			1.00
Lane Grp Cap(c), veh/h	316	0	66	1906	1402	
V/C Ratio(X)	0.55	0.00	0.62	0.37	0.52	
Avail Cap(c_a), veh/h	972	0	456	3015	1612	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	18.7	0.0	23.6	6.6	11.5	0.0
Incr Delay (d2), s/veh	0.5	0.0	3.5	0.1	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	0.0	0.5	1.3	2.3	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	19.3	0.0	27.1	6.8	11.8	0.0
LnGrp LOS	B	A	C	A	B	
Approach Vol, veh/h	173			748	731	A
Approach Delay, s/veh	19.3			7.9	11.8	
Approach LOS	B			A	B	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		34.2		16.1	7.2	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		43.0		28.0	15.0	23.0
Max Q Clear Time (g_c+I1), s		7.8		6.5	3.3	9.9
Green Ext Time (p_c), s		4.9		0.2	0.0	3.8

Intersection Summary	
HCM 6th Ctrl Delay	10.8
HCM 6th LOS	B

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection						
Int Delay, s/veh	2.2					

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y		↰	↑	↑	↱
Traffic Vol, veh/h	44	19	12	718	753	39
Future Vol, veh/h	44	19	12	718	753	39
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	250	-	-	250
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	3	2	2
Mvmt Flow	48	21	13	780	818	42

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1624	818	860	0	-	0
Stage 1	818	-	-	-	-	-
Stage 2	806	-	-	-	-	-
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	113	376	781	-	-	-
Stage 1	434	-	-	-	-	-
Stage 2	439	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	111	376	781	-	-	-
Mov Cap-2 Maneuver	111	-	-	-	-	-
Stage 1	427	-	-	-	-	-
Stage 2	439	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	52.5	0.2	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	781	-	141	-	-
HCM Lane V/C Ratio	0.017	-	0.486	-	-
HCM Control Delay (s)	9.7	-	52.5	-	-
HCM Lane LOS	A	-	F	-	-
HCM 95th %tile Q(veh)	0.1	-	2.3	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥		↰	↰	↱	↰	↑↑	↱	↰	↑↑	↱
Traffic Volume (veh/h)	4	1	4	736	0	10	3	653	748	17	827	12
Future Volume (veh/h)	4	1	4	736	0	10	3	653	748	17	827	12
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	1870	1870	1752	1870	1856	1856	1870	1870	418
Adj Flow Rate, veh/h	4	1	0	767	0	0	3	680	0	18	861	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, %	2	2	2	2	2	10	2	3	3	2	2	100
Cap, veh/h	10	2		1002	0		7	1334		38	1406	
Arrive On Green	0.01	0.01	0.00	0.28	0.00	0.00	0.00	0.38	0.00	0.02	0.40	0.00
Sat Flow, veh/h	1439	360	0	3563	0	1485	1781	3526	1572	1781	3554	354
Grp Volume(v), veh/h	5	0	0	767	0	0	3	680	0	18	861	0
Grp Sat Flow(s),veh/h/ln	1798	0	0	1781	0	1485	1781	1763	1572	1781	1777	354
Q Serve(g_s), s	0.2	0.0	0.0	12.0	0.0	0.0	0.1	9.0	0.0	0.6	11.8	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0	12.0	0.0	0.0	0.1	9.0	0.0	0.6	11.8	0.0
Prop In Lane	0.80		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	12	0		1002	0		7	1334		38	1406	
V/C Ratio(X)	0.42	0.00		0.77	0.00		0.41	0.51		0.47	0.61	
Avail Cap(c_a), veh/h	148	0		2635	0		176	3187		176	3212	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	30.1	0.0	0.0	20.0	0.0	0.0	30.2	14.6	0.0	29.4	14.7	0.0
Incr Delay (d2), s/veh	21.5	0.0	0.0	1.3	0.0	0.0	13.4	0.4	0.0	3.3	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	0.1	0.0	0.0	4.7	0.0	0.0	0.1	3.2	0.0	0.3	4.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.6	0.0	0.0	21.3	0.0	0.0	43.7	15.0	0.0	32.7	15.3	0.0
LnGrp LOS	D	A		C	A		D	B		C	B	
Approach Vol, veh/h		5	A		767	A		683	A		879	A
Approach Delay, s/veh		51.6			21.3			15.1			15.6	
Approach LOS		D			C			B			B	
Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	5.3	28.0		22.1	4.2	29.1		5.4				
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0				
Max Green Setting (Gmax), s	6.0	55.0		45.0	6.0	55.0		5.0				
Max Q Clear Time (g_c+I1), s	2.6	11.0		14.0	2.1	13.8		2.2				
Green Ext Time (p_c), s	0.0	7.7		3.1	0.0	10.3		0.0				

Intersection Summary		
HCM 6th Ctrl Delay		17.4
HCM 6th LOS		B

Notes

User approved volume balancing among the lanes for turning movement.
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)	80	260	110	420	140	280	40	720	580	350	670	40
Future Volume (veh/h)	80	260	110	420	140	280	40	720	580	350	670	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		1.00	0.99		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	1826	1870	1841	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	84	274	0	442	147	0	42	758	0	368	705	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, %	2	2	2	5	2	4	2	2	2	2	2	2
Cap, veh/h	319	238		382	477		264	714		325	925	
Arrive On Green	0.05	0.13	0.00	0.18	0.25	0.00	0.03	0.38	0.00	0.15	0.49	0.00
Sat Flow, veh/h	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	84	274	0	442	147	0	42	758	0	368	705	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	4.5	14.0	0.0	20.0	7.0	0.0	1.6	42.0	0.0	16.0	33.6	0.0
Cycle Q Clear(g_c), s	4.5	14.0	0.0	20.0	7.0	0.0	1.6	42.0	0.0	16.0	33.6	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	319	238		382	477		264	714		325	925	
V/C Ratio(X)	0.26	1.15		1.16	0.31		0.16	1.06		1.13	0.76	
Avail Cap(c_a), veh/h	320	238		382	477		286	714		325	925	
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	48.0	0.0	33.5	33.1	0.0	21.5	34.0	0.0	35.3	22.6	0.0
Incr Delay (d2), s/veh	0.4	105.2	0.0	96.6	0.3	0.0	0.1	51.2	0.0	91.3	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	2.0	13.4	0.0	18.9	3.2	0.0	0.6	27.8	0.0	12.3	14.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.1	153.2	0.0	130.1	33.4	0.0	21.6	85.2	0.0	126.6	27.0	0.0
LnGrp LOS	D	F		F	C		C	F		F	C	
Approach Vol, veh/h		358	A		589	A		800	A		1073	A
Approach Delay, s/veh		126.4			106.0			81.8			61.2	
Approach LOS		F			F			F			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	47.0	24.0	19.0	7.6	59.4	10.0	33.0
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	16.0	42.0	20.0	14.0	5.0	53.0	6.0	28.0
Max Q Clear Time (g_c+I1), s	18.0	44.0	22.0	16.0	3.6	35.6	6.5	9.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	84.7
HCM 6th LOS	F

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
2: Waiale Rd & Kuikahi Dr

Future (2045) No Project
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	450	620	90	60	480	410	120	280	90	430	190	210
Future Volume (veh/h)	450	620	90	60	480	410	120	280	90	430	190	210
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.97	1.00		0.97
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	1856	1856	1856	1856	1856	1856	1856	1856
Adj Flow Rate, veh/h	474	653	93	63	505	127	126	295	88	453	200	195
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, %	2	2	2	3	3	3	3	3	3	3	3	3
Cap, veh/h	418	671	96	124	461	378	296	281	84	403	299	291
Arrive On Green	0.21	0.42	0.42	0.03	0.25	0.25	0.06	0.21	0.21	0.20	0.35	0.35
Sat Flow, veh/h	1781	1595	227	1767	1856	1523	1767	1360	406	1767	850	828
Grp Volume(v), veh/h	474	0	746	63	505	127	126	0	383	453	0	395
Grp Sat Flow(s),veh/h/ln	1781	0	1822	1767	1856	1523	1767	0	1766	1767	0	1678
Q Serve(g_s), s	30.0	0.0	58.2	3.8	36.0	9.9	8.0	0.0	30.0	29.0	0.0	28.9
Cycle Q Clear(g_c), s	30.0	0.0	58.2	3.8	36.0	9.9	8.0	0.0	30.0	29.0	0.0	28.9
Prop In Lane	1.00		0.12	1.00		1.00	1.00		0.23	1.00		0.49
Lane Grp Cap(c), veh/h	418	0	767	124	461	378	296	0	365	403	0	590
V/C Ratio(X)	1.13	0.00	0.97	0.51	1.10	0.34	0.43	0.00	1.05	1.12	0.00	0.67
Avail Cap(c_a), veh/h	418	0	767	124	461	378	296	0	365	403	0	590
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	46.6	0.0	41.2	42.8	54.5	44.7	42.9	0.0	57.5	45.9	0.0	39.8
Incr Delay (d2), s/veh	85.7	0.0	25.9	1.4	70.6	0.5	0.4	0.0	60.3	82.9	0.0	2.9
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	20.7	0.0	31.6	1.8	26.0	3.9	3.7	0.0	19.6	20.0	0.0	12.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	132.2	0.0	67.1	44.2	125.1	45.2	43.3	0.0	117.8	128.8	0.0	42.8
LnGrp LOS	F	A	E	D	F	D	D	A	F	F	A	D
Approach Vol, veh/h		1220			695			509			848	
Approach Delay, s/veh		92.4			103.2			99.3			88.7	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	34.0	35.0	10.0	66.0	13.0	56.0	35.0	41.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	29.0	30.0	5.0	61.0	8.0	51.0	30.0	36.0
Max Q Clear Time (g_c+I1), s	31.0	32.0	5.8	60.2	10.0	30.9	32.0	38.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.4	0.0	2.7	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	94.8
HCM 6th LOS	F

HCM 6th Roundabout
3: S. Kamehameha Ave & Maui Lani Pkwy

Future (2045) No Project
AM Peak Hour

Intersection	
Intersection Delay, s/veh	203.1
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	905	726	579	1021
Demand Flow Rate, veh/h	928	749	591	1042
Vehicles Circulating, veh/h	688	795	1132	685
Vehicles Exiting, veh/h	1039	928	484	859
Ped Vol Crossing Leg, #/h	28	5	28	23
Ped Cap Adj	0.996	0.999	1.000	0.997
Approach Delay, s/veh	191.6	137.3	202.3	260.6
Approach LOS	F	F	F	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	928	749	591	1042
Cap Entry Lane, veh/h	684	613	435	686
Entry HV Adj Factor	0.976	0.970	0.979	0.980
Flow Entry, veh/h	905	726	579	1021
Cap Entry, veh/h	665	594	426	670
V/C Ratio	1.362	1.222	1.359	1.523
Control Delay, s/veh	191.6	137.3	202.3	260.6
LOS	F	F	F	F
95th %tile Queue, veh	39	27	27	51

HCM 6th Signalized Intersection Summary — Future (2045) No Project

4: Kuihelani Hwy & Maui Lani Pkwy — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	620	0	240	0	0	0	140	1280	0	0	880	450
Future Volume (veh/h)	620	0	240	0	0	0	140	1280	0	0	880	450
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	1870	1870	1870	1870	1870	1870	1841	1870	1870	1841	1856
Adj Flow Rate, veh/h	653	0	0	0	0	0	147	1347	0	0	926	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, %	3	2	2	2	2	2	2	4	2	2	4	3
Cap, veh/h	729	0		0	890	0	160	1492	0	1	1045	
Arrive On Green	0.48	0.00	0.00	0.00	0.00	0.00	0.09	0.43	0.00	0.00	0.30	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3589	0	1781	3497	1572
Grp Volume(v), veh/h	653	0	0	0	0	0	147	1347	0	0	926	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1749	0	1781	1749	1572
Q Serve(g_s), s	59.6	0.0	0.0	0.0	0.0	0.0	10.9	47.9	0.0	0.0	33.6	0.0
Cycle Q Clear(g_c), s	59.6	0.0	0.0	0.0	0.0	0.0	10.9	47.9	0.0	0.0	33.6	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	729	0		0	890	0	160	1492	0	1	1045	
V/C Ratio(X)	0.90	0.00		0.00	0.00	0.00	0.92	0.90	0.00	0.00	0.89	
Avail Cap(c_a), veh/h	778	0		0	983	0	160	1492	0	40	1103	
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	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	33.9	0.0	0.0	0.0	0.0	0.0	60.1	35.6	0.0	0.0	44.5	0.0
Incr Delay (d2), s/veh	12.0	0.0	0.0	0.0	0.0	0.0	46.4	8.4	0.0	0.0	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	22.7	0.0	0.0	0.0	0.0	0.0	6.8	20.6	0.0	0.0	15.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	45.9	0.0	0.0	0.0	0.0	0.0	106.5	44.1	0.0	0.0	53.9	0.0
LnGrp LOS	D	A		A	A	A	F	D	A	A	D	
Approach Vol, veh/h		653	A		0			1494			926	A
Approach Delay, s/veh		45.9			0.0			50.2			53.9	
Approach LOS		D						D			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	0.0	63.8		69.4	17.0	46.8		69.4
Change Period (Y+Rc), s	5.0	7.0		6.0	5.0	7.0		* 6
Max Green Setting (Gmax), s	3.0	51.0		68.0	12.0	42.0		* 70
Max Q Clear Time (g_c+I1), s	0.0	49.9		61.6	12.9	35.6		0.0
Green Ext Time (p_c), s	0.0	1.0		1.8	0.0	4.2		0.0

Intersection Summary	
HCM 6th Ctrl Delay	50.4
HCM 6th LOS	D

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) No Project

5: Honoapiilani Hwy & Waiko Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	40	30	30	250	20	40	10	1140	330	120	1070	20
Future Volume (veh/h)	40	30	30	250	20	40	10	1140	330	120	1070	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	0.99		0.97	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	1856	1856	1856	1870	1856	1870	1870	1870	1856	1856	1870	1870
Adj Flow Rate, veh/h	42	32	7	263	21	40	11	1200	341	126	1126	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, %	3	3	3	2	3	2	2	2	3	3	2	2
Cap, veh/h	207	148	293	219	14	27	172	925	263	107	1291	
Arrive On Green	0.19	0.19	0.19	0.19	0.19	0.19	0.01	0.66	0.66	0.03	0.69	0.00
Sat Flow, veh/h	882	769	1518	911	73	139	1781	1392	396	1767	1870	1585
Grp Volume(v), veh/h	74	0	7	324	0	0	11	0	1541	126	1126	0
Grp Sat Flow(s),veh/h/ln	1651	0	1518	1123	0	0	1781	0	1787	1767	1870	1585
Q Serve(g_s), s	0.0	0.0	0.6	23.5	0.0	0.0	0.3	0.0	100.0	5.0	70.5	0.0
Cycle Q Clear(g_c), s	5.5	0.0	0.6	29.0	0.0	0.0	0.3	0.0	100.0	5.0	70.5	0.0
Prop In Lane	0.57		1.00	0.81		0.12	1.00		0.22	1.00		1.00
Lane Grp Cap(c), veh/h	356	0	293	260	0	0	172	0	1188	107	1291	
V/C Ratio(X)	0.21	0.00	0.02	1.25	0.00	0.00	0.06	0.00	1.30	1.18	0.87	
Avail Cap(c_a), veh/h	356	0	293	260	0	0	194	0	1188	107	1291	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	51.2	0.0	49.3	65.5	0.0	0.0	23.2	0.0	25.3	52.0	18.1	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	139.5	0.0	0.0	0.1	0.0	140.2	144.4	7.3	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	2.4	0.0	0.2	20.2	0.0	0.0	0.2	0.0	85.7	8.4	31.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.3	0.0	49.3	204.9	0.0	0.0	23.3	0.0	165.5	196.4	25.4	0.0
LnGrp LOS	D	A	D	F	A	A	C	A	F	F	C	
Approach Vol, veh/h		81			324			1552			1252	A
Approach Delay, s/veh		51.1			204.9			164.5			42.6	
Approach LOS		D			F			F			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	9.0	106.0		35.5	5.1	109.9		35.5
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5
Max Green Setting (Gmax), s	5.0	100.0		28.5	3.0	102.0		* 29
Max Q Clear Time (g_c+I1), s	7.0	102.0		7.5	2.3	72.5		31.0
Green Ext Time (p_c), s	0.0	0.0		0.2	0.0	20.6		0.0

Intersection Summary	
HCM 6th Ctrl Delay	118.2
HCM 6th LOS	F

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection						
Int Delay, s/veh	97.7					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	100	400	220	140	340	90
Future Vol, veh/h	100	400	220	140	340	90
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	3	2	3	4	2	2
Mvmt Flow	105	421	232	147	358	95

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	384	0	-	0	947	316
Stage 1	-	-	-	-	311	-
Stage 2	-	-	-	-	636	-
Critical Hdwy	4.13	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.227	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1169	-	-	-	~ 290	724
Stage 1	-	-	-	-	743	-
Stage 2	-	-	-	-	527	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1164	-	-	-	~ 254	718
Mov Cap-2 Maneuver	-	-	-	-	~ 254	-
Stage 1	-	-	-	-	652	-
Stage 2	-	-	-	-	525	-

Approach	EB	WB	SB
HCM Control Delay, s	1.7	0	291
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1164	-	-	-	294
HCM Lane V/C Ratio	0.09	-	-	-	1.54
HCM Control Delay (s)	8.4	0	-	-	291
HCM Lane LOS	A	A	-	-	F
HCM 95th %tile Q(veh)	0.3	-	-	-	26.3

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	630	100	50	790	760	360
Future Volume (veh/h)	630	100	50	790	760	360
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	1856	1841	1870	1870	1841	1841
Adj Flow Rate, veh/h	663	99	53	832	800	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	4	2	2	4	4
Cap, veh/h	693	103	76	1314	929	
Arrive On Green	0.46	0.46	0.04	0.37	0.27	0.00
Sat Flow, veh/h	1511	226	1781	3647	3589	1560
Grp Volume(v), veh/h	763	0	53	832	800	0
Grp Sat Flow(s),veh/h/ln	1739	0	1781	1777	1749	1560
Q Serve(g_s), s	34.5	0.0	2.4	15.7	17.8	0.0
Cycle Q Clear(g_c), s	34.5	0.0	2.4	15.7	17.8	0.0
Prop In Lane	0.87	0.13	1.00			1.00
Lane Grp Cap(c), veh/h	798	0	76	1314	929	
V/C Ratio(X)	0.96	0.00	0.69	0.63	0.86	
Avail Cap(c_a), veh/h	895	0	109	1481	1029	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.3	0.0	38.5	21.2	28.5	0.0
Incr Delay (d2), s/veh	18.6	0.0	4.2	0.7	7.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	16.9	0.0	1.1	6.0	7.7	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	39.9	0.0	42.7	21.9	35.6	0.0
LnGrp LOS	D	A	D	C	D	
Approach Vol, veh/h	763			885	800	A
Approach Delay, s/veh	39.9			23.1	35.6	
Approach LOS	D			C	D	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		37.2		44.4	8.5	28.7
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		34.0		42.0	5.0	24.0
Max Q Clear Time (g_c+I1), s		17.7		36.5	4.4	19.8
Green Ext Time (p_c), s		4.8		0.9	0.0	1.9

Intersection Summary	
HCM 6th Ctrl Delay	32.4
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.
Unsignalized Delay for [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	20	100	80	20	480	60	630	40	260	890	190
Future Volume (veh/h)	320	20	100	80	20	480	60	630	40	260	890	190
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	0.99		0.96	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1870	1856	1870	1870	1870	1856	1856
Adj Flow Rate, veh/h	337	21	32	84	21	298	63	663	19	274	937	141
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, %	3	2	2	2	2	2	3	2	2	2	3	3
Cap, veh/h	317	202	307	373	20	279	111	833	687	331	953	787
Arrive On Green	0.15	0.31	0.31	0.04	0.19	0.19	0.03	0.45	0.45	0.10	0.51	0.51
Sat Flow, veh/h	1767	655	998	1781	102	1444	1767	1870	1542	1781	1856	1531
Grp Volume(v), veh/h	337	0	53	84	0	319	63	663	19	274	937	141
Grp Sat Flow(s),veh/h/ln	1767	0	1654	1781	0	1546	1767	1870	1542	1781	1856	1531
Q Serve(g_s), s	21.0	0.0	3.2	5.0	0.0	27.0	2.7	42.6	1.0	11.3	69.4	6.9
Cycle Q Clear(g_c), s	21.0	0.0	3.2	5.0	0.0	27.0	2.7	42.6	1.0	11.3	69.4	6.9
Prop In Lane	1.00		0.60	1.00		0.93	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	317	0	509	373	0	299	111	833	687	331	953	787
V/C Ratio(X)	1.06	0.00	0.10	0.23	0.00	1.07	0.57	0.80	0.03	0.83	0.98	0.18
Avail Cap(c_a), veh/h	317	0	509	373	0	299	111	833	687	375	956	789
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.1	0.0	34.6	43.6	0.0	56.4	33.7	33.3	21.8	27.2	33.4	18.2
Incr Delay (d2), s/veh	68.3	0.0	0.1	0.3	0.0	71.4	6.6	5.4	0.0	13.0	24.9	0.1
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	15.2	0.0	1.3	2.4	0.0	16.5	1.3	20.4	0.4	5.8	36.9	2.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	111.4	0.0	34.7	43.9	0.0	127.8	40.3	38.8	21.8	40.1	58.3	18.3
LnGrp LOS	F	A	C	D	A	F	D	D	C	D	E	B
Approach Vol, veh/h		390			403			745			1352	
Approach Delay, s/veh		101.0			110.4			38.5			50.5	
Approach LOS		F			F			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.6	66.3	9.0	47.0	8.0	75.8	25.0	31.0
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	17.0	59.0	5.0	43.0	4.0	72.0	21.0	27.0
Max Q Clear Time (g_c+I1), s	13.3	44.6	7.0	5.2	4.7	71.4	23.0	29.0
Green Ext Time (p_c), s	0.3	4.0	0.0	0.3	0.0	0.4	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	62.5
HCM 6th LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	10	30	180	10	50	10	640	100	30	1030	10
Future Volume (veh/h)	30	10	30	180	10	50	10	640	100	30	1030	10
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		0.96	1.00		0.97	1.00		0.98
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	1870	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	32	11	0	189	11	8	11	674	69	32	1084	8
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, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	58	20	69	238	14	214	166	1169	966	414	1194	986
Arrive On Green	0.04	0.04	0.00	0.14	0.14	0.14	0.01	0.62	0.62	0.02	0.64	0.64
Sat Flow, veh/h	1342	461	1585	1688	98	1518	1781	1870	1545	1781	1870	1545
Grp Volume(v), veh/h	43	0	0	200	0	8	11	674	69	32	1084	8
Grp Sat Flow(s),veh/h/ln	1803	0	1585	1786	0	1518	1781	1870	1545	1781	1870	1545
Q Serve(g_s), s	2.2	0.0	0.0	10.4	0.0	0.4	0.2	20.3	1.7	0.6	47.9	0.2
Cycle Q Clear(g_c), s	2.2	0.0	0.0	10.4	0.0	0.4	0.2	20.3	1.7	0.6	47.9	0.2
Prop In Lane	0.74		1.00	0.94		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	78	0	69	252	0	214	166	1169	966	414	1194	986
V/C Ratio(X)	0.55	0.00	0.00	0.79	0.00	0.04	0.07	0.58	0.07	0.08	0.91	0.01
Avail Cap(c_a), veh/h	395	0	347	391	0	332	221	1520	1256	446	1520	1256
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	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	45.0	0.0	0.0	39.9	0.0	35.6	18.0	10.6	7.1	8.3	14.9	6.3
Incr Delay (d2), s/veh	5.9	0.0	0.0	6.0	0.0	0.1	0.2	0.5	0.0	0.1	7.0	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	1.1	0.0	0.0	4.9	0.0	0.2	0.1	7.7	0.5	0.2	19.8	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	50.9	0.0	0.0	45.9	0.0	35.7	18.1	11.0	7.1	8.4	22.0	6.3
LnGrp LOS	D	A	A	D	A	D	B	B	A	A	C	A
Approach Vol, veh/h		43			208			754			1124	
Approach Delay, s/veh		50.9			45.5			10.8			21.5	
Approach LOS		D			D			B			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	6.3	64.0	8.2	5.0	65.3	17.6
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	4.0	78.0	21.0	4.0	78.0	21.0
Max Q Clear Time (g_c+I1), s	2.6	22.3	4.2	2.2	49.9	12.4
Green Ext Time (p_c), s	0.0	5.9	0.1	0.0	11.4	0.7

Intersection Summary	
HCM 6th Ctrl Delay	20.6
HCM 6th LOS	C

HCM 6th Roundabout
11: Waiale Rd & Makai Pkwy

Future (2045) No Project
AM Peak Hour

Intersection	
Intersection Delay, s/veh	3.8
Intersection LOS	A

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	147	127	148
Demand Flow Rate, veh/h	150	129	151
Vehicles Circulating, veh/h	11	64	118
Vehicles Exiting, veh/h	258	97	75
Ped Vol Crossing Leg, #/h	5	5	5
Ped Cap Adj	0.999	0.999	0.999
Approach Delay, s/veh	3.6	3.6	4.0
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	LR	LT	TR
Assumed Moves	LR	LT	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	150	129	151
Cap Entry Lane, veh/h	1364	1293	1223
Entry HV Adj Factor	0.980	0.983	0.979
Flow Entry, veh/h	147	127	148
Cap Entry, veh/h	1336	1270	1197
V/C Ratio	0.110	0.100	0.124
Control Delay, s/veh	3.6	3.6	4.0
LOS	A	A	A
95th %tile Queue, veh	0	0	0

HCM 6th Signalized Intersection Summary
12: Honoapiilani Hwy & Kuihelani Hwy

Future (2045) No Project
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	760	10	90	10	660	720	130	1110	10
Future Volume (veh/h)	10	10	10	760	10	90	10	660	720	130	1110	10
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	1870	1856	1856	1856	1870	1856	1870	1870	1870	1870	1856
Adj Flow Rate, veh/h	11	11	0	808	0	0	11	695	0	137	1168	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, %	3	2	3	3	3	2	3	2	2	2	2	3
Cap, veh/h	23	23		961	0		24	1134		173	1431	
Arrive On Green	0.03	0.03	0.00	0.27	0.00	0.00	0.01	0.32	0.00	0.10	0.40	0.00
Sat Flow, veh/h	912	912	0	3534	0	1585	1767	3554	1585	1781	3554	1572
Grp Volume(v), veh/h	22	0	0	808	0	0	11	695	0	137	1168	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1767	0	1585	1767	1777	1585	1781	1777	1572
Q Serve(g_s), s	0.8	0.0	0.0	14.3	0.0	0.0	0.4	11.0	0.0	5.0	19.4	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0	14.3	0.0	0.0	0.4	11.0	0.0	5.0	19.4	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	46	0		961	0		24	1134		173	1431	
V/C Ratio(X)	0.48	0.00		0.84	0.00		0.45	0.61		0.79	0.82	
Avail Cap(c_a), veh/h	138	0		1172	0		133	1339		242	1553	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	31.9	0.0	0.0	22.8	0.0	0.0	32.5	19.1	0.0	29.3	17.6	0.0
Incr Delay (d2), s/veh	7.6	0.0	0.0	4.7	0.0	0.0	4.7	0.8	0.0	7.4	3.5	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	0.4	0.0	0.0	6.1	0.0	0.0	0.2	4.2	0.0	2.4	7.6	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.5	0.0	0.0	27.5	0.0	0.0	37.2	20.0	0.0	36.6	21.2	0.0
LnGrp LOS	D	A		C	A		D	B		D	C	
Approach Vol, veh/h		22	A		808	A		706	A		1305	A
Approach Delay, s/veh		39.5			27.5			20.2			22.8	
Approach LOS		D			C			C			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	10.5	26.2		23.0	4.9	31.7		6.7
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0
Max Green Setting (Gmax), s	9.0	25.0		22.0	5.0	29.0		5.0
Max Q Clear Time (g_c+I1), s	7.0	13.0		16.3	2.4	21.4		2.8
Green Ext Time (p_c), s	0.0	4.7		1.7	0.0	5.3		0.0

Intersection Summary	
HCM 6th Ctrl Delay	23.6
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.
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)	50	170	60	560	200	290	80	630	530	290	750	60
Future Volume (veh/h)	50	170	60	560	200	290	80	630	530	290	750	60
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		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	1870	1870	1870	1870	1870	1856	1870	1856	1870
Adj Flow Rate, veh/h	52	177	0	583	208	0	83	656	0	302	781	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, %	2	2	2	2	2	2	2	2	3	2	3	2
Cap, veh/h	225	174		552	628		160	684		294	837	
Arrive On Green	0.04	0.09	0.00	0.28	0.34	0.00	0.04	0.37	0.00	0.12	0.45	0.00
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Grp Volume(v), veh/h	52	177	0	583	208	0	83	656	0	302	781	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Q Serve(g_s), s	3.4	12.0	0.0	36.0	10.7	0.0	3.8	44.3	0.0	16.0	51.6	0.0
Cycle Q Clear(g_c), s	3.4	12.0	0.0	36.0	10.7	0.0	3.8	44.3	0.0	16.0	51.6	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	225	174		552	628		160	684		294	837	
V/C Ratio(X)	0.23	1.02		1.06	0.33		0.52	0.96		1.03	0.93	
Avail Cap(c_a), veh/h	231	174		552	628		160	694		294	847	
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	50.6	58.7	0.0	36.8	32.1	0.0	31.3	40.0	0.0	38.5	33.7	0.0
Incr Delay (d2), s/veh	0.5	73.6	0.0	54.2	0.2	0.0	1.3	24.7	0.0	59.5	17.5	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	1.6	9.2	0.0	23.8	4.9	0.0	1.6	24.1	0.0	14.2	25.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	51.2	132.2	0.0	91.1	32.3	0.0	32.6	64.7	0.0	98.0	51.1	0.0
LnGrp LOS	D	F		F	C		C	E		F	D	
Approach Vol, veh/h		229	A		791	A		739	A		1083	A
Approach Delay, s/veh		113.8			75.6			61.1			64.2	
Approach LOS		F			E			E			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	52.3	40.0	17.0	9.0	63.3	8.6	48.4
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	16.0	48.0	36.0	12.0	5.0	59.0	5.0	43.0
Max Q Clear Time (g_c+I1), s	18.0	46.3	38.0	14.0	5.8	53.6	5.4	12.7
Green Ext Time (p_c), s	0.0	1.0	0.0	0.0	0.0	3.4	0.0	1.0

Intersection Summary	
HCM 6th Ctrl Delay	70.6
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)	360	540	60	100	640	410	110	200	60	460	200	260
Future Volume (veh/h)	360	540	60	100	640	410	110	200	60	460	200	260
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.96	0.99		0.97
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	1870	1856	1856	1856	1856	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	379	568	60	105	674	179	116	211	57	484	211	242
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, %	3	2	3	3	3	3	2	3	2	2	3	2
Cap, veh/h	331	763	81	257	627	516	189	241	65	413	240	275
Arrive On Green	0.16	0.46	0.46	0.04	0.34	0.34	0.05	0.17	0.17	0.19	0.31	0.31
Sat Flow, veh/h	1767	1658	175	1767	1856	1526	1781	1394	376	1781	775	888
Grp Volume(v), veh/h	379	0	628	105	674	179	116	0	268	484	0	453
Grp Sat Flow(s),veh/h/ln	1767	0	1833	1767	1856	1526	1781	0	1770	1781	0	1663
Q Serve(g_s), s	22.0	0.0	39.1	5.0	47.0	12.2	7.0	0.0	20.5	26.0	0.0	35.9
Cycle Q Clear(g_c), s	22.0	0.0	39.1	5.0	47.0	12.2	7.0	0.0	20.5	26.0	0.0	35.9
Prop In Lane	1.00		0.10	1.00		1.00	1.00		0.21	1.00		0.53
Lane Grp Cap(c), veh/h	331	0	844	257	627	516	189	0	306	413	0	515
V/C Ratio(X)	1.14	0.00	0.74	0.41	1.07	0.35	0.61	0.00	0.87	1.17	0.00	0.88
Avail Cap(c_a), veh/h	331	0	844	257	627	516	189	0	382	413	0	586
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	46.2	0.0	30.8	32.5	46.0	34.5	47.1	0.0	56.0	37.9	0.0	45.5
Incr Delay (d2), s/veh	94.4	0.0	3.6	0.4	57.7	0.4	4.2	0.0	16.8	100.2	0.0	13.2
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	15.9	0.0	18.2	2.4	31.8	4.7	3.6	0.0	10.7	23.1	0.0	16.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	140.6	0.0	34.4	32.9	103.8	34.9	51.3	0.0	72.8	138.1	0.0	58.8
LnGrp LOS	F	A	C	C	F	C	D	A	E	F	A	E
Approach Vol, veh/h		1007			958			384			937	
Approach Delay, s/veh		74.4			83.1			66.3			99.7	
Approach LOS		E			F			E			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	31.0	29.1	10.0	69.0	12.0	48.1	27.0	52.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	26.0	30.0	5.0	64.0	7.0	49.0	22.0	47.0
Max Q Clear Time (g_c+I1), s	28.0	22.5	7.0	41.1	9.0	37.9	24.0	49.0
Green Ext Time (p_c), s	0.0	0.9	0.0	4.8	0.0	2.4	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	83.2
HCM 6th LOS	F

Intersection	
Intersection Delay, s/veh	169.7
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1031	959	288	918
Demand Flow Rate, veh/h	1055	982	293	937
Vehicles Circulating, veh/h	515	683	1161	651
Vehicles Exiting, veh/h	1073	771	409	1014
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	1.000	0.999
Approach Delay, s/veh	159.2	220.0	29.6	173.0
Approach LOS	F	F	D	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1055	982	293	937
Cap Entry Lane, veh/h	816	688	422	710
Entry HV Adj Factor	0.977	0.976	0.982	0.980
Flow Entry, veh/h	1031	959	288	918
Cap Entry, veh/h	797	671	415	695
V/C Ratio	1.294	1.429	0.694	1.320
Control Delay, s/veh	159.2	220.0	29.6	173.0
LOS	F	F	D	F
95th %tile Queue, veh	39	44	5	37

HCM 6th Signalized Intersection Summary
4: Kuihelani Hwy & Maui Lani Pkwy

Future (2045) No Project
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥		↰	↑↑↱		↰	↑↑	↱
Traffic Volume (veh/h)	520	0	160	0	0	0	250	1130	0	10	1300	670
Future Volume (veh/h)	520	0	160	0	0	0	250	1130	0	10	1300	670
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	1856	1870	1870	1870	1870	1856	1870	1870	1841	1870
Adj Flow Rate, veh/h	547	0	0	0	0	0	263	1189	0	11	1368	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, %	2	2	3	2	2	2	2	3	2	2	4	2
Cap, veh/h	556	0		0	655	0	223	1736	0	14	1312	
Arrive On Green	0.35	0.00	0.00	0.00	0.00	0.00	0.13	0.49	0.00	0.01	0.38	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3618	0	1781	3497	1585
Grp Volume(v), veh/h	547	0	0	0	0	0	263	1189	0	11	1368	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1763	0	1781	1749	1585
Q Serve(g_s), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.0	0.0	0.7	45.0	0.0
Cycle Q Clear(g_c), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.0	0.0	0.7	45.0	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	556	0		0	655	0	223	1736	0	14	1312	
V/C Ratio(X)	0.98	0.00		0.00	0.00	0.00	1.18	0.69	0.00	0.80	1.04	
Avail Cap(c_a), veh/h	556	0		0	686	0	223	1736	0	45	1312	
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	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	41.0	0.0	0.0	0.0	0.0	0.0	52.5	23.3	0.0	59.4	37.5	0.0
Incr Delay (d2), s/veh	33.8	0.0	0.0	0.0	0.0	0.0	118.0	1.5	0.0	31.9	36.9	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	22.0	0.0	0.0	0.0	0.0	0.0	13.7	11.9	0.0	0.4	24.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	74.7	0.0	0.0	0.0	0.0	0.0	170.5	24.8	0.0	91.4	74.4	0.0
LnGrp LOS	E	A		A	A	A	F	C	A	F	F	
Approach Vol, veh/h		547	A		0			1452			1379	A
Approach Delay, s/veh		74.7			0.0			51.2			74.5	
Approach LOS		E						D			E	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	5.9	66.1	48.0	20.0	52.0	48.0
Change Period (Y+Rc), s	5.0	7.0	6.0	5.0	7.0	* 6
Max Green Setting (Gmax), s	3.0	57.0	42.0	15.0	45.0	* 44
Max Q Clear Time (g_c+I1), s	2.7	33.0	44.0	17.0	47.0	0.0
Green Ext Time (p_c), s	0.0	14.3	0.0	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	64.5
HCM 6th LOS	E

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
5: Honoapiilani Hwy & Waiko Rd

Future (2045) No Project
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		✥		↰	↑↱		↰	↑	↱
Traffic Volume (veh/h)	30	30	20	500	30	50	20	1120	320	60	1190	40
Future Volume (veh/h)	30	30	20	500	30	50	20	1120	320	60	1190	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.97	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	1870	1870	1870	1870	1870	1856	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	32	32	6	526	32	52	21	1179	331	63	1253	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, %	3	2	2	2	2	2	3	2	3	2	2	2
Cap, veh/h	295	284	484	392	21	34	68	779	219	83	1059	
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.01	0.56	0.56	0.02	0.57	0.00
Sat Flow, veh/h	829	909	1550	1111	68	110	1767	1396	392	1781	1870	1585
Grp Volume(v), veh/h	64	0	6	610	0	0	21	0	1510	63	1253	0
Grp Sat Flow(s),veh/h/ln	1738	0	1550	1289	0	0	1767	0	1787	1781	1870	1585
Q Serve(g_s), s	0.0	0.0	0.4	43.2	0.0	0.0	0.8	0.0	84.0	2.3	85.2	0.0
Cycle Q Clear(g_c), s	3.8	0.0	0.4	47.0	0.0	0.0	0.8	0.0	84.0	2.3	85.2	0.0
Prop In Lane	0.50		1.00	0.86		0.09	1.00		0.22	1.00		1.00
Lane Grp Cap(c), veh/h	579	0	484	447	0	0	68	0	998	83	1059	
V/C Ratio(X)	0.11	0.00	0.01	1.36	0.00	0.00	0.31	0.00	1.51	0.76	1.18	
Avail Cap(c_a), veh/h	579	0	484	447	0	0	83	0	998	83	1059	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	36.9	0.0	35.7	55.8	0.0	0.0	37.5	0.0	33.3	37.3	32.6	0.0
Incr Delay (d2), s/veh	0.0	0.0	0.0	177.9	0.0	0.0	0.9	0.0	236.4	29.1	92.0	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	1.7	0.0	0.2	39.6	0.0	0.0	0.4	0.0	100.7	2.0	64.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.9	0.0	35.7	233.7	0.0	0.0	38.5	0.0	269.6	66.4	124.7	0.0
LnGrp LOS	D	A	D	F	A	A	D	A	F	E	F	
Approach Vol, veh/h		70			610			1531			1316	A
Approach Delay, s/veh		36.8			233.7			266.4			121.9	
Approach LOS		D			F			F			F	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	7.0	90.0	53.5	5.8	91.2	53.5
Change Period (Y+Rc), s	4.0	6.0	6.5	4.0	6.0	* 6.5
Max Green Setting (Gmax), s	3.0	84.0	46.5	3.0	84.0	* 47
Max Q Clear Time (g_c+I1), s	4.3	86.0	5.8	2.8	87.2	49.0
Green Ext Time (p_c), s	0.0	0.0	0.2	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	202.3
HCM 6th LOS	F

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th TWSC — Future (2045) No Project
6: Waiko Rd & Waiale Rd — PM Peak Hour

Intersection	
Int Delay, s/veh	34.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	120	300	460	280	170	70
Future Vol, veh/h	120	300	460	280	170	70
Conflicting Peds, #/hr	5	0	0	5	5	5
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	3	2	2	3	2
Mvmt Flow	126	316	484	295	179	74

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	784	0	-	0	1210	642
Stage 1	-	-	-	-	637	-
Stage 2	-	-	-	-	573	-
Critical Hdwy	4.12	-	-	-	6.43	6.22
Critical Hdwy Stg 1	-	-	-	-	5.43	-
Critical Hdwy Stg 2	-	-	-	-	5.43	-
Follow-up Hdwy	2.218	-	-	-	3.527	3.318
Pot Cap-1 Maneuver	834	-	-	-	201	474
Stage 1	-	-	-	-	525	-
Stage 2	-	-	-	-	562	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	831	-	-	-	~ 163	470
Mov Cap-2 Maneuver	-	-	-	-	~ 163	-
Stage 1	-	-	-	-	427	-
Stage 2	-	-	-	-	560	-

Approach	EB	WB	SB
HCM Control Delay, s	2.9	0	196.8
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	831	-	-	-	201
HCM Lane V/C Ratio	0.152	-	-	-	1.257
HCM Control Delay (s)	10.1	0	-	-	196.8
HCM Lane LOS	B	A	-	-	F
HCM 95th %tile Q(veh)	0.5	-	-	-	13.5

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

HCM 6th Signalized Intersection Summary — Future (2045) No Project
7: Kuihelani Hwy & Waiko Rd — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	440	60	70	940	990	470
Future Volume (veh/h)	440	60	70	940	990	470
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	0.98	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	1856	1870	1841	1856	1856	1856
Adj Flow Rate, veh/h	463	57	74	989	1042	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	2	4	3	3	3
Cap, veh/h	510	63	100	1587	1108	
Arrive On Green	0.33	0.33	0.06	0.45	0.31	0.00
Sat Flow, veh/h	1546	190	1753	3618	3618	1572
Grp Volume(v), veh/h	521	0	74	989	1042	0
Grp Sat Flow(s),veh/h/ln	1740	0	1753	1763	1763	1572
Q Serve(g_s), s	18.2	0.0	2.6	13.6	18.3	0.0
Cycle Q Clear(g_c), s	18.2	0.0	2.6	13.6	18.3	0.0
Prop In Lane	0.89	0.11	1.00			1.00
Lane Grp Cap(c), veh/h	574	0	100	1587	1108	
V/C Ratio(X)	0.91	0.00	0.74	0.62	0.94	
Avail Cap(c_a), veh/h	711	0	138	1662	1108	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	20.4	0.0	29.5	13.4	21.2	0.0
Incr Delay (d2), s/veh	12.1	0.0	7.0	0.7	15.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.6	0.0	1.2	4.4	8.6	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	32.5	0.0	36.6	14.1	36.2	0.0
LnGrp LOS	C	A	D	B	D	
Approach Vol, veh/h	521			1063	1042	A
Approach Delay, s/veh	32.5			15.6	36.2	
Approach LOS	C			B	D	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		35.6		28.0	8.6	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		30.0		26.0	5.0	20.0
Max Q Clear Time (g_c+I1), s		15.6		20.2	4.6	20.3
Green Ext Time (p_c), s		5.5		0.5	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	27.1
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [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)	250	20	80	50	20	320	100	870	70	450	940	320
Future Volume (veh/h)	250	20	80	50	20	320	100	870	70	450	940	320
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		0.96	0.96		0.93	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1856	1870	1870	1870	1870
Adj Flow Rate, veh/h	263	21	12	53	21	32	105	916	36	474	989	255
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, %	2	2	2	2	2	2	2	3	2	2	2	2
Cap, veh/h	287	150	85	201	41	63	262	908	755	449	1252	1034
Arrive On Green	0.11	0.14	0.14	0.04	0.06	0.06	0.04	0.49	0.49	0.22	0.67	0.67
Sat Flow, veh/h	1781	1097	627	1781	638	972	1781	1856	1543	1781	1870	1545
Grp Volume(v), veh/h	263	0	33	53	0	53	105	916	36	474	989	255
Grp Sat Flow(s),veh/h/ln	1781	0	1724	1781	0	1610	1781	1856	1543	1781	1870	1545
Q Serve(g_s), s	15.0	0.0	2.3	3.8	0.0	4.4	4.1	68.0	1.7	31.0	51.5	9.1
Cycle Q Clear(g_c), s	15.0	0.0	2.3	3.8	0.0	4.4	4.1	68.0	1.7	31.0	51.5	9.1
Prop In Lane	1.00		0.36	1.00		0.60	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	287	0	235	201	0	104	262	908	755	449	1252	1034
V/C Ratio(X)	0.92	0.00	0.14	0.26	0.00	0.51	0.40	1.01	0.05	1.06	0.79	0.25
Avail Cap(c_a), veh/h	287	0	372	201	0	232	262	908	755	449	1252	1034
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	55.6	0.0	52.8	58.0	0.0	62.9	19.4	35.5	18.5	47.8	16.1	9.1
Incr Delay (d2), s/veh	32.0	0.0	0.3	0.7	0.0	3.9	1.0	32.0	0.0	57.8	3.5	0.1
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	1.0	1.8	0.0	1.9	1.8	38.0	0.6	22.1	22.0	3.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	87.7	0.0	53.1	58.6	0.0	66.7	20.4	67.5	18.6	105.6	19.6	9.2
LnGrp LOS	F	A	D	E	A	E	C	F	B	F	B	A
Approach Vol, veh/h		296			106			1057			1718	
Approach Delay, s/veh		83.8			62.7			61.2			41.8	
Approach LOS		F			E			E			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	35.0	72.0	9.0	22.9	10.0	97.0	19.0	12.9
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	31.0	68.0	5.0	30.0	6.0	93.0	15.0	20.0
Max Q Clear Time (g_c+I1), s	33.0	70.0	5.8	4.3	6.1	53.5	17.0	6.4
Green Ext Time (p_c), s	0.0	0.0	0.0	0.1	0.0	12.1	0.0	0.2

Intersection Summary	
HCM 6th Ctrl Delay	52.8
HCM 6th LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	10	30	120	10	30	30	970	160	50	1000	20
Future Volume (veh/h)	20	10	30	120	10	30	30	970	160	50	1000	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.91	1.00		0.95	1.00		0.97	1.00		0.98
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	1870	1870	1870	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	21	11	3	126	11	5	32	1021	133	53	1053	16
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, %	2	2	2	2	2	2	2	3	2	2	3	2
Cap, veh/h	47	25	57	179	16	164	216	1168	973	231	1184	986
Arrive On Green	0.04	0.04	0.04	0.11	0.11	0.11	0.02	0.63	0.63	0.03	0.64	0.64
Sat Flow, veh/h	1188	623	1448	1645	144	1507	1781	1856	1545	1781	1856	1545
Grp Volume(v), veh/h	32	0	3	137	0	5	32	1021	133	53	1053	16
Grp Sat Flow(s),veh/h/ln	1811	0	1448	1788	0	1507	1781	1856	1545	1781	1856	1545
Q Serve(g_s), s	1.5	0.0	0.2	6.3	0.0	0.3	0.5	38.4	3.0	0.9	40.2	0.3
Cycle Q Clear(g_c), s	1.5	0.0	0.2	6.3	0.0	0.3	0.5	38.4	3.0	0.9	40.2	0.3
Prop In Lane	0.66		1.00	0.92		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	71	0	57	194	0	164	216	1168	973	231	1184	986
V/C Ratio(X)	0.45	0.00	0.05	0.70	0.00	0.03	0.15	0.87	0.14	0.23	0.89	0.02
Avail Cap(c_a), veh/h	449	0	359	443	0	373	255	1708	1422	255	1708	1422
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	39.8	0.0	39.2	36.5	0.0	33.8	15.0	12.9	6.4	14.7	12.8	5.6
Incr Delay (d2), s/veh	4.4	0.0	0.4	4.6	0.0	0.1	0.3	3.7	0.1	0.5	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	0.7	0.0	0.1	2.9	0.0	0.1	0.3	14.5	0.9	0.5	15.2	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.2	0.0	39.6	41.1	0.0	33.9	15.3	16.7	6.4	15.2	17.3	5.6
LnGrp LOS	D	A	D	D	A	C	B	B	A	B	B	A
Approach Vol, veh/h		35			142			1186			1122	
Approach Delay, s/veh		43.8			40.8			15.5			17.0	
Approach LOS		D			D			B			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	6.9	57.4		7.3	6.1	58.1		13.2
Change Period (Y+Rc), s	4.0	4.0		4.0	4.0	4.0		4.0
Max Green Setting (Gmax), s	4.0	78.0		21.0	4.0	78.0		21.0
Max Q Clear Time (g_c+I1), s	2.9	40.4		3.5	2.5	42.2		8.3
Green Ext Time (p_c), s	0.0	11.9		0.1	0.0	11.8		0.5

Intersection Summary	
HCM 6th Ctrl Delay	18.0
HCM 6th LOS	B

Intersection			
Intersection Delay, s/veh	3.9		
Intersection LOS	A		

Approach	EB	NB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	232	106	85
Demand Flow Rate, veh/h	236	108	86
Vehicles Circulating, veh/h	11	118	97
Vehicles Exiting, veh/h	172	129	129
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	4.1	3.7	3.5
Approach LOS	A	A	A

Lane	Left	Left	Left
Designated Moves	LR	LT	TR
Assumed Moves	LR	LT	TR
RT Channelized			
Lane Util	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976
Entry Flow, veh/h	236	108	86
Cap Entry Lane, veh/h	1364	1223	1250
Entry HV Adj Factor	0.983	0.979	0.986
Flow Entry, veh/h	232	106	85
Cap Entry, veh/h	1341	1198	1232
V/C Ratio	0.173	0.088	0.069
Control Delay, s/veh	4.1	3.7	3.5
LOS	A	A	A
95th %tile Queue, veh	1	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	940	10	120	10	1040	930	100	1080	20
Future Volume (veh/h)	10	10	10	940	10	120	10	1040	930	100	1080	20
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	1870	1870	1841	1870	1856	1856	1870	1870	1841
Adj Flow Rate, veh/h	10	10	0	986	0	0	10	1083	0	104	1125	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, %	2	2	2	2	2	4	2	3	3	2	2	4
Cap, veh/h	20	20		1116	0		22	1262		131	1489	
Arrive On Green	0.02	0.02	0.00	0.31	0.00	0.00	0.01	0.36	0.00	0.07	0.42	0.00
Sat Flow, veh/h	912	912	0	3563	0	1560	1781	3526	1572	1781	3554	1560
Grp Volume(v), veh/h	20	0	0	986	0	0	10	1083	0	104	1125	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1781	0	1560	1781	1763	1572	1781	1777	1560
Q Serve(g_s), s	0.9	0.0	0.0	21.4	0.0	0.0	0.5	23.2	0.0	4.7	22.0	0.0
Cycle Q Clear(g_c), s	0.9	0.0	0.0	21.4	0.0	0.0	0.5	23.2	0.0	4.7	22.0	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	41	0		1116	0		22	1262		131	1489	
V/C Ratio(X)	0.49	0.00		0.88	0.00		0.45	0.86		0.79	0.76	
Avail Cap(c_a), veh/h	112	0		1266	0		109	1340		131	1489	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.4	0.0	0.0	26.6	0.0	0.0	40.0	24.3	0.0	37.2	20.1	0.0
Incr Delay (d2), s/veh	8.9	0.0	0.0	7.0	0.0	0.0	5.3	5.8	0.0	25.7	2.4	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	0.5	0.0	0.0	9.7	0.0	0.0	0.2	10.0	0.0	2.9	8.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	48.3	0.0	0.0	33.6	0.0	0.0	45.3	30.1	0.0	62.9	22.6	0.0
LnGrp LOS	D	A		C	A		D	C		E	C	
Approach Vol, veh/h		20	A		986	A		1093	A		1229	A
Approach Delay, s/veh		48.3			33.6			30.2			26.0	
Approach LOS		D			C			C			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	10.0	34.2	30.6	5.0	39.2	6.8
Change Period (Y+Rc), s	4.0	5.0	5.0	4.0	5.0	5.0
Max Green Setting (Gmax), s	6.0	31.0	29.0	5.0	32.0	5.0
Max Q Clear Time (g_c+I1), s	6.7	25.2	23.4	2.5	24.0	2.9
Green Ext Time (p_c), s	0.0	4.0	2.1	0.0	5.4	0.0

Intersection Summary	
HCM 6th Ctrl Delay	29.8
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

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)	80	260	110	370	140	290	40	670	420	370	630	40
Future Volume (veh/h)	80	260	110	370	140	290	40	670	420	370	630	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		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	1826	1870	1841	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	84	274	0	389	147	0	42	705	0	389	663	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, %	2	2	2	5	2	4	2	2	2	2	2	2
Cap, veh/h	315	255		350	476		302	697		357	942	
Arrive On Green	0.05	0.14	0.00	0.16	0.25	0.00	0.03	0.37	0.00	0.16	0.50	0.00
Sat Flow, veh/h	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Grp Volume(v), veh/h	84	274	0	389	147	0	42	705	0	389	663	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1739	1870	1560	1781	1870	1585	1781	1870	1585
Q Serve(g_s), s	4.5	15.0	0.0	18.0	7.0	0.0	1.6	41.0	0.0	18.0	30.0	0.0
Cycle Q Clear(g_c), s	4.5	15.0	0.0	18.0	7.0	0.0	1.6	41.0	0.0	18.0	30.0	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	315	255		350	476		302	697		357	942	
V/C Ratio(X)	0.27	1.07		1.11	0.31		0.14	1.01		1.09	0.70	
Avail Cap(c_a), veh/h	315	255		350	476		325	697		357	942	
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	38.6	47.5	0.0	33.9	33.2	0.0	21.1	34.5	0.0	35.4	21.0	0.0
Incr Delay (d2), s/veh	0.4	77.5	0.0	81.6	0.3	0.0	0.1	36.9	0.0	73.9	3.0	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	2.0	12.4	0.0	15.8	3.2	0.0	0.6	24.5	0.0	12.1	12.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.1	125.0	0.0	115.5	33.4	0.0	21.2	71.4	0.0	109.3	24.0	0.0
LnGrp LOS	D	F		F	C		C	F		F	C	
Approach Vol, veh/h		358	A		536	A		747	A		1052	A
Approach Delay, s/veh		104.8			93.0			68.6			55.5	
Approach LOS		F			F			E			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.0	46.0	22.0	20.0	7.6	60.4	9.0	33.0
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	18.0	41.0	18.0	15.0	5.0	54.0	5.0	28.0
Max Q Clear Time (g_c+I1), s	20.0	43.0	20.0	17.0	3.6	32.0	6.5	9.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	73.2
HCM 6th LOS	E

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) With Project

2: Waiale Rd & Kuikahi Dr — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	340	580	100	90	440	400	130	420	120	420	270	200
Future Volume (veh/h)	340	580	100	90	440	400	130	420	120	420	270	200
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.97	1.00		0.97
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	1856	1856	1856	1856	1856	1856	1856	1856
Adj Flow Rate, veh/h	358	611	101	95	463	138	137	442	118	442	284	190
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, %	2	2	2	3	3	3	3	3	3	3	3	3
Cap, veh/h	314	536	89	128	445	365	307	403	108	354	418	280
Arrive On Green	0.14	0.34	0.34	0.04	0.24	0.24	0.05	0.29	0.29	0.17	0.41	0.41
Sat Flow, veh/h	1781	1558	257	1767	1856	1523	1767	1401	374	1767	1024	685
Grp Volume(v), veh/h	358	0	712	95	463	138	137	0	560	442	0	474
Grp Sat Flow(s),veh/h/ln	1781	0	1815	1767	1856	1523	1767	0	1775	1767	0	1710
Q Serve(g_s), s	18.0	0.0	43.0	5.0	30.0	9.5	6.0	0.0	36.0	21.0	0.0	28.4
Cycle Q Clear(g_c), s	18.0	0.0	43.0	5.0	30.0	9.5	6.0	0.0	36.0	21.0	0.0	28.4
Prop In Lane	1.00		0.14	1.00		1.00	1.00		0.21	1.00		0.40
Lane Grp Cap(c), veh/h	314	0	624	128	445	365	307	0	511	354	0	698
V/C Ratio(X)	1.14	0.00	1.14	0.74	1.04	0.38	0.45	0.00	1.10	1.25	0.00	0.68
Avail Cap(c_a), veh/h	314	0	624	128	445	365	307	0	511	354	0	698
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	38.1	0.0	41.0	38.3	47.5	39.7	32.2	0.0	44.5	39.6	0.0	30.3
Incr Delay (d2), s/veh	94.1	0.0	81.3	18.1	53.3	0.6	0.4	0.0	68.4	132.6	0.0	2.7
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	15.1	0.0	33.2	2.9	20.5	3.7	0.7	0.0	25.5	20.0	0.0	12.2
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	132.2	0.0	122.3	56.4	100.8	40.3	32.6	0.0	112.9	172.2	0.0	33.0
LnGrp LOS	F	A	F	E	F	D	C	A	F	F	A	C
Approach Vol, veh/h		1070			696			697			916	
Approach Delay, s/veh		125.6			82.8			97.1			100.1	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	26.0	41.0	10.0	48.0	11.0	56.0	23.0	35.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	21.0	36.0	5.0	43.0	6.0	51.0	18.0	30.0
Max Q Clear Time (g_c+I1), s	23.0	38.0	7.0	45.0	8.0	30.4	20.0	32.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	104.0
HCM 6th LOS	F

HCM 6th Roundabout — Future (2045) With Project

3: S. Kamehameha Ave & Maui Lani Pkwy — AM Peak Hour

Intersection	
Intersection Delay, s/veh	205.7
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	894	737	579	1021
Demand Flow Rate, veh/h	917	760	591	1041
Vehicles Circulating, veh/h	709	784	1142	685
Vehicles Exiting, veh/h	1017	949	484	859
Ped Vol Crossing Leg, #/h	28	5	28	23
Ped Cap Adj	0.996	0.999	1.000	0.997
Approach Delay, s/veh	197.5	138.6	208.3	260.0
Approach LOS	F	F	F	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	917	760	591	1041
Cap Entry Lane, veh/h	670	620	431	686
Entry HV Adj Factor	0.975	0.970	0.979	0.981
Flow Entry, veh/h	894	737	579	1021
Cap Entry, veh/h	651	601	422	671
V/C Ratio	1.375	1.226	1.373	1.522
Control Delay, s/veh	197.5	138.6	208.3	260.0
LOS	F	F	F	F
95th %tile Queue, veh	39	27	28	51

4: Kuihelani Hwy & Maui Lani Pkwy

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	620	0	250	0	0	0	140	1350	0	0	890	450
Future Volume (veh/h)	620	0	250	0	0	0	140	1350	0	0	890	450
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	1870	1870	1870	1870	1870	1870	1841	1870	1870	1841	1856
Adj Flow Rate, veh/h	653	0	0	0	0	0	147	1421	0	0	937	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, %	3	2	2	2	2	2	2	4	2	2	4	3
Cap, veh/h	692	0		0	826	0	164	1535	0	2	1053	
Arrive On Green	0.44	0.00	0.00	0.00	0.00	0.00	0.09	0.44	0.00	0.00	0.30	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3589	0	1781	3497	1572
Grp Volume(v), veh/h	653	0	0	0	0	0	147	1421	0	0	937	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1749	0	1781	1749	1572
Q Serve(g_s), s	48.0	0.0	0.0	0.0	0.0	0.0	8.9	41.7	0.0	0.0	27.8	0.0
Cycle Q Clear(g_c), s	48.0	0.0	0.0	0.0	0.0	0.0	8.9	41.7	0.0	0.0	27.8	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	692	0		0	826	0	164	1535	0	2	1053	
V/C Ratio(X)	0.94	0.00		0.00	0.00	0.00	0.90	0.93	0.00	0.00	0.89	
Avail Cap(c_a), veh/h	692	0		0	860	0	164	1535	0	49	1094	
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	0.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh	31.4	0.0	0.0	0.0	0.0	0.0	48.9	28.8	0.0	0.0	36.3	0.0
Incr Delay (d2), s/veh	21.2	0.0	0.0	0.0	0.0	0.0	41.2	10.3	0.0	0.0	9.8	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	21.3	0.0	0.0	0.0	0.0	0.0	5.6	17.6	0.0	0.0	12.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	52.6	0.0	0.0	0.0	0.0	0.0	90.0	39.1	0.0	0.0	46.1	0.0
LnGrp LOS	D	A		A	A	A	F	D	A	A	D	
Approach Vol, veh/h		653	A		0			1568			937	A
Approach Delay, s/veh		52.6			0.0			43.9			46.1	
Approach LOS		D						D			D	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	0.0	54.7		54.0	15.0	39.7		54.0
Change Period (Y+Rc), s	5.0	7.0		6.0	5.0	7.0		* 6
Max Green Setting (Gmax), s	3.0	41.0		48.0	10.0	34.0		* 50
Max Q Clear Time (g_c+I1), s	0.0	43.7		50.0	10.9	29.8		0.0
Green Ext Time (p_c), s	0.0	0.0		0.0	0.0	2.9		0.0

Intersection Summary		
HCM 6th Ctrl Delay		46.3
HCM 6th LOS		D

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

5: Honoapiilani Hwy & Waiko Rd

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	40	20	20	70	10	60	10	910	30	160	950	20
Future Volume (veh/h)	40	20	20	70	10	60	10	910	30	160	950	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.98		0.96	1.00		0.97	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	1856	1870	1856	1870	1870	1870	1856	1856	1870	1870
Adj Flow Rate, veh/h	42	21	3	74	11	28	11	958	31	168	1000	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, %	3	3	3	2	3	2	2	2	3	3	2	2
Cap, veh/h	205	87	207	175	33	43	235	1057	34	266	1194	
Arrive On Green	0.14	0.14	0.14	0.14	0.14	0.14	0.01	0.59	0.59	0.06	0.64	0.00
Sat Flow, veh/h	922	638	1509	705	238	310	1781	1800	58	1767	1870	1585
Grp Volume(v), veh/h	63	0	3	113	0	0	11	0	989	168	1000	0
Grp Sat Flow(s),veh/h/ln	1561	0	1509	1253	0	0	1781	0	1858	1767	1870	1585
Q Serve(g_s), s	0.0	0.0	0.1	4.5	0.0	0.0	0.2	0.0	35.8	2.6	31.7	0.0
Cycle Q Clear(g_c), s	2.6	0.0	0.1	7.0	0.0	0.0	0.2	0.0	35.8	2.6	31.7	0.0
Prop In Lane	0.67		1.00	0.65		0.25	1.00		0.03	1.00		1.00
Lane Grp Cap(c), veh/h	293	0	207	250	0	0	235	0	1091	266	1194	
V/C Ratio(X)	0.22	0.00	0.01	0.45	0.00	0.00	0.05	0.00	0.91	0.63	0.84	
Avail Cap(c_a), veh/h	507	0	425	466	0	0	290	0	1146	277	1202	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	29.5	0.0	28.4	31.7	0.0	0.0	11.4	0.0	13.9	17.1	10.7	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	10.8	3.2	5.9	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	1.0	0.0	0.0	2.0	0.0	0.0	0.1	0.0	15.7	1.9	12.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	29.6	0.0	28.5	32.2	0.0	0.0	11.5	0.0	24.7	20.2	16.6	0.0
LnGrp LOS	C	A	C	C	A	A	B	A	C	C	B	
Approach Vol, veh/h		66			113			1000			1168	A
Approach Delay, s/veh		29.5			32.2			24.5			17.1	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	8.5	50.8		16.9	4.6	54.7		16.9
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5
Max Green Setting (Gmax), s	5.0	47.0		21.5	3.0	49.0		* 22
Max Q Clear Time (g_c+I1), s	4.6	37.8		4.6	2.2	33.7		9.0
Green Ext Time (p_c), s	0.0	7.0		0.2	0.0	10.8		0.3

Intersection Summary		
HCM 6th Ctrl Delay		21.4
HCM 6th LOS		C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

Intersection	
Intersection Delay, s/veh	27.8
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	242	505	727	589
Demand Flow Rate, veh/h	247	515	744	602
Vehicles Circulating, veh/h	838	336	601	386
Vehicles Exiting, veh/h	150	1009	484	465
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	12.8	10.5	56.0	14.1
Approach LOS	B	B	F	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	247	515	744	602
Cap Entry Lane, veh/h	587	980	748	931
Entry HV Adj Factor	0.981	0.981	0.977	0.978
Flow Entry, veh/h	242	505	727	589
Cap Entry, veh/h	575	960	730	910
V/C Ratio	0.421	0.526	0.996	0.647
Control Delay, s/veh	12.8	10.5	56.0	14.1
LOS	B	B	F	B
95th %tile Queue, veh	2	3	16	5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	830	100	50	660	660	480
Future Volume (veh/h)	830	100	50	660	660	480
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	1856	1841	1870	1870	1841	1841
Adj Flow Rate, veh/h	874	101	53	695	695	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	4	2	2	4	4
Cap, veh/h	811	94	73	1148	789	
Arrive On Green	0.52	0.52	0.04	0.32	0.23	0.00
Sat Flow, veh/h	1562	181	1781	3647	3589	1560
Grp Volume(v), veh/h	976	0	53	695	695	0
Grp Sat Flow(s),veh/h/ln	1744	0	1781	1777	1749	1560
Q Serve(g_s), s	46.0	0.0	2.6	14.6	17.0	0.0
Cycle Q Clear(g_c), s	46.0	0.0	2.6	14.6	17.0	0.0
Prop In Lane	0.90	0.10	1.00			1.00
Lane Grp Cap(c), veh/h	905	0	73	1148	789	
V/C Ratio(X)	1.08	0.00	0.72	0.61	0.88	
Avail Cap(c_a), veh/h	905	0	100	1203	789	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.3	0.0	42.0	25.2	33.2	0.0
Incr Delay (d2), s/veh	53.3	0.0	7.9	0.8	11.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	30.3	0.0	1.3	5.8	8.0	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	74.6	0.0	49.9	26.1	44.5	0.0
LnGrp LOS	F	A	D	C	D	
Approach Vol, veh/h	976			748	695	A
Approach Delay, s/veh	74.6			27.7	44.5	
Approach LOS	E			C	D	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		35.6		53.0	8.6	27.0
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		30.0		46.0	5.0	20.0
Max Q Clear Time (g_c+I1), s		16.6		48.0	4.6	19.0
Green Ext Time (p_c), s		3.6		0.0	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	51.5
HCM 6th LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [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)	220	100	100	50	100	100	60	580	30	40	860	130
Future Volume (veh/h)	220	100	100	50	100	100	60	580	30	40	860	130
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.96	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1870	1856	1870	1870	1870	1856	1856
Adj Flow Rate, veh/h	232	105	63	53	105	63	63	611	18	42	905	77
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, %	3	2	2	2	2	2	3	2	2	2	3	3
Cap, veh/h	310	211	127	287	151	91	200	993	819	390	971	801
Arrive On Green	0.09	0.20	0.20	0.04	0.14	0.14	0.04	0.53	0.53	0.03	0.52	0.52
Sat Flow, veh/h	1767	1078	647	1781	1075	645	1767	1870	1544	1781	1856	1531
Grp Volume(v), veh/h	232	0	168	53	0	168	63	611	18	42	905	77
Grp Sat Flow(s),veh/h/ln	1767	0	1725	1781	0	1720	1767	1870	1544	1781	1856	1531
Q Serve(g_s), s	7.0	0.0	6.7	2.0	0.0	7.2	1.3	17.6	0.4	0.8	35.1	1.9
Cycle Q Clear(g_c), s	7.0	0.0	6.7	2.0	0.0	7.2	1.3	17.6	0.4	0.8	35.1	1.9
Prop In Lane	1.00		0.38	1.00		0.38	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	310	0	338	287	0	242	200	993	819	390	971	801
V/C Ratio(X)	0.75	0.00	0.50	0.18	0.00	0.69	0.31	0.62	0.02	0.11	0.93	0.10
Avail Cap(c_a), veh/h	310	0	514	317	0	445	224	1041	860	427	1033	853
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.9	0.0	27.6	27.1	0.0	31.6	16.6	12.6	8.6	9.8	17.1	9.2
Incr Delay (d2), s/veh	9.5	0.0	1.1	0.3	0.0	3.6	0.9	1.0	0.0	0.1	14.1	0.1
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	1.6	0.0	2.8	0.8	0.0	3.1	0.5	6.8	0.1	0.3	16.8	0.6
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	36.4	0.0	28.8	27.4	0.0	35.2	17.5	13.6	8.6	10.0	31.2	9.3
LnGrp LOS	D	A	C	C	A	D	B	B	A	A	C	A
Approach Vol, veh/h		400			221			692			1024	
Approach Delay, s/veh		33.2			33.3			13.9			28.7	
Approach LOS		C			C			B			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	6.4	45.0	6.7	19.1	7.0	44.4	11.0	14.9
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	4.0	43.0	4.0	23.0	4.0	43.0	7.0	20.0
Max Q Clear Time (g_c+I1), s	2.8	19.6	4.0	8.7	3.3	37.1	9.0	9.2
Green Ext Time (p_c), s	0.0	4.4	0.0	0.7	0.0	3.3	0.0	0.6

Intersection Summary		
HCM 6th Ctrl Delay		25.5
HCM 6th LOS		C

Intersection	
Intersection Delay, s/veh	7.6
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	496	159	159	474
Demand Flow Rate, veh/h	505	162	163	484
Vehicles Circulating, veh/h	249	635	569	55
Vehicles Exiting, veh/h	290	97	185	742
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	8.8	7.7	7.1	6.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	505	162	163	484
Cap Entry Lane, veh/h	1070	722	772	1305
Entry HV Adj Factor	0.982	0.980	0.975	0.979
Flow Entry, veh/h	496	159	159	474
Cap Entry, veh/h	1050	707	752	1276
V/C Ratio	0.472	0.225	0.211	0.371
Control Delay, s/veh	8.8	7.7	7.1	6.3
LOS	A	A	A	A
95th %tile Queue, veh	3	1	1	2

Intersection				
Intersection Delay, s/veh	30.9			
Intersection LOS	D			
Approach	**EB**	**WB**	**NB**	**SB**
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	85	243	748	1064
Demand Flow Rate, veh/h	87	249	764	1085
Vehicles Circulating, veh/h	1291	710	87	249
Vehicles Exiting, veh/h	43	141	1291	710
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	1.000	0.999	0.999	0.999
Approach Delay, s/veh	14.2	10.6	10.3	51.4
Approach LOS	B	B	B	F
Lane	**Left**	**Left**	**Left**	**Left**
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	87	249	764	1085
Cap Entry Lane, veh/h	370	669	1263	1070
Entry HV Adj Factor	0.972	0.974	0.979	0.980
Flow Entry, veh/h	85	243	748	1064
Cap Entry, veh/h	360	651	1235	1049
V/C Ratio	0.235	0.373	0.605	1.014
Control Delay, s/veh	14.2	10.6	10.3	51.4
LOS	B	B	B	F
95th %tile Queue, veh	1	2	4	21

Intersection				
Intersection Delay, s/veh	4.0			
Intersection LOS	A			
Approach	**EB**	**WB**	**NB**	**SB**
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	137	179	137	116
Demand Flow Rate, veh/h	140	183	139	117
Vehicles Circulating, veh/h	85	96	118	216
Vehicles Exiting, veh/h	248	161	107	63
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	3.8	4.2	3.9	4.2
Approach LOS	A	A	A	A
Lane	**Left**	**Left**	**Left**	**Left**
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	140	183	139	117
Cap Entry Lane, veh/h	1265	1251	1223	1107
Entry HV Adj Factor	0.977	0.976	0.983	0.988
Flow Entry, veh/h	137	179	137	116
Cap Entry, veh/h	1235	1220	1201	1093
V/C Ratio	0.111	0.146	0.114	0.106
Control Delay, s/veh	3.8	4.2	3.9	4.2
LOS	A	A	A	A
95th %tile Queue, veh	0	1	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	730	10	20	10	690	670	50	1150	10
Future Volume (veh/h)	10	10	10	730	10	20	10	690	670	50	1150	10
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	1870	1856	1856	1856	1870	1856	1870	1870	1870	1870	1856
Adj Flow Rate, veh/h	11	11	0	776	0	0	11	726	0	53	1211	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, %	3	2	3	3	3	2	3	2	2	2	2	3
Cap, veh/h	23	23		922	0		24	1360		83	1477	
Arrive On Green	0.03	0.03	0.00	0.26	0.00	0.00	0.01	0.38	0.00	0.05	0.42	0.00
Sat Flow, veh/h	912	912	0	3534	0	1585	1767	3554	1585	1781	3554	1572
Grp Volume(v), veh/h	22	0	0	776	0	0	11	726	0	53	1211	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1767	0	1585	1767	1777	1585	1781	1777	1572
Q Serve(g_s), s	0.8	0.0	0.0	13.9	0.0	0.0	0.4	10.6	0.0	2.0	20.2	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0	13.9	0.0	0.0	0.4	10.6	0.0	2.0	20.2	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	46	0		922	0		24	1360		83	1477	
V/C Ratio(X)	0.48	0.00		0.84	0.00		0.45	0.53		0.63	0.82	
Avail Cap(c_a), veh/h	137	0		1111	0		132	1543		160	1596	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	32.1	0.0	0.0	23.4	0.0	0.0	32.7	16.0	0.0	31.3	17.3	0.0
Incr Delay (d2), s/veh	7.6	0.0	0.0	5.1	0.0	0.0	4.8	0.5	0.0	3.0	3.5	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	0.4	0.0	0.0	6.0	0.0	0.0	0.2	3.9	0.0	0.9	7.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.7	0.0	0.0	28.5	0.0	0.0	37.4	16.5	0.0	34.2	20.8	0.0
LnGrp LOS	D	A		C	A		D	B		C	C	
Approach Vol, veh/h		22	A		776	A		737	A		1264	A
Approach Delay, s/veh		39.7			28.5			16.8			21.4	
Approach LOS		D			C			B			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.1	30.6		22.4	4.9	32.8		6.7
Change Period (Y+Rc), s	4.0	5.0		5.0	4.0	5.0		5.0
Max Green Setting (Gmax), s	6.0	29.0		21.0	5.0	30.0		5.0
Max Q Clear Time (g_c+I1), s	4.0	12.6		15.9	2.4	22.2		2.8
Green Ext Time (p_c), s	0.0	5.9		1.5	0.0	5.6		0.0

Intersection Summary	
HCM 6th Ctrl Delay	22.3
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) WIth Project
1: Honoapiilani Hwy & Kuikahi Dr — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↑	↱	↰	↑	↱	↰	↑	↱
Traffic Volume (veh/h)	50	170	60	460	210	300	80	600	450	310	680	60
Future Volume (veh/h)	50	170	60	460	210	300	80	600	450	310	680	60
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		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	1870	1870	1870	1870	1870	1856	1870	1856	1870
Adj Flow Rate, veh/h	52	177	0	479	219	0	83	625	0	323	708	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, %	2	2	2	2	2	2	2	2	3	2	3	2
Cap, veh/h	259	189		470	523		231	672		331	805	
Arrive On Green	0.04	0.10	0.00	0.21	0.28	0.00	0.05	0.36	0.00	0.12	0.43	0.00
Sat Flow, veh/h	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Grp Volume(v), veh/h	52	177	0	479	219	0	83	625	0	323	708	0
Grp Sat Flow(s),veh/h/ln	1781	1870	1585	1781	1870	1585	1781	1870	1572	1781	1856	1585
Q Serve(g_s), s	2.3	8.4	0.0	19.0	8.5	0.0	2.6	28.6	0.0	10.5	31.1	0.0
Cycle Q Clear(g_c), s	2.3	8.4	0.0	19.0	8.5	0.0	2.6	28.6	0.0	10.5	31.1	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	259	189		470	523		231	672		331	805	
V/C Ratio(X)	0.20	0.94		1.02	0.42		0.36	0.93		0.98	0.88	
Avail Cap(c_a), veh/h	297	189		470	523		244	694		331	814	
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	34.2	39.7	0.0	27.9	26.1	0.0	20.1	27.4	0.0	21.7	23.1	0.0
Incr Delay (d2), s/veh	0.4	46.9	0.0	46.3	0.4	0.0	0.4	19.7	0.0	42.4	11.6	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	1.0	6.2	0.0	14.7	3.8	0.0	1.0	15.2	0.0	7.7	14.5	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.5	86.6	0.0	74.2	26.5	0.0	20.5	47.1	0.0	64.1	34.6	0.0
LnGrp LOS	C	F		F	C		C	D		E	C	
Approach Vol, veh/h		229	A		698	A		708	A		1031	A
Approach Delay, s/veh		74.8			59.2			44.0			43.9	
Approach LOS		E			E			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	36.9	23.0	14.0	8.4	43.6	7.1	29.9
Change Period (Y+Rc), s	4.0	5.0	4.0	5.0	4.0	5.0	4.0	5.0
Max Green Setting (Gmax), s	11.0	33.0	19.0	9.0	5.0	39.0	5.0	23.0
Max Q Clear Time (g_c+I1), s	12.5	30.6	21.0	10.4	4.6	33.1	4.3	10.5
Green Ext Time (p_c), s	0.0	1.3	0.0	0.0	0.0	3.4	0.0	0.8

Intersection Summary			
HCM 6th Ctrl Delay			50.6
HCM 6th LOS			D

Notes

Unsignalized Delay for [NBR, EBR, WBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) WIth Project
2: Waiale Rd & Kuikahi Dr — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↑	↱	↰	↱		↰	↱	
Traffic Volume (veh/h)	330	500	70	130	600	400	120	260	90	450	340	210
Future Volume (veh/h)	330	500	70	130	600	400	120	260	90	450	340	210
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.96	1.00		0.97
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	1870	1856	1856	1856	1856	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	347	526	71	137	632	153	126	274	87	474	358	205
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, %	3	2	3	3	3	3	2	3	2	2	3	2
Cap, veh/h	306	654	88	231	576	473	172	267	85	418	400	229
Arrive On Green	0.14	0.41	0.41	0.05	0.31	0.31	0.04	0.20	0.20	0.21	0.37	0.37
Sat Flow, veh/h	1767	1607	217	1767	1856	1525	1781	1336	424	1781	1094	627
Grp Volume(v), veh/h	347	0	597	137	632	153	126	0	361	474	0	563
Grp Sat Flow(s),veh/h/ln	1767	0	1824	1767	1856	1525	1781	0	1761	1781	0	1721
Q Serve(g_s), s	21.0	0.0	41.8	7.0	45.0	11.2	6.0	0.0	29.0	30.0	0.0	44.7
Cycle Q Clear(g_c), s	21.0	0.0	41.8	7.0	45.0	11.2	6.0	0.0	29.0	30.0	0.0	44.7
Prop In Lane	1.00		0.12	1.00		1.00	1.00		0.24	1.00		0.36
Lane Grp Cap(c), veh/h	306	0	742	231	576	473	172	0	352	418	0	629
V/C Ratio(X)	1.14	0.00	0.80	0.59	1.10	0.32	0.73	0.00	1.03	1.13	0.00	0.90
Avail Cap(c_a), veh/h	306	0	742	231	576	473	172	0	352	418	0	629
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	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	47.8	0.0	37.9	37.8	50.0	38.3	52.2	0.0	58.0	45.7	0.0	43.4
Incr Delay (d2), s/veh	93.3	0.0	6.4	2.8	66.9	0.4	13.3	0.0	54.6	85.7	0.0	15.4
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	14.8	0.0	20.2	3.6	31.7	4.3	2.4	0.0	18.3	25.3	0.0	21.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	141.0	0.0	44.4	40.6	116.9	38.7	65.5	0.0	112.6	131.4	0.0	58.8
LnGrp LOS	F	A	D	D	F	D	E	A	F	F	A	E
Approach Vol, veh/h		944			922			487			1037	
Approach Delay, s/veh		79.9			92.6			100.4			92.0	
Approach LOS		E			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	35.0	34.0	12.0	64.0	11.0	58.0	26.0	50.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	30.0	29.0	7.0	59.0	6.0	53.0	21.0	45.0
Max Q Clear Time (g_c+I1), s	32.0	31.0	9.0	43.8	8.0	46.7	23.0	47.0
Green Ext Time (p_c), s	0.0	0.0	0.0	3.8	0.0	2.1	0.0	0.0

Intersection Summary			
HCM 6th Ctrl Delay			90.0
HCM 6th LOS			F

Intersection	
Intersection Delay, s/veh	171.6
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	1020	969	288	918
Demand Flow Rate, veh/h	1044	992	293	936
Vehicles Circulating, veh/h	536	672	1171	651
Vehicles Exiting, veh/h	1051	792	409	1013
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	1.000	0.999
Approach Delay, s/veh	165.6	219.1	30.4	172.4
Approach LOS	F	F	D	F

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	1044	992	293	936
Cap Entry Lane, veh/h	799	695	418	710
Entry HV Adj Factor	0.977	0.977	0.982	0.981
Flow Entry, veh/h	1020	969	288	918
Cap Entry, veh/h	780	679	410	696
V/C Ratio	1.308	1.428	0.701	1.319
Control Delay, s/veh	165.6	219.1	30.4	172.4
LOS	F	F	D	F
95th %tile Queue, veh	40	44	5	37

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	520	0	170	0	0	0	250	1140	0	10	1320	670
Future Volume (veh/h)	520	0	170	0	0	0	250	1140	0	10	1320	670
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	1856	1870	1870	1870	1870	1856	1870	1870	1841	1870
Adj Flow Rate, veh/h	547	0	0	0	0	0	263	1200	0	11	1389	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, %	2	2	3	2	2	2	2	3	2	2	4	2
Cap, veh/h	556	0		0	655	0	223	1736	0	14	1312	
Arrive On Green	0.35	0.00	0.00	0.00	0.00	0.00	0.13	0.49	0.00	0.01	0.38	0.00
Sat Flow, veh/h	1418	0	0	0	1870	0	1781	3618	0	1781	3497	1585
Grp Volume(v), veh/h	547	0	0	0	0	0	263	1200	0	11	1389	0
Grp Sat Flow(s),veh/h/ln	1418	0	0	0	1870	0	1781	1763	0	1781	1749	1585
Q Serve(g_s), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.4	0.0	0.7	45.0	0.0
Cycle Q Clear(g_c), s	42.0	0.0	0.0	0.0	0.0	0.0	15.0	31.4	0.0	0.7	45.0	0.0
Prop In Lane	1.00		0.00	0.00		0.00	1.00		0.00	1.00		1.00
Lane Grp Cap(c), veh/h	556	0		0	655	0	223	1736	0	14	1312	
V/C Ratio(X)	0.98	0.00		0.00	0.00	0.00	1.18	0.69	0.00	0.80	1.06	
Avail Cap(c_a), veh/h	556	0		0	686	0	223	1736	0	45	1312	
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	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	41.0	0.0	0.0	0.0	0.0	0.0	52.5	23.4	0.0	59.4	37.5	0.0
Incr Delay (d2), s/veh	33.8	0.0	0.0	0.0	0.0	0.0	118.0	1.5	0.0	31.9	42.1	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	22.0	0.0	0.0	0.0	0.0	0.0	13.7	12.1	0.0	0.4	25.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	74.7	0.0	0.0	0.0	0.0	0.0	170.5	25.0	0.0	91.4	79.6	0.0
LnGrp LOS	E	A		A	A	A	F	C	A	F	F	
Approach Vol, veh/h		547	A		0			1463			1400	A
Approach Delay, s/veh		74.7			0.0			51.1			79.7	
Approach LOS		E						D			E	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	5.9	66.1		48.0	20.0	52.0		48.0
Change Period (Y+Rc), s	5.0	7.0		6.0	5.0	7.0		* 6
Max Green Setting (Gmax), s	3.0	57.0		42.0	15.0	45.0		* 44
Max Q Clear Time (g_c+I1), s	2.7	33.4		44.0	17.0	47.0		0.0
Green Ext Time (p_c), s	0.0	14.2		0.0	0.0	0.0		0.0

Intersection Summary	
HCM 6th Ctrl Delay	66.6
HCM 6th LOS	E

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
5: Honoapiilani Hwy & Waiko Rd

Future (2045) WIth Project
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑	↱		↔		↰	↑↱		↰	↑	↱
Traffic Volume (veh/h)	30	10	10	210	40	80	20	990	110	90	1000	40
Future Volume (veh/h)	30	10	10	210	40	80	20	990	110	90	1000	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.97	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	1870	1870	1870	1870	1870	1856	1870	1856	1870	1870	1870
Adj Flow Rate, veh/h	32	11	3	221	42	77	21	1042	114	95	1053	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, %	3	2	2	2	2	2	3	2	3	2	2	2
Cap, veh/h	271	87	356	243	38	69	160	1012	111	110	1181	
Arrive On Green	0.23	0.23	0.23	0.23	0.23	0.23	0.01	0.61	0.61	0.03	0.63	0.00
Sat Flow, veh/h	971	377	1548	861	164	300	1767	1652	181	1781	1870	1585
Grp Volume(v), veh/h	43	0	3	340	0	0	21	0	1156	95	1053	0
Grp Sat Flow(s),veh/h/ln	1348	0	1548	1324	0	0	1767	0	1832	1781	1870	1585
Q Serve(g_s), s	0.0	0.0	0.2	26.9	0.0	0.0	0.6	0.0	80.0	2.9	62.0	0.0
Cycle Q Clear(g_c), s	3.1	0.0	0.2	30.0	0.0	0.0	0.6	0.0	80.0	2.9	62.0	0.0
Prop In Lane	0.74		1.00	0.65		0.23	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	358	0	356	350	0	0	160	0	1123	110	1181	
V/C Ratio(X)	0.12	0.00	0.01	0.97	0.00	0.00	0.13	0.00	1.03	0.87	0.89	
Avail Cap(c_a), veh/h	358	0	356	350	0	0	179	0	1123	110	1181	
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	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.8	0.0	38.8	53.2	0.0	0.0	23.4	0.0	25.3	35.1	20.3	0.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	40.3	0.0	0.0	0.1	0.0	34.6	45.4	9.3	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	1.1	0.0	0.1	15.3	0.0	0.0	0.3	0.0	43.1	3.2	28.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	39.9	0.0	38.8	93.5	0.0	0.0	23.6	0.0	59.9	80.5	29.6	0.0
LnGrp LOS	D	A	D	F	A	A	C	A	F	F	C	
Approach Vol, veh/h		46			340			1177			1148	A
Approach Delay, s/veh		39.8			93.5			59.2			33.8	
Approach LOS		D			F			E			C	

Timer - Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	8.0	86.0		36.5	5.6	88.4		36.5
Change Period (Y+Rc), s	4.0	6.0		6.5	4.0	6.0		* 6.5
Max Green Setting (Gmax), s	4.0	80.0		29.5	3.0	81.0		* 30
Max Q Clear Time (g_c+I1), s	4.9	82.0		5.1	2.6	64.0		32.0
Green Ext Time (p_c), s	0.0	0.0		0.1	0.0	12.4		0.0

Intersection Summary			
HCM 6th Ctrl Delay			52.4
HCM 6th LOS			D

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.
Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Roundabout
6: Waiko Rd & Waiale Rd

Future (2045) WIth Project
PM Peak Hour

Intersection	
Intersection Delay, s/veh	22.9
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	232	948	526	453
Demand Flow Rate, veh/h	238	967	538	466
Vehicles Circulating, veh/h	853	270	389	687
Vehicles Exiting, veh/h	300	657	702	550
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	12.9	32.8	12.2	19.6
Approach LOS	B	D	B	C

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	238	967	538	466
Cap Entry Lane, veh/h	578	1048	928	685
Entry HV Adj Factor	0.973	0.980	0.978	0.973
Flow Entry, veh/h	232	948	526	453
Cap Entry, veh/h	562	1026	907	666
V/C Ratio	0.412	0.924	0.580	0.681
Control Delay, s/veh	12.9	32.8	12.2	19.6
LOS	B	D	B	C
95th %tile Queue, veh	2	15	4	5

HCM 6th Signalized Intersection Summary — Future (2045) WIth Project

7: Kuihelani Hwy & Waiko Rd — PM Peak Hour

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	580	60	70	800	870	630
Future Volume (veh/h)	580	60	70	800	870	630
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	0.98	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	1856	1870	1841	1856	1856	1856
Adj Flow Rate, veh/h	611	59	74	842	916	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	2	4	3	3	3
Cap, veh/h	640	62	94	1460	1040	
Arrive On Green	0.40	0.40	0.05	0.41	0.30	0.00
Sat Flow, veh/h	1589	153	1753	3618	3618	1572
Grp Volume(v), veh/h	671	0	74	842	916	0
Grp Sat Flow(s),veh/h/ln	1745	0	1753	1763	1763	1572
Q Serve(g_s), s	28.5	0.0	3.2	14.1	18.9	0.0
Cycle Q Clear(g_c), s	28.5	0.0	3.2	14.1	18.9	0.0
Prop In Lane	0.91	0.09	1.00			1.00
Lane Grp Cap(c), veh/h	703	0	94	1460	1040	
V/C Ratio(X)	0.95	0.00	0.79	0.58	0.88	
Avail Cap(c_a), veh/h	730	0	115	1567	1106	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	22.2	0.0	35.8	17.2	25.7	0.0
Incr Delay (d2), s/veh	22.0	0.0	20.1	0.5	8.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	16.0	0.0	1.8	5.0	8.2	0.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	44.2	0.0	55.9	17.7	33.8	0.0
LnGrp LOS	D	A	E	B	C	
Approach Vol, veh/h	671			916	916	A
Approach Delay, s/veh	44.2			20.8	33.8	
Approach LOS	D			C	C	
Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		38.7		37.8	9.1	29.6
Change Period (Y+Rc), s		7.0		7.0	5.0	7.0
Max Green Setting (Gmax), s		34.0		32.0	5.0	24.0
Max Q Clear Time (g_c+I1), s		16.1		30.5	5.2	20.9
Green Ext Time (p_c), s		5.1		0.3	0.0	1.6
Intersection Summary						
HCM 6th Ctrl Delay			31.8			
HCM 6th LOS			C			

Notes

User approved volume balancing among the lanes for turning movement.

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary — Future (2045) WIth Project

8: Honoapiilani Hwy & Main Street — PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	180	100	80	30	100	60	100	860	50	100	890	230
Future Volume (veh/h)	180	100	80	30	100	60	100	860	50	100	890	230
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.98		0.95	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1856	1870	1870	1870	1870
Adj Flow Rate, veh/h	189	105	51	32	105	38	105	905	29	105	937	138
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, %	2	2	2	2	2	2	2	3	2	2	2	2
Cap, veh/h	312	222	108	272	162	59	208	987	821	228	995	821
Arrive On Green	0.09	0.19	0.19	0.03	0.13	0.13	0.05	0.53	0.53	0.05	0.53	0.53
Sat Flow, veh/h	1781	1173	570	1781	1292	468	1781	1856	1544	1781	1870	1543
Grp Volume(v), veh/h	189	0	156	32	0	143	105	905	29	105	937	138
Grp Sat Flow(s),veh/h/ln	1781	0	1742	1781	0	1760	1781	1856	1544	1781	1870	1543
Q Serve(g_s), s	7.0	0.0	6.2	1.2	0.0	6.0	2.0	34.6	0.7	2.0	36.5	3.6
Cycle Q Clear(g_c), s	7.0	0.0	6.2	1.2	0.0	6.0	2.0	34.6	0.7	2.0	36.5	3.6
Prop In Lane	1.00		0.33	1.00		0.27	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	312	0	330	272	0	220	208	987	821	228	995	821
V/C Ratio(X)	0.61	0.00	0.47	0.12	0.00	0.65	0.50	0.92	0.04	0.46	0.94	0.17
Avail Cap(c_a), veh/h	312	0	516	318	0	453	217	1027	855	236	1035	854
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	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	25.5	0.0	28.0	28.5	0.0	32.3	17.6	16.6	8.7	16.7	17.1	9.3
Incr Delay (d2), s/veh	3.3	0.0	1.0	0.2	0.0	3.2	1.9	12.3	0.0	1.5	15.6	0.1
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	2.6	0.5	0.0	2.7	1.0	16.1	0.2	0.9	17.9	1.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	28.8	0.0	29.1	28.7	0.0	35.5	19.4	28.9	8.7	18.1	32.7	9.4
LnGrp LOS	C	A	C	C	A	D	B	C	A	B	C	A
Approach Vol, veh/h		345			175			1039			1180	
Approach Delay, s/veh		28.9			34.3			27.4			28.7	
Approach LOS		C			C			C			C	
Timer - Assigned Phs	1	2	3	4	5	6	7	8				
Phs Duration (G+Y+Rc), s	7.6	45.3	6.0	18.7	7.6	45.3	11.0	13.7				
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0				
Max Green Setting (Gmax), s	4.0	43.0	4.0	23.0	4.0	43.0	7.0	20.0				
Max Q Clear Time (g_c+I1), s	4.0	36.6	3.2	8.2	4.0	38.5	9.0	8.0				
Green Ext Time (p_c), s	0.0	3.5	0.0	0.7	0.0	2.8	0.0	0.5				
Intersection Summary												
HCM 6th Ctrl Delay			28.6									
HCM 6th LOS			C									

Intersection				
Intersection Delay, s/veh	7.6			
Intersection LOS	A			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	348	127	148	684
Demand Flow Rate, veh/h	354	129	151	699
Vehicles Circulating, veh/h	291	452	472	43
Vehicles Exiting, veh/h	451	171	173	538
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	7.2	5.7	6.1	8.5
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	354	129	151	699
Cap Entry Lane, veh/h	1026	870	853	1321
Entry HV Adj Factor	0.982	0.983	0.977	0.978
Flow Entry, veh/h	348	127	148	684
Cap Entry, veh/h	1006	855	833	1291
V/C Ratio	0.345	0.148	0.177	0.530
Control Delay, s/veh	7.2	5.7	6.1	8.5
LOS	A	A	A	A
95th %tile Queue, veh	2	1	1	3

Intersection				
Intersection Delay, s/veh	29.5			
Intersection LOS	D			

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	63	179	1178	1053
Demand Flow Rate, veh/h	63	184	1213	1084
Vehicles Circulating, veh/h	1193	1061	53	172
Vehicles Exiting, veh/h	63	205	1203	1073
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	1.000	1.000	0.999	0.999
Approach Delay, s/veh	11.2	15.0	29.4	33.1
Approach LOS	B	B	D	D

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	63	184	1213	1084
Cap Entry Lane, veh/h	409	468	1307	1158
Entry HV Adj Factor	0.993	0.971	0.971	0.972
Flow Entry, veh/h	63	179	1178	1053
Cap Entry, veh/h	406	454	1269	1124
V/C Ratio	0.154	0.393	0.929	0.937
Control Delay, s/veh	11.2	15.0	29.4	33.1
LOS	B	B	D	D
95th %tile Queue, veh	1	2	16	16

Intersection	
Intersection Delay, s/veh	4.2
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	201	169	116	64
Demand Flow Rate, veh/h	206	173	118	65
Vehicles Circulating, veh/h	96	129	163	216
Vehicles Exiting, veh/h	185	152	139	86
Ped Vol Crossing Leg, #/h	5	5	5	5
Ped Cap Adj	0.999	0.999	0.999	0.999
Approach Delay, s/veh	4.4	4.3	4.0	3.8
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	206	173	118	65
Cap Entry Lane, veh/h	1251	1210	1169	1107
Entry HV Adj Factor	0.976	0.978	0.980	0.978
Flow Entry, veh/h	201	169	116	64
Cap Entry, veh/h	1221	1182	1144	1082
V/C Ratio	0.165	0.143	0.101	0.059
Control Delay, s/veh	4.4	4.3	4.0	3.8
LOS	A	A	A	A
95th %tile Queue, veh	1	0	0	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	10	10	910	10	30	10	1090	880	10	1130	20
Future Volume (veh/h)	10	10	10	910	10	30	10	1090	880	10	1130	20
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	1870	1870	1841	1870	1856	1856	1870	1870	1841
Adj Flow Rate, veh/h	10	10	0	955	0	0	10	1135	0	10	1177	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, %	2	2	2	2	2	4	2	3	3	2	2	4
Cap, veh/h	21	21		1107	0		22	1417		22	1428	
Arrive On Green	0.02	0.02	0.00	0.31	0.00	0.00	0.01	0.40	0.00	0.01	0.40	0.00
Sat Flow, veh/h	912	912	0	3563	0	1560	1781	3526	1572	1781	3554	1560
Grp Volume(v), veh/h	20	0	0	955	0	0	10	1135	0	10	1177	0
Grp Sat Flow(s),veh/h/ln	1825	0	0	1781	0	1560	1781	1763	1572	1781	1777	1560
Q Serve(g_s), s	0.8	0.0	0.0	19.0	0.0	0.0	0.4	21.4	0.0	0.4	22.3	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0	19.0	0.0	0.0	0.4	21.4	0.0	0.4	22.3	0.0
Prop In Lane	0.50		0.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	41	0		1107	0		22	1417		22	1428	
V/C Ratio(X)	0.48	0.00		0.86	0.00		0.45	0.80		0.45	0.82	
Avail Cap(c_a), veh/h	121	0		1324	0		118	1544		118	1556	
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	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	36.4	0.0	0.0	24.5	0.0	0.0	36.9	19.9	0.0	36.9	20.1	0.0
Incr Delay (d2), s/veh	8.5	0.0	0.0	5.3	0.0	0.0	5.1	3.1	0.0	5.1	3.7	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	0.5	0.0	0.0	8.3	0.0	0.0	0.2	8.5	0.0	0.2	9.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	44.8	0.0	0.0	29.8	0.0	0.0	42.1	23.0	0.0	42.1	23.9	0.0
LnGrp LOS	D	A		C	A		D	C		D	C	
Approach Vol, veh/h		20	A		955	A		1145	A		1187	A
Approach Delay, s/veh		44.8			29.8			23.2			24.0	
Approach LOS		D			C			C			C	

Timer - Assigned Phs	1	2	4	5	6	8
Phs Duration (G+Y+Rc), s	4.9	35.3	28.4	4.9	35.3	6.7
Change Period (Y+Rc), s	4.0	5.0	5.0	4.0	5.0	5.0
Max Green Setting (Gmax), s	5.0	33.0	28.0	5.0	33.0	5.0
Max Q Clear Time (g_c+I1), s	2.4	23.4	21.0	2.4	24.3	2.8
Green Ext Time (p_c), s	0.0	6.3	2.4	0.0	6.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	25.5
HCM 6th LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

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)	30	180	20	260	80	140	20	260	410	350	170	40
Future Volume (veh/h)	30	180	20	260	80	140	20	260	410	350	170	40
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.97	1.00		0.97	1.00		0.97
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	1870	1870	1870	1870	1856	1870	1870	1856	1870
Adj Flow Rate, veh/h	32	189	18	274	84	79	21	274	371	368	179	35
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, %	2	2	2	2	2	2	2	3	2	2	3	2
Cap, veh/h	284	240	23	293	185	174	591	286	387	404	834	163
Arrive On Green	0.02	0.14	0.14	0.09	0.21	0.21	0.02	0.41	0.41	0.17	0.56	0.56
Sat Flow, veh/h	1781	1674	159	1781	870	818	1781	702	950	1781	1500	293
Grp Volume(v), veh/h	32	0	207	274	0	163	21	0	645	368	0	214
Grp Sat Flow(s),veh/h/ln	1781	0	1833	1781	0	1688	1781	0	1652	1781	0	1794
Q Serve(g_s), s	1.3	0.0	9.3	8.0	0.0	7.1	0.6	0.0	32.2	12.0	0.0	5.1
Cycle Q Clear(g_c), s	1.3	0.0	9.3	8.0	0.0	7.1	0.6	0.0	32.2	12.0	0.0	5.1
Prop In Lane	1.00		0.09	1.00		0.48	1.00		0.58	1.00		0.16
Lane Grp Cap(c), veh/h	284	0	263	293	0	359	591	0	673	404	0	997
V/C Ratio(X)	0.11	0.00	0.79	0.94	0.00	0.45	0.04	0.00	0.96	0.91	0.00	0.21
Avail Cap(c_a), veh/h	324	0	345	293	0	398	642	0	681	421	0	997
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	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	29.9	0.0	35.1	31.1	0.0	29.1	14.2	0.0	24.5	22.8	0.0	9.5
Incr Delay (d2), s/veh	0.2	0.0	8.6	36.0	0.0	0.9	0.0	0.0	24.5	23.3	0.0	0.1
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	0.6	0.0	4.7	4.6	0.0	2.9	0.2	0.0	16.3	9.7	0.0	1.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	30.1	0.0	43.8	67.1	0.0	30.0	14.2	0.0	48.9	46.1	0.0	9.6
LnGrp LOS	C	A	D	E	A	C	B	A	D	D	A	A
Approach Vol, veh/h		239			437			666			582	
Approach Delay, s/veh		41.9			53.3			47.8			32.7	
Approach LOS		D			D			D			C	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	8.2	38.6	12.0	16.2	5.6	51.2	6.1	22.1
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	15.0	35.0	8.0	16.0	4.0	46.0	4.0	20.0
Max Q Clear Time (g_c+I1), s	14.0	34.2	10.0	11.3	2.6	7.1	3.3	9.1
Green Ext Time (p_c), s	0.1	0.4	0.0	0.4	0.0	1.4	0.0	0.6

Intersection Summary	
HCM 6th Ctrl Delay	43.8
HCM 6th LOS	D

Queues — Future (2045) With Project Signal Alt
6: Waiko Rd & Waiale Rd — AM Peak Hour

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	32	210	274	231	21	706	368	221
v/c Ratio	0.13	0.72	1.00	0.50	0.04	0.98	0.96	0.21
Control Delay	23.6	49.2	86.2	22.3	8.7	54.2	63.6	9.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.6	49.2	86.2	22.3	8.7	54.2	63.6	9.9
Queue Length 50th (ft)	13	109	126	68	4	345	159	46
Queue Length 95th (ft)	33	184	#290	142	13	#602	#343	103
Internal Link Dist (ft)		1982		4578		1623		6781
Turn Bay Length (ft)	100		290		50		350	
Base Capacity (vph)	249	337	273	466	536	719	382	1041
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.13	0.62	1.00	0.50	0.04	0.98	0.96	0.21

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM 6th Signalized Intersection Summary — Future (2045) With Project Signal Alt
10: Honoapiilani Hwy & Waiale Rd — AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	30	20	30	200	20	10	10	620	80	30	970	10
Future Volume (veh/h)	30	20	30	200	20	10	10	620	80	30	970	10
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.97	0.99		0.97	1.00		0.97	1.00		0.97
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	1856	1870	1870	1870
Adj Flow Rate, veh/h	32	21	9	211	21	9	11	653	78	32	1021	10
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, %	2	2	2	3	2	2	2	2	3	2	2	2
Cap, veh/h	263	158	53	406	27	12	235	1023	122	418	1158	11
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.63	0.63	0.63	0.63	0.63	0.63
Sat Flow, veh/h	721	742	248	1272	127	54	547	1634	195	725	1848	18
Grp Volume(v), veh/h	62	0	0	241	0	0	11	0	731	32	0	1031
Grp Sat Flow(s),veh/h/ln	1711	0	0	1452	0	0	547	0	1829	725	0	1867
Q Serve(g_s), s	0.0	0.0	0.0	6.3	0.0	0.0	0.9	0.0	12.4	1.4	0.0	22.9
Cycle Q Clear(g_c), s	1.4	0.0	0.0	7.7	0.0	0.0	23.8	0.0	12.4	13.8	0.0	22.9
Prop In Lane	0.52		0.15	0.88		0.04	1.00		0.11	1.00		0.01
Lane Grp Cap(c), veh/h	474	0	0	445	0	0	235	0	1146	418	0	1169
V/C Ratio(X)	0.13	0.00	0.00	0.54	0.00	0.00	0.05	0.00	0.64	0.08	0.00	0.88
Avail Cap(c_a), veh/h	641	0	0	598	0	0	288	0	1324	489	0	1351
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	0.00	1.00
Uniform Delay (d), s/veh	16.0	0.0	0.0	18.3	0.0	0.0	17.7	0.0	5.8	10.1	0.0	7.8
Incr Delay (d2), s/veh	0.1	0.0	0.0	1.0	0.0	0.0	0.1	0.0	0.8	0.1	0.0	6.5
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	0.5	0.0	0.0	2.4	0.0	0.0	0.1	0.0	3.0	0.2	0.0	7.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	16.1	0.0	0.0	19.3	0.0	0.0	17.8	0.0	6.6	10.2	0.0	14.2
LnGrp LOS	B	A	A	B	A	A	B	A	A	B	A	B
Approach Vol, veh/h		62			241			742			1063	
Approach Delay, s/veh		16.1			19.3			6.8			14.1	
Approach LOS		B			B			A			B	

Timer - Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		35.1		14.6		35.1		14.6
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		36.0		16.0		36.0		16.0
Max Q Clear Time (g_c+I1), s		25.8		3.4		24.9		9.7
Green Ext Time (p_c), s		3.8		0.2		6.2		0.7

Intersection Summary	
HCM 6th Ctrl Delay	12.2
HCM 6th LOS	B

Queues
10: Honoapiilani Hwy & Waiale Rd

Future (2045) With Project Signal Alt
AM Peak Hour

Lane Group	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	85	243	11	737	32	1032
v/c Ratio	0.22	0.73	0.09	0.64	0.10	0.89
Control Delay	13.6	34.6	7.1	10.5	6.1	22.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	34.6	7.1	10.5	6.1	22.4
Queue Length 50th (ft)	15	76	1	147	4	285
Queue Length 95th (ft)	44	#164	8	256	14	#580
Internal Link Dist (ft)	447	967		6714		4002
Turn Bay Length (ft)			50		50	
Base Capacity (vph)	438	381	126	1150	313	1166
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.64	0.09	0.64	0.10	0.89

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM 6th Signalized Intersection Summary
6: Waiko Rd & Waiale Rd

Future (2045) WIth Project Signal Alt
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	50	140	30	380	240	280	20	180	300	170	240	20
Future Volume (veh/h)	50	140	30	380	240	280	20	180	300	170	240	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.96	0.99		0.97	0.99		0.97	1.00		0.97
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	1856	1870	1870	1870	1870	1870	1856	1870	1856	1856	1870
Adj Flow Rate, veh/h	53	147	20	400	253	236	21	189	231	179	253	18
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, %	2	3	2	2	2	2	2	3	2	3	3	2
Cap, veh/h	234	296	40	561	286	267	420	219	267	312	606	43
Arrive On Green	0.04	0.19	0.19	0.18	0.33	0.33	0.02	0.29	0.29	0.08	0.35	0.35
Sat Flow, veh/h	1781	1590	216	1781	876	817	1781	746	911	1767	1708	122
Grp Volume(v), veh/h	53	0	167	400	0	489	21	0	420	179	0	271
Grp Sat Flow(s),veh/h/ln	1781	0	1807	1781	0	1694	1781	0	1657	1767	0	1829
Q Serve(g_s), s	1.5	0.0	5.1	10.7	0.0	16.8	0.5	0.0	14.7	4.1	0.0	6.9
Cycle Q Clear(g_c), s	1.5	0.0	5.1	10.7	0.0	16.8	0.5	0.0	14.7	4.1	0.0	6.9
Prop In Lane	1.00		0.12	1.00		0.48	1.00		0.55	1.00		0.07
Lane Grp Cap(c), veh/h	234	0	336	561	0	553	420	0	486	312	0	649
V/C Ratio(X)	0.23	0.00	0.50	0.71	0.00	0.88	0.05	0.00	0.86	0.57	0.00	0.42
Avail Cap(c_a), veh/h	281	0	471	561	0	634	501	0	593	312	0	685
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	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.6	0.0	22.4	15.0	0.0	19.6	14.8	0.0	20.6	14.9	0.0	15.0
Incr Delay (d2), s/veh	0.5	0.0	1.1	4.2	0.0	12.8	0.0	0.0	10.9	2.5	0.0	0.4
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	0.6	0.0	2.1	4.4	0.0	7.9	0.2	0.0	6.6	1.7	0.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.1	0.0	23.6	19.2	0.0	32.4	14.8	0.0	31.5	17.4	0.0	15.4
LnGrp LOS	C	A	C	B	A	C	B	A	C	B	A	B
Approach Vol, veh/h		220			889			441			450	
Approach Delay, s/veh		22.7			26.5			30.7			16.2	
Approach LOS		C			C			C			B	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	9.0	22.0	15.0	15.4	5.2	25.8	6.4	24.1
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	5.0	22.0	11.0	16.0	4.0	23.0	4.0	23.0
Max Q Clear Time (g_c+I1), s	6.1	16.7	12.7	7.1	2.5	8.9	3.5	18.8
Green Ext Time (p_c), s	0.0	1.3	0.0	0.5	0.0	1.3	0.0	1.3

Intersection Summary			
HCM 6th Ctrl Delay			24.7
HCM 6th LOS			C

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	53	179	400	548	21	505	179	274
v/c Ratio	0.25	0.50	0.78	0.83	0.05	0.87	0.75	0.38
Control Delay	15.2	26.5	27.3	30.9	11.5	34.6	36.6	17.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.2	26.5	27.3	30.9	11.5	34.6	36.6	17.3
Queue Length 50th (ft)	13	60	118	189	5	152	46	72
Queue Length 95th (ft)	31	115	#233	#376	16	#320	#133	154
Internal Link Dist (ft)		1982		4578		1623		6781
Turn Bay Length (ft)	100		290		50		350	
Base Capacity (vph)	214	467	516	675	437	659	239	736
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.25	0.38	0.78	0.81	0.05	0.77	0.75	0.37

Intersection Summary

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	20	20	120	20	30	20	940	160	10	970	20
Future Volume (veh/h)	20	20	20	120	20	30	20	940	160	10	970	20
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.96	1.00		0.98	1.00		0.98
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	1856	1856	1870	1856	1870
Adj Flow Rate, veh/h	21	21	5	126	21	23	21	989	162	11	1021	20
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, %	2	2	2	3	2	2	2	3	3	2	3	2
Cap, veh/h	171	149	28	261	36	31	308	1113	182	223	1303	26
Arrive On Green	0.15	0.15	0.15	0.15	0.15	0.15	0.72	0.72	0.72	0.72	0.72	0.72
Sat Flow, veh/h	575	971	184	1052	232	201	542	1549	254	488	1813	36
Grp Volume(v), veh/h	47	0	0	170	0	0	21	0	1151	11	0	1041
Grp Sat Flow(s),veh/h/ln	1730	0	0	1485	0	0	542	0	1802	488	0	1848
Q Serve(g_s), s	0.0	0.0	0.0	5.3	0.0	0.0	1.6	0.0	31.1	1.1	0.0	22.7
Cycle Q Clear(g_c), s	1.4	0.0	0.0	6.7	0.0	0.0	24.3	0.0	31.1	32.2	0.0	22.7
Prop In Lane	0.45		0.11	0.74		0.14	1.00		0.14	1.00		0.02
Lane Grp Cap(c), veh/h	349	0	0	328	0	0	308	0	1296	223	0	1328
V/C Ratio(X)	0.13	0.00	0.00	0.52	0.00	0.00	0.07	0.00	0.89	0.05	0.00	0.78
Avail Cap(c_a), veh/h	509	0	0	475	0	0	404	0	1613	310	0	1654
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	0.00	1.00
Uniform Delay (d), s/veh	23.0	0.0	0.0	25.1	0.0	0.0	13.5	0.0	6.8	19.4	0.0	5.7
Incr Delay (d2), s/veh	0.2	0.0	0.0	1.3	0.0	0.0	0.1	0.0	5.5	0.1	0.0	2.0
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	0.6	0.0	0.0	2.4	0.0	0.0	0.2	0.0	8.3	0.1	0.0	5.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.2	0.0	0.0	26.4	0.0	0.0	13.6	0.0	12.3	19.5	0.0	7.7
LnGrp LOS	C	A	A	C	A	A	B	A	B	B	A	A
Approach Vol, veh/h		47			170			1172			1052	
Approach Delay, s/veh		23.2			26.4			12.4			7.8	
Approach LOS		C			C			B			A	

Timer - Assigned Phs	2	4	6	8
Phs Duration (G+Y+Rc), s	49.0	13.6	49.0	13.6
Change Period (Y+Rc), s	4.0	4.0	4.0	4.0
Max Green Setting (Gmax), s	56.0	16.0	56.0	16.0
Max Q Clear Time (g_c+I1), s	33.1	3.4	34.2	8.7
Green Ext Time (p_c), s	11.9	0.1	9.6	0.5

Intersection Summary	
HCM 6th Ctrl Delay	11.6
HCM 6th LOS	B

Lane Group	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	63	179	21	1157	11	1042
v/c Ratio	0.21	0.69	0.10	0.90	0.09	0.79
Control Delay	21.6	41.6	5.2	20.6	5.7	13.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	21.6	41.6	5.2	20.6	5.7	13.4
Queue Length 50th (ft)	17	76	3	363	1	276
Queue Length 95th (ft)	50	142	11	#788	7	499
Internal Link Dist (ft)	447	967		6714		4002
Turn Bay Length (ft)			50		50	
Base Capacity (vph)	359	321	216	1372	133	1399
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.18	0.56	0.10	0.84	0.08	0.74

Intersection Summary

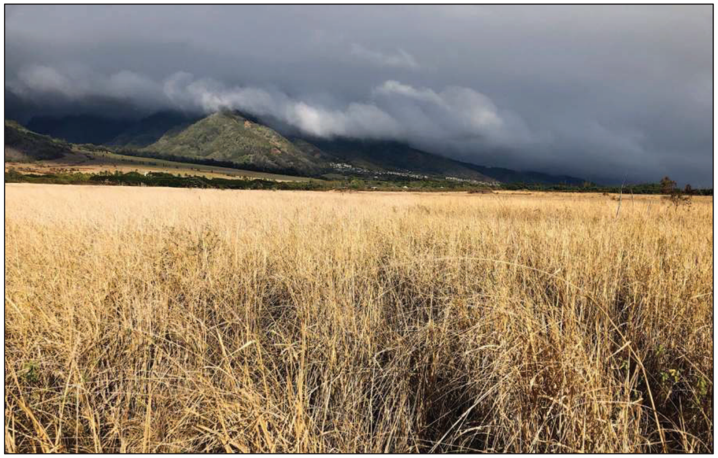
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

APPENDIX D

Natural Resources Assessment

AECOS No. 1196B

A natural resources assessment for the County of Maui, Waiʻale Road Extension Project Waikapū, Maui



AECOS Inc.
45-939 Kamehameha Highway
Suite 104
Kāneʻohe, Hawaiʻi 96744

July 5, 2022

A natural resources assessment for the County of Maui, Waiʻale Road Extension Project Waikapū, Maui

July 5, 2022 *AECOS* No. 1196B

Susan Burr, Reginald David III, Bryson Luke, Lesley Davidson
AECOS, Inc.
45-939 Kamehameha Highway Suite 104
Kāneʻohe, Hawaiʻi 96744
Phone: (808) 234-7770 Email: bryson@aecos.com

Introduction

The County of Maui, Department of Public Works (MDPW) is planning to extend Waiʻale Road from East Waiko Road to Honoʻapiʻilani Highway at Old Quarry Road through portions of parcels owned by Waiale 905 Partners, LLC. (TMK 3-6-002:003) and County of Maui (TMK 3-6-002:004). The Waiʻale Road Extension Project (hereafter, "Project") will add: a two-lane roadway with paved shoulders; grassed swales; a drainage system including detention basin(s); a water system; potentially sewerlines; and supporting infrastructure (e.g., electrical, telephone, CATV, landscaping and irrigation, etc.). The Project will include utilities and maintenance easements, as well as relocate existing utilities. The proposed roadway extension will cross Waikapū Stream opposite the existing intersection of Waiʻale Road at East Waiko Road. *AECOS*, Inc. was tasked with the delineation of federal jurisdictional waters and an assessment of biological resources and water quality at the Project site. This report details the findings of our field survey efforts[1].

Site Description

The Project is located in Waikapū Watershed (DAR Watershed Code 66010; Parham et al., 2008) and a segment of the Project will cross Waikapū Stream. The name *Waikapū* translates to English as "water of the conch shell", named from a legendary sounding conch stolen by a supernatural dog (Pukui, Elbert, &

[1] This document prepared for Munekiyo Hiraga to be incorporated into the Environmental Assessment (EA) for the Waiʻale Road Extension Project and become part of the public record.

Moʻokini, 1974). State of Hawaiʻi Dept. of Land and Natural Resources (HDLNR) Commission on Water Resource Management (CWRM) assigns Waikapū Stream a hydrologic unit code (6001). The watershed occupies an area of 4,200 ha (10,400 ac) in South Central Maui, from sea level to approx. 1,550 m (5,100 ft) above sea level (ASL) on West Maui Mountain.

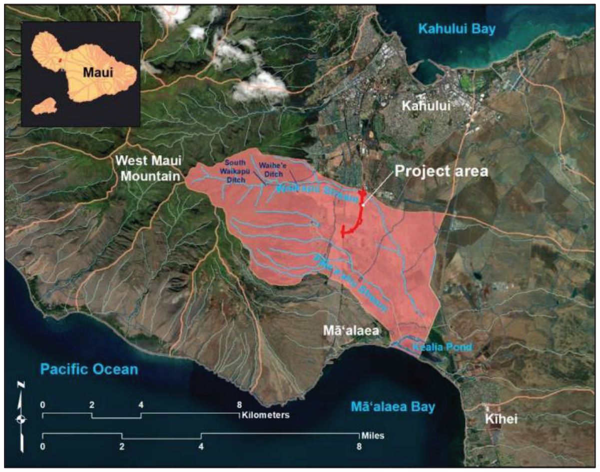


Figure 1. Project location (in red), overlaid on Waikapū Watershed (in pink).

Waikapū Watershed supports two principal tributaries–perennial Waikapū Stream to the north, and intermittent Paleʻaʻahu Stream to the south (Figure 1). Waikapū Stream is fed from headwaters in Waikapū Valley of West Maui Mountain. From the valley, the stream courses eastward through foothills of the mountain between Waikapū subdivision on the north and agricultural fields on the south, then onto the central Maui plain east of Hōnoapiʻilani Highway. The stream turns southward and drains into the Pacific Ocean through the Keālia Pond Complex at Maʻalaea Bay (Fig. 1). The Hawaiʻi Stream Assessment (HCPSU, 1990) rates the riparian resources of Waikapū Stream as 'Outstanding', with opportunities for hiking, swimming, natural study, and scenic views. Two active diversions occur on Waikapū Stream: South Waikapū Ditch at around 350 m (1150 ft) ASL and Waiheʻe Ditch at 275 m (900 ft) ASL. The Project will cross the middle reach of Waikapū Stream at around 90 m (300 ft), downstream of the

diversions. The ditch intake to Reservoir 6 near the Project is inactive and abandoned.

Waikapū Stream is one of the *Nā Wai ʻEhā* or "Four Great Waters" that charge the ʻĪao Aquifer of West Maui Mountain. Of the *Nā Wai ʻEhā*, Waikapū Stream is the only one to flow southward, whereas the others—Waiheʻe River, Waiʻehu Stream, and Wailuku River [formerly ʻĪao Stream]—flow generally north- or eastward to Kahului Bay (HDLNR-CWRM, 2021). *Nā Wai ʻEhā*, including Waikapū Stream, are the subject of a long and complex series legal dissidences spanning many decades. The most recent ruling by HDLNR-CWRM, dated June 30, 2021 (HDLNR-CWRM, 2021), provides Interim Instream Flow Standards (IIFS) for *Nā Wai ʻEhā*. The IIFS provides an estimated total discharge for Waikapū Stream at 3.3 million gallons per day (mgd) upstream of all diversions, and an IIFS of 2.9 mgd downstream of South Waikapu Ditch during median baseflow (expected 70% of the time), and 2.27 mgd for periods of below-average baseflow. Stream discharge and IIFS are derived from historical data at South Side Waikapū Ditch (1910-1917; 1984-2007), 2004 USGS stream data (USGS Gage 16650000), and seepage-run data. As indicated in the IIFS, more than half of the total stream discharge must be allocated to (natural) instream habitat and related benefits (HDLNR-CWRM, 2021).

The Project in Central Maui is in the lee of both East and West Maui mountains, and typically blocked from precipitation carried by prevalent Trade Winds. Thus, climate in the Project area is dry to mesic. The *Rainfall Atlas of Hawaiʻi* (Giambelluca et al., 2013) approximates the average annual rainfall at the Project as 523 mm (20.6 in). Rainfall varies greatly in wet and dry seasons, with rainfall being typically greatest in January and least in June (Figure 2). The U.S. Climate normals data set reports average annual rainfall at the nearest climate normal station (Waikapu 390, Sta. Id USC00519376) as 694 mm (27.31 in; NOAA-NCEI, 2021), with rainfall being highest in March and least in June. U.S. Climate Normals data are based on a 30-year average (1991 to 2020).

Project Site

The Project will extend Waiʻale Road southward from East Waiko Road to Honoʻapiʻilani Highway at Old Quarry Road, running approximately 2.1 km (1.3 mi) between county-owned (TMK 3-6-002:004) and private lands held by Waiʻale 905 Partners LLC (TMK 3-6-002:003) and Waikapū Properties LLC (3-6-004:003). The road extension will provide transportation infrastructure for a separately-proposed community development, Waikapū Country Town. At present, these lands are fallow fields formerly in sugarcane production. The Project proposes to implement a bridge crossing at Waikapū Stream near the existing intersection of Waiʻale Road and East Waiko Road.

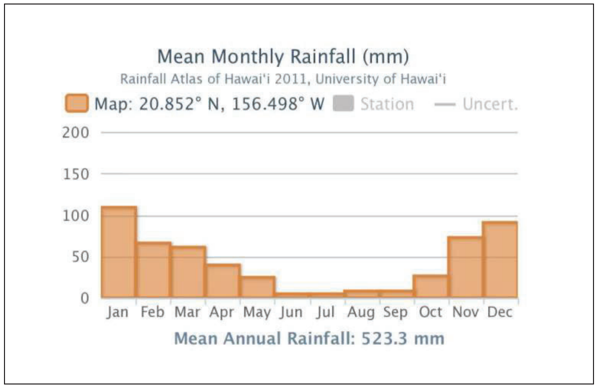


Figure 2. Mean monthly rainfall (mm) at the Project site (Giambelluca et al., 2013).

The U.S. Fish and Wildlife Service (USFWS), National Wetlands Inventory (NWI) is a nationwide geospatial dataset of wetlands and other surface hydrology features (USFWS, nd-a). The NWI maps only Waikapū Stream in the Project area, although several ponds and ditches are mapped on the far side of Honoapiʻilani Highway (Figure 3). The NWI does not map any wetlands in or near the Project area.

The U.S. Dept. of Agriculture, Natural Resources Conservation Service (USDA-NRCS) web soil survey (2021) shows the dominant soil types at the Project as ʻIao clay 3 to 7% slopes (map unit ICB), Pulehu clay loam 3 to 7% slopes (map unit PrB), and Pulehu cobbly clay loam 0 to 3% slopes (PtA) and 3 to 7% slopes (PtB, see Fig. 3). None of the soil types mapped in the Project area is listed in the USDA-NRCS Soil Data Access *Hydric Soils List* (USDA-NRCS, nd.) for Maui County.

Both Federal Emergency Management Agency (FEMA) and Hawaiʻi Dept. of Land and Natural Resources (HDLNR) Flood Zone Hazard Assessment Tool (FHAT) place the majority of the Project area in 'Flood Zone X', or an area of minimal flood hazard determined to be outside the elevation of a 0.2% annual chance (or 500-year) flood. Waikapu Stream at the Project site is classified as a floodway area, including 'Flood Zone AE' and 'Flood Zone AEF'. These areas are within the 1% annual chance (100-year) flood (HDLNR, 2019; Figure 4).

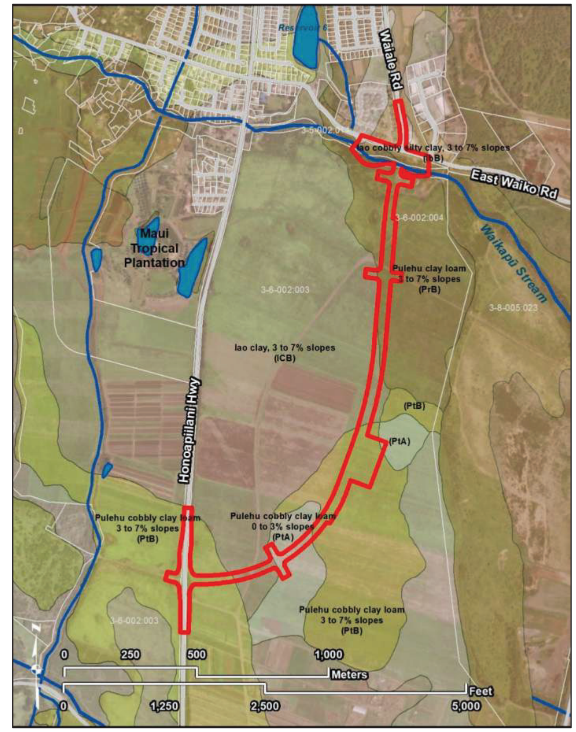


Figure 3. NWI surface water features (blue) and near the Project area (red).

Jurisdictional Waters

Jurisdictional waters (also called "waters of the U.S.") are surface waters that come under federal jurisdiction as authorized by the federal Clean Water Act (CWA) and Rivers and Harbors Act (RHA). Authority over these waters is granted to various federal agencies, including the U.S. Environmental Protection Agency (USEPA), with the U.S. Army Corps of Engineers (USACE) having permit authority for actions that impact jurisdictional waters. Jurisdictional waters include all tidal waters and a subset of streams, lakes, reservoirs, and wetlands.

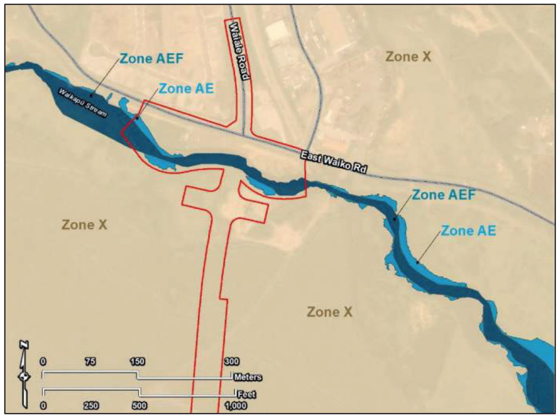


Figure 4. The proposed Project area (red outline) at Waikapū Stream, with FEMA Flood Zone overlay.

Because ecosystem boundaries are gradients in nature, defining the limits of jurisdiction is partly a political decision. Recent Supreme Court cases (including *Rapanos v. United States*, *SWANCC v. USACE*, and *Carabell v. United States*), a guidance memorandum (USEPA and DA, 2008), and recent published rules (USACE and USEPA, 2015; 2020) have variously refined the definition of waters of the U.S. However, on August 20, 2021, a District Court order remanded and vacated the most recent definition of waters of the U.S. (US District Court for AZ, 2021) and, until a new rule is published, the definition reverts back to the pre-2015 regulatory language, decided by the Supreme Court and described in the guidance memorandum (USEPA and DA, 2008). The USEPA and USACE announced their intent to initiate renewed rulemaking to revise the definition of waters of the U.S. (USEPA, 2021), a definition likely to remain in flux for years.

Our jurisdictional assessment presented herein is based on best professional judgement, but the USACE must concur with our findings for these to become official. If a feature is determined by the USACE to be jurisdictional, certain activities would require a permit from that agency before undertaking work within the boundaries of that feature.

Methods

Jurisdictional Waters Survey

AECOS, Inc. biologists conducted a delineation of federal jurisdictional waters in the Project area on November 4, 2021.

To determine 'typical' or 'atypical' stream conditions, we use federal (USGS) and state (HDLNR-DAR or CWRM) stream gages with established historical averages to compare to real-time stream discharge prior to and during our survey. To supplement official data, we collect stream water velocity using a Swoffer Model 3000 flow meter at the Project reach to estimate stream discharge.

Tributaries

The jurisdictional boundary of a non-tidal tributary is the *ordinary high water mark* (OHWM). OHWM is defined as: "…that line on the shore established by the fluctuations of water and indicated by [various] physical characteristics… or other appropriate means that consider the characteristics of the surrounding areas" (USACE, 1986). According to a regulatory guidance letter (RGL No. 05-05; USACE, 2005), the following physical characteristics may be indicators of the OHWM:

Natural line impressed on the bank	Leaf litter disturbed or washed away
Shelving	Scour
Changes in the character of the soil	Deposition
Destruction of terrestrial vegetation	Multiple observed flow events
Presence of litter and debris	Bed and banks
Wracking	Water staining

Waikapū Stream at the Project site is well beyond the influence of ocean tides. Thus, federal jurisdiction for this non-tidal tributary is the OHWM. We delineated OHWM at the Project site by marking paired locations along the stream channel with colored flagging tape and by recording the geospatial position of each flag using a Trimble Geo7X, capable of sub-meter accuracy. The resulting shapefile was processed with GPS Pathfinder Office, including differential correction, and exported as ArcMap shapefiles using a Projected coordinate system of NAD 1983 UTM Zone 4N.

Photographs from the channel at each paired point were made to document the OHWM characteristics and to illustrate the environment. A survey team from Warren S. Unemori Engineering, Inc. recorded the locations and elevations of each paired-point flag on November 4, 2021.

Wetlands

We inspected the Project area for the presence of wetlands, either in or adjacent to the Project site, and found no evidence of wetlands.

Water Quality Survey

On November 4, 2021, *AECOS* biologist collected water quality from three sampling stations in Waikapū Stream. The locations of the stations were established from an earlier water quality collection conducted by *AECOS* on August 20, 2009 on behalf of the initial proposal for the extension of Waiʻale Road (*AECOS*, 2009). Station "Upstream" is located at the *mauka* (landward) juncture of Waikapū Stream and Honoapiʻilani Highway, approx. 0.6 km (0.4 mi) upstream of the proposed Waiʻale Road crossing; Station "Midstream" is located at the proposed crossing; and Station "Downstream" is located approximately 1.5 km (0.9 mi) downstream of the proposed crossing (see Figure 5). Results of the November 2021 and prior August 2009 water quality measurements are presented in Table 4. *In situ* measurements of stream water were made for temperature, conductivity, pH, and dissolved oxygen. Water samples were collected from just below the water surface and placed on ice, then taken to the *AECOS* Laboratory (*AECOS* Log No. 43994) in Kāneʻohe, Oʻahu for analyses of turbidity, total suspended solids (TSS), and nutrients. Table 1 lists the instruments and analytical methods used in the field and laboratory to analyze the water samples.

Table 1. Analytical methods used for water quality analysis.

Analysis	Method	Reference
Temperature	thermister calibrated to NBS. Cert. thermometer/ SM 2550 B	SM (1998)
Conductivity	SM 2510-B	SM (1998)
pH	SM 4500 H+	SM (1998)
Dissolved Oxygen	SM 4500-O G	SM (1998)
Turbidity	EPA 180.1 Rev 2.0	USEPA (1993)
Total Suspended Solids	SM 2540 D	SM (1998)
Nitrate + Nitrite	EPA 353.2	USEPA (1993)
Total Nitrogen	ASTMD5176-08	ASTM (2015)
Total Phosphorus	EPA 365.5 (Persulfate digestion)	USGS (2003), USEPA (1993)

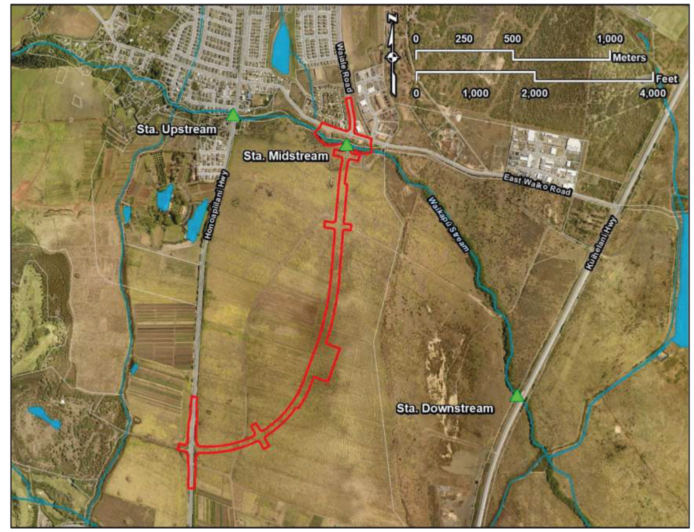


Figure 5. Water quality stations (green triangles) on Waikapū Stream.

Botanical Survey

On November 4, 2021, *AECOS* biologists conducted a botanical survey by walking the Project area and the riparian corridor of Waikapū Stream approximately 300 m (1,000 ft) upstream and 200 m (650 ft) downstream of the proposed Project crossing. A Trimble 7X Series GNSS unit was used to provide real-time guidance to ensure adequacy of the survey coverage and record locations of any plants of particular interest or concern. Plants were identified to species as they were encountered. Any plant not immediately recognized during the survey was photographed and/or a representative feature (e.g., flower, fruit, or leaf) collected for later identification at the laboratory. As the survey progressed, the relative abundance of each plant species in the survey area was noted.

Plant names used in the report follow *Manual of the Flowering Plants of Hawaiʻi* (Wagner, Herbst, & Sohmer, 1990; Wagner & Herbst, 1999) for native and naturalized flowering plants, *Hawaiʻi's Ferns and Fern Allies* (Palmer, 2003) for ferns, and *A Tropical Garden Flora* (Staples & Herbst, 2005) for crop and ornamental plants. More recent name changes for naturalized plants follow Imada (2019).

Fauna Survey

Aquatic Fauna

On November 4, 2021, *AECOS* biologists surveyed aquatic species by making visual observations from the streambanks and/or hand capture of aquatic specimens. As the survey progressed, biologists made notes on the relative abundance (e.g. rare, common, or abundant) of each species encountered. Nomenclature and identifications follow *Hawai'i's Native and Exotic Freshwater Animals* (Yamamoto and Tagawa, 2000) and *Stream macroalgae of Hawai'i: An identification guide to the common genera* (Sherwood, 2004).

Blackburn's Sphinx moth

Blackburn's sphinx moth (*Manduca blackburni*) is an endangered endemic moth known from the lowlands on the Island on Maui. This species is a Solanaceae specialist and because its original native hosts plants have all but disappeared the larval stage of the species has adapted to feed on tree tobacco (*Nicotiana glauca*), a widespread introduced weed. Tree tobacco is found on all islands in dry, ruderal areas. We conducted the survey for Blackburn's sphinx moth by identifying any plants in the Solanaceae family, particularly tree tobacco, in the Project area during the botanical survey.

Avian Survey

On November 4, 2021, *AECOS* biologists established seven avian point-count stations and two 30-minute waterbird counts to assess the avian species present within the Project site. A six-minute count was conducted at each point-count station conducted in the early morning hours when birds are most active. Birds were identified to species by visual observation, aided by Leica 8 X 42 binoculars, and by listening for vocalizations. The avian phylogenetic order and nomenclature used in this report follow the AOS 62nd *Check-List of North and Middle American Birds* 2021 (Chesser et al., 2021).

Mammals

The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all mammalian species detected within the survey area. Mammal scientific

names follow *Mammal species of the world: a taxonomic and geographic reference* (Wilson and Reeder, 2005).

We did not conduct a survey for Hawaiian hoary bat or *'ōpe'ape'a* (*Lasiurus semotus*[2]). Detection requires night surveys and deployment of special detection equipment to record observations over a long period of time; negative results from a single or several such surveys does not prove the absence of the bat. Rather, habitat and trees in the Project area that could serve as roost-sites for the species were noted, if present.

Results

Jurisdictional Waters Delineation

A photolog of our delineation is provided in Attachment A. An overlay of the delineated OHWM and Project drawings are provided in Attachment B.

The nearest National Oceanographic Atmospheric Administration–National Weather Service (NOAA–NWS) rain gage, Waikapu Country Club (WCCH1), recorded a total of 20.6 mm (0.81 in) of rainfall in a three-month period (August to October) preceding our jurisdictional waters survey in early November 2021, including a month of no recorded rainfall in September (Table 2; NOAA-NWS, 2021b). Total rainfall in that three-month period was 34% of the moving 30-year average rainfall for the gage. Climate normals from the nearest NOAA-NCEI gage (Waikapu 390 [USC00519376]) are provided in Table 2. An exceptional drought condition was prevalent in the West Maui region at the Project area during our survey, and the upper watershed was abnormally dry (Figure 6; NOAA-NWS, 2021a).

USGS real-time stream data are not available for Waikapū Stream covering the dates of our survey. HDLNR-CWRM has a real-time station on Waikapū Stream at 915-ft ASL (used to establish the IIFS for Waikapu Stream), but data were not available for this report due to pressing external factors. CWRM and Mahi Pono LLC are working to establish another real-time stream gage at a lower elevation. Waikapū Stream was flowing within the bounds of the OHWM at the time of our delineation. We estimate the discharge in the Project area during our survey was about 1.74 cu ft/s, or 1.13 mgd. CWRM established an IIFS for Waikapu Stream of 2.9 mgd, with 2.29 mgd during low-flow conditions, and half of the IIFS is

[2] The USFWS refers to the Hawaiian hoary bat as a subspecies (*Lasiurus cinereus semotus)* of the northern hoary bat, but a number of genetic studies that found the bat to be a distinct species only found in Hawai'i (Russell et al. 2015; Baird et al. 2015; Baird et al. 2017; Pinzari et al, 2020).

Table 2. Local NOAA rainfall data in the 3-month period preceding fieldwork.

	NOAA-NWS rain gage Waikapu Country Club (WCCH1)		NOAA-NCEI Climate Normals Waikapu 390 (USC00519376)
	2021 Monthly Total (inches)	Moving 30-year Monthly Average (inches)	1991-2020 Climate Normals (inches)
August	0.61	0.51	1.10
September	0.00	0.47	1.30
October	0.20	1.42	1.26
Cumulative	**0.81**	**2.40**	**3.66**

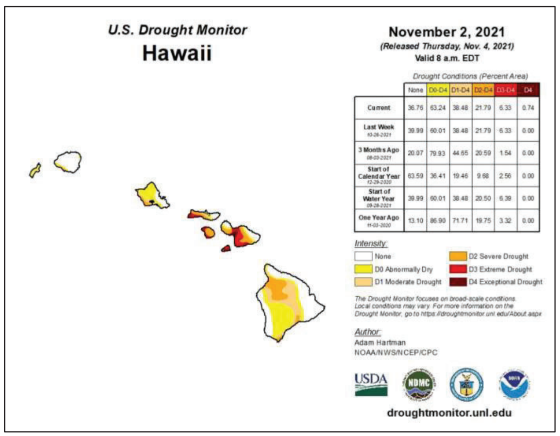


Figure 6. Prevaling drought conditions in Hawai'i in early November 2021 (NOAA-NWS, 2021a).

designated for instream habitat (HDLNR-CWRM, 2021). Our estimated discharge is nearly half of the IIFS, presumably reflective of the extreme draught in the

region at the time. For the purposes of jurisdictional determinations, hydrologic conditions in the West Maui region can be considered to be in drought (atypical) conditions, albeit somewhat expected for the tail-end of the Hawaiian dry season (May to October; see Fig. 2).

Tributaries

Waikapū Stream - Lands surrounding the proposed crossing of Waikapū Stream have been in agricultural production for over a century, with sugar cane constituting the bulk of that production. Pre-contact Hawaiians used the land for *lo'i kalo* and other agriculture in centuries prior, and the region was known for its expansive cultivation (Dega, 2014). Handy and Handy (1972) report that, during the pre-contact period, water from Waikapū Stream "was diverted into *lo'i kalo* and its overflow was dissipated on the dry plains of the broad isthmus between West and East Maui." Thus, Waikapū Stream on the central Maui plain has a long history of agricultural modifications shifting the stream flow. At present, Waikapū Stream at the Project is incised between 1.5 to 4.5 m (5 to 15 ft) from the surrounding landscape, and further contoured by earthen berms and large boulders lining the top-of-banks of the stream to shield the fields from floodwater.

Banks of the stream are steep throughout the Project area, with no room for a floodplain or adjacent wetland to develop. Banks are natural earth, consisting of a loose clay loam and vegetated by Java plum and Guinea grass. A layer of windblown sand is accumulated atop the left bank and absent from the right bank. Exposed Java plum roots anchor the majority of the bank and the trees shade the stream channel. Clumps of Guinea grass occupy breaks in the tree canopy (Figure 7). Substrate on the streambed is approximately 50% large boulders, 40% cobble, and less than 10% silt and finer sediment. Most material is well-rounded, stream worn igneous rock, and no bedrock is exposed. The course of the stream is relatively straight with little sinuosity. During our survey, the stream ran as a series of riffles spread evenly across the width of the streambed in most segments, and the stream occupied approximately 60 to 90% of the channel bottom. Occasional pools were shallow, and often filled with fruit of Java plum. Leaf litter accumulated on the stream banks but was mostly absent from the channel bottom.

We used changes in bank slope, changes in vegetative community (bare rock to mature Java plum tree), erosion lines, exposed roots, and sediment sorting as the primary indicators for OHWM in Waikapū Stream. The line between cobble/boulder and soil clay loam was another prevailing indicator of OHWM in this reach of Waikapū Stream. In all, we delineated approximately 500 m (1600 ft) of the left and right bank of Waikapū Stream through the Project site using 16

Figure 7. Java plum trees line Waikapū Stream at the Project area.

paired points (Figure 8 and Table 3). The area delineated extends approximately 300 m (1,000 ft) upstream and 200 m (600 ft) downstream of the proposed crossing near the intersection of Waiʻale Road and East Waiko Road, ending at an existing concrete box-bridge crossing on the downstream-end.

Water Quality

The stream bottom was visible through the water column at all stations during our sample collection on November 4, 2021. Despite the presence of Java plum fruit and other accumulated organic matter in some sections, the water appeared exceptionally clear throughout the stream, with no visible turbidity.

In situ water quality measurements from Waikapū Stream near or at the Project area ranged in temperature from 22.2 to 22.9°C. Dissolved oxygen (DO) concentrations ranged from 7.55 to 8.54 mg/L, corresponding to 87% to 99% DO saturation. Values for stream pH ranged from 6.35 to 7.20. Stream water conductivity ranged between 43 to 93 µmhos/cm across three stations.

Figure 8. Delineated OHWM (blue line) at the Project area (in red).

Table 3. Primary indicators of OHWM at Waikapū Stream.

Left Bank		Right Bank	
Flag	Primary OHWM feature	Flag	Primary OHWM feature
01L	Water mark on existing bridge, change in bank slope/material.	01R	Water mark on existing bridge, change in bank slope/material.
02L	Change in bank slope, change in vegetative community (*honohono* to Guinea grass), erosion line.	02R	Incised bank, change in bank slope.
03L to 08L	Change in vegetative community (bare rock to mature Java plum), exposed roots, change in substratum (worn bolder/cobble to soil).	03R to 08R	Change in vegetative community (bare rock to mature Java plum), exposed roots, change in substratum (worn bolder/cobble to soil).

Table 3 (continued).

Left Bank Flag	Left Bank Primary OHWM feature	Right Bank Flag	Right Bank Primary OHWM feature
08L to 16L	Change in vegetative community (bare rock to mature Java plum), water-line on trunks, exposed roots, change in substratum (worn bolder/cobble to soil).	08R to 16R	Change in vegetative community (bare rock to mature Java plum), water-line on trunks, exposed roots, change in substratum (worn bolder/cobble to soil).

Table 4. Physical and chemical water quality at the Project location for samples collected November 2021 and August 2009.

Station	Temp. (°C)	Conductivity (µmhos/cm)	pH	DO (mg/L)	DO sat. (%)
Upstream (Nov 2021)	22.9	93	6.35	8.54	99
(Aug 2009)	23.7	125	6.71	7.85	93
Midstream (Nov 2021)	22.6	93	6.35	7.55	87
(Aug 2009)	24.6	98	6.41	8.05	97
Downstream (Nov 2021)	22.2	43	7.20	7.94	91
(Aug 2009)	24.6	109	6.55	7.83	94

Station	Turbidity (ntu)	TSS (mg/L)	NO_3+NO_2 (µg N/L)	Total N (µg N/L)	Total P (µg P/L)
Upstream (Nov 2021)	1.23	2.0	< 1	107	28
(Aug 2009)	1.80	1.0	16	60	20
Midstream (Nov 2021)	0.71	1.2	1	88	21
(Aug 2009)	1.30	1.0	< 9	60	20
Downstream (Nov 2021)	1.08	0.8	< 1	84	20
(Aug 2009)	1.42	2.2	18	80	20

Particulates, measured as turbidity and total suspended solids (TSS), were excellent for Hawaiian streams at the beginning of the wet season: turbidity values ranged between 0.71 to 1.23 ntu; TSS ranged from 0.8 to 2.0 mg/L.

Regarding stream nutrients, nitrate+nitrite (1 to <1 µg N/L) and total nitrogen (84 to 107 µg N/L) were near to-, or below, detection limits at all stream stations. Total phosphorous (20 to 28 µg P/L) was low. Total nitrogen and total phosphorous, along with stream particulates (turbidity, TSS) were highest at station Upstream, although still fairly low.

Flora Survey

Vegetation

Vegetation across the Project area is nearly all open grassland dominated by Guinea grass (*Megathyrsus maximus*; Figure 9), having covered the fallow sugarcane fields south of East Waiko Road. Ruderal herbs grow along the margins of farm roads. At Waikapū Stream, a riparian forest of mostly Java plum (*Syzgium cumini*) grows along the stream margins (see Fig. 7).

Figure 9. Grassland vegetation in fallow field.

Flora

The botanical survey of the Project area identified 56 taxa of plants (Table 5). The vast majority (93%) are non-native species. Three indigenous species are present: *moa* (*Psilotum nudum*) and primrose willow (*Ludwigia octovalvis*) in the riparian zone of Waikapū Stream; and *ʻuhāloa* (*Waltheria indica*) in ruderal (disturbed) areas. The percent of natives (7%) is typical for a lowland location on Maui. A single Polynesian introduction, coconut or *niu* (*Cocos nucifera*), and two non-native ornamentals, be-still tree (*Thevetia peruviana*) and small crown flower or *puakalaʻunu* (*Calotropis procera*), were recorded.

Table 5. List of and plants and their relative abundances at the Project site.

Family / *Species*	Common name	STATUS	ABUNDANCE	NOTES
FERNS AND FERN ALLIES				
PSILOTACEAE				
Psilotum nudum (L.) P. Beauv.	*moa*	**Ind**	R	<2>
FLOWERING PLANTS – MONOCOTS				
AGAVACEAE				
Furcraea foetida (L.) Haw.	Mauritius hemp	Nat	R	---
Sansevieria trifasciata Prain	Mother-in-law's tongue	Nat	R	---
ARECACEAE				
Chrysalidocarpus lutescens L.	golden fruited palm	Nat	R	---
Cocos nucifera L.	coconut palm; *niu*	**Pol**	R	---
CYPERACEAE				
Cyperus involucratus Rottb.	umbrella sedge	Nat	U	<2>
POACEAE (GRAMINEAE)				
Digitaria insularis (L.) Mez ex Ekman	sourgrass	Nat	R	---
Cenchrus purpureus (Schumach.) Morrone	elephant grass	Nat	O	<2>
Chloris barbata (L.) Sw.	swollen fingergrass	Nat	C	---
Coix lacryma-jobi L.	Job's tears	Nat	U	<2>
Cynodon dactylon (L.) Pers.	Bermuda grass	Nat	O	---
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	Nat	U	---
Megathyrsus maximus (Jacq.) B.K. Simon & W.L. Jacobs	Guinea grass	Nat	AA	---
Melinus repens (Willd.) Zizka	Natal redtop	Nat	U	---

Table 5 (continued).

Family / *Species*	Common name	STATUS	ABUNDANCE	NOTES
FLOWERING PLANTS – EUDICOTS				
ACANTHACEAE				
Justicia betonica L.	white shrimp plant	Nat	C	<2>
AMARANTHACEAE				
Alternanthera pungens Kunth	khaki weed	Nat	U	---
Amaranthus spinosus L.	spiny amaranth	Nat	U	---
ANACARDIACEAE				
Mangifera indica L.	mango	Nat	U	---
Schinus terebinthefolius Raddi	Christmas berry	Nat	R	---
APOCYNACEAE				
Thevetia peruviana (Pers.) K. Schum.	be-still tree	Orn	U	---
ASCLEPIADACEAE				
Asclepias physocarpa (E. Mey.) Schlechter	balloon plant	Nat	R	---
Calotropis procera (Aiton) W. T. Aiton	*puakalaunu*, crown flower	Orn	U	---
ASTERACEAE				
Pluchea indica (L.) Less.	Indian fleabane	Nat	U	---
Pluchea carolinensis (Jacq.) G. Don	---	Nat	O	---
Tridax procumbens L.	coat buttons	Nat	O	---
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	Nat	O	---
Xanthium strumarium L	*kīkānia*	Nat	C	---
Sonchus sp. or *Lactuca* sp.	---	Nat	R	<1>
BIGNONIACEAE				
Spathodea campanulata P. Beauv.	African tulip	Nat	R	---
BORAGINACEAE				
Heliotropium procumbens Mil.	---	Nat	O	---
BRASSICACEAE				
Lepidium virginicum L.	peppergrass	Nat	R	---
COMMELINACEAE				
Commelina diffusa N. L. Burm.	*honohono*	Nat	R	<2>
CONVOLVULACEAE				
Ipomoea obscura (L.) Ker-Gawl.	---	Nat	R	---
CUCURBITACEAE				
Cucumis dipsaceus Ehrenb. ex Spach	teasel gourd	Nat	R	---
Momordica charantia L.	balsam pear	Nat	R	---

Table 5 (continued).

Family *Species*	Common name	STATUS	ABUNDANCE	NOTES
EUPHORBIACEAE				
Euphorbia hypericifolia L.	graceful spurge	Nat	O	---
Macaranga tanarius (L.) Müll. Arg.	---	Nat	U	---
FABACEAE				
Enterolobium cf. *cyclocarpum* (Jacq.)	earpod	Orn	R	<1,2>
Chamaecrista nictitans (L.) Moench	partridge pea	Nat	U	---
Indigophera hendecaphyla Jacq.	creeping indigo	Nat	C	---
Indigofera suffruticosa Mill.	indigo	Nat	O	---
Leucaena leucocephala (Lam.) deWit	*koa haole*	Nat	C	---
Macroptilium atropurpureum (DC.) Urb.	---	Nat	C	---
Neonotonia wightii (Wight & Arn.) Lackey	glycine vine	Nat	R	---
Prosopis pallida (Humb. & Bonnpl. ex Willd.) Kunth	*kiawe*	Nat	O	---
LAMIACEAE				
Leonotis nepetifoilia (L.) R. Br.	lion's ear	Nat	C	---
MALVACEAE				
Abutilon grandifolium (Willd.) Sweet	hairy albutilon	Nat	R	---
Malvastrum coromandelianum (L.) Garcke	false mallow	Nat	O	---
Sida ciliaris L.	---	Nat	U	---
Sida rhombifolia L.	Cuba jute	Nat?	U	---
Sida spinosa L.	prickly sida	Nat	U	---
Waltheria indica L.	*'uhaloa*	**Ind?**	O	---
MYRTACEAE				
Syzgium cumini (L.) Skeels	Java plum	Nat	A	<2>
NYCTAGINACEAE				
Boerhavia coccinea Mill.	false *alena*	Nat	U	---
ONAGRACEAE				
Ludwigia octovalvis (Jacq.) Raven	primrose willow	**Pol?**	U	<2>
SCROPHULARIACEAE				
Buddleja asiatica Lour.	dog tail	Nat	R	---

Key to Table 5.

Status = distributional status
Ind = Indigenous; native to Hawaii, but not unique to the Hawaiian Islands.

Table 5 (continued).

Nat = Naturalized, exotic, plant introduced/established to the Hawaiian Islands after 1778.
Orn = exotic, ornamental or cultivated; plant not naturalized (not well-established outside of cultivation).
Pol = Early Polynesian introduction ("canoe plant").
Abundance = occurrence ratings for plants in the Project area
R – Rare - only one or two plants seen.
U - Uncommon - several to a dozen plants observed.
O - Occasional - found regularly, but not abundant anywhere.
C - Common - considered an important part of the vegetation and observed numerous times.
A - Abundant - found in large numbers; may be locally dominant.
AA - Dominant - found in large numbers; may be locally dominant.
Notes:
<1> - Plant without clearly identifying feature; identification uncertain.
<2> - Found only along Waikapū Stream

Fauna

Aquatic Fauna

Table 6 lists aquatic species identified in Waikapū Stream. The table includes observations made by *AECOS* biologists in the Project area on November 4, 2021 as well as earlier observations made by *AECOS* in August 20, 2009, and in various upstream reaches of the stream by Hawai'i Dept. of Land and Natural Resources–Division of Aquatic Resources (HDLNR-DAR) summarized in the *Hawai'i Watershed Atlas* (Parham et al., 2008).

Table 6. Checklist of aquatic species found in Waikapu Stream in the Project vicinity.

PHYLUM, CLASS, ORDER, FAMILY *Species*	Common name	Status	Abundance	Notes
	ALGAE			
CYANOPHYTA, CHLOROPHYCEAE, CHAETOPHORALES				
CHAETOPHORACEAE				
Cloniophora sp.	unident. cyanobacteria	---	P	<1>

Table 6 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Species*	Common name	Status	Abundance	Notes
	INVERTEBRATES			
MOLLUSCA, GASTROPODA, BASOMMATOPHORA				
PHYSIDAE				
unid. Physid	pouch snail	Nat	R	<1,2>
NEOTAENIOGLOSSA				
THIARIDAE				
Melania tuberculata Muller	red-rimmed melania	Nat	O	<1,3>
MOLLUSCA, BIVALVIA, VENEROIDEA				
CYRENIDAE				
Corbicula fluminea Muller	Asiatic clam	Nat	C	<1,2,3>
ARTHROPODA, INSECTA ODONATA				
AESHNIDAE				
Anax junius Drury	green darner	**Ind**	---	<2,3>
COENAGRIONIDAE				
Ischnura ramburii Selyx	Rambur's forktail	Nat	R	<1,3>
Megalagrion sp.	unident. Hawaiian damselfly	**End**	---	<3>
LIBELLULIDAE				
Crocothemis erythraea	scarlet skimmer	Nat	R	<1>
ARTHROPODA, MALACOSTRACA, DECAPODA				
ATYIDAE				
Atyoida bisulcata Randall	*ʻōpae kalaʻole,*	**End**	---	<3>
CAMBARIDAE				
Procambarus clarkii Girard	American crayfish	Nat	O	<1,2,3>
PALAEMONIDAE				
Macrobrachium grandimanus L.	*ʻōpae oehaʻa*	**End**	---	<3>
Macrobrachium lar Fabricius	Pacific prawn	Nat	C	<1,2>

Table 6 (continued).

PHYLUM, CLASS, ORDER, FAMILY *Species*	Common name	Status	Abundance	Notes
	VERTEBRATES FISHES			
CHORDATA, ACTINOPTERYGII, GOBIIFORMES				
OXUDERCIDAE				
Awaous stamineus Eydoux & Souleyt	*ʻoʻopu nākea*	**End**	---	<3>
Sicyopterus stimpsoni Gill	*ʻoʻopu nōpili*	**End**	---	<3>
CICHLIFORMES				
CICHLIDAE				
Tilapia sp.	tilapia	Nat	---	<3>
SILURIFORMES				
ICTALURIDA				
Ictalurus punctatus Rafinesque	channel catfish	Nat	---	<3>
CYPRINODONTIFORMES				
POECILIIDAE				
Gambusia affinis Baird	mosquitofish			<1,2,3>
Poecilia sp. hybrid complex (*salvatoris/Mexicana* group)	liberty/Mexican molly	Nat	A	<1,2,3>
Poecilia reticulata Peters	rainbow fish	Nat	C	<1,2>
Xiphophorus helleri Heckel	green swordtail	Nat	O	<1,2>
CHORDATA, AMPHIBIA, ANURA				
BUFONIDAE				
Bufo marinus L.	cane toad	Nat	---	<2,3>

Key to Table 6

STATUS:
- Nat - naturalized. An introduced or exotic species.
- **Ind** - indigenous. A native species also found elsewhere in the Pacific.
- **End** - endemic - A native species found only in the Hawaiian Islands.

ABUNDANCE:
- P - present; abundance not noted.
- R - rare; only one to three individuals seen.
- O - occasional; three to twelve individuals seen.
- C - common; many individuals seen.
- A - abundant; numerous.

Table 6 (continued).

NOTES:
<1> – Observed in the present *AECOS* survey (2021).
<2> – Observed in previous *AECOS* survey (2009)
<3> – Reported in DAR data, summarized in *Hawaii Watershed Atlas* (Parham et. al, 2008).

During our survey, we observed ten aquatic species, comprising one alga, two odonata (damselflies and dragonflies), two crustaceans, and three fishes. No native indigenous or endemic species were observed in our survey of the middle reach of Waikapū Stream.

Non-native mosquitofish (*Gambusia affinis*) and other poeciliids were common in the stream, as were Pacific prawn (*Macrobrachium lar*; Figure 10). Nearly the entire channel is shaded in a dense canopy of Java plum, inhibiting the growth of stream algae on rocks. Two species of Hawaiian stream goby and two species of native shrimp recorded in the Waikapū Stream system by DAR surveys (summarized in Parham et al., 2008) were not observed in our survey, although it is likely they occupy upper reaches of the stream.

Figure 10. Pacific Prawn carcass and Java plum fruit in Waikapū Stream.

Blackburn's Sphinx moth

No tree tobacco or other plants in the family Solanaceae were found to occur within the Project area.

Avian Fauna

A total of 102 individual birds of 18 species, representing 10 separate families, was recorded during the station counts (Table 7). Two species—Warbling White-eye (*Zosterops japonicus*) and Zebra Dove (*Geopilia striata*)—accounted for 39% of the total number of birds recorded. The most frequently recorded species was Warbling White-eye: 28% of the total birds recorded during station counts. All species recorded are well established alien species.

Table 7. Avian species detected on November 4, 2021 survey of the Project area.

Common Name	Scientific Name	Status	*RA*
	GALLIFORMES		
	PHASIANIDAE – Pheasants & Allies		
Ring-necked Pheasant	*Phasianus colchicus*	NN	0.14
Gray Francolin	*Francolinus pondicerianus*	NN	0.57
Black Francolin	*Francolinus francolinus*	NN	1.00
Domestic Chicken	*Gallus gallus*	NN	0.57
	COLUMBIFORMES		
	COLUMBIDAE – Pigeons & Doves		
Rock Pigeon	*Columba livia*	NN	1.57
Spotted Dove	*Streptopelia chinensis*	NN	0.43
Zebra Dove	*Geopelia striata*	NN	2.86
	PELECANIFORMES		
	ARDEIDAE – Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	NN	0.29
	PASSERIFORMES		
	ALAUDIDAE - Larks		
Eurasian Skylark	*Alauda arvensis*	NN	1.00

Table 7 (continued).

Common Name	Scientific Name	Status	*RA*
	ZOSTEROPIDAE – White-eyes		
Warbling White-eye	*Zosterops japonicus*	NN	0.29
	MIMIDAE – Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	NN	0.29
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	NN	2.00
	ESTRILDIDAE – Estrildid Finches		
Java Sparrow	*Padda oryzivora*	NN	0.29
Scaly-breasted Munia	*Lonchura punctulata*	NN	1.00
Chestnut Munia	*Lonchura atricapilla*	NN	1.00
Common Waxbill	*Estrilda astrild*	NN	0.29
	FRINGILLIDAE – Fringilline and Carduline Finches & Allies		
	Carduelinae – Carduline Finches and Hawaiian Honeycreepers		
House Finch	*Haemorhous mexicanus*	NN	0.86
	CARDINALIDAE – Cardinals & Allies		
Northern Cardinal	*Cardinalis cardinalis*	NN	0.14

Key to Table 7.

Status
NN = Alien naturalized, non-native species (introduced).
RA Relative Abundance – number of birds recorded divided by count stations (7).

Mammals

At least 15 axis deer (*Axis axis*) and one small Indian mongoose (*Herpestes javanicus*) were observed utilizing the fallow sugarcane fields in the Project area. Trails made by axis deer crisscross the entirety of the Project area, making travel through the dense Guinea grass relatively easy. Tracks of cat (*Felis catus*) were observed along the deer trails, while domestic dog (*Canis lupis familiaris*) could be heard nearby. No other mammals were observed, though it is highly probable that one or more of the four naturalized rodent species (Family Muridae) use resources on the property on a seasonal or temporal basis. The four species currently established in the Hawaiian Islands are: roof rat (*Rattus rattus*), brown

rat (*Rattus norvegicus*), Polynesian rat (*Rattus exulans hawaiiensis*), and European house mouse (*Mus musculus*).

Discussion and Recommendations

Recommendations are partly based on U.S. Fish and Wildlife Service, Animal Avoidance and Minimization Measures (USFWS-PIFWO, nd). Implementation by the Project contractor of recommendations provided below as bulleted items will minimize impacts to listed species to the maximum extent practicable.

Jurisdictional Waters

We determined that Waikapū Stream is a tributary to the Pacific Ocean at Maʻālaea Bay. The stream is perennial with relatively permanent flow to the Pacific Ocean and, therefore, is a waters of the U.S. The Project area does not contain wetlands adjacent to the jurisdictional tributary; therefore, the limit of federal jurisdiction is the OHWM, as delineated within the Project area (see Fig. 8).

Federal jurisdiction is solely determined by the USACE and is based upon the USACE accepting our findings. Acceptance may require a field visit by a USACE representative from the Regulatory Branch to inspect all or representative locations surveyed by *AECOS*. Our delineation is not official until an acceptance letter from the USACE is received by the applicant.

Water Quality and Aquatic Resources

Waikapū Stream is a Class 2 inland water in the Project area, although it is classified as Class 1 inland water within the West Maui Natural Area Reserve and at the Keālia Pond National Wildlife Refuge (HDOH, 2014). Waikapū Stream is listed in the Hawaiʻi Department of Health, *2020 State of Hawaiʻi Water Quality Monitoring and Assessment Report*, List of Impaired Waters in Hawaiʻi, prepared under Section 303(d) of the Clean Water Act (HDOH, 2020). The HDOH listing indicates that Waikapū Stream is "impaired" for turbidity in the dry season. Waikapū Stream has been assigned a TMDL priority code of "low."

The purpose of the water quality measurements presented in this report is to characterize existing conditions and not to establish compliance with water quality standards (Table 8). In fact, the criteria for turbidity, TSS, and nutrient measurements require making comparisons with geometric mean values, so a minimum of three separate sampling events per station would be required to generate a statistic for comparison with these criteria.

Table 8. Selected state of Hawaiʻi water quality criteria for streams (HAR §11-54-5.2; HDOH, 2014).

Parameter	Geometric Mean value not to exceed this value	Value not to be exceeded more than 10% of the time	Value not to be exceeded more than 2% of the time
Total Nitrogen (µg N/l)	250.0 ***180.0***	520.0 ***380.0***	800.0 ***600.0***
Nitrate+Nitrite (µg N/l)	70.0 ***30.0***	180.0 ***90.0***	300.0 ***170.0***
Total Phosphorus (µg P/l)	50.0 ***30.0***	100.0 ***60.0***	150.0 ***80.0***
Total Suspended Solids (mg/l)	20.0 ***10.0***	50.0 ***30.0***	80.0 ***55.0***
Turbidity (NTU)	5.0 ***2.0***	15.0 ***5.5***	25.0 ***10.0***

Upper values are for the wet season (November 1 through April 30).
Lower ***bold italicized*** values are for the dry season (May 1 through October 31).

Other applicable "standards":
- pH units shall not deviate more than 0.5 units from ambient conditions and not lower than 5.5 nor higher than 8.0
- Dissolved oxygen shall not decrease below 80% of saturation.
- Temperature shall not vary more than 1 C° from ambient conditions.
- Specific conductance shall not be more than 300 µmhos/cm.

Waikapū Stream at the Project area does not appear to be degraded in terms of basic water quality, suspended sediments, or nutrients. The current water regime in the Project area appears be one of sustained flow. Conductivity, pH, and temperature present water quality conditions that are supportive of native fauna. Project work may be completed with minimum impacts to stream water quality and without negative impacts to long-term water quality if the following suggested best management (BMPs) are implemented:

- Minimize turbidity and siltation from Project-related work. Use effective silt containment devices and curtail work during adverse weather conditions.
- Prior to use, clean pollutants from all Project-related materials and equipment (dredges, barges, backhoes, etc.) that will be placed in the water.
- Do not stockpile Project-related materials (fill, revetment rock, pipe, etc.) in the water.
- Dispose of all debris removed from aquatic environments at an approved upland or ocean dumping site.
- Prevent contamination (trash or debris disposal, non-native species introductions, attraction of non-native pests, etc.) of aquatic habitats from Project-related activities. Implement a litter-control plan and develop a hazard analysis and critical control point plan to prevent attraction and introduction of non-native species.
- Fuel Project-related vehicles and equipment away from the water and develop a contingency plan to control petroleum products accidentally spilled during the Project. Store absorbent pads and containment booms on-site, as appropriate, to facilitate the clean-up of accidental petroleum releases.
- Protect under-layer fills from erosion with stones (or core-loc units) as soon after placement as practicable.
- Protect from erosion any soil exposed near water as part of the Project (with plastic sheeting, filter fabric, etc.) after exposure and stabilize as soon as practicable (with native or non-invasive vegetation matting, hydroseeding, etc.).

Floral Resources

A floristic composition of 7% native species is low but typical for disturbed agricultural lowlands in Central Maui. No plant species listed as endangered or threatened under either federal or State of Hawaiʻi endangered species statutes (HDLNR, 1998; USFWS, nd-b) was recorded during the course of this survey. Project activities will not adversely impact botanical resources.

Fauna Resources

Aquatic Fauna

No endangered damselfly was identified from this survey along the middle- to lower- reach of Waikapū Stream. Six species of damselflies are listed as endangered in Hawaiʻi, and three occur on Maui Island (50 CFR § 17, 2016; USFWS, 2015; HDLNR, 2015): flying earwig damselfly (*Megalagrion nesiotes*), Pacific damselfly (*M. pacificum*), and orange-black damselfly (*M. xanthomelas*). Of these three species, *M. nesiotes* occurs in higher elevations and known from a single high-elevation stream on East Maui; *M. pacificum* occurs in low elevation seepage pools with thick vegetation; and *M. xanthomelas* occupies a wide range of low-elevation aquatic habitats (Polhemus and Asquith, 1996). The *Hawaiʻi Watershed Atlas* (Parham et. al, 2008) lists an unidentified *Megalagrion* as occurring within Waikapū Watershed. *Megalagrion* species are on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Odonata Specialist Group, 1996). Introduced predatory fish and crustaceans are threats to native damselflies.

- BMPs implemented to minimize the degradation of water quality will protect aquatic animals.

Waikapū Stream flows from the West Maui Natural Area Reserve, and into the Keālia Pond National Wildlife Refuge. Many native aquatic species within these protected areas have an amphidromous lifecycle: eggs are laid in freshwater stream reaches, and hatched larvae drift downstream and out into the ocean where they develop for a time before migrating back into freshwater to grow to maturity (Ford and Kinzie, 1982; Kinzie, 1988). The following BMPs are recommended to minimize or avoid impacts to these species:

- Downstream and upstream migration pathways should be maintained for native aquatic species with amphidromous life cycles.
- New structures should not include drains or grates that may entrain drifting larvae, nor overhanging culverts that may obstruct upstream movement of recruiting juveniles.
- Construction BMPs for work in aquatic environments should be incorporated into the Project plan to minimize the degradation of water quality and impacts to fish and wildlife resources.

Terrestrial Invertebrates

Blackburn's sphinx moth (*Manduca blackburni*) is a federally listed insect found in Hawaiʻi (USFWS, 2000) and a population is known from Maui Island. The caterpillar of this moth feeds exclusively on plants in the Family Solanaceae (USFWS, 2005) and particularly on the widely-distributed, tree tobacco (*Nicotiana glauca*). No tree tobacco plants were observed in the Project area during this survey, but the weedy plant propagates readily in disturbed fields, and can attain a height greater than 1-m (3-ft) tall in less than six weeks.

- A biologist familiar with Blackburn's sphinx moth and its host plants should survey areas of proposed Project activities 4-6 weeks prior to the

initiation of Project construction. If moths, the native *aiea* (*Nothocestrum* sp.), or tree tobacco plants over 1 m (3 ft) tall are found during the survey, contact USFWS for additional guidance to avoid take.

Avian Fauna

The species recorded are typical of the fallow lowland agricultural fields on the island of Maui. No avian species currently listed or proposed for listing under either the federal or State of Hawaiʻi endangered species statutes was detected (HDLNR, 2015; USFWS, nd-b). The avian assemblage consists of all non-native, naturalized species with little value from an ecological perspective.

Although no seabirds were detected during this survey, it is probable that the endangered Hawaiian Petrel or *ʻuaʻu* (*Pterodroma sandwichensis),* endangered Band-rumped Storm-Petrel or ʻ*akēʻakē (Hydrobates castro)* and the threatened endemic Newell's Shearwater or *ʻaʻo* (*Puffinus newelli*) overfly the Project area. Night lights can disorient seabirds, resulting in their potential downing and harm from collision with objects and/or predation by feral dogs and cats if downed (Ainley et al., 2001; Day and Telfer, 2003; Podolsky et al., 1998; Reed et al., 1985).

- If night-time construction activity or equipment maintenance is proposed during any construction, all associated lights should be shielded and, if large flood/work lights are used, these must be placed on poles high enough to allow the lights to be pointed directly downward at the ground.
- If exterior lighting, including street lights, are installed in conjunction with the Project, it is recommended that the lights be shielded to reduce the potential for interactions of nocturnally flying seabirds with external lights or other man-made structures. All outdoor lighting should be "dark sky compliant" (HDLNR-DOFAW, 2016)

No protected Hawaiian waterbirds were recorded during the survey despite the presence of riparian habitat in the Project. Non-native, feral Mallard Duck (*Anas platyrhynchos*) or Mallard Duck-Hawaiian Duck hybrids (*A. platyrhynchos* x A. *wyvilliana*), and the indigenous Black-crowned Night-heron or *aukuʻu* (*Nycticorax nycticorax*) are waterbird species most likely to utilize the forested riparian habitat and stream reach available at the Project site, but are afforded few protections besides the Migratory Bird Treaty Act. Hawaiian Duck or *koloa maoli* (*Anas wyvilliana*) are federal and state-listed endangered species but are heavily hybridized with feral Mallard Duck on most main Hawaiian Islands with the exception of Kauaʻi and a small Hawaiʻi Island population. Only about 20 Hawaiian Duck were estimated on Maui between 1999 and 2003 (USFWS, 2011). The shallow runs and forested riparian corridors along Waikapū Stream at the Project area do not provide habitat for other federal- and state-listed threatened or endangered waterbird species, including: Hawaiian Coot or *ʻalae keʻokeʻo* (*Fulica alai*); and Hawaiian Stilt or *aeʻo* (*Himantopus mexicanus knudseni*). Hawaiian Goose (*nēnē*) is a federally-listed threatened, and state-listed endangered species with a population on Maui. No habitat suitable for use by Nēnē (*Branta sandwichensis*) occurs in the area.

Mammals

The mammals and other terrestrial macrofauna observed during the survey are not native to Hawaiʻi and offer little value from an ecological perspective.

Hawaiian hoary bat is the only Endangered Species Act (ESA)-listed terrestrial mammal in Hawaiʻi. While not surveyed for during this survey, potential Hawaiian hoary bat roosts (trees over 4.6 m [15 ft]) are likely present along Waikapū Stream in the Project area. Potential roost-tree species include Java plum (*Syzgium cumini*), African tulip (*Spathodea campanulatea*), Christmas berry (*Schinus terebinthefolius*) and mango (*Mangifera indica*).

- To avoid potential deleterious impacts to roosting bats with pups, it is recommended that no woody vegetation taller than 4.6 m (15 ft) be removed during the bat pupping season between June 1 and September 15 (USFWS, 1998).

Critical Habitat

No federally designated Critical Habitat for any species occurs within the Project area (USFWS, nd-c). No equivalent designation exists under State of Hawaiʻi endangered species statutes.

References

Ainley, D. G, R. Podolsky, L. Deforest, G. Spencer, and N. Nur. 2001. The Status and Population Trends of the Newell's Shearwater on Kaua'i: Insights from Modeling, in: Scott, J. M, S. Conant, and C. Van Riper III (editors) *Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A Vanishing Avifauna. Studies in Avian Biology No. 22*. Cooper's Ornithological Society, Allen Press, Lawrence, Kansas. pp. 108-123.

ASTM. 2015. Standard Test Method for Total Chemically Bound Nitrogen in Water by Pyrolysis and Chemiluminescence Detection. ASTM D5176-08(2015).

Baird, A. B., J. K. Braun, M. A. Mares, J. C. Morales, J. C. Patton, C. Q. Tran, and J. W. Bickham. 2015. Molecular systematic revision of tree bats (Lasiurini): doubling the native mammals of the Hawaiian Islands. *Journal of Mammalogy*, 96(6):1255-1274.

________, J. K. Braun, M. D. Engstrom, A. C. Holbert, M. G. Huerta, B. K. Lim, and J. W. Bickham. 2017. Nuclear and mtDNA phylogenetic analyses clarify the evolutionary history of two species of native Hawaiian bats and the taxonomy of Lasiurini. *PLOS ONE*, 12(10): 1-27. Available online at URL: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0186085; last retrieved November 28, 2021.

Chesser, R. T., S. M. Billerman, K. J. Burns, C. Cicero, J. L. Dunn, B. E. Hernández-Baños, A. W. Kratter, I. J. Lovette, N. A. Mason, P. C. Rasmussen, J. V. Remsen Jr., D. F. Stotz, K. Winker. 2021. Sixty-second Supplement to the Check-list of North American Birds. *The Auk Ornithological Advances*, 138: 1-18.

Day, R. H., B. Cooper, and T. C. Telfer. 2003. Decline of Townsend's (Newell's Shearwaters (*Puffinus auricularis newelli*) on Kauai, Hawaii. *The Auk,* 120: 669-679.

Dega, M. F. 2014. An Archaeological Monitoring Plan for the Proposed Central Maui Regional Park, Wailuku and Waikapu Ahupuaa, Wailuku District. Prepared for R.M. Towill. Available online at URL: http://hiepro.ehawaii.gov; last retrieved September 28, 2021.

Ford, J. I. and R. A. Kinzie III. 1982. Life crawls upstream. *Nat. Hist.*, 91: 61-67.

Giambelluca, T. W., Q. Chen, A. G. Frazier, J. P. Price, Y.-L. Chen, P.-S. Chu, J. K. Eischeid, and D. M. Delparte. 2013. Online Rainfall Atlas of Hawaiʻi. Bull. Amer. Meteor. Soc. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1. available online at URL: http://rainfall.geography.hawaii.edu/; last retrieved November 28, 2021.

Handy, E.S.C. and E.G. Handy. 1972. *Native Planters in Old Hawaii – Their Life, Lore, and Environment*. Bishop Museum Press. Honolulu, Hawaii.

Hawaiʻi Cooperative Park Service Unit (HCPSU). 1990. Hawaii stream assessment. A preliminary appraisal of Hawaii's stream resources. Prep. for State of Hawaii, Commission on Water Resource Management. National Park Service, Hawaii Cooperative Park Service Unit, Rept. No. R84: 294 pp.

Hawaiʻi Department of Health (HDOH). 2014. Hawaiʻi Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards. 110 pp.

______. 2020. State of Hawaii Water Quality Monitoring and Assessment Report: Integrated Report to the U.S. Environmental Protection Agency and the U.S. Congress Pursuant to §303(d) and §305(b), Clean Water Act (P.L. 97-117). 134 pp.

Hawai'i Department of Land and Natural Resources (HDLNR). 1998. Indigenous Wildlife, Endangered And Threatened Wildlife And Plants, And Introduced Wild Birds. Department of Land and Natural Resources. State of Hawaii. Administrative Rule §13-134-1 through §13-134-10, dated March 02, 1998.

_______. 2015. Hawaiʻi Administrative Rules, Title 13, Department of Land and Natural Resources, Subtitle 5 Forestry and Wildlife, Part 2 Wildlife, Chapter 124, Indigenous wildlife, endangered and threatened wildlife, injurious wildlife, introduced wild birds, and introduced wildlife, Exhibit 2 List of species of endangered wildlife in Hawaiʻi, and Exhibit 3 List of species of threatened wildlife in Hawaiʻi. 16 pp.

_______. 2019. Flood Hazard Assessment Tool. Available online at URL: http://gis.hawaiinfip.org/FHAT/; last retrieved November 28, 2021.

Hawaiʻi Department of Land and Natural Resources-Division of Forestry and Wildlife (HDLNR-DOFAW). 2016. Wildlife Lighting. PDF available at URL: http://dlnr.hawaii.gov/wildlife/files/2016/03/DOC439.pdf; last retrieved November 28, 2021.

Imada, C. T. 2019. Hawaiian Naturalized Vascular Plants Checklist (February 2019 update). Bishop Museum Tech. Rept. 69. 209 pp.

Kinzie, R. A. III. 1988. Habitat utilization by Hawaiian stream fishes with reference to community structure in oceanic stream islands. *Environ. Biol. of Fishes*, 22: 179-192.

National Oceanographic and Atmospheric Administration-National Centers for Environmental Information (NOAA-NCEI). 2021. U.S. Climate Normals. Available online at URL: https://www.ncei.noaa.gov/products/us-climate-normals; last retrieved November 22, 2021.

National Oceanographic and Atmospheric Administration-National Weather Service Forecast Office (NOAA-NWS). 2021a. U.S. Drought Monitor,

Hawaiʻi. National Drought Mitigation Center, University of Nebraska-Lincoln. Available online at URL: https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?HI; last retrieved November 22, 2021.

National Oceanographic and Atmospheric Administration-National Weather Service Forecast Office (NOAA-NWS). 2021b. August 2021 precipitation summary. Available online at URL: https://www.weather.gov/hfo/hydro_summary; last retrieved November 22, 2021.

Odonata Specialist Group. 1996. *Megalagrion oceanicum*. *The IUCN Red List of threatened species* 1996: e.T12958A3402487. Available online at URL: https://www.iucnredlist.org/species/12958/3402487; last retrieved July 28, 2021.

Palmer, D. D. 2003. *Hawai'i's ferns and fern allies*. Honolulu: University of Hawaii Press.

Parham, J. E., G. R. Higashi, E. K. Lapp, D. G. K. Kuamoʻo, R. T. Nishimoto, S. Hau, J. M. Fitzsimmons, D. A. Polhemus and W. S. Devick. 2008. Atlas of Hawaiian Watersheds and their Aquatic Resources. Island of Oʻahu. Bishop Museum and Division of Aquatic Resources. 614 pp.

Pinzari, C. A., L. Kang, P. Michalak, L. S. Jermiin, D. K. Price, F. J. Bonaccorso. Analysis of Genomic Sequence Data Reveals the Origin and Evolutionary Separation of Hawaiian Hoary Bat Populations. *Genome Biology and Evolution*, 12(9): 1504-1514. Available online at URL: https://doi.org/10.1093/gbe/evaa137; last retrieved November 28, 2021.

Podolsky, R., D. G. Ainley, G. Spencer, L. de Forest, and N. Nur. 1998. Mortality of Newell's Shearwaters Caused by Collisions with Urban Structures on Kauaʻi. *Colonial Waterbirds*, 21: 20-34.

Polhemus, D. and A. Asquith. 1996. *Hawaiian Damselflies: A Field Identification Guide*. Bishop Museum Press. Honolulu: 122 pp.

Pukui, Mary K., Elbert S., Mookini E. 1974. *Place Names of Hawaiʻi: Revised and Expanded Edition*. University of Hawaii Press, Honolulu: 320 pp.

Reed, J. R., J. L Sincock, and J. P. Hailman. 1985. Light Attraction in Endangered Procellariform Birds: Reduction by Shielding Upward Radiation. *The Auk*, 102: 377-383.

Russell, A. L., Pinzari, C. A., Vonhof, M. J., Olival, K. J., Bonaccorso, F. J. 2015. Two tickets to paradise: multiple dispersal events in the founding of hoary bat populations in Hawai'i. *PLoS ONE* 10 (6): e0127912.

Sherwood, A. R. 2004. Stream macroalgae of Hawaiʻi: An identification guide to the common genera. Available online at URL: https://dlnr.hawaii.gov/dar/reports/algaeid/; last retrieved September 28, 2021.

Standard Methods (SM). 1998. Standard Methods for the Examination of Water and Wastewater. 20th Edition. 1998. (Greenberg, Clesceri, and Eaton, eds.). APHA, AWWA, & WEF. 1220 pp.

Staples, G. W., and D. R. Herbst. 2005. *A Tropical Garden Flora. Plants Cultivated in the Hawaiian Islands and other Tropical Places.* Bishop Museum, Honolulu. 908 pp.

U.S. Army Corps of Engineers (USACE). 1986. Department of Defense, Department of the Army, Corps of Engineers, 33 CFR Parts 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, and 330, Final Rule for Regulatory Programs of the Corps of Engineers. Federal Register, 51 (219; Thursday, November 13, 1986): 41206-41260.

_______. 1987. *Corps of Engineers Wetlands Delineation Manual*. Tech. Rept. Y-87-1. Environmental Laboratory, Dept. of the Army, Waterways Experiment Station, Vicksberg.

_______. 2005. Regulatory Guidance Letter (RGL) No. 05-05. 4 pp.

_______. 2012. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Hawaiʻi and Pacific Islands Region Version 2.0,* ed. J. F. Berkowitz, J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-12-5. U.S. Army Engineer Research and Development Center. Vicksberg, MS. 130 pp.

_______ and U.S. Environmental Protection Agency (USACE and USEPA). 2015. _Department of Defense, Department of the Army, Corps of Engineers, 33 CFR Part 328, Environmental Protection Agency, 40 CFR Parts 110, 112, 116, 117, 122, 230, 232, 300, 302, and 401, Clean Water Rule: Definition of "Waters of the United States". Federal Register, 80 (124; Monday, June 29, 2020): 37054-37127.

_______. 2020. Department of Defense, Department of the Army, Corps of Engineers, 33 CFR Part 328, Environmental Protection Agency, 40 CFR Parts 110, 112, 116, 117, 122, 230, 232, 300, 302, and 401, The Navigable

Waters Protection Rule: Definition of "Waters of the United States". *Federal Register*, 85 (77; Tuesday, April 21, 2020): 22250-22342.

U.S. Department of Agriculture–Natural Resources Conservation Service (USDA-NRCS). 2021. Web Soil Survey, Soil Map—Hawaiʻi. Available online at URL: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx; last retrieved September 28, 2021.

_______. No date (nd.). Soil Data Access, Hydric Soils List: State of Hawaii, County of Hawaii. Available online at URL: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcseprd1316620.html; last retrieved September 28, 2021.

U.S. Environmental Protection Agency (USEPA). 1993. USEPA. 1993. Methods for the determination of inorganic substances in environmental samples. US EPA, Office of Research and Development, Environmental Monitoring Systems Laboratory, Cincinnati, OH. EPA/600/R-93/100.

______. 2021. EPA, Army announce intent to revise definition of WOTUS. Available _online at URL: https://www.epa.gov/newsreleases/epa-army-announce-intent-revise-definition-wotus; last retrieved August 30,2021.

_______ and Department of Army (USEPA and DA). 2008. Clean Water Act jurisdiction following the U.S. Supreme Court's decision in *Rapanos v. United States & Carabell v. United States*. December 2, 2008. 13 pp.

U.S. Fish & Wildlife Service (USFWS). 1983. Hawaiian Dark-Rumped Petrel & Newell's Manx Shearwater Recovery Plan. USFWS, Portland, Oregon. February 1983.

_______. 1998. Recovery Plan for the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). U.S. Fish and Wildlife Service, Region 1, Portland, OR. Available online: https://ecos.fws.gov/docs/ recovery_plans/1998/980511b.pdf; last accessed August 2, 2021

______. 2000. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for Blackburn's Sphinx Moth from the Hawaiian Islands, *Federal Register*, 65 (21; February 1, 2000): 4770-4779.

_______. 2005. Draft recovery plan for the Blackburn's Sphinx Moth (*Manduca blackburni*). USFWS, Portland, Oregon. September 2005.

U.S. Fish & Wildlife Service (USFWS). 1983. 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision. Available online at URL: https://www.fws.gov/pacificislands/CH_Rules/Hawaiian Waterbirds RP 2nd Revision.pdf; last retrieved November 28, 2021.

______. 2015. USFWS Endangered Species in Hawaii. Available online at URL: https://ecos.fws.gov/ecp0/reports/species-listed-by-state-report?state=HI&status =listed; last retrieved November 28, 2021.

______. Undated website (nd-a). National Wetlands Inventory (NWI). U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Access gateway online at URL: https://www.fws.gov/wetlands/index.html; last retrieved November 28, 2021.

______. Undated website (nd-b). Environmental Conservation Online System (ECOS). Access gateway online at URL: https://ecos.fws.gov/ecp/species-reports; last retrieved November 28, 2021.

______. Undated website (nd-c). Critical Habitat Portal. Available online at URL: https://ecos.fws.gov/ecp/report/table/critical-habitat.html; last retrieved November 28, 2021.

U.S. Fish & Wildlife Service-Pacific Islands Fish and Wildlife Office (USFWS-PIFWO). undated website (nd.). Avoidance and Minimization Measures. Available online at URL: https://www.fws.gov/pacificislands/ articles.cfm?id=149489720; last retrieved November 28, 2021.

U.S. Geological Survey (USGS). 2003. Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory: evaluation of alkaline persulfate digestion as an alternative to Kjeldahl digestion for determination of total and dissolved nitrogen and phosphorus in water. Water-Resources Investigations Report 03–4174.

Wagner, W. L., D. R. Herbst and S.H. Sohmer. 1990. *Manual of the Flowering Plants of Hawai'i: Volume I and II*. Bishop Museum Special Publication 83. University of Hawai'i Press. 1853 pp.

______, and ______. 1999. *Supplement to the Manual of the flowering plants of Hawai'i*, pp. 1855-1918. *In:* Wagner, W.L., D.R. Herbst, and S.H. Sohmer, Manual of the flowering plants of Hawai'i. Revised edition. 2 vols. University of Hawaii Press and B.P. Bishop Museum.

Wilson, D. E. and D. M. Reeder (eds.). 2005. Wilson & Reeder's Mammal Species of the World (Third Edition). Available online at URL: http://www.departments.bucknell.edu/biology/resources/msw3/browse.asp; last retrieved November 28, 2021.

Yamamoto, M. N., & Tagawa, A. W. 2000. *Hawai'i's native & exotic freshwater animals*. Honolulu, HI: Mutual Publishing.

ATTACHMENT A

PHOTOGRAPHIC RECORD OF
OHWM FLAG LOCATIONS

OWHM Location 1, facing upstream from existing access road bridge.

OHWM Location 1, facing downstream from existing access road bridge.

OHWM Location 1 left bank.

OHWM Location 1 right bank.

OWHM Location 3, facing upstream.

OHWM Location 3, facing downstream.

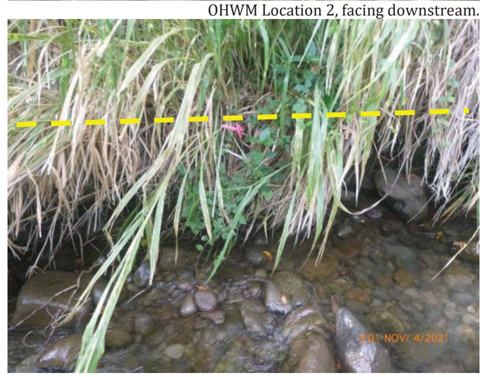
OHWM Location 3 left bank.

OHWM Location 3 right bank.

OWHM Location 2, facing upstream.

OHWM Location 2, facing downstream.

OHWM Location 2 left bank.



OHWM Location 2 right bank.


OWHM Location 5, facing upstream.


OHWM Location 5, facing downstream.


OHWM Location 5 left bank.


OHWM Location 5 right bank.


OWHM Location 4, facing upstream.


OHWM Location 4, facing downstream.


OHWM Location 4 left bank.


OHWM Location 4 right bank.


OWHM Location 7, facing upstream.

OHWM Location 7, facing downstream.


OHWM Location 7 left bank.

OHWM Location 7 right bank.


OWHM Location 6, facing upstream.


OHWM Location 6, facing downstream.


OHWM Location 6 left bank.


OHWM Location 6 right bank.


OWHM Location 9, facing upstream.


OHWM Location 9, facing downstream.

OHWM Location 9 left bank.

OHWM Location 9 right bank.

OWHM Location 8, facing upstream.


OHWM Location 8, facing downstream.


OHWM Location 8 left bank.


OHWM Location 8 right bank.

OWHM Location 11, facing upstream.

OHWM Location 11, facing downstream.

OHWM Location 11 left bank.

OHWM Location 11 right bank.

OWHM Location 10, facing upstream.

OHWM Location 10, facing downstream.

OHWM Location 10 left bank.

OHWM Location 10 right bank.


OWHM Location 13, facing upstream.


OHWM Location 13, facing downstream.


OHWM Location 13 left bank.


OHWM Location 13 right bank.


OWHM Location 12, facing upstream.


OHWM Location 12, facing downstream.


OHWM Location 12 left bank.


OHWM Location 12 right bank.


OWHM Location 15, facing upstream.


OHWM Location 15, facing downstream.

OHWM Location 15 left bank.

OHWM Location 15 right bank.

OWHM Location 14, facing upstream.

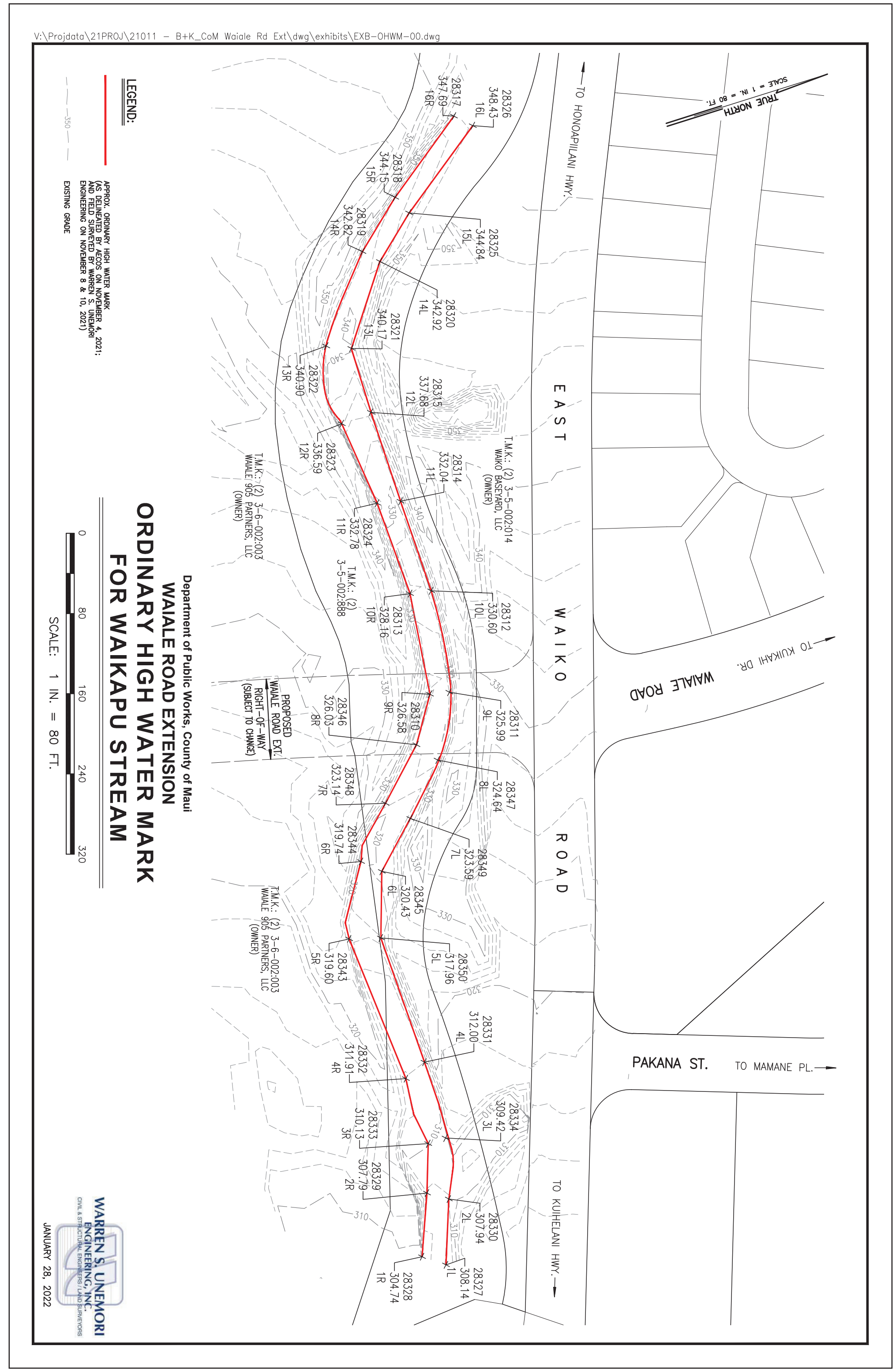
OHWM Location 14, facing downstream.


OHWM Location 14 left bank.


OHWM Location 14 right bank.

ATTACHMENT B

OHWM AND BRIDGE DRAWING



APPENDIX E-1

County of Maui – Waikapu Country Town
Public Private Partnership Agreement

LAND COURT SYSTEM	REGULAR SYSTEM

Return by Mail ( ) Pickup ( ) To:

TMK: (2) 3-6-004:003 & 006
(2) 3-6-005:007
(2) 3-6-006:036
(2)3-6-002:003

Total No. of Pages: 13

PUBLIC PRIVATE PARTNERSHIP AGREEMENT

County of Maui – Waikapu Country Town

THIS PUBLIC PRIVATE PARTNERSHIP AGREEMENT (the "Agreement") made this 28th day of April, 2022, by and between WAIKAPU PROPERTIES, LLC, a Hawaii limited liability company; MTP LAND PARTNERS, LLC, a Hawaii limited liability company; WAIALE 905 PARTNERS, LLC, a Hawaii limited liability company; and WILLIAM S. FILIOS, Trustee of the William S. Filios Separate Property Trust dated April 3, 2020, all of whose address is 1670 Honoapiilani Highway, Wailuku, Hawaii 96793 (collectively "WCT"), and the COUNTY OF MAUI, a political subdivision of the State of Hawaii, whose address is 200 South High Street, Wailuku, Maui, Hawaii 96793 ("County").

WHEREAS, WCT intends to develop Waikapu Country Town (the "Development"), a mixed use residential community consisting of 1,433 dwelling units, with the potential for 146 `ohana units, commercial uses, an agricultural/conservation easement area, a park, and a school site, on approximately 1400 acres of land;

WHEREAS, the Development is subject to the requirements of the Findings of Fact, Conclusions of Law, and Decision and Order, entered on February 26, 2018, in Docket No. A15-798, which reclassified portions of Development from the State Land Use Agricultural District to the State Land Use Rural and Urban Districts (the "DBA");

WHEREAS, the Development is also subject to the requirements of the conditions of zoning set forth in Ordinance 4998 (2019), the ordinance which changed the zoning for portions of WCT (the "CIZ");

WHEREAS, the Development is currently configured with a 12-acre school site, however the State of Hawaii Department of Education (the "DOE") desires to expand the area of school site;

WHEREAS, in accordance with Chapter 2.96, Maui County Code ("MCC"), upon full buildout the Development shall include a minimum of 287 residential workforce housing units ("RWHUs") as part of the 1,433 permitted dwelling units, resulting in a breakdown of 287 RWHUs and 1146 market units;

WHEREAS, the State of Hawaii and the County desire additional RWHUs in the Development;

WHEREAS, pursuant to Chapter 2.96, MCC, the sales price for RWHUs are established by the County's Affordable Housing Price Guidelines;

WHEREAS, the Development is limited in the total number of units that may be developed;

WHEREAS, by committing to provide the additional RWHUs, WCT is foregoing the opportunity to sell those same units at market prices, and one potential opportunity cost is shown on Exhibit "A", attached hereto;

WHEREAS, WCT anticipates that the Development will produce, on average, 650,000 gallons per day of wastewater;

WHEREAS, WCT originally intended to construct a private wastewater treatment facility for the Development;

WHEREAS, the State of Hawaii has committed matching funds for the construction of a Central Maui Regional Wastewater Treatment Facility ("Central WWTF");

WHEREAS, County and WCT now desire the Development to connect to the Wailuku/Kahului Wastewater Treatment Facility ("Kahului WWTF") in the interim while the Cetnral WWTF is being constructed;

WHEREAS, WCT is required to provide the Development's pro rata share for the total anticipated costs for design and construction of the Waiale Road Extension ("WRE") and other traffic improvements;

WHEREAS, the County and State of Hawaii are working together to secure a funding source for the construction of the WRE;

WHEREAS, the County and WCT desire to establish an agreement where WCT will provide additional RWHUs along with additional acreage for the school site in the Development in-lieu of monetary contributions for infrastructure improvements;

WHEREAS, WCT requires a commitment from the County in regards to its ability to deliver the Development's wastewater to a County treatment facility prior to the commencement of subdivision improvements for the Development;

WHEREAS, before the terms of this agreement may take effect, WCT will be required to amend certain conditions of the DBA and CIZ to make them consistent with this agreement; and

NOW THEREFORE, County and WCT, for good and valuable consideration, the receipt and sufficiency of which is acknowledged, hereby agree as follows:

I. AMENDMENTS TO THE CIZ AND THE DBA

The covenants herein shall not become effective until the conditions of the CIZ and DBA are amended to reflect the terms of this Agreement, including the use of RWHUs to satisfy infrastructure requirements. Nothing herein shall be deemed a commitment on the part of County to amend the terms of the CIZ or support an amendment of the DBA.

II. WRE and TEMPORARY CONNECTION TO THE KAHULUI WWTF

If allowed by the DBA and CIZ conditions, in consideration of WCT providing an additional 63 RWHUs (the "Initial RWHUs") in the Development, resulting in 350 RWHUs and 1,083 market units at full buildout, the County agrees as follows:

A. The opportunity cost of the Initial RWHUs shall be considered an in-lieu contribution for WCT's obligations under this Section II.

B. Pursuant to condition 8(b) of the DBA, County and WCT shall enter into a Traffic Memorandum of Agreement, discussed further in Section III, below, where WCT's traffic impact mitigation obligations and the associated costs will be agreed upon by the County and WCT, including a determination in regards to the Project's pro rata share of the total anticipated costs for design and construction of the WRE, in accordance with Condition 3(b) of the CIZ. The Traffic Memorandum of Agreement shall allow WCT to provide RWHUs in lieu of cash contributions to satisfy the requirements of said Agreement, including WCT's obligations to:

1. Contribute the Development's pro rata share of the total anticipated costs for design and construction of the WRE, in accordance with Condition 3(b) of the CIZ;
2. Mitigate all traffic impacts generated by the Development as recommended or required by the County per Condition 8(b) of the DBA;
3. Fully fund the intersection at Honoapiilani Highway and the WRE, per Condition 1(b) of the CIZ; and
4. Provide a pedestrian crossing at the intersection of Honoapiilani Highway and the WRE, per Condition 1(d) of the CIZ.

C. Upon execution of this Agreement, provided the DBA and CIZ conditions are amended to allow the Initial RWHUs to satisfy WCT's obligations to fund adequate wastewater facilities, WCT shall be able to temporarily connect and transmit a maximum amount of 100,000 gallons per day of wastewater to the Kahului WWTF for the Development (the "Temporary Connection"), granting WCT the ability to connect at least 300 dwelling units to the Kahului WWTF. Upon completion of the Central WWTF, the Temporary Connection shall expire and the wastewater shall be diverted to the Central WWTF. If allowed by the DBA and CIZ conditions, the opportunity cost of the Initial RWHUs shall be considered an in-lieu contribution for WCT's participation in the funding and/or construction of adequate public wastewater source, storage, and transmission facilities to accommodate the proposed uses of the Development.

III. TRAFFIC MEMORANDUM OF AGREEMENT

As required by conditions 8(b) of the DBA, County and WCT shall enter into a memorandum of agreement ("MOA") concerning WCT's satisfaction of the conditions of the CIZ and the DBA relating to traffic impact mitigation, including, but not limited to those listed in Subsection II.B, above, through the contribution of the Initial RWHUs.

The amount of WCT's pro rata share for the total anticipated cost for the design and construction of the WRE shall be based on the County's anticipated cost, as agreed to by the parties, shall be included in the MOA, less any State of Federal funds received for such purposes.

County and WCT shall reach an agreement regarding the cost of the various traffic impact mitigation obligations set forth in Subsection II.B, above. In the event that the agreed upon cost exceeds the opportunity cost of the Initial RWHUs, as shown on Exhibit A, by more than fifteen percent (15%), then WCT shall have the ability to 1) elect to re-assume specific traffic impact mitigation obligation(s); 2) adjust the number of Initial RWHUs to satisfy the deficit; or 3) come to an agreement with the County in the MOA to satisfy the deficit.

Upon execution of the MOA, WCT shall be deemed to have satisfied the requirement of Condition 8(b) of the DBA and Condition 1(a) of the CIZ for the purpose of allowing subdivision of the property, provided such conditions are amended to allow WCT to provide RWHUs in lieu of cash contributions to satisfy the requirements of the conditions, as each relates

to the execution of a MOA with the County. WCT will still be required to perform its obligations under such agreement even after subdivision approval, and failure to perform the terms of the agreement may constitute a violation of the conditions.

WCT and the State of Hawaii shall enter into a separate MOA in regards to the requirements of the State of Hawaii.

Nothing in this Agreement shall limit the ability of the County to negotiate the terms of the MOA, provided however, the conditions of the CIZ and DBA, and any amendments thereto, as well as the opportunity cost of the Initial RWHUs, as shown on Exhibit A, shall not be subject to further negotiation, as long as the opportunity cost is consistent with the DBA and CIZ conditions as amended.

IV. PRIVATE WASTEWATER TREATMENT FACILITY

The County and WCT recognize that it is the County's intent to construct the Central WWTF and that the construction of the Central WWTF eliminates the need for WCT to construct a private wastewater treatment facility to service the Development. Upon completion of the Central WWTF, the County acknowledges that the Development is within the service area of the Central WWTF and the remainder of the Development shall be able to connect to the Central WWTF (the "Central Connection"). In the event that WCT elects to utilize the Central Connection, an additional 150 RWHUs (the "Private WWTF RWHUs") shall be provided in the Development, resulting in 500 RWHUs and 933 market units at full buildout. If allowed by the DBA and CIZ conditions, the opportunity cost of the Private WWTF RWHUs shall be considered an in-lieu contribution for WCT's participation in the funding and/or construction of adequate public wastewater source, storage, and transmission facilities to accommodate the proposed uses of the Development, along with those matters discussed in Sections V and VIII, below. In the event that WCT does not utilize the Central Connection, the Private WWTF RWHUs will not be provided in the Development.

Upon request by WCT, County shall provide updates to WCT on the capacity of the Kahului WWTF and the status of construction of the Central WWTF. In the event that WCT utilizes the entire Temporary Connection prior to the completion of the Central WWTF, the Director is authorized to permit the Development to connect to the Kahului WWTF upon application for building permit, provided capacity is available at the Kahului WWTF.

V. WASTEWATER ASSESSMENT FEES

In addition to the matters discussed in Section II above, and if allowed by the DBA and CIZ conditions, the opportunity cost of the Initial RWHUs, shall be considered an in-lieu contribution for all wastewater assessment fees, including any connection fees, assessed to those units utilizing the initial 100,000 gallons per day of wastewater transmission.

In addition to the matters discussed in Sections IV and VIII, and if allowed by the DBA and CIZ conditions, the opportunity cost of the Private WWTF RWHUs, shall be considered an in-lieu contribution for all wastewater assessment fees, including connection fees, assessed to the remainder of the Development and no wastewater assessment fees, including connection fees, shall be assessed to the remainder of the Development.

This Agreement shall not exempt the Development from the County's monthly rates and fees for wastewater service.

VI. ADDITIONAL RESIDENTIAL WORKFORCE HOUSING UNITS

The Initial RWHUs and the potential Private WWTF RWHUs (hereinafter collectively the "Additional RWHUs") shall be subject to the terms and conditions of the Residential Workforce Housing Agreement, and any amendments thereto, that is required by Section 2.96.080, MCC. The Additional RWHUs shall not be considered a requirement of the Development per Condition 3 of the DBA or Condition 5 of the CIZ. The Additional RWHUs shall be "for-sale" units and shall be marketed and sold in accordance with the Residential Workforce Housing Agreement. 2.96.060, MCC requires that RWHUs be made available for occupancy either before or concurrently with market rate units at the same ratio required of the development, and that certificates of occupancy shall not be issued and/or final inspections shall not be passed for the market rate units unless certificates of occupancy are issued and/or final inspections are passed for the RWHUs concurrently or sooner. The income group distribution for the Initial RWHUs and the Private WWTF RWHUs are set forth in Exhibit B, attached hereto and made a part hereof.

VII. SATISFACTION OF REQUIREMENT FOR WASTEWATER SERVICE

County and WCT agree that if allowed by the DBA and CIZ conditions, the opportunity cost for the Additional RWHUs shall be considered an in-lieu contribution for WCT's participation in the funding and/or construction of adequate public wastewater source, storage, and transmission facilities to accommodate the proposed uses of the Development in satisfaction of the DBA and CIZ conditions. The Temporary Connection and any determination made in Section IV, above, if applicable, shall satisfy the requirement of Condition 6 of the CIZ relating to the availability of County wastewater facilities prior to the issuance of building permits, for the first 300 units or the remainder of the Development, as applicable.

VIII. RECLAIMED WATER FROM THE CENTRAL WWTF

The Development shall be required to construct a reclaimed water storage/distribution system and shall utilize reclaimed water in an amount approximately equal to the amount of wastewater delivered to the Central WWTF for irrigation purposes. In consideration of the Private WWTF RWHUs, and if allowed by the DBA and CIZ conditions, connection fees for reclaimed water service shall not be assessed to the Development in addition to the matters discussed in Sections IV and VI, above.

IX. DEVELOPMENT OF PRIVATE WASTEWATER TREATMENT FACILITY

Nothing in this Agreement shall preclude WCT from constructing a private wastewater treatment facility for the Development.

X. MISCELLANEOUS

A. Binding Effect. All the terms and conditions of this Agreement shall inure to the benefit of and be binding upon the parties hereto and their respective heirs, personal representatives, successors in interest and assigns and shall run with the land. This Agreement shall be for the benefit of parties herein.

B. Severability. If any provision of this Agreement, or any section, sentence, clause, phrase or word or the application thereof in any circumstances, shall be held invalid, the validity of the remainder of this Agreement and of the application of such provision, sentence, clause, phrase or word under any other circumstances shall not be affected.

C. Applicable Law: Jurisdiction. This Agreement shall be governed by and construed under the laws of the State of Hawaii. Any legal action under this Agreement shall be filed in the Hawaii judicial system only, and the parties hereby unconditionally submit themselves to the jurisdiction of the courts of the State of Hawaii and the United States District Court for the District of Hawaii, and waive the right to assert that such courts are in an inconvenient forum.

D. Entire Agreement; Amendments; Interpretation. This Agreement constitutes the entire agreement between the parties regarding subject matter. Any modifications of this Agreement must be in writing and signed by the parties hereto. The headings of sections in this Agreement are inserted only for convenience and shall in no way define, describe or limit the scope or intent of any provision of this Agreement. As used herein, the singular shall include the plural and the masculine shall include the feminine and neuter.

E. Counterparts. This Agreement may be executed in two or more counterparts, each of which shall be deemed to be an original, but all of which shall constitute one and the same instrument. Duplicate unexecuted and unacknowledged pages of the counterparts may be discarded and the remaining pages assembled as one document.

(*Signatures on the following page*)

IN WITNESS WHEREOF, the parties hereto have executed this Agreement the day and year first above written.

WAIKAPU PROPERTIES, LLC,
a Hawaii limited liability company

By michael w. Atherton

Its manager

By Albert G. Boyce V

Its manager

MTP LAND PARTNERS, LLC,
a Hawaii limited liability company

By michael w. Atherton

Its manager

By Albert G. Boyce V

Its manager

WAIALE 905 PARTNERS, LLC,
a Hawaii limited liability company

By Michael W. Atherton

Its Manager

By Albert G. Boyce V

Its Manager

WILLIAM S. FILIOS SEPARATE PROPERTY TRUST DATED APRIL 3, 2020

William S. Filios, Trustee

COUNTY OF MAUI

By
MICHAEL P. VICTORINO
Its Mayor

APPROVAL RECOMMENDED:

LORI TSUHAKO
Director of Housing and Human Concerns

JORDAN MOLINA
Director of Public Works

MICHELE CHOUTEAU MCLEAN
Director of Planning

SCOTT TERUYA
Director of Finance

ERIC NAKAGAWA
Director of Environmental Management

APPROVED AS TO FORM
AND LEGALITY:

Deputy Corporation Counsel

EXHIBIT A

OPPORTUNITY COST OF ADDITIONAL RWHUS

Assumption that "market" price is the sales price for a 3-bedroom unit using a 4% interest rate, which is priced for the 180% area median income group, estimated to be $951,500 (based on 2021 Maui County Affordable Sales Price Guidelines).

Initial RHWUs (63) – $22,368,100

	Below-Moderate 81-100	Moderate 101-120	Above-Moderate 121-140
Number of RWHUs	19	32	12
Average Sales Price	$502,200	$607,900	$713,650
Opportunity Cost of Each RWHU	$449,300	$343,600	$237,850
Total Value of Add'l RWHUs	$8,491,770	$10,823,400	$2,996,910

Private WWTF RWHUs (150) – $53,124,000

	Below-Moderate 81-100	Moderate 101-120	Above-Moderate 121-140
Number of RWHUs	45	75	30
Average Sales Price	$502,200	$607,900	$713,650
Opportunity Cost of Each RWHU	$449,300	$343,600	$237,850
Total Value of Add'l RWHUs	$20,218,500	$25,770,000	$7,135,500

The total opportunity cost for the Additional RWHUs is **$75,510,100.**

EXHIBIT B

INCOME GROUP DISTRIBUTIONS

The income group distribution for Initial RWHUs shall be as follows:

i. 19 units shall be marketed to "below-moderate income" residents;
ii. 32 units shall be marketed to "moderate income" residents; and
iii. 12 units shall be marketed to "above-moderate income" residents.

The income group distribution for Private WWTF RWHUs shall be as follows:

i. 45 units shall be marketed to "below-moderate income" residents;
ii. 75 units shall be marketed to "moderate income" residents; and
iii. 30 units shall be marketed to "above-moderate income" residents.

APPENDIX E-2

Maui County Ordinance No.5556

ORDINANCE NO. 5556

BILL NO. 28, CD1, FD1 (2023)

A BILL FOR AN ORDINANCE AMENDING ORDINANCE 4998 (2019) RELATING TO THE CHANGE IN ZONING (CONDITIONAL ZONING) TO WAIKAPU COUNTRY TOWN (WCT) DISTRICT FOR PROPERTY SITUATED AT WAILUKU, MAUI, HAWAII

BE IT ORDAINED BY THE PEOPLE OF THE COUNTY OF MAUI:

SECTION 1. Condition 1.a of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with new material underscored:

> "Landowners shall mitigate all Project-generated traffic impacts as required by the SDOT-H. Landowners shall enter into an agreement regarding the scope and timing of required traffic improvements to mitigate the traffic related impacts of the project on SDOT-H facilities as generally indicated in the project's Pro Rata Share Calculations for Waikapu Country Town Project dated June 29, 2018, as approved by SDOT-H. Alternatively, Landowners may, subject to agreement with SDOT-H, provide additional residential workforce housing units in the project in lieu of providing funding or constructing traffic improvements to mitigate the traffic-related impacts of the project. The agreement shall be executed prior to the approval of the first subdivision application to the County of Maui for the project."

SECTION 2. Condition 1.b of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with deleted material in brackets and new material underscored:

> "Landowners shall fully fund the project [intersections] intersection with Honoapiilani Highway only at the Main Street Intersection (also referred to as Study Intersection #9 in the TIAR/EIS) [and at the Waiale Road Extension Intersection (also referred to as Study Intersection #13 in the TIAR/EIS.)]. Landowners are solely responsible for funding the Main Street [and

Waiale Road Extension] intersection improvements. Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, provide additional residential workforce housing units in the project in lieu of providing funding or constructing the intersection with Honoapiilani Highway at the Waiale Road Extension intersection (also referred to as Study Intersection #13 in the TIAR/EIS)."

SECTION 3. Condition 1.d of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with deleted material in brackets and new material underscored:

"Landowners shall provide pedestrian crossings on Honoapiilani Highway at the [intersections] intersection of Main Street [and Waiale Road Extension,] and ensure that the development layout provides pedestrian routes to [these] this pedestrian [crossings.] crossing. Landowners are not constructing the Waiale Road Extension or the Waiale Road Extension intersection with Honoapiilani Highway. Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, provide additional residential workforce housing units in the project in consideration of the County providing pedestrian crossings on Honoapiilani Highway at the intersection of the Waiale Road Extension."

SECTION 4. Condition 3.b of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with deleted material in brackets and new material underscored:

"Landowners shall enter into an agreement with DPW regarding the project's pro rata share contribution to the Waiale Road Extension from Waiko Road to Honoapiilani Highway. The agreement shall determine the project's pro rata share of the total anticipated costs for design and construction of the future Waiale Road Extension and the methods and timing by which the payments or similar contributions are made. Alternatively, Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, provide additional residential workforce housing units in lieu of contributing funding for the design and construction of the future Waiale Road Extension. [The agreement will also consider the project's actual traffic generated insomuch as any reductions or increases in traffic than

originally estimated may reduce or increase the pro rata share in the future.] Further, Landowners shall deed the Waiale Road Extension right-of-way to DPW, upon demand, the value of which shall not be considered towards the pro rata share used in the agreement. The agreement shall be executed prior to the approval of the first subdivision application to the County of Maui for the project. DPW shall confirm compliance with this condition."

SECTION 5. Condition 5 of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with deleted material in brackets and new material underscored:

"Residential Workforce Housing. Landowners shall provide residential workforce housing opportunities in accordance with the County of Maui's residential workforce housing requirements. The required number of residential workforce housing units as determined by the County of Maui shall be completed [according to a timetable associated with the issuance of building permits for market-rate dwelling units] as required by [the] Chapter 2.96.060, Maui County Code, and as agreed to by the Department of Housing and Human Concerns. All residential workforce housing units in the project are subject to the following deed restriction periods:

a. "Below-moderate income," ten years.
b. "Moderate income," eight years.
c. "Above-moderate income," five years.

Landowners will not seek project approvals authorized by Chapter 201H, Hawaii Revised [Statues,] Statutes, or similar project approvals for this project."

SECTION 6. Condition 6 of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with deleted material in brackets and new material underscored:

"Wastewater. Landowners shall participate in the funding and construction of adequate private or public wastewater facilities for the Project Area. The wastewater facilities shall be in accordance with the applicable standards and requirements of the DOH and the County of Maui as applicable. If Landowners' proposed wastewater facilities are to be located within the State agricultural [districts,] district, Landowners shall apply for a State Special Permit in accordance with the provisions of Chapter 205, Hawaii Revised Statutes [(HRS)]. Alternatively, Landowners may, subject to the

Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, provide additional residential workforce housing units in the project in lieu of participating in the funding and construction of adequate private or public wastewater facilities. Subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, an interim connection to the Wailuku/Kahului Wastewater Treatment Facility for 100,000 gallons per day of wastewater may be made available for the project, provided that upon the County's new wastewater treatment facility in the vicinity of the project coming online, the project's wastewater may be diverted to the County's new wastewater treatment facility. If Landowners desire to request an initial or interim connection to County wastewater facilities for any dwellings, an agreement must be made to the satisfaction of the Department of Environmental Management and other applicable agencies prior to the issuance of any building permit. County or private operable wastewater facilities must be available to serve any use or structure prior to the issuance of the building permit for such use or structure."

SECTION 7. Condition 8 of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with new material underscored:

"Education Contribution Agreement. Landowners shall contribute to the development, funding, and construction of school facilities in compliance with the Educational Contribution Agreement for Waikapu Country Town, undated but executed as of January 31, 2017, entered into by Landowners and the Department of Education, as may be amended. Landowners shall ensure that prospective buyers, purchasers, and subsequent owner-builders of lots are given notice of the requirement to pay the Central Maui District Impact Fee in accordance with the Educational Contribution Agreement, as may be amended. Such notice shall be recorded and run with the land."

SECTION 8. Condition 16 of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with new material underscored:

"Agricultural Easement. Landowners shall submit to the Department an executed copy of the conservation easement or relevant instrument for 877.50 acres of adjacent agricultural lands as represented to the State of Hawaii Land Use Commission and to

the County of Maui and depicted in Exhibit "1" to Ordinance 4998 (2019) prior to the first final subdivision approval. No dwelling or structure shall be constructed or used for residential or dwelling purposes, including farm dwellings, farm labor dwellings and farm worker housing, on the agricultural lands that are subject to the agricultural easement or conservation easement, and such easement shall include this restriction. On the lands that are subject to the conservation easement, there shall be no animal hospitals and animal board facilities; riding academies; open land recreation uses, except that farm tours are allowed; parks for public use; and family child care homes. The following non-commercial open land recreation uses are allowed along the fifty-foot perimeter of the preserve: hiking, equestrian activities, greenways, mountain biking, and accessory restroom facilities. Landowners shall not seek county special use permits for open land recreation activities in the area subject to the conservation easement. There shall be no commercial agricultural structures, except farmer's markets and agricultural product stands in the area subject to the conservation easement. If any development is proposed in the area subject to the conservation easement or relevant instrument, Department of Land and Natural Resources State Historic Preservation Division (DLNR-SHPD) shall first determine whether an archaeological inventory survey shall be provided by Landowners for such area. Landowners shall notify the Department of any proposed development within the conservation easement lands and any determination made by DLNR-SHPD. Landowners shall supply adequate water for agricultural use in the areas subject to the conservation easement, to the maximum extent feasible. There shall be no removal of sand classified as Qdo in the USGS Mineral Resources Spatial Data as older dune deposits (Holocene and Pleistocene), from property identified for real property tax purposes as tax map keys (2) 3-6-002:003 and (2) 3-6-002:001."

SECTION 9. Condition 25 of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with new material underscored:

"The Project Area's Agricultural Master Plan, as set forth in Chapter III, Section 5 of the project's Final EIS identifies an agricultural preserve that is subject to an agricultural conservation easement, and a balance of approximately 270 acres that is mauka of Honoapiilani Highway, for which the zoning remains agriculture. The approximately 270-acre area is depicted in Exhibit "2" of Ordinance 4998 (2019) as being a portion of Lot 6 and identified as the Mauka Agricultural Lands. The use of the 270-acre area is restricted to the permitted principal uses in the County's Agricultural District and to only the following accessory uses: two farm dwellings per lot, one of which shall not exceed 1,000 square feet of developable area; storage, wholesale, and distribution facilities associated with agriculture in the County; processing of agricultural products; small-scale energy systems; small-scale animal-keeping; non-commercial open land recreation uses; and other uses that primarily support a permitted principal use, provided that such uses shall be approved by the appropriate planning commission as conforming to the intent of the County's Agricultural District. Landowners shall not seek county special use permits; state special permits; or approvals under Chapter 201H, Hawaii Revised Statutes. If subdivided, the 270-acre area shall consist of no more than five lots. Landowners shall record with the bureau of conveyances, or land court, as appropriate, this condition on property identified for real property tax purposes as tax map key (2) 3-6-004:003, as pertaining to the 270-acre area and provide proof of recordation to the Maui County Council prior to the first final subdivision approval, and such condition shall run with the land and bind all future owners or lessees of the area."

SECTION 10. Condition 26 of Exhibit "C" (Conditions of Zoning) of Ordinance 4998 (2019) is amended to read as follows, with new material underscored:

"Landowners shall, prior to the first final subdivision approval, implement as described the following priority projects in the Integrated Natural-Cultural Resource Preservation & Management Plan, dated June 2019, and attached as Exhibit "3" of Ordinance 4998 (2019):

A. Waikapū Watershed Management
   1. Priority Project #1 - prepare and initiate implementation of the 5-year Integrated Waikapū Watershed Management Plan.
   2. Priority Project #2 - establish the Mauna Kahalawai Watershed Partnership Perpetual Fund when a homeowners' association is established and generating revenue from residents and businesses within the Project Area.

B. Waikapū Stream
   1. Priority Project #1 - comply with instream flow standards and State water use permits.
   2. Priority Project #2 - support the kuleana ʻauwai restoration in South Waikapū to the extent practicable.

C. Land and Cultural Resources

   1. Priority Project #1 - develop and initiate implementation of a plan to ensure access to the Waikapū Valley for Native Hawaiian traditional and customary practices and gathering while controlling access to the general public to protect natural and cultural resources.
   2. Priority Project #2 - Establish access easements for the two Mahi kuleana parcels.
   3. Priority Project #3 - Establish the Waikapū Cultural Preserve, Cultural Corridor and Riparian Buffer and fund its management.
   4. Priority Project #4 - Integrate Waikapū ethnohistorical resources throughout the Project Area."

SECTION 11. Under Section 19.510.050, Maui County Code, the zoning granted by this Ordinance is subject to:

- the conditions in Ordinance 4998's Exhibit "C," as amended by this Ordinance's Sections 1-7; and
- this Ordinance's Exhibit "1," the First Amendment to the Unilateral Agreement and Declaration for Conditional Zoning.

SECTION 12. This Ordinance takes effect on approval.

hlu:misc:008abill02:alkl

INTRODUCED BY:

[signature]

Upon the request of the Mayor.

EXHIBIT "1"

Doc A - 86370739

August 25, 2023 11:45 AM

LAND COURT | REGULAR SYSTEM

Return by Mail to:

OFFICE OF THE COUNTY CLERK
County of Maui
200 South High Street
Wailuku, Maui, Hawaii 96793

TITLE OF DOCUMENT:

FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING

Tax Map Key No.: (2) 3-6-004:003 (portions);
(2) 3-6-004:006;
(2) 3-6-006:036;
(2) 3-6-005:007; and
(2) 3-6-002:003 (portion)

TOTAL NUMBER OF PAGES 27

FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING

THIS FIRST AMENDMENT TO UNILATERAL AGREEMENT "the First Amendment", made on August 11, 2023, by Waikapu Properties, LLC, a Hawaii limited liability company; MTP Land Partners, LLC, a Hawaii limited liability company; the William Filios Separate Property Trust dated April 3, 2000; and Waiale 905 Partners, LLC, a Hawaii limited liability company, all of which have a mailing address of P.O. Box 1870, Manteca, California 95336, jointly referred to as "the DECLARANT," and which cumulatively are the title owners of those parcels located at Waikapu, Maui, Hawaii, comprising 495.905 acres and identified for real property tax purposes by tax map keys (2) 3-6-004:003 (portions), (2) 3-6-004:006, (2) 3-6-006:036, (2) 3-6-005:007, and (2) 3-6-002:003 (portion).

W I T N E S S E T H:

WHEREAS, under that certain recorded Unilateral Agreement and Declaration for Conditional Zoning dated August 30, 2019, and recorded in the Bureau of Conveyances of the State of Hawaii as Document No. A-71880097 "the Declaration", the DECLARANT agreed to twenty-seven zoning conditions; and

WHEREAS the Council recommends through its Housing and Land Use Committee Report 23-69 that Bill 28, CD1 (2023), proposing to establish amended conditional zoning be approved for passage on first reading under Section 19.510.050, Maui County Code, "Conditional zoning"; and

WHEREAS, the DECLARANT has agreed to execute this instrument under Section 19.510.050, Maui County Code, "Conditional zoning"; and

WHEREAS, the DECLARANT now agrees to amended zoning condition 1.a to read as follows, with new material underscored:

"Landowners shall mitigate all Project-generated traffic impacts as required by the SDOT-H. Landowners shall enter into an agreement regarding the scope and timing of required traffic improvements to mitigate the traffic related impacts of the project on SDOT-H facilities as generally indicated in the project's Pro Rata Share Calculations for Waikapu Country Town Project dated June 29, 2018, as approved by SDOT-H. <u>Alternatively, Landowners may, subject to agreement with SDOT-H, provide additional residential workforce housing units in the project in lieu of providing funding or constructing traffic improvements to mitigate the traffic related impacts of the project.</u> The agreement

shall be executed prior to the approval of the first subdivision application to the County of Maui for the project."; and

WHEREAS, the DECLARANT now agrees to amended zoning condition 1.b to read as follows, with deleted material in brackets and new material underscored:

"Landowners shall fully fund <u>the</u> project [intersections] <u>intersection</u> with Honoapiilani Highway only at the Main Street Intersection (also referred to as Study Intersection #9 in the TIAR/EIS)<u>.</u> [and at the Waiale Road Extension Intersection (also referred to as Study Intersection #13 in the TIAR/EIS.] Landowners are solely responsible for funding the Main Street [and Waiale Road Extension] intersection improvements. <u>Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in the project in lieu of providing funding or constructing the intersection with Honoapiilani Highway at the Waiale Road Extension intersection (also referred to as Study Intersection #13 in the TIAR/EIS).</u>"; and

WHEREAS, the DECLARANT now agrees to amended zoning condition 1.d to read as follows, with deleted material in brackets and new material underscored:

"Landowners shall provide pedestrian crossings on Honoapiilani Highway at the [intersections] <u>intersection</u> of Main Street [and Waiale Road Extension,] and ensure that the development layout provides pedestrian routes to [these] <u>this</u> pedestrian [crossings.] <u>crossing. Landowners are not constructing the Waiale Road Extension or the Waiale Road Extension intersection with Honoapiilani Highway. Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in the project in consideration of the County providing pedestrian crossings on Honoapiilani Highway at the intersection of the Waiale Road Extension.</u>"; and

WHEREAS, the DECLARANT now agrees to amended zoning condition 3.b to read as follows, with deleted material in brackets and new material underscored:

"Landowners shall enter into an agreement with DPW regarding the project's pro rata share contribution to the Waiale

Road Extension from Waiko Road to Honoapiilani Highway. The agreement shall determine the project's pro rata share of the total anticipated costs for design and construction of the future Waiale Road Extension and the methods and timing by which the payments or similar contributions are made. Alternatively, Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in lieu of contributing funding for the design and construction of the future Waiale Road Extension. [The agreement will also consider the project's actual traffic generated insomuch as any reductions or increases in traffic than originally estimated may reduce or increase the pro rata share in the future.] Further, Landowners shall deed the Waiale Road Extension right-of-way to DPW, upon demand, the value of which shall not be considered towards the pro rata share used in the agreement. The agreement shall be executed prior to the approval of the first subdivision application to the County of Maui for the project. DPW shall confirm compliance with this condition."; and

WHEREAS, the DECLARANT now agrees to amended zoning condition 5 to read as follows, with deleted material in brackets and new material underscored:

"Residential Workforce Housing. Landowners shall provide residential workforce housing opportunities in accordance with the County of Maui's residential workforce housing requirements. The required number of residential workforce housing units as determined by the County of Maui shall be completed [according to a timetable associated with the issuance of building permits for market-rate dwelling units] as required by [the] Chapter 2.96.060, Maui County Code, and as agreed to by the Department of Housing and Human Concerns. Further provided, all residential workforce housing units in the project are subject to the following deed restriction periods:

a. "Below-moderate income," ten years.
b. "Moderate income," eight years.
c. "Above-moderate income," five years.

Landowners will not seek project approvals authorized by Chapter 201H, Hawaii Revised [Statues,] Statutes, or similar project approvals for this project."; and

WHEREAS, DECLARANT now agrees to amended zoning condition 6 to read as follows, with deleted material in brackets and new material underscored:

"Wastewater. Landowners shall participate in the funding and construction of adequate private or public wastewater facilities for the Project Area. The wastewater facilities shall be in accordance with the applicable standards and requirements of the DOH and the County of Maui as applicable. If Landowners' proposed wastewater facilities are to be located within the State agricultural [districts,] district, Landowners shall apply for a State Special Permit in accordance with the provisions of Chapter 205, Hawaii Revised Statutes [(HRS)]. Alternatively, Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in the project in lieu of participating in the funding and construction of adequate private or public wastewater facilities. Subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, an interim connection to the Wailuku/Kahului Wastewater Treatment Facility for 100,000 gallons per day of wastewater may be made available for the project, provided that upon the County's new wastewater treatment facility in the vicinity of the project coming online, the project's wastewater may be diverted to the County's new wastewater treatment facility. If Landowners desire to request an initial or interim connection to County wastewater facilities for any dwellings, an agreement must be made to the satisfaction of the Department of Environmental Management and other applicable agencies prior to the issuance of any building permit. County or private operable wastewater facilities must be available to serve any use or structure prior to the issuance of the building permit for such use or structure."; and

WHEREAS, the DECLARANT now agrees to amended zoning condition 8 to read as follows with new material underscored:

"8. Education Contribution Agreement. Landowners shall contribute to the development, funding, and construction of school facilities in compliance with the Educational Contribution Agreement for Waikapu Country Town, undated but executed as of January 31, 2017, entered into by Landowners and the Department of Education, as may be amended. Landowners shall ensure that prospective buyers, purchasers, and subsequent owner-builders of lots are given notice of the requirement to pay the Central Maui District Impact Fee in accordance with the Educational Contribution Agreement, as may be amended. Such notice shall be recorded and run with the land."; and

WHEREAS, the DECLARANT amends the Declaration, to recognize the amended conditions of zoning set forth in Bill 28, CD1 (2023); and

WHEREAS, the DECLARANT agrees that all other conditions of zoning established by Ordinance 4998 (2019) remain in effect; and

NOW THEREFORE the DECLARANT makes the following Declaration:

1. That this First Amendment is made pursuant to the provisions of Section 19.510.050, Maui County Code, "Conditional zoning";

2. That the conditions of zoning imposed are reasonable and rationally relate to the objective of preserving the public health, safety, and general welfare, and the conditions fulfill the need for the public service demands created by the proposed use;

3. That the Declaration, as amended, and all of the covenants, conditions, and, restrictions continue to be effective as to and run with the land in perpetuity or until the Declarant notifies the appropriate County department that any of the covenants, conditions, and restrictions are satisfied by the Declarant and the appropriate County department verifies the satisfaction and provides a written release of the covenant, condition, or restriction;

4. That the term "Declarant" and any pronoun in reference to the Declarant means the singular or the plural, the masculine or the feminine, or the neuter, and vice versa, includes any corporation, and includes the Declarant, the Declarant's heirs, devisees, executors, administrators, personal representatives, successors, and assigns;

5. That this First Amendment will become fully effective on the effective date of Bill 28, CD1 (2023), the zoning ordinance amending the conditional zoning, and this First Amendment must be recorded in the Bureau of Conveyances or filed in the Land Court of the State of Hawaii, as may be appropriate;

6. That Exhibit "3", "Conditions of Zoning", attached to the Declaration is hereby removed and replaced with Exhibit "3-A", "Conditions of Zoning" attached hereto. Any references to the Exhibit "3" within the Declaration shall now reference Exhibit "3-A" attached hereto.

7. That the Declarant agrees to develop the Property in conformance with the conditions in Exhibit "3-A" attached hereto;

AND IT IS EXPRESSLY UNDERSTOOD AND AGREED that until released in writing by the County the conditions imposed in the Declaration, as amended, will run with the land identified as the Property and will bind and constitute notice to all later owners, lessees, grantees, assignees, mortgagees, lienors, and any other persons who claim an interest in the Property, and the County of Maui will have the right to enforce the Declaration, as amended, by appropriate action at law or suit in equity against all persons, except that the Declarant or its successors and assigns may at any time file a petition for the removal of the conditions and terminate the Declaration, as amended, with the petition to be processed in the same manner as petitions for change in zoning.

This First Amendment may be executed in counterparts, each of which will be considered an original but all of which taken together are one and the same First Amendment.

Each person signing this First Amendment represents and warrants that they are duly authorized and have legal capacity to execute and deliver this First Amendment. Each party represents and warrants to the other that the execution and delivery of this First Amendment and the performance of the party's obligations have been duly authorized and that this First Amendment is a valid and legal agreement binding on the party and enforceable in accordance with its terms.

(*SIGNATURES ON THE FOLLOWING PAGES*)

IN WITNESS WHEREOF, the undersigned have executed this First Amendment the day and year first written above.

DECLARANT:

WAIKAPU PROPERTIES, LLC,
a Hawaii limited liability company

Larry W. Anderson, Manager

Michael W. Atherton, Manager

WAIALE 905 PARTNERS, LLC,
a Hawaii limited liability company

Larry W. Anderson, Manager

Michael W. Atherton, Manager

MTP LAND PARTNERS, LLC,
a Hawaii limited liability company

Michael W. Atherton, Manager

Albert G. Boyce V, Manager

RESTATED WILLIAM S. FILIOS SEPARATE PROPERTY TRUST DATED SEPTEMBER 9, 2016

William S. Filios, Trustee

APPROVED AS TO FORM AND LEGALITY:

Department of the Corporation Counsel
County of Maui

MTP LAND PARTNERS, LLC,
a Hawaii limited liability company

____
Michael W. Atherton, Manager

____
Albert G. Boyce V, Manager

RESTATED WILLIAM S. FILIOS SEPARATE PROPERTY TRUST DATED SEPTEMBER 9, 2016

____
William S. Filios, Trustee

APPROVED AS TO FORM AND LEGALITY:

____
Department of the Corporation Counsel
County of Maui

STATE OF HAWAII)
) SS.
COUNTY OF MAUI)

On AUG 11 2023, before me personally appeared LARRY W. ANDERSON and ~~MICHAEL W. ATHERTON~~, each as a Manager of Waikapu Properties, LLC, to me personally known, who, being by me duly sworn or affirmed, did say that such person(s) executed this 24-page FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING, undated at the time of signature, in the Second Circuit of the State of Hawaii, as the free act and deed of such person(s), and if applicable, in the capacity(ies) shown, having been duly authorized to execute such instrument in such capacity(ies).

LAURA AMARAL NOTARY PUBLIC No. 04-86 STATE OF HAWAII

____
Print Name: Laura Amaral
Notary Public, State of Hawaii.
My commission expires: 02/29/2024

STATE OF HAWAII)
) SS.
COUNTY OF MAUI)

On August 9, 2023, before me personally appeared ~~LARRY W. ANDERSON and~~ MICHAEL W. ATHERTON, each as a Manager of Waikapu Properties, LLC, to me personally known, who, being by me duly sworn or affirmed, did say that such person(s) executed this 24-page FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING, undated at the time of signature, in the Second Circuit of the State of Hawaii, as the free act and deed of such person(s), and if applicable, in the capacity(ies) shown, having been duly authorized to execute such instrument in such capacity(ies).

Print Name: Kimberly Uradomo
Notary Public, State of Hawaii.
My commission expires: 07-02-2026

KIMBERLY URADOMO
NOTARY PUBLIC
STATE OF HAWAII

STATE OF HAWAII)
) SS.
COUNTY OF MAUI)

On AUG 11 2023, before me personally appeared LARRY W. ANDERSON ~~and MICHAEL W. ATHERTON,~~ each as a Manager of Waiale 905 Partners, LLC, to me personally known, who, being by me duly sworn or affirmed, did say that such person(s) executed this 24-page FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING, undated at the time of signature, in the Second Circuit of the State of Hawaii, as the free act and deed of such person(s), and if applicable, in the capacity(ies) shown, having been duly authorized to execute such instrument in such capacity(ies).

LAURA AMARAL
NOTARY PUBLIC
No. 04-86
STATE OF HAWAII

Print Name: Laura Amaral
Notary Public, State of Hawaii.
My commission expires: 02/29/2024

STATE OF HAWAII)
) SS.
COUNTY OF MAUI)

On August 9, 2023, before me personally appeared ~~LARRY W. ANDERSON and~~ MICHAEL W. ATHERTON, each as a Manager of Waiale 905 Partners, LLC, to me personally known, who, being by me duly sworn or affirmed, did say that such person(s) executed this 24-page FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING, undated at the time of signature, in the Second Circuit of the State of Hawaii, as the free act and deed of such person(s), and if applicable, in the capacity(ies) shown, having been duly authorized to execute such instrument in such capacity(ies).

KIMBERLY URADOMO NOTARY PUBLIC STATE OF HAWAII

Print Name: ______________________
Notary Public, State of Hawaii.
Kimberly Uradomo
My commission expires: 07-02-2026

STATE OF HAWAII)
) SS.
COUNTY OF MAUI)

On August 9, 2023, before me personally appeared MICHAEL W. ATHERTON, as a Manager of MTP Land Partners, LLC, to me personally known, who, being by me duly sworn or affirmed, did say that such person(s) executed this 24-page FIRST AMENDMENT TO UNILATERAL AGREEMENT AND DECLARATION FOR CONDITIONAL ZONING, undated at the time of signature, in the Second Circuit of the State of Hawaii, as the free act and deed of such person(s), and if applicable, in the capacity(ies) shown, having been duly authorized to execute such instrument in such capacity(ies).

KIMBERLY URADOMO NOTARY 06-397 PUBLIC STATE OF HAWAII

Print Name: ______________________
Notary Public, State of Hawaii.
Kimberly Uradomo
My commission expires: 07-02-2026

ACKNOWLEDGMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California
County of SAN JOAQUIN)

On August 9, 2023 before me, HEATHER GILBERT, NOTARY PUBLIC
(insert name and title of the officer)

personally appeared Albert G. Boyce V Manager,
who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

HEATHER GILBERT
Notary Public - California
San Joaquin County
Commission # 2300003
My Comm. Expires Aug 30, 2023

Signature ______ **(Seal)**

ACKNOWLEDGMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California
County of SAN JOAQUIN)

On August 8, 2023 before me, HEATHER GILBERT, NOTARY PUBLIC
(insert name and title of the officer)

personally appeared William S Filos Trustee,
who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

HEATHER GILBERT
Notary Public - California
San Joaquin County
Commission # 2300003
My Comm. Expires Aug 30, 2023

Signature ______ **(Seal)**

EXHIBIT "3-A"

CONDITIONS OF ZONING

As it relates to the following conditions, "Landowners" means Waikapu Properties, LLC; MTP Land Partners, LLC; the William S. Filios Separate Property Trust dated April 3, 2000; Waiale 905 Partners, LLC; and any future owner or lessee.

1. Transportation – State Department of Transportation, Highways Division (SDOT-H).

   a. Landowners shall mitigate all Project-generated traffic impacts as required by the SDOT-H. Landowners shall enter into an agreement regarding the scope and timing of required traffic improvements to mitigate the traffic-related impacts of the project on SDOT-H facilities as generally indicated in the project's Pro Rata Share Calculations for Waikapu Country Town Project dated June 29, 2018, as approved by SDOT-H. Alternatively, Landowners may, subject to agreement with SDOT-H, provide additional residential workforce housing units in the project in lieu of providing funding or constructing traffic improvements to mitigate the traffic-related impacts of the project. The agreement shall be executed prior to the approval of the first subdivision application to the County of Maui for the project.

   b. Landowners shall fully fund the project intersection with Honoapiilani Highway only at the Main Street Intersection (also referred to as Study Intersection #9 in the TIAR/EIS). Landowners are solely responsible for funding the Main Street intersection improvements. Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in the project in lieu of providing funding or constructing the intersection with Honoapiilani Highway at the Waiale Road Extension intersection (also referred to as Study Intersection #13 in the TIAR/EIS).

   c. Landowners shall conduct an analysis of the suitability of a roundabout at the required Honoapiilani Highway and Main Street Intersection. Landowners shall transmit its analysis with findings to the SDOT-H; County of Maui, Department of Planning (Department); and the County of Maui, Department of Public Works (DPW). The SDOT-H shall determine if such a roundabout or traffic signal must be funded by Landowners.

   d. Landowners shall provide pedestrian crossings on Honoapiilani Highway at the intersection of Main Street and ensure that the development layout provides pedestrian routes to this pedestrian crossing. Landowners are not constructing the Waiale Road Extension or the Waiale Road Extension intersection with Honoapiilani Highway. Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in the project in consideration of the County providing pedestrian crossings on Honoapiilani Highway at the intersection of the Waiale Road Extension.

   SDOT-H will confirm compliance with this condition.

2. Transportation – State Department of Transportation, Airports Division (SDOT-A). Landowners shall work with SDOT-A to confirm compliance with the Federal Aviation Administration or other relevant government agency's guidelines and regulations regarding aircraft passage or airport operations at the Kahului Airport.

3. Transportation – DPW.

   a. Landowners shall conduct a pro rata traffic share study for the Waiale Road Extension and transmit it to DPW for review and approval prior to the County's approval of the first subdivision application for the project. The pro rata share study shall evaluate the project's percentage of future vehicle trips on the Waiale Road Extension from Waiko Road to Honoapiilani Highway.

   b. Landowners shall enter into an agreement with DPW regarding the project's pro rata share contribution to the Waiale Road Extension from Waiko Road to Honoapiilani Highway. The agreement shall determine the project's pro rata share of the total anticipated costs for design and construction of the future Waiale Road Extension and the methods and timing by which the payments or similar contributions are made. Alternatively, Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in lieu of contributing funding for the design and construction of the future Waiale Road Extension. Further, Landowners shall deed the Waiale Road Extension right-of-way to DPW, upon demand, the value of which shall not be considered towards the pro rata share used in the agreement. The agreement shall be executed prior to the approval of the first subdivision application to the County of Maui for the project. DPW shall confirm compliance with this condition.

4. Stormwater Management and Drainage. Landowners shall maintain existing drainage patterns to the maximum extent feasible and shall implement Best Management Practices (BMPs) to: a) minimize infiltration and runoff from construction and vehicle operations, b) reduce or eliminate the potential for soil erosion and ground water pollution, and c) formulate dust control measures to be implemented during and after the construction process in accordance with Department of Health (DOH) and County of Maui guidelines, ordinances and rules. The BMPs shall include a program for the maintenance of drainage swales within the Project Area. The design of drainage improvements and maintenance approved by the DPW shall not increase runoff from the Project Area as a result of an increase in impervious surfaces. The DPW shall confirm compliance with this condition.

5. Residential Workforce Housing. Landowners shall provide residential workforce housing opportunities in accordance with the County of Maui's residential workforce housing requirements. The required number of residential workforce housing units as determined by the County of Maui shall be completed as required by Chapter 2.96.060, Maui County Code, and as agreed to by the Department of Housing and Human Concerns. Further provided, all residential workforce housing units in the project are subject to the following deed restriction periods:

   a. "Below-moderate income," ten years.
   b. "Moderate income," eight years.
   c. "Above-moderate income," five years.

   Landowners will not seek project approvals authorized by Chapter 201H, Hawaii Revised Statutes, or similar project approvals for this project.

6. Wastewater. Landowners shall participate in the funding and construction of adequate private or public wastewater facilities for the Project Area. The wastewater facilities shall be in accordance with the applicable standards and requirements of the DOH and the County of Maui as applicable. If Landowners' proposed wastewater facilities are to be located within the State agricultural district, Landowners shall apply for a State Special Permit in accordance with the provisions of Chapter 205, Hawaii Revised Statutes. Alternatively, Landowners may, subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, provide additional residential workforce housing units in the project in lieu of

participating in the funding and construction of adequate private or public wastewater facilities. Subject to the Public Private Partnership Agreement County of Maui – Waikapu Country Town, dated April 28, 2022, as may be amended, an interim connection to the Wailuku/Kahului Wastewater Treatment Facility for 100,000 gallons per day of wastewater may be made available for the project, provided that upon the County's new wastewater treatment facility in the vicinity of the project coming online, the project's wastewater may be diverted to the County's new wastewater treatment facility. If Landowners desire to request an initial or interim connection to County wastewater facilities for any dwellings, an agreement must be made to the satisfaction of the Department of Environmental Management and other applicable agencies prior to the issuance of any building permit. County or private operable wastewater facilities must be available to serve any use or structure prior to the issuance of the building permit for such use or structure.

7. Air Quality. Landowners shall participate in an air quality monitoring program as required by the DOH.

8. Education Contribution Agreement. Landowners shall contribute to the development, funding, and construction of school facilities in compliance with the Educational Contribution Agreement for Waikapu Country Town, undated but executed as of January 31, 2017, entered into by Landowners and the Department of Education, as may be amended. Landowners shall ensure that prospective buyers, purchasers, and subsequent owner-builders of lots are given notice of the requirement to pay the Central Maui District Impact Fee in accordance with the Educational Contribution Agreement, as may be amended. Such notice shall be recorded and run with the land.

9. Energy Conservation Measures. Landowners shall implement measures to promote energy conservation, sustainable design and environmental stewardship including the use of solar water heating and photovoltaic systems for on-site infrastructure systems, residential, commercial, and civic uses. Solar water heating systems shall be required for new single-family residential construction per Section 196-6.5, Hawaii Revised Statutes. Landowners shall provide information to home purchasers regarding energy conservation measures that may be undertaken by individual homeowners in the Project Area. Verification of compliance with this condition shall be provided to the Department prior to submitting any building permit application.

10. Water Conservation Measures. Landowners shall implement water conservation measures and BMPs such as the use of indigenous plants and as required by the County of Maui. Verification of compliance with

this condition shall be provided to the Department prior to submitting any building permit application.

11. Water System. Landowners shall participate in the funding and construction of adequate private or public water source, storage, and transmission facilities to accommodate the proposed uses for each subdivision in the Project Area in accordance with the applicable standards and requirements of the DOH and the County of Maui, with plans submitted for approval by the appropriate agency. Landowners shall coordinate with the Commission on Water Resources Management regarding the overall impact of water pumpage on the Waikapu aquifer. Further, Landowners shall submit such information to the Department of Water Supply as may be requested to reflect changes in water demand forecasts and supply for the proposed uses in accordance with the County of Maui's Water Use and Development Plan. Compliance with this condition shall be confirmed by the Department of Water Supply.

12. Street Lights. Landowners shall use fully shielded street lights within the Project Area to avoid impacts to avifauna and other wildlife populations and to prevent light diffusion into the night sky.

13. Sirens. Landowners shall fund and install three (3) civil defense warning sirens as specified by and in the locations identified by the State Department of Defense according to a timetable agreed upon by the State Department of Defense.

14. Parks. Landowners shall comply with the park dedication requirements of the County of Maui. Landowners shall provide a park construction and phasing plan approved by the Department of Parks and Recreation, DPW, and Department of Planning, which shall be in accordance with the Maui County Code. Landowners shall develop parks and recreational areas that may be used by all ages and are not used primarily as water retention basins.

15. Established Gathering and Access Rights Protected. Pursuant to Article Xll, Section 7 of the Hawaii State Constitution, Landowners shall preserve and protect any established gathering and access rights of Native Hawaiians who have customarily and traditionally used the Project Area to exercise subsistence, cultural, gathering, and religious practices or for access to other areas for such purpose.

16. Agricultural Easement. Landowners shall submit to the Department an executed copy of the conservation easement or relevant instrument for 877.50 acres of adjacent agricultural lands as represented to the State of Hawaii Land Use Commission and to the County of Maui and depicted in Exhibit "1" to Ordinance 4998 (2019) prior to the first final subdivision

approval. No dwelling or structure shall be constructed or used for residential or dwelling purposes, including farm dwellings, farm labor dwellings and farm worker housing, on the agricultural lands that are subject to the agricultural easement or conservation easement, and such easement shall include this restriction. On the lands that are subject to the conservation easement, there shall be no animal hospitals and animal board facilities; riding academies; open land recreation uses, except that farm tours are allowed; parks for public use; and family child care homes. The following non-commercial open land recreation uses are allowed along the fifty-foot perimeter of the preserve: hiking, equestrian activities, greenways, mountain biking, and accessory restroom facilities. Landowners shall not seek county special use permits for open land recreation activities in the area subject to the conservation easement. There shall be no commercial agricultural structures, except farmer's markets and agricultural product stands in the area subject to the conservation easement. If any development is proposed in the area subject to the conservation easement or relevant instrument, Department of Land and Natural Resources State Historic Preservation Division (DLNR-SHPD) shall first determine whether an archaeological inventory survey shall be provided by Landowners for such area. Landowners shall notify the Department of any proposed development within the conservation easement lands and any determination made by DLNR-SHPD. Landowners shall supply adequate water for agricultural use in the areas subject to the conservation easement, to the maximum extent feasible. There shall be no removal of sand classified as Qdo in the USGS Mineral Resources Spatial Data as older dune deposits (Holocene and Pleistocene), from property identified for real property tax purposes as tax map keys (2) 3-6-002:003 and (2) 3-6-002:001.

17. Notification of Agricultural Use. Landowners, and all subsequent owners, shall disclose to developers, purchasers, and lessees of the provisions of Chapter 165, Hawaii Revised Statutes, the Hawaii Right to Farm Act. The notice and disclosure shall be a part of any conveyance document such as a deed, lease, or agreement of sale. The notice and disclosure shall contain at least the following information: a) that the developers, purchasers, and lessees shall not take any action that would interfere with or restrain farming operations conducted in a manner consistent with generally accepted agricultural and management practices on adjacent lands in the State Land Use Agricultural District; and b) that potential nuisances from noise, odors, dust, fumes, spray, smoke, or vibration may result from agricultural uses on adjacent lands. For the purpose of this condition, the term "farming operations" shall have the same meaning as provided in Section 165-2, Hawaii Revised Statutes.

18. Archaeological and Historic Sites. Landowners shall provide the following prior to any ground disturbance, including the issuance of grading or grubbing permits, as agreed upon with DLNR-SHPD's acceptance of Landowners' Archaeological Inventory Survey: a) Archaeological monitoring for all ground disturbing activities pursuant to a DLNR-SHPD approved monitoring plan, which shall include data recovery of archaeological and historic sites; b) If site 50-50-04-5197 (Waihee Ditch) is impacted by the Project, it will be further documented in consultation with DLNR-SHPD; c) If any development is proposed for the area to be dedicated to agriculture, DLNR-SHPD shall be notified and will make a determination on whether an archaeological inventory survey is to be provided by Landowners; d) Landowners shall submit a preservation plan to DLNR-SHPD for two (2) sites: the irrigation features (Site 50-50-04-7884) and the WWII bunker (Site 50-50-04-7883); and e) If there is an inadvertent discovery of single or multiple human skeletal remains, Landowners shall provide written consent to DLNR-SHPD extending for at least 30 days the statutory timeline outlined in Section 13-300-40, Hawaii Administrative Rules. The preservation plan shall be submitted to the DLNR-SHPD for review and acceptance prior to any ground disturbance in the vicinity of the two (2) sites. Landowners shall comply with all interim and permanent mitigation and preservation measures required by DLNR-SHPD. Landowners shall provide verification to the Department that DLNR-SHPD has determined that all required historic preservation measures have been implemented. Landowners shall notify DLNR-SHPD prior to the first ground disturbance activity.

19. Cultural. Landowners shall consult with those persons known as Waikapu Stream South Kuleana Lo'i Kalo Farmers and Hui o Na Wai 'Eha to minimize the impacts on their traditional customary rights and practices from any development in the Project Area. Additionally, Landowners shall grant access easements over the appropriate portions of the Project Area in favor of the owners of the Mahi-Puleloa parcels, identified as LCA 2944:3 to Ehunui (TMK: (2) 3-6-005:010) and as Grant 1513 to Ehunui (TMK: (2) 3-6-005:009) and in favor of the owners of the Kauihou parcels, identified as LCA 3340:1 (por.) to Nahau (TMK: (2) 3-6-005:067), as LCA 3103 to Kalawaia (TMK: (2) 3-6-005:014) and as LCA 3110:3.2 to Kuolaia (TMK: (2) 3-6-005:066). The easements shall be recorded and run with the land.

20. Endangered Species. Landowners shall implement the following procedures to avoid potential impacts to endangered species: a) Landowners shall not clear dense vegetation, including woody plants greater than fifteen feet (15 ft.) in height, along the periphery of the Project Area during the period from June 1 to September 15 of each year, which is the time that the Hawaiian hoary bat may be carrying young

and thus could be at risk from the clearing activities; b) landowners shall consult with the United States Fish and Wildlife Service to determine measures needed with regard to the endangered Blackburn's Sphinx Moth and shall implement such measures in connection with the development of the Project Area; and c) for any nighttime work required during any construction within the Project Area and for long term features, exterior lighting shall be shielded so as to reduce the potential for interactions of or disturbance to Hawaiian Petrels and Newell's Shearwaters.

21. Development in Compliance with Maui Island Plan. Landowners shall develop the Project in substantial compliance with the Planned Growth Area Rationale and goals, objectives, policies, and implementing actions described in the Maui Island Plan for the Project identified as "Waikapu Tropical Plantation Town."

22. Infrastructure Deadline. Landowners shall complete construction of the backbone infrastructure, which consists of primary roadways and access points; internal roadways; on-site and off-site water, sewer, and electrical system improvements; and stormwater and drainage and other utility improvements within ten (10) years from the date of the first final subdivision approval.

23. Compliance with Representations to the Maui County Council. Landowners shall develop the Project Area in substantial compliance with the representations made to the Maui County Council in its approval of the subject change in zoning. Failure to develop the Project Area in accordance with such representations may result in enforcement, including reversion of the Project Area to its former zoning and community plan classifications.

24. Annual Reports. Landowners shall provide the Department an annual report on the status of the development of the Project Area and Landowners' progress in complying with the conditions imposed herein. The first annual report shall be submitted within one (1) year of the effective date of the CIZ ordinance, and subsequent reports shall be submitted annually on or near the same date.

25. The Project Area's Agricultural Master Plan, as set forth in Chapter III, Section 5 of the project's Final EIS identifies an agricultural preserve that is subject to an agricultural conservation easement, and a balance of approximately 270 acres that is mauka of Honoapiilani Highway, for which the zoning remains agriculture. The approximately 270-acre area is depicted in Exhibit "2" of Ordinance 4998 (2019) as being a portion of Lot 6 and identified as the Mauka Agricultural Lands. The use of the 270-acre area is restricted to the permitted principal uses in the

County's Agricultural District and to only the following accessory uses: two farm dwellings per lot, one of which shall not exceed 1,000 square feet of developable area; storage, wholesale, and distribution facilities associated with agriculture in the County; processing of agricultural products; small-scale energy systems; small-scale animal-keeping; non-commercial open land recreation uses; and other uses that primarily support a permitted principal use, provided that such uses shall be approved by the appropriate planning commission as conforming to the intent of the County's Agricultural District. Landowners shall not seek county special use permits; state special permits; or approvals under Chapter 201H, Hawaii Revised Statutes. If subdivided, the 270-acre area shall consist of no more than five lots. Landowners shall record with the bureau of conveyances, or land court, as appropriate, this condition on property identified for real property tax purposes as tax map key (2) 3-6-004:003, as pertaining to the 270-acre area and provide proof of recordation to the Maui County Council prior to the first final subdivision approval, and such condition shall run with the land and bind all future owners or lessees of the area.

26. Landowners shall, prior to the first final subdivision approval, implement as described the following priority projects in the Integrated Natural-Cultural Resource Preservation & Management Plan, dated June 2019, and attached as Exhibit "3" of Ordinance 4998 (2019):
    A. Waikapū Watershed Management
        1. Priority Project #1 - prepare and initiate implementation of the 5-year Integrated Waikapū Watershed Management Plan.
        2. Priority Project #2 - establish the Mauna Kahalawai Watershed Partnership Perpetual Fund when a homeowners' association is established and generating revenue from residents and businesses within the Project Area.
    B. Waikapū Stream
        1. Priority Project #1 - comply with instream flow standards and State water use permits.
        2. Priority Project #2 - support the kuleana `auwai restoration in South Waikapū to the extent practicable.
    C. Land and Cultural Resources
        1. Priority Project #1 - develop and initiate implementation of a plan to ensure access to the Waikapū Valley for Native Hawaiian traditional and customary practices and gathering while controlling access to the general public to protect natural and cultural resources.
        2. Priority Project #2 - Establish access easements for the two Mahi kuleana parcels
        3. Priority Project #3 - Establish the Waikapū Cultural Preserve, Cultural Corridor and Riparian Buffer and fund its management.

        4. Priority Project #4 - Integrate Waikapū ethnohistorical resources throughout the Project Area.

27. Landowners shall submit all street names in the Project Area for review and approval to the Public Works Commission. Streets in the Project Area shall be named in consideration of traditional land divisions, trade winds, and other natural and cultural factors relevant to the Project Area.

END OF EXHIBIT "3-A"

WE HEREBY CERTIFY that the foregoing BILL NO. 28, CD1, FD1 (2023)

1. Passed FINAL READING at the meeting of the Council of the County of Maui, State of Hawaii, held on the 1st day of September, 2023, by the following vote:

Alice L. LEE Chair	Yuki Lei K. SUGIMURA Vice-Chair	Tom COOK	Gabriel JOHNSON	Natalie A. KAMA	Tamara A. M. PALTIN	Keani N. W. RAWLINS-FERNANDEZ	Shane M. SINENCI	Nohelani U'U-HODGINS
Aye	Aye	Aye	Aye	Aye	Aye	No	Aye	Aye

2. Was transmitted to the Mayor of the County of Maui, State of Hawaii, on the 1st day of September, 2023.

DATED AT WAILUKU, MAUI, HAWAII, this 1st day of September, 2023.

ALICE L. LEE, CHAIR
Council of the County of Maui

MOANA M. LUTEY, COUNTY CLERK
County of Maui

THE FOREGOING BILL IS HEREBY APPROVED THIS DAY OF September 5, 2023.

RICHARD T. BISSEN, JR. MAYOR
County of Maui

I HEREBY CERTIFY that upon approval of the foregoing BILL by the Mayor of the County of Maui, the said BILL was designated as ORDINANCE NO. **5556** of the County of Maui, State of Hawaii.

MOANA M. LUTEY, COUNTY CLERK
County of Maui

Passed First Reading on August 22, 2023
Effective date of Ordinance September 5, 2023

I HEREBY CERTIFY that the foregoing is a true and correct copy of Ordinance No. 5556, the original of which is on file in the Office of the County Clerk, County of Maui, State of Hawaii.

Dated at Wailuku, Hawaii, on

County Clerk, County of Maui