OAHU COMMUNITY CORRECTIONAL CENTER

MASTER PLAN REPORT

VOLUME III: APPENDICES I-K

Prepared For:
Department of Public Safety (PSD)
Department of Accounting and General Services (DAGS)

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APPENDIX I

VALUE FOR MONEY ANALYSIS

Oahu Community Correctional Center

Prepared for:

State of Hawaii
Department of Accounting and General Services
Department of Public Safety

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Prepared By:

Louis Berger

Value for Money Analysis

Oahu Community Correctional Center

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State of Hawaii
Hawaii Department of Public Safety

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List of Abbreviations and Acronyms

CapEx	Capital Expenditures
DAGS	Hawaii Department of Accounting and General Services
DB	Design - Build
DBB	Design – Bid - Build
DBFM	Design – Build – Finance - Maintain
GO	General Obligation
NPV	Net Present Value
PSD	Hawaii Department of Public Safety
P3	Public Private Partnership
VfM	Value for Money
YOE	Year of Expenditure

EXECUTIVE SUMMARY

The Hawaii Department of Public Safety (PSD) operates the Oahu Community Correctional Center (OCCC), which acts as the local detention center for the First Circuit Court on Oahu. With increasingly aged and obsolete correctional facilities, the State of Hawaii is proposing to improve PSD's corrections infrastructure through modernization of existing facilities when possible and construction of new institutions to replace others when necessary. Among its priority projects is the replacement of OCCC.

Louis Berger U.S., Inc. (Louis Berger) was engaged to conduct a Value for Money (VfM) analysis of the proposed OCCC. The objective of the analysis is to evaluate the suitability of various OCCC project delivery options in terms of total lifecycle cost, risk transfer, and qualitative considerations. Based on the OCCC construction cost estimates provided by Cumming Corporation (the consultant providing cost estimation services) Louis Berger utilized an analytical tool to evaluate the traditional Design-Bid-Build project delivery option, also known as the public sector comparator, the Design-Build option, and two Public Private Partnership (P3) options that are well suited for social infrastructure and may be feasible alternatives for this project. The evaluation focused on the following:

- *Project Overview*: Description of proposed OCCC project, including project baseline design and construction costs as estimated by Cumming in April 2018.
- *Overview of the Procurement Options Evaluated*: The evaluation analyzed the following four project delivery options:

  (1) Design-Bid-Build, or traditional public sector comparator option where the public sector procures the design and construction separately and does not fully transfer any risk;

  (2) Design-Build, where design and construction are procured together and the public-sector transfers some of the risk related to this aspect of the project;

  (3) Design-Build-Finance with Long-Term Maintenance (DBFM – Availability Payments), where the private sector takes on the risk for all aspects of the project except operations which are retained by the State of Hawaii (i.e., PSD) and is compensated through availability payments made by the State contingent on construction completion and maintenance performance measures; and

  (4) Non-Profit Design-Build-Finance with Long-Term Maintenance (DBFM 63-20 – Lease), where the private sector takes on all risks and is compensated through yearly lease payments and payment for the remainder of the balance of the value of the asset at the end of 30 years of operation.

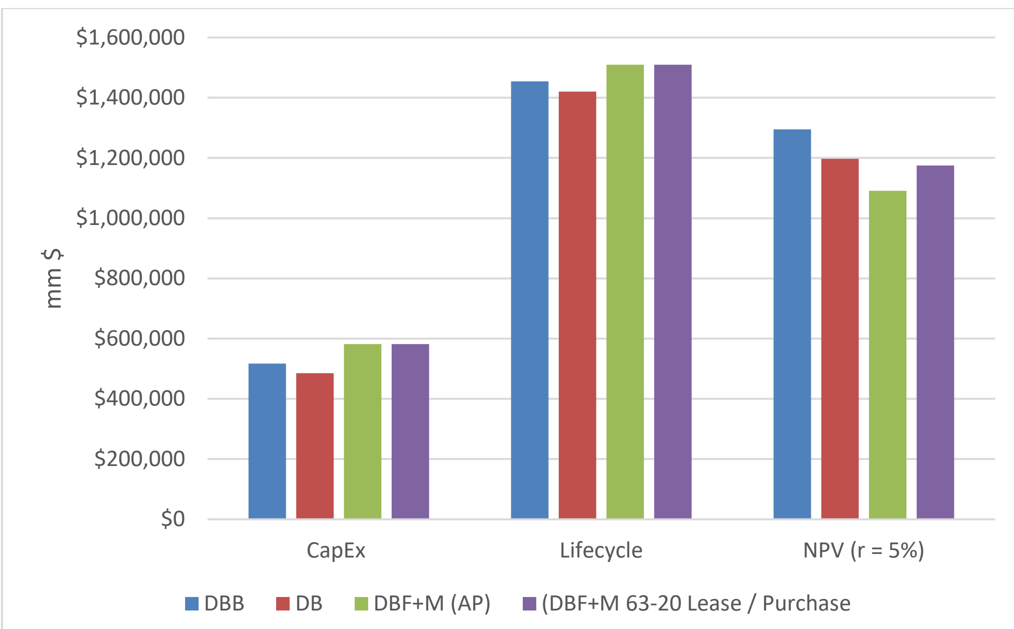
  The attributes, including risk allocation, of each of these options was assessed and documented.
- *Project Proposed Schedules*: Description of assumptions on schedule and construction completion timeline for each of the delivery options. These assumptions frame the Net Present Value analysis.
- *Net Present Value Evaluation*: Net Present Value (NPV) is the present value of cash flows over a time period. All cash flows were discounted at a rate of 5% based on State of Hawaii precedents.

- Table E-1 and Figure E-1 provide the Capital Expenditures (CapEx), Lifecycle, and NPV Calculations of the NPV analysis. All costs for CapEx and Lifecycle are in Year of Expenditure (YoE) dollars. The risk-adjusted CapEx and Lifecycle costs are higher for the DBB and DBF+M options compared to the engineering cost estimates, and lowest for the DB option. The Lifecycle costs for the DBF+M delivery options are slightly higher than the DBB and DB CapEx costs. The NPV results, which incorporate considerations for financing and timeline of design and construction indicate that the DBB option has the highest cost, followed by the DB option and the DBFM 63-20 option. The DBF+M (AP) delivery option is the least costly once all quantitative aspects of the analysis are considered. Compared to the DBB option, the DB option is 8% lower, the DBF+M 63-20 is 9% lower, and the DBF+M (AP) option is 16% lower.

Table E-1: Results of NPV Analysis (r = 5%)

Option	DBB	DB	DBF+M (AP)	DBF+M 63-20 Lease / Purchase
CapEx (YoE $)	$516,846,000	$485,477,000	$582,129,000	$582,129,000
Lifecycle (YoE $)	$1,454,254,000	$1,420,370,000	$1,509,145,000	$1,509,145,000
NPV (r = 5%) (2018 $)	$1,295,471,000	$1,197,058,000	$1,091,247,000	$1,175,266,000

Figure E-1: Results of NPV Analysis



In addition to the quantitative results, there are qualitative considerations to consider when selecting a project delivery method. These are summarized as follows:

- The DBFM options are attractive from a cost perspective assuming that the procuring agency receives the necessary support and assistance to guide it through the negotiating process in a timely fashion along with the project management and oversight skills and resources to overcome the lack of experience with this procurement method.

- In addition to being the most expensive option in NPV terms, the DBB option may not be the best alternative for the OCCC project for the following reasons: (1) delays in schedule and associated cost increases as well as a longer period of time between procurement and construction completion; (2) the limited experience in procuring and delivering the construction of an entirely new facility, particularly one as large, complex, and costly as OCCC; and (3) the option provides little to no risk transfer and therefore virtually any issue comes at the full cost to the State of Hawaii.
- The DB option is less expensive than the DBB option after adjusting for risk and offers the following advantages: (1) the risk of cost overruns for design and construction is reduced once the two procurements are combined; (2) the procurement process is less complex than the DBFM procurements and only slightly more intricate than the DBB procurement; and (3) the DB option has lower financing costs than the DBFM option and higher risk transfer than the DBB option.

Based on a comprehensive Value for Money assessment, which considers quantitative and qualitative considerations, the DB option may be the most efficient alternative procurement for delivery of the OCCC project. However, with the proper support, technical assistance and resources, the DBFM options are attractive.

This Value for Money analysis is considered the first step in the process of evaluating the many complex aspects associated with delivering this important facility in a manner that benefits the people of Hawaii. The work to date represents a high-level analysis of a number of possible options for consideration by the State's financial, legal, and procurement specialists. This report does not offer a recommendation for a specific method of financing or delivery of the OCCC project. Each option presented requires further in-depth study that goes far beyond the limitations of this report and ultimately leads to the definitive solution.

1.0 INTRODUCTION

The Hawaii Department of Public Safety (PSD) operates the Oahu Community Correctional Center (OCCC) located at 2199 Kamehameha Highway in Honolulu. The State of Hawaii is proposing to replace the current OCCC with a new facility as part of a broader effort to improve PSD's corrections infrastructure through modernization of existing facilities and construction of new replacement institutions where necessary. Four sites located on the island of Oahu were identified as potential locations for the proposed OCCC facility, with the Animal Quarantine Station site in Halawa selected as the preferred location for new OCCC development.

With assistance from the Hawaii Department of Accounting and General Services (DAGS), the State of Hawaii is preparing for the eventual design and construction of a new OCCC and recognizes the substantial effort and investment required to bring the project to fruition. Therefore, it is appropriate that the State evaluate options available to deliver and finance construction of a new OCCC.

Louis Berger U.S., Inc. (Louis Berger) was engaged to develop a Value for Money (VfM) analysis of the OCCC project. The objective of the analysis is to evaluate the suitability of various project delivery options in terms of total lifecycle cost, risk transfer, and qualitative considerations. Based on construction cost estimates provided by Cumming Corporation (April 2018), Louis Berger utilized an analytical tool to evaluate the traditional Design-Bid-Build project delivery option, also known as the public sector comparator, the Design-Build option, and two Public Private Partnership (P3) options that are well suited for social infrastructure and may be feasible alternatives for this project.

The sections that follow summarize the components of the VfM analysis, as follows:

- OCCC Project Overview
- Value for Money Analysis Objectives
- Base Project Design and Construction Costs
- Overview of Procurement Options Evaluated
- Summary of Procurement Option Attributes
- Risk Analysis and Allocation
- Proposed Project Schedules
- Net Present Value Evaluation
- Key Qualitative Considerations for OCCC
- Conclusion
- Next Steps

This Value for Money analysis is considered the first step in the process of evaluating the many complex aspects associated with delivering this important facility in a manner that benefits the people of Hawaii. The work to date represents a high-level analysis of a number of possible options for consideration by the State's financial, legal, and procurement specialists. This report does not offer a recommendation for a specific method of financing or delivery of the OCCC project. Each option presented requires further in-depth study that goes far beyond the limitations of this report and ultimately leads to the definitive solution.

2.0 OCCC PROJECT OVERVIEW

The State of Hawaii, via PSD, operates OCCC which houses sentenced (i.e., felons, probation, and misdemeanor), pretrial offenders (i.e., felons and misdemeanor), other jurisdiction, and probation/parole violators. OCCC provides the customary county jail function of managing both pre-trial detainees and locally-sentenced misdemeanant offenders and others with a sentence of one year or less. OCCC also provides an important pre-release preparation/transition function for prison system inmates when they reach less than a year until their scheduled release.

With increasingly aged and obsolete correctional facilities, the State is proposing to improve Hawaii's corrections infrastructure through modernization of existing facilities and construction of new institutions to replace others when necessary. Among the State's priority projects is the replacement of OCCC. OCCC is currently the largest county jail facility in the Hawaii system and can be expected to remain so as it serves the Honolulu/Oahu population.

Developing new correctional facilities are time-consuming, complex, and costly undertakings. The State of Hawaii is anticipating the need to make substantial investments in many of its correctional facilities to accommodate future inmate populations and meet state and national standards. Therefore, it is appropriate that the State evaluate options available for financing construction of a new OCCC, recognizing that the investments needed now and, in the future, could have a major impact on budgeting cycles.

3.0 VALUE FOR MONEY ANALYSIS OBJECTIVES

The VfM analysis compares the total costs of delivering an infrastructure project using different forms of procurement. Its purpose is to identify which procurement approach for a given project delivers the greatest value for the public sector. VfM is an effective practice to evaluate the traditional Design-Bid-Build (DBB) project delivery approach against Design-Build (DB); Public Private Partnership (P3) delivery options including private financing and/or transfer of responsibility for long-term operations, maintenance, and rehabilitation, such as Design-Build-Finance (DBF); or Design-Build-Finance-Operate-Maintain (DBFOM) approaches.

The assessment considers the estimated risk-adjusted costs of delivering the OCCC project using different procurement options that result in distinct financing, ownership, and implementation approaches, and varying levels of private involvement. The procurement approach that results in the lowest cost – lifecycle costs and risks considered – would deliver the most “value for money” and therefore, the most benefit to the public sector (in this case the State of Hawaii). This report does not offer the State a definitive solution but is meant to serve as a first step in the process of evaluating these options. The options favored by the State will require further in-depth study.

Performing a VfM analysis is a critical step when evaluating procurement options, and it has already become the standard in several countries where project delivery, through P3 delivery and project finance arrangements, are common. The United Kingdom, Australia, Ireland, New Zealand, South Africa and China have VfM practices that have been developed for at least a decade. In the State of Virginia, the Department of Transportation (DOT) undertakes VfM analyses for all proposed concessions. In Canada, once a Public Private Partnership has been identified as a potential procurement method for further consideration through the P3 screen, VfM is the determining factor for selecting the preferred method. The decision whether to proceed with a Public Private Partnership is based on the results of the VfM analysis together with the analysis of program requirements, strategic considerations, and project-specific qualitative, quantitative, and risk factors.

4.0 BASE PROJECT DESIGN AND CONSTRUCTION COSTS

In April 2018, Cumming, a consultant providing capital cost estimates for the OCCC project, prepared an updated estimate of project costs for the new OCCC facility, replacing earlier versions developed during project planning. The estimates included construction costs, design costs, and soft costs, and incorporated values for project management, permitting fees, and contingency. The construction costs used pricing data from Cumming's database for Honolulu County construction to estimate the cost of materials and cost escalation over the duration of the construction period. The estimates were based on a four-year design and construction schedule, two years for each activity. Table 4-1 presents a summary of the project cost estimates.

In preparing a VfM analysis, it is important to utilize the best available information on capital costs prepared by the project sponsor together with any appropriate adjustments for risk and uncertainty that may not have been factored into the sponsor estimate. Uncertainty in total project cost and schedule duration are common before a project enters the design and construction phase. Review of historical cost variation in facility building capital costs is ±25% to ±30% in the pre-design estimate stage.[1] In the State of Hawaii in particular, the Honolulu rail project has increased in cost from the initial $5.26 billion estimate in 2014 to $8.3 billion in 2018 – a 58% increase in capital costs.

Cumming developed the project capital cost estimate and associated contingency allowances under the assumption that the project delivery option would be Design-Bid-Build. At this stage of project development, however, a full project risk assessment has not been undertaken by the sponsor and it is possible that increases in project cost and schedule duration could affect the project as it advances through the design, procurement, and construction phases. For the purposes of the VfM analysis the costs in Table 4-1 are used, therefore, as a base and further adjustments are made, as appropriate, for each delivery option to reflect the risks retained by the State of Hawaii during project delivery.

Under the DBB option, the State of Hawaii bears the full risk of any changes to cost and schedule during the design process, the risk that bids will come in higher than the engineer's estimate, and the risk of cost overruns during construction itself. Historically DBB project delivery has been associated with increased risk of schedule delays and cost overruns especially in comparison to DB and P3 delivery options where the private partner provides cost and schedule guarantees.

The risk-adjusted cost used in in the Net Present Value quantitative analysis, and the basis for those adjustments, are outlined in Section 9.0 of this report.

1 Canadian Construction Association, *Guide to Cost Predictability in Construction: An Analysis of Issues Affecting the Accuracy of Construction Cost Estimates,* November 2012.

Table 4-1: OCCC Design and Construction Cost Summary

Item Description	Detention Facility	Pre-Release Facility	Site Work	Off-Site Improvements	Subtotal	Group Total
Building Permits						
Permit Fee Allowance	$4,301,483	$894,560	$288,368	$114,071		**$5,598,482**
Construction Cost						
Detention Facility	$286,765,519				**$286,765,519**	
Pre-Release Facility		$59,637,353			**$59,637,353**	
Site work			$28,836,841		**$28,836,841**	
Off-Site Improvements				$11,407,095	**$11,407,095**	
Total Construction Cost	**$286,765,519**	**$59,637,353**	**$28,836,841**	**$11,407,095**		**$386,646,808**
New Animal Quarantine Station Facility						
Cost to rebuild Animal Quarantine Station				Excluded		
Construction Phasing						
Phasing allowance and interim swing space cost	$200,000	$200,000			**$400,000**	
	$200,000	**$200,000**	**$0**	**$0**		**$400,000**
FF&E Costs						
Allowance	$5,000,000	w/main bldg.			**$5,000,000**	
	$5,000,000	**$0**	**$0**	**$0**		**$5,000,000**
Exterior Signage	**$35,000**	**$0**	**$0**	**$0**		**$35,000**
Support Equipment						
Kitchen, Laundry, and Departmental equipment					**Included**	
Systems						
Computer and security system software					**Excluded**	
Telephone system	$150,000	$75,000			**$225,000**	
Security system					**Included**	
	$150,000	**$75,000**	**$0**	**$0**		**$225,000**
Community Partnering					**TBD**	
Inventory (Consumables/ Admin Supplies)					**Excluded**	

Item Description	Detention Facility	Pre-Release Facility	Site Work	Off-Site Improvements	Subtotal	Group Total
Design & PM Costs						
Design Costs						
Allow 7% of construction, FF&E, and equipment costs	$20,423,586	$4,174,615		$0	**$24,598,201**	
Allow 4% of construction costs			$1,153,474	$456,284	**$1,609,758**	
Reimbursable expenses	$2,042,359	$417,461	$115,347	$45,628	**$2,620,795**	
Subtotal Design Costs	**$22,465,945**	**$4,592,076**	**$1,268,821**	**$501,912**	**$28,828,754**	
Project Management						
Allow 4% of construction, FF&E and equipment costs	$11,670,621	$2,385,494	$1,153,474	$456,284	**$15,665,873**	
Reimbursable expenses	$1,167,062	$238,549	$115,347	$45,628	**$1,566,586**	
Sub Total PM Costs	**$12,837,683**	**$2,624,043**	**$1,268,821**	**$501,912**	**$17,232,459**	
Total Design and PM Costs	**$35,303,628**	**$7,216,119**	**$2,537,642**	**$1,003,824**		**$46,061,213**
Working Capital/Financing					**Excluded**	
Financial, Taxes & Legal (Legal, OCIP, Property Taxes)					**Excluded**	
Capitalized Interest					**Excluded**	
Contingency						
Contingency on construction @ 10%	$28,676,552	$5,963,735	$2,883,684	$1,140,709	**$38,664,680**	
Contingency on soft costs @ 5%	$2,239,506	$409,284	$141,301	$55,895	**$2,845,986**	
	$30,916,058	**$6,373,019**	**$3,024,985**	**$1,196,604**		**$41,510,666**
Land Cost					**Excluded**	
Total Project Costs	**$362,671,688**	**$74,396,051**	**$34,687,836**	**$13,721,594**		**$485,477,169**

Source: OCCC – Animal Quarantine Station Site, Oahu, HI, Cumming, April 26, 2018.

5.0 OVERVIEW OF PROCUREMENT OPTIONS EVALUATED

The first stage of a VfM analysis involves identifying which financing and project delivery options are applicable, given the various legal, financial, and political factors, such as the nature and scale of the project and the fiscal health of the public entity sponsoring its construction and operation. In October 2017, Louis Berger developed an analysis of financing plan options for developing a new OCCC. The analysis, summarized in Appendix I to the Draft Environmental Impact Statement, identified and described options ranging from conventional public financing (“pay as you go,” different types of bonds) to alternative financing and public private partnerships. Of the options identified in that document, four were considered valid alternatives for the OCCC project. In addition to the traditional Design-Bid-Build and the Design-Build project delivery options, the performance-based P3 Concession and the Lease/Purchase Concession selected are two of the most commonly used project delivery alternatives for social infrastructure. These two alternatives are well suited to provide both the necessary incentives for private sector participation and the highest benefits to the State in terms of efficiency, innovation, cost savings, and risk allocation. The following describes and compares these four options as a first step to identifying which option provides the highest Value for Money to the State of Hawaii.

Of importance underlying this analysis is the assumption that the State of Hawaii, via PSD, will retain responsibility for OCCC operations, and therefore the outsourcing of operations is not included in any of the alternative procurement options considered.

5.1 Design-Bid-Build (DBB)

The traditional and most common type of procurement in the United States is Design-Bid-Build (DBB), which considers design and construction as sequential phases that are procured separately, with two contracts and two contractors. The DBB method is divided into three phases: Design Phase, Bidding Phase, and Construction Phase.

In the first phase, the contracting authority commissions an architecture/engineering firm for the design of the project and the development of the bid (or tender) documents, which will serve as a basis for the bidders’ proposals in the second phase and will guide the execution of construction work in the third and last phase. The architecture/engineering firm is required to work closely with the client (PSD) to ensure they can meet their needs, develop a detailed project plan, and, finally, develop an appropriate list of required activities.

In the second phase, the bidding or tender phase, the tender may be "open" to the participation of any firm believed to be adequately qualified to perform the work, or "closed", if the contracting authority arranges to pre-select a limited number of contractors to participate in the tender. Admitted competitors are required to examine the tender documents and, if the project includes a series of tasks concerning specific activities, disclose them to potential subcontractors who will be called upon to submit an offer for their contribution.

The last phase, the construction phase, begins after award of the construction contract. The design plans, possibly finalized by the designer alone or according to variants introduced in the agreement with the contractor, are finalized and the winning bidder can request all the authorizations required by law to start construction.

This project delivery method has the advantage of giving the contracting authority complete control over the design phase and the construction phase. The appointed designer acts as an impartial controller of the offers presented by the contractors and, therefore, the designer’s interests coincide perfectly with those of the client (PSD). Moreover, this method discourages the tendency to decrease quotes for pricing, which, below a certain threshold, undermine the quality of the work to be carried out. As the design plans are provided by an impartial entity, competitors will not be able to exclude certain elements from their scope of work if these are deemed necessary for project execution, for the purpose of providing the lowest quote, and winning the contract award. Conversely, any lower offers lacking the necessary characteristics mentioned in the design plans will be penalized. Further advantages of this method are the transparency of tender operations and the ability to select - potentially - the competitor who best achieves the tradeoff between a solid professional qualification and an appropriate cost management.

On the other hand, any technical and qualitative inaccuracies of the design plan (generally imputable to incorrect evaluations by the designer) are likely to affect the subsequent execution phase. Once the project design is greenlighted, bidders will be "forced" to adapt their proposals to the approved design. Therefore, if the project eventually becomes infeasible (even if only partially) within the costs estimated by the contracting authority, there is the risk that the entire tender may be abandoned (with an inevitable waste of time and resources) or that it becomes necessary to extend the time required to complete construction in order to allow the project to be revised in accordance with the economic and performance needs of the contracting authority. This method tends to reduce the possibility of changing plans during construction, unless these are expressly agreed between the designer, whose interests, in the construction phase, coincide with those of the client, (PSD) and the contractor.

In most cases the public entity issues bonds to finance the project and is responsible for maintenance for the useful life of the investment (i.e. facility), and assumes most of the financial risks, depending on the terms and conditions of the design and construction contracts.

DBB, also known as public sector comparator, is the most common project delivery approach in use in the United States, and the primarily means for public sector development in the State of Hawaii. This approach does not provide for risk transfer to the private sector and, therefore, any delays in design or construction timelines or cost overruns will have a financial impact on the public sector party. On the other hand, the procurement process for DBB is simple and straight forward and allows the project sponsor to retain full control over design elements, construction timelines, and other key measures. In addition, the DBB uses traditional municipal finance to cover the construction and other costs of the facilities, and therefore any bond(s) issued for this purpose counts toward the limit of the State’s debt capacity.

5.2 Design-Build (DB)

In contrast to the traditional DBB procurement commonly used by public entities throughout the United States, the Design-Build (DB) method involves a single process for awarding the design and execution of the work. The awarded contractor takes the name of design-builder (or design-contractor) and is expected to carry out the entire project, from preliminary design to actual implementation. Under the Design-Build method, the design activity falls within the general project implementation and is carried out more so in the interest of the contractor and not the client (PSD). It is common for architecture/engineering firms to compete directly for the award of the contract, and then "subcontract" the execution of the works to specialized companies associated with them. At the same time, if, in general, competitors outsource the design or construction activity, it is also possible for contractors to present professional architects or engineers in their own staff (in-house) to carry out the design activity, so that the selection of proposals becomes easier for the contracting authority.

The main characteristic of the Design-Build method is the potential to achieve greater efficiency in the management of the various project phases: design, construction (or execution), and release of the necessary legal authorizations (from obtaining building and other permits, to utilities certification, to final testing and commissioning). This last aspect is formally unrelated to the procurement option, however, thanks to the coordination of the planning phase with the construction phase, the requests for legal permits may be anticipated to reduce the actual wait times for the necessary administrative checks.

The advantages derived from the adoption of the DB method are due specifically to the efficiencies afforded by the combination of the design and construction responsibilities in the same contract and the commitments to project cost and schedule that the DB contractor makes to the project sponsor. DB project delivery provides the following benefits.

- Alignment of incentives for efficient production of the design to minimize total cost for both design and construction.
- Continuity benefits with one entity responsible for the entire process through delivery of the completed facility.
- Incentive for incorporating innovations in design and in means and methods during construction to minimize total cost.
- Efficiencies in schedule allowed by the ability for certain materials procurement and construction activities to take place during the design period.
- Certainty in cost and schedule afforded to the owner by the commitments made by the Design Builder. Risks to cost and schedule related to project execution are borne by the Design Builder and the Design Builder is totally accountable for cost, schedule, and quality.

Given the benefits noted above, DB project delivery has been found to provide substantial cost and schedule savings compared to traditional DBB processes. Overall costs have been found to be approximately 6% to 10% lower with savings in unit costs and schedule certainty.[2]

Comparing the two methods, DBB and DB, it is possible to see how the different role of the designer in Design-Build positively influences the quality of the work. This is because the designer is obliged - by contract - to represent the interests of the client (PSD) in the phases of awarding and carrying out the contract. Therefore, the risks of selecting inadequate contractors or performing imprecise work are considerably reduced, especially in the cases when the

2 Performance Services, 10 Reasons Why the Design-Build Delivery Method Works, October 2016.

contracting authority staff may not have the required qualifications for accurate decisions and evaluations. At the same time, the designer is responsible for the actual project feasibility, as it will supervise its execution. The designer, therefore, will be held accountable by the public entity in cases of plan changes during construction related to issues in carrying out the project.

5.3 P3 Concession

A P3 Concession arrangement is often defined as a long-term contract between a private party and a government agency for providing a public asset or service, in which the private party bears significant risk and management responsibility (World Bank, 2012). It relies on the recognition that public and private sectors each have certain advantages, relative to each other, in performing specific tasks. The responsibilities of the private sector could entail finance, design, construction, operation, management and maintenance of the project. In contracting with private firms, governments must balance their obligations to protect the public and provide for the social welfare with the private firms' need to manage its operations in an efficient and effective manner. If a government imposes too few regulations or oversight, the private firm may have an incentive to act contrary to the government's interest; if it imposes too many regulations, it may be too costly for the firm to operate successfully. The P3 model has become well-established for the construction of economic and social infrastructure and is now used in more than half of the world's countries.

Social infrastructure P3s have been proven to be generally successful in Canada, Australia, and Europe and are now gaining traction in the United States, informed by lessons learned in other countries. The United Kingdom has been undertaking social infrastructure P3s since the 1990's and its Building Schools for the Future program, which aims to build and improve secondary school buildings with private sector partners' capital and expertise, has received more than half of the £2.2 billion in financing through P3s. Since 2004, Canadian provinces have undertaken $35 billion in social infrastructure projects using the P3 model, including Ontario's health care facilities and the expansion, modernization and replacement of other types of infrastructure assets such as courthouses, schools, and correctional facilities. Since 1998, when Australia implemented its first P3 project, the number of social infrastructure P3 projects has steadily grown with delivery of a wide range of projects including hospitals, schools, and correctional facilities.

In the United States, many real estate developers have participated in community redevelopment projects, but only a handful of these have used the DBFM model. The DBFM model, however, is starting to find a foothold in the U.S. market, with several DBFM social infrastructure P3 projects successfully undertaken in recent years in California, beginning with the Long Beach Courthouse, and, more recently, the University of California's Merced Campus Expansion project and the Long Beach Civic Center project. A number of similar projects are in advanced pre-procurement stages across the United States.

A social infrastructure P3 is an innovative and collaborative project delivery model for vertical infrastructure that accommodates the provision of social services – typically, public buildings such as schools, universities, hospitals, courthouses, correctional facilities, and community housing. With a social infrastructure P3, the buildings are typically developed by the private sector but owned by the public sector, although it is not always the case. There are various social infrastructure P3 models in existence today, characterized by which partner is responsible for owning and maintaining assets at different stages of the project, the most common for correctional facilities being DBFM. For purposes of this VfM analysis, two variations of the DBFM model were selected for comparison.

5.3.1 Non-Profit Design Build Finance with Long-Term Maintenance (DBF+M 63-20 – Lease)

In this P3 scenario the public agency commissions a single developer to design, build, finance, and maintain the project under a tax-exempt financing structure with a non-profit vehicle. Public sector agencies in the United States may finance capital projects by issuing tax-exempt debt, often making it more cost-effective for public project sponsors to issue debt than their private sector partners. Using this type of debt keeps interest costs low and generates attractive opportunities for both private and corporate investors. One method of reducing the borrowing costs to the private partner is to issue debt through a nonprofit public benefit corporation pursuant to Internal Revenue Service (IRS) Rule 63-20 and Revenue Proclamation 82-26. The nonprofit corporation is then able to issue tax-exempt debt on behalf of private project developers.

This scenario also introduces a "Lease/Purchase" approach, according to which the private sector finances and builds the new facility, which it then leases to the public agency. The public agency makes scheduled lease payments to the private party with the public agency accruing equity in the facility with each payment. At the end of the lease term, the public agency owns the facility or purchases it at the cost of any remaining unpaid balance in the lease.

5.3.2 Design Build Finance with Long-Term Maintenance (DBF+M – Availability Payments)

In this structure, the government entity enters into an agreement with a private sector party under which it allocates to that party all the project's duties except for operations. This includes designing, constructing, financing and maintaining the project. In exchange for assuming these obligations, the private sector party is entitled to receive, for a specified period, fees from the end users of the project or payments from the government in the form of availability payments or shadow tolls.

Availability payments are a means of compensating a private concessionaire for its responsibility to design, construct, and/or maintain a facility for a set time period. These payments are made by a public project sponsor (a state DOT or authority, for example) based on particular project milestones or facility performance standards. Availability payments may be structured in a variety of ways. In certain cases, no payments may be made until after construction is complete. Alternatively, they may be predicated on particular construction milestones. Project sponsors may also define how the periodic payments are to be made and may also set a maximum payment cap based on agreed-to construction and maintenance performance standards. Different from the previous scenario, the State retains ownership of the facility for the duration of the contract.

This approach can take the form of Performance Based Infrastructure (PBI), an innovative approach to capital projects in which the investment, risk, responsibility, and rewards of the project are shared between government and private-sector participants. Design, construction, financing, and maintenance are bundled together into a single project. The development team is the single point of contact for procurement and delivery of all services under the contract. Shifting the financial risk and responsibility for long-term maintenance to the private partner creates a compelling incentive to ensure high levels of performance: both high-quality construction and proactive upkeep of the finished building.

A key difference between DBFM and other delivery methods is the early integration of maintenance considerations into the design-build process. Incorporating the input of the FM (“Finance” and “Maintain”) services provider throughout procurement and, following award, design and construction, is key to the development of a sustainable, effective building systems solution that considers whole-of-life costs rather than focusing solely on construction-first costs. Long-term building performance is often sacrificed when the lowest construction price option is selected, thereby limiting the FM services provider’s ability to manage maintenance costs effectively. Given the long-term nature of social infrastructure P3 contracts, including the FM services provider’s perspective regarding future maintenance costs, the design discussion emphasizes lifecycle costs in a way that often creates a better balance between upfront and future costs, thereby providing the most cost effective long-term result for the owner.

5.4 P3s in Social Infrastructures

Social infrastructure P3s have a significantly wider set of stakeholders compared to transportation P3 projects. This is primarily due to a building’s use: employees work in the building each day and therefore have uniquely important needs for physical infrastructure to better fulfil their objectives. In addition, the public interacts with a social infrastructure building in a more personal manner – traveling on a road that is delivered as a P3 project may be important to a person’s commute, but a student’s accommodations at a university is more all-encompassing and impactful. Considering the effect that a project has on key stakeholders is important to understanding the cumulative impact the model has on public buildings. Typical stakeholders for these kinds of projects include:

- **Public Users.** First-time user experience is critical to ensure that buildings are utilized in an efficient manner. A courthouse facility, for example, is a building that an individual may visit a handful of times for a hearing or trial. Wayfinding and signage in the building is therefore important to assist infrequent visitors in arriving at the right courtroom quickly. Furthermore, public buildings such as courthouses must provide equal access to disabled persons.
- **Day-to-Day Staff.** The building should also be user-friendly for workplace professionals and staff, such as professors, doctors, nurses, judges, clerks and bailiffs that provide social services on behalf of the public-sector owner. Workplace design considerations include natural light, green space, ergonomic considerations, and flow across building functions. There are also operational considerations, such as automatic vs. manually adjustable blinds, or temperature controls by room that must integrated into a project’s overall delivery.
- **Service Providers**. The engineering and design of the project should take into consideration the requirements of ancillary service providers, such as laundry and kitchen facilities. A key consideration is how these spaces are designed, as well as how they interact with the larger building. This provides additional opportunities for private sector

innovation. In addition, the delivery of supplies and materials to an operating building can have significant community impact, which must be considered carefully.

- **Labor.** Public service workers, trades professionals, and construction workers have a specific interest in how their jobs are affected by the implementation of a new project. Unions that represent these groups may be particularly concerned about whether their members' wages and rights as an employee or member of the union will be affected by private sector involvement in a P3. Strategic engagement and education is necessary to minimize miscommunications and misunderstandings.
- **Local Community.** The lives of non-users of social infrastructure will be affected as well, particularly those living within the vicinity of the building. The presence of or improvements made to a new building can result in more traffic, greater demand on local utilities, or increased noise. Similarly, a P3 project may present an opportunity to provide a new community asset, such as adjacent park or improved integration of an outdated structure into the community fabric.

5.4.1 Consideration of Stakeholders in Project Development

A robust and sustained stakeholder consultation process reduces the risk of a project receiving inadequate support and increases its chance of success. Stakeholder consultations should be on-going throughout the project's life, beginning early enough to define the project's scope on key issues that have an effect on project decisions. The community consultation process should be executed pursuant to a rigorous schedule and strategy with an aim to provide consistent messaging. A strong political champion must support this effort and a project manager should manage this aspect of the project procurement.

Since the interests of different stakeholder groups vary and may at times be in conflict, it is important to balance out opposing viewpoints but ensure that each is taken into consideration. In terms of designing a user-friendly and productive project, the functional purpose of space must be weighed against budget considerations and other objectives of the owner.

6.0 SUMMARY OF PROCUREMENT OPTION ATTRIBUTES

The four delivery options present several differences as shown in Table 6-1. The table presents key project criteria and assigns a rating, or grade, to each option based on how well it satisfies the criteria. Grades are defined as:

A. Positive grade, satisfies the criteria
B. Somewhat positive grade, moderately satisfies the criteria
C. Neutral grade, minimally satisfies the criteria

These grades, while qualitative in nature, provide an indication of performance of each delivery option in relation to key project characteristics (funding and costs; risks; project delivery and maintenance) based on best industry practice and past comparisons. For example, the traditional DBB option usually presents the lowest cost to the public agency before adjusting for risk factors and is usually the most familiar for the public agency when managing procurement according to existing laws. It also allows the public entity to retain control and influence over schematic design to implement changes during design/construction. The Design-Build option presents similar grades to the DBB, however it involves a higher level of risk transfer on cost overruns and schedule delays, as well as greater efficiency in procurement and delivery timeline. The two P3 options generally present the highest grade, providing greater flexibility in using funding sources, and greater opportunities for the competitive setting to deliver innovations and cost reductions. Their high level of risk transfer ensures the best cost and schedule certainty as well as control over lifecycle maintenance costs.

Table 6-1: Qualitative Evaluation of Delivery Options

Category	Criteria	DBB	DB	DBF+M 63-20 (L/P)	DBF+M Availability Payments
Funding and Costs	NPV of cost to public agency (before risks)	A	A	B	B
	Flexibility in using funding sources	B	B	A	A
	Flexibility in use of future funding, ability to refinance	B	B	B	C
	Impact on State debt limit	C	C	A	A
	Innovation and cost reduction opportunities	B	B	A	A
Risks	Capital Cost Overruns	C	B	A	A
	Lifecycle Cost Overruns	C	C	A	A
	Delays	C	B	A	A
	Procurement Execution	A	B	C	C
	Procurement Legal	A	A	B	B
Project Delivery and Maintenance	Control over facility's design and quality	A	B	B	B
	Adequate maintenance over time	C	C	A	A
	Procurement and project timeline	C	B	A	A
	Responsiveness to agency needs and requests	A	B	B	B

7.0 RISK ANALYSIS AND ALLOCATION

One of the main differences that define specific delivery options is their risk allocation structure. Risks are transferred among stakeholders at different stages of the project, with several opportunities to increase efficiency and long-term value for money. An appropriate risk allocation exercise should consider which stakeholder is best fit to manage certain risks. For example, risks related to political and local legal issues are better managed by the contracting public agency, while construction risks should be allocated to the contractor responsible for implementing the project. Risk allocation for each delivery option should be evaluated carefully, as transferring too much risk to the private sector will result in higher risk premiums, making the project costlier and decreasing VfM, while transferring too little risk to the private sector constrains the magnitude of the VfM that can be achieved.

Table 7-1 shows the typical risk allocation structure for the four delivery options analyzed. In the case of the four options, it is clear from the information in the table that more risk is allocated to the private sector in the DBF+M options compared to the DB, and both the DBF+M and the DB options transfer more risk than the DBB option. The DBB option only allows for risk transfer of subcontractors and shared risk for procurement, construction and material availability; all other risks are retained by the public agency. The DB option fully transfers these risks, and the design risk, to the contractor, and shares a series of risks that are retained by the public agency in the DBB alternative.

The DBF+M options are similar to DB, the main difference being the financing risk. For the lease/purchase option, the financing risk is fully transferred to the private sector. For the DBF+M Availability Payments option, this risk is shared, since the private sector is responsible for acquiring financing for construction, and in addition the public sector is responsible for acquiring either funding or financing to make the availability payments. Although in the lease/purchase option the public agency will still need to make payments to the private sector, the annual amounts through the concession period are much smaller compared to the availability payments, which at the midpoint of construction and at construction completion are significant and may require a bond issuance if the public agency is unable to secure the level of appropriations required. Therefore, while financing risk is fully transferred in the case of the lease/purchase option, it is shared for the availability payments option.

Table 7-1: Typical Risk Allocation for Delivery Options

Risk Category	Risk Description	Risk Allocation			
		DBB	DB	DBF+M 63-20 (Lease/Purchase)	DBF+M Availability Payments
Site	Land acquisition, latent site conditions, site security, site accessibility.	State	State	State	State
Permits and Approvals	Environmental approvals, utilities (water, wastewater, power, telecom), approvals for complimentary facilities. Loss of schedule and market related efficiency due to approval delays.	State	State	State	State
Hazardous Materials	Known risks relating to geotechnical, hazardous, contaminated materials.	State	State	State	State
Scope	Change in project scope.	State	State	State	State
Legal	Legislation changes, lack of legal regulation, contract changes, contract default.	State	State	State	State
Bidding Market	Issues with bidding process.	State	State	State	State
Funding / Financing	Delays/inability in achieving financing for the project and related costs.	State	State	Contractor	Shared
Procurement	Risk of sudden spike in materials' prices.	Shared	Contractor	Contractor	Contractor
Design	Errors in design criteria, design is not sufficient for its intended purposes or is unable to deliver the contracted services.	State	Contractor	Contractor	Contractor
Construction	Cost overruns and schedule delays during construction due to unforeseen costs, poor planning, etc. Repairs, rebuild, or other processes required due to defective/poor quality construction.	Shared	Contractor	Contractor	Contractor
Material Availability	Risk of missing material related to transportation delays, supply issues, etc.	Shared	Contractor	Contractor	Contractor
Subcontractors	Subcontractor failures and/or markups.	Contractor	Contractor	Contractor	Contractor
Labor Availability	Shortage of skilled/unskilled labor.	State	Shared	Shared	Shared
Maintenance	Costs related to maintaining facility operation and in good status.	State	State	Contractor	Contractor
Force Majeure	Risk of a force majeure event preventing the contractor from completing the facilities.	State	Shared	Shared	Shared

Risk Category	Risk Description	Risk Allocation			
		DBB	DB	DBF+M 63-20 (Lease/Purchase)	DBF+M Availability Payments
Macroeconomic Events	Economic events, inflation volatility, interest rate volatility, transportation price volatility.	State	Shared	Shared	Shared
Relationship	Lack of coordination between stakeholders.	State	Shared	Shared	Shared
Social	Risk of community concern delaying or cancelling the project.	State	Shared	Shared	Shared

8.0 ALTERNATIVE DELIVERY OPTION SCHEDULES

Louis Berger developed a project timeline for each of the alternative delivery options evaluated. The schedule corresponding to the costs in Section 4.0 is the DB schedule, which was estimated by Cumming as part of its cost estimates. Table 8-1 presents the different timelines which were taken into consideration for the quantitative assessment.

All four delivery options assume the procurement phase to last for approximately one year. For the following phases, timelines vary according to each delivery option's structure. The Design-Bid-Build option has the latest estimated completion date, in June 2024, due to the sequential procurements and design and construction activities. It is followed by the Design-Build option, with the project expected to be completed by June 2023. It is shorter than the DBB option due to the single competitive procurement process that combines design and construction. The remaining two options are shorter, with an estimated completion date for both in June 2022, because the options leverage early/parallel design work undertaken by proposer teams during the procurement process.

Table 8-1: OCCC Project Schedule by Delivery Option

Procurement Option	Activity	2019		2020		2021		2022		2023		2024	
		6	12	6	12	6	12	6	12	6	12	6	12
DBB	Procurement		■	■									
	Design				■	■							
	Construction							■	■	■	■	■	
DB	Procurement		■	■									
	Design + Construction				■	■	■	■	■	■			
DBF + M-L/P	Procurement		■	■									
	Design + Construction				■	■	■	■					
DBFM	Procurement		■	■									
	Design + Construction				■	■	■	■					

Source: OCCC – Animal Quarantine Station Site, Oahu, HI, Cumming, April 26, 2018.

9.0 NET PRESENT VALUE EVALUATION

Louis Berger has developed four sets of cash flow models to evaluate the Net Present Value (NPV) costs for each of the four project delivery options. Each cash flow includes considerations for design, construction, soft costs, and financing costs. This section describes the cash flow evaluation of the options and summarizes the NPV findings for each. As noted earlier, cost estimates developed by Cumming were used for the DB option with adjustments made to cost estimates for the other alternatives based on comparable projects. Therefore, comparisons related to costs are all in reference to the DB base costs.

9.1 Cost Assumptions

9.1.1 Capital Expenditures (CapEx)

CapEx includes design, construction, and soft costs. Cumming developed the most recent base engineering cost estimate for this project in April 2018. This estimate was risk-adjusted for each of the project delivery options evaluated. The DBB design cost was adjusted to consider key risks and probability of risk occurrence given the State of Hawaii's limited experience engaging in design for a major new facility, particularly such a large and complex facility as the proposed OCCC. Therefore, the DBB CapEx cost was risk-adjusted with respect to the Cumming estimate. The risk adjustment resulted in a 6.5% difference between the Cumming estimate and the DBB estimate based on past project experience. The DB CapEx did not require additional adjustments: the levels of contingency and schedule flexibility included in the estimate are appropriate with expectations for this type of project delivery alternative based on industry experience.

The CapEx estimated for the two other DBF+M delivery options were adjusted from the base estimate based on reasonable deviations used for social infrastructure VfM analyses and experience from implementation of alternative delivery methods. Key items adjusted included contingency, construction schedule and associated escalation assumptions, and design costs. In addition, DBF+M options include an additional 10% to account for private sector profit. The resulting CapEx for the P3 options resulted in a ~20% difference compared to the Cumming estimate. The cash flow evaluation took into account the year in which each activity took place and allocated costs accordingly. The timing of expenses is particularly important when assessing the project's NPV. Items such as project management cost were spread across the years as needed: five years for the DBB, four years for the DB, and three years for the DBF+M approaches. Table 9-1 provides the CapEx estimates for each of the delivery options after accounting for risk-adjustments, and the corresponding difference compared to the base engineering cost estimate. The adjustments made to the CapEx, both for the DB option and for the P3 options, are based on comparable social infrastructure projects in the U.S., including the recent Los Angeles Court House Value for Money study, which presents similar project characteristics.

Table 9-1: Risk-Adjusted CapEx

Option	CapEx (YOE $ mm)	Percent Difference Compared to Engineer's Estimate
DBB	$516,846	6.5%
DB	$485,477	0.0%
DBF+M (AP)	$582,129	20%
DBF+M 63-20 Lease/Purchase	$582,129	20%

9.1.2 Lifecycle Costs

Lifecycle costs (Lifecycle) take into account annual maintenance costs for the facility physical plant and major maintenance that takes place every 10 years during the period in which the state owns and operates the facility. Lifecycle costs are critical to understanding the full costs of the project beyond the initial capital expenditure costs. Since lifecycle costs take place over the full term during which the project is financed, the project delivery options that allocate lifecycle cost risks to the private sector have a cost advantage given the common issues of deferred maintenance in publicly maintained assets. To allow for comparison across the four project delivery options, we account for lifecycle costs for a 30-year period during which the initial capital expenses are financed through borrowing or a concession arrangement. Beyond that initial 30-year analysis period, we make no specific calculations, but assume, for the four project scenarios, that the State of Hawaii will continue to own and operate the facility for the remainder of its useful life, typically 50 to 75 years in total.

The Cumming report did not include any estimates for lifecycle costs. Instead, lifecycle costs for all four scenarios are based on standard estimates used in cost estimation for construction. Annual maintenance expenses were assumed at 3% of the total construction cost for both the DBB and the DB options, and 2.95% for the DBF+M option (before adding profit). The difference in these percentages is due to a higher rate of growth of operation and maintenance (O&M) costs for the DB and DBB options compared to the P3 options, primarily due to deferred maintenance.

For all alternatives, major maintenance costs are expected to occur every 10 years during the 30-year analysis period. The cost of this maintenance differs by alternative after considering the potential for deferred maintenance under the scenarios where the State of Hawaii is solely responsible for facility maintenance: the major maintenance costs as a percentage of construction costs are 5% lower in the DBF+M options than in the DBB option, and the DB is 3% lower than the DBB option. The small difference between the DBB and the DB options is due to efficiencies generated through the integration of the design-build contracting. The slightly higher difference with the P3 options is a result of the low probability of deferrals on annual maintenance and therefore the likelihood that major maintenance costs are kept as low as possible. Table 9–2 illustrates the key assumptions of lifecycle cost calculations for annual operations and maintenance expenses and periodic major maintenance costs.

Table 9-2: Risk-Adjusted Lifecycle Cost Assumptions

Assumption	DBB	DB	DBFM 63-20 (Lease Purchase)	DBF+M (AP)
Annual Maintenance Expense (% construction costs)	3.0%	No difference	-0.05% compared to DBB due to higher growth rate in O&M costs	-0.05% compared to DBB due to higher growth rate in O&M costs
Major Maintenance Costs (% construction costs)	23%	-2% compared to DBB due to efficiencies generated through the integration of the design-build process	-5% compared to DBB due to low/no deferrals on annual maintenance, keeping maintenance costs low	-5% compared to DBB due to low/no deferrals on annual maintenance, keeping maintenance costs low
Major Maintenance Period (years)	10	No difference	No difference	No difference

9.1.3 Financing Considerations

The financing assumptions differ between each alternative delivery option as follows:

- *Design-Bid-Build*: In the DBB option, the State of Hawaii takes on the financing risk for the design, construction, and maintenance of the project. This project delivery scenario is based on the assumption that the CapEx is financed through General Obligation (GO) bond issues that would allow the state to pay back the capital investment over a 30-year term. The 30-year term was chosen to create a scenario that is comparable to the term of borrowing most likely for the P3 Concession and Lease/Purchase Concession options also analyzed. It is recognized, however, that, at present, individual bond issues in the State of Hawaii are limited to a 25-year term and 20-year term is standard—this shorter borrowing period would not affect the overall conclusions of the analysis. The GO bonds would be secured by the State of Hawaii's pledge to use all available resources — including tax revenues — to repay bondholders, and therefore, comes at a low interest rate, a 5.0% fixed rate over the 30-year term. This interest rate was selected based on information provided from State officials on the historic cost of capital and is common for GO bond issuances. Interest rates are subject to a wide range of variation and can changed substantially within a short timeframe based on economic and financial conditions in Hawaii and the U.S. as a whole. To account for this uncertainty and the potential of lower or higher interest rates to finance the project, a sensitivity analysis is presented with a 3% and 10% cost of borrowing (see Section 9.1.5). When considering this option for project delivery, it is important to note that the value of this GO bond borrowing would count against the State's debt limit. The State of Hawaii receives the bond proceeds at the beginning of construction period and the agency starts paying principal and interest by the end of that year. Maintenance costs are paid for as "pay-as-you-go" expenses of the project, which require no debt financing and therefore, no associated interest payments. Lifecycle costs also count towards PSD's budget.

- *Design-Build*: The financing requirements and assumptions for the DB option are the same as the DBB alternative, where a GO bond debt pays for the design and construction, and the maintenance costs are paid for as "pay-as-you-go" expenses of the project.
- *DBF+M (AP)*: In this delivery alternative, the private sector takes on the financing risk for design, construction and maintenance costs. However, the agency also needs to make availability payments to the private sector entity based on performance and completion measures as established in the concession agreement. As such, on the private sector side, the concessionaire issues taxable private placement bonds to cover the CapEx costs. These bonds have an assumed interest rate of 8.5%, 350 basis points above the GO bond rate. The higher cost of capital is attributable to the bonds' taxable nature and the reduced credit quality given the lack of recourse to the State of Hawaii or its finances. However, this financing approach does not impact the State's debt capacity. The lifecycle costs for this alternative is covered through the availability payments made to the private sector entity by the State of Hawaii on an annual basis, plus four commercial loans payable within one year. These commercial loans cover the first annual maintenance cost and each of the three major maintenance costs for the one-year gap before the availability payment is made. The commercial loan interest rate is 9.0%. The analysis assumes that all availability payments from the State of Hawaii to the concessionaire can be paid for as "pay-as-you-go" expenses of the project, which requires no debt financing and therefore no associated interest payments. However, some of the payments are large, particularly those related to payment for construction progress and construction completion, and therefore the agency may need to issue a bond to cover the payments. If so, the financing costs of issuing the bond would be in addition to the financing costs estimated for this option. In either case – whether "pay-as-you-go" or financing through a GO bond, the payments count towards PSD's budget.
- *DBFM 63-20 Lease/Purchase*: In this delivery alternative, the private sector bidder establishes a non-profit company (NGO) through which it is responsible for the financing risk for design, construction and maintenance costs of the project. The State of Hawaii would make annual lease payments to the NGO in exchange for the use of the facility during the 30-year period. These payments will accrue as equity and at the end of the concession term, the State of Hawaii will pay the remaining balance of the value of the facility. To pay for CapEx expenses, the NGO issues 63-20 tax-exempt bonds on behalf of the State of Hawaii in its condition as a non-profit regulated under the Internal Revenue Service (IRS) Rule 63-20, whereby a non-profit public benefit corporation (e.g. a 501(c)(3) organization) can issue tax-exempt debt on behalf of a private developer delivering a public project. This loan has a higher cost of capital compared to a GO bond (e.g., 6.5% vs. 5.0%) because although it is tax-exempt, the credit quality is lower since there is no recourse to the State or its finances. When considering this option for project delivery, it is important to note that the bond values do not count toward the State's spending limit. To cover lifecycle costs, the NGO will acquire a line of credit, disbursed every year to pay for annual maintenance costs and major maintenance costs due every ten years. The assumed interest rate for the line of credit is 6.5%. The analysis assumes that all lease payments made by the State of Hawaii to the NGO, and the final payment, or remaining balance, to purchase the asset, can be paid for as "pay-as-you-go" expenses of the project, which require no debt financing and therefore no associated interest payments. Unlike the availability payments, the lease payments are evenly distributed through the

term of the lease period. The last payment at the end of the lease period to purchase the facility is large, however, and therefore the agency may need to issue a bond to cover the payments. The model estimates the final payment due in 2053 to be $157 million in nominal terms. This was discounted to present value at the 5% discount rate assumed for the base case. If the State is unable to make this payment, the financing costs associated with issuing a bond to pay for the remaining balance would be in addition to the financing costs estimated for this option and will count toward the spending limit of the State. "Pay-as-you-go" payments will count toward the spending limit of the State. To account for the uncertainty in interest rates, which historically can be highly variable and somewhat volatile, an analysis is presented with a 3% and 10% base cost of borrowing (see Section 9.1.5).

Table 9-3 presents the assumptions on interest rates and different loans for each of the delivery options evaluated. These assumptions take into account the cost of capital and increases for cost of capital based on the levels of risk associated with the financing for each option as well as the tax requirements of the bond.

Table 9-3: Financing Cost Assumptions

Design & Construction	Financing Type	Interest Rate	Count toward Spending Limit?
DBB	30-year fixed rate GO bond	5.0%	Yes
DB	30-year fixed rate GO bond	5.0%	Yes
DBF+M (AP)	Private Placement Bond	9.0%	No
DBFM 63-20 Lease / Purchase	63-20 Tax Exempt Bonds	6.5%	No
Lifecycle Costs	**Financing Type**	**Interest Rate**	**Count toward Spending Limit?**
DBB	Pay-as-You-go	N/A	Yes
DB	Pay-as-You-go	N/A	Yes
DBF+M (AP) – Private Sector	N/A	N/A	N/A
DBF+M (AP) – Public Sector	Pay-as-You-go	N/A	Yes
DBFM 63-20 Lease / Purchase – Private Sector	Line of Credit	6.5%	No
DBFM 63-20 Lease / Purchase – Public Sector	Pay-as-You-go	N/A	Yes

9.1.4 Net Present Value Calculation

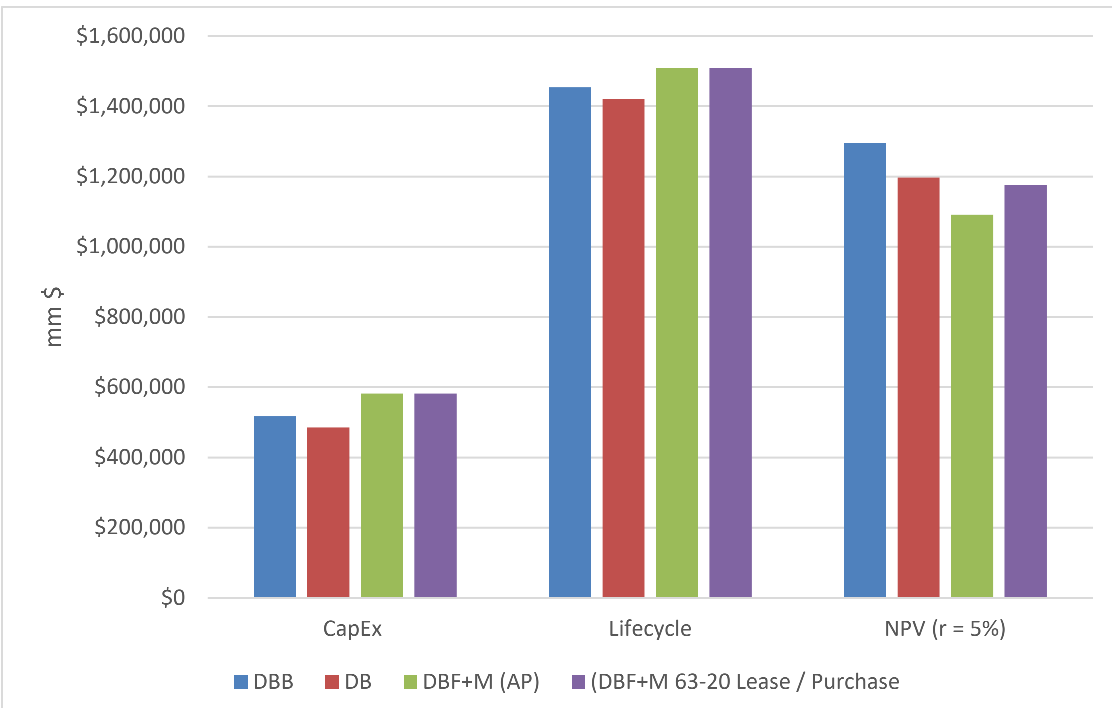
The Net Present Value (NPV) is the present value of cash flows over a period of time. All cash flows were discounted at a rate of 5.0% based on State of Hawaii precedents.

Table 9-4 and Figure 9-1 provide the CapEx, Lifecycle, and NPV Calculations of the NPV analysis. All costs for CapEx and Lifecycle are in Year of Expenditure (YoE) dollars. The risk-adjusted CapEx and Lifecycle costs are higher for the DBB and DBF+M options compared to the engineering cost estimates, and lowest for the DB option. The lifecycle costs are costs for the DBF+M delivery options are slightly higher than the DBB and DB CapEx costs. The NPV results, which incorporate considerations for financing and timeline of design and construction indicate that the DBB option has the highest cost, followed by the DB option and the DBFM 63-20 option. The DBF+M (AP) delivery option is the least expensive once all quantitative aspects of the analysis are considered. Compared to the DBB option, the DB option is 8% lower, the DBF+M 63-20 is 9% lower, and the DBF+M (AP) option is 16% lower (see also Appendix A).

Table 9-4: Results of NPV Analysis (r = 5%)

Option	DBB	DB	DBF+M (AP)	DBF+M 63-20 Lease Purchase
CapEx (YoE $)	$516,846,000	$485,477,000	$582,129,000	$582,129,000
Lifecycle (YoE $)	$1,454,254,000	$1,420,370,000	$1,509,145,000	$1,509,145,000
NPV (r = 5%) (2018 $)	$1,295,471,000	$1,197,058,000	$1,091,247,000	$1,175,266,000

Figure 9-1: Results of NPV Analysis



9.1.5 Discount Rate Sensitivity Tests

The selection of the discount rate can have a significant impact on the results of the net present value results. As noted in the base case, all cash flows were discounted at a rate of 5.0% based on State of Hawaii precedents. Louis Berger conducted two additional sensitivity tests to understand the extent to which results change with a higher or lower discount rate. Table 9-5 and Table 9-6 presents the results of the NPV analysis using a 3% and 10% discount rate.

Table 9-5: Results of NPV Analysis (r = 3%)

Option	DBB	DB	DBF+M (AP)	DBF+M 63-20 Lease Purchase
NPV (r = 3%) (2018 $)	$1,720,327,000	$1,540,730,000	$1,398,389,000	$1,630,459,000

Table 9-6: Results of NPV Analysis (r= 10%)

Option	DBB	DB	DBF+M (AP)	DBF+M 63-20 Lease Purchase
NPV (r = 10%) (2018 $)	$750,705,000	$725,601,000	$694,020,000	$594,660,000

Figure 9-2: Results of NPV Analysis

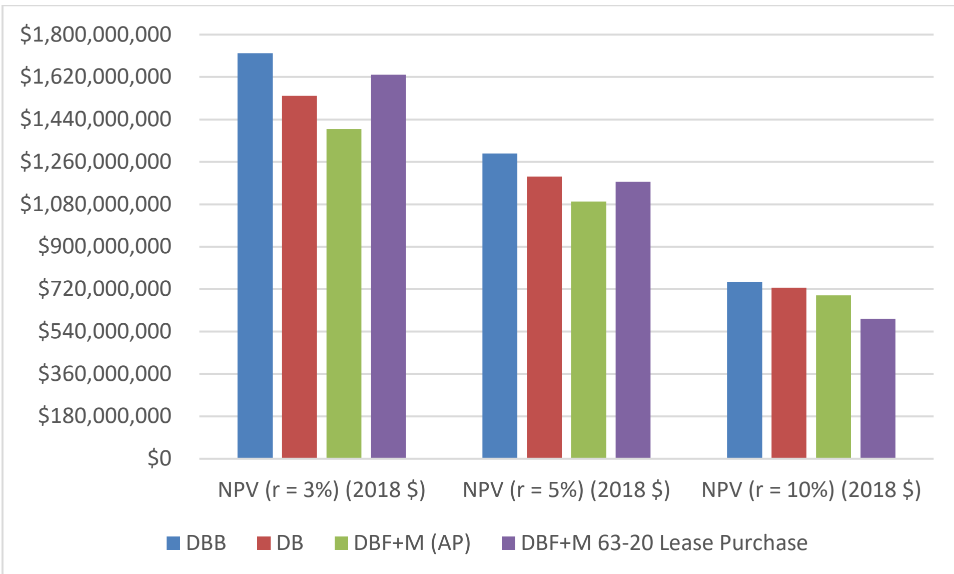


Figure 9-2 provides a comparison of the NPV for each project delivery alternative using different discount rate assumptions. In every case, the design-bid-build option is the most expensive. The DBF+M (AP) option is the most cost-effective under the 3% and 5% discount rate assumption, and the DBF+M 63-20 option is the most cost-effective under the 10% discount rate assumption.

10.0 QUALITATIVE CONSIDERATIONS

A VfM analysis extends beyond the quantitative assessment of project costs. Qualitative considerations have a strong influence on outcome of the analysis because there are often substantial qualitative factors that could greatly influence the project's actual performance. These qualitative factors should be considered carefully for the OCCC project.

No legal or financial impediments to pursuing public or private sector financing for jail improvements or expansions were identified during a review of various Hawaii State government documents and annual financial reports. Hawaii's economic indicators for the tourism industry, tax revenues, the construction industry, and unemployment were found to be positive, and according to forecasts developed by the Department of Business, Economic Development and Tourism, Hawaii's economy will continue to show positive growth in the near future.

However, there are some important issues that need to be considered. Although several of the P3 structures outlined in this report may, if successfully implemented, result in positive impacts for the State of Hawaii with respect to managing its borrowing capacity, transferring project delivery risk, and achieving policy goals through performance-based contracting, the novel nature of P3 procurement in the state could pose implementation challenges. The timeline and exact form of the requirements for P3 project delivery that would apply to Hawaii state agencies and private partners is uncertain. Although the analysis in this report suggests that P3 options may be more cost-effective, on a risk-adjusted basis, than traditional delivery options, there may be delays associated with this process that may not be compatible with the delivery schedule for the OCCC project.

It should be recognized that the P3 procurement process is complex and may pose challenges to any agency seeking to use these methods for the first time. First time implementation of P3s in certain (other) jurisdictions have been found to require extra time and resources on the part of public agencies for legal, financial, and policy review, coordination with stakeholders, and other key activities. While P3 implementation can provide substantial efficiencies over the long-term, it can also require substantial upfront effort in the first instance where those involved in the public and private sector would be working under a unique framework for P3 and may have limited experience with these types of alternative delivery methods. Implementing the P3 procurement process, therefore, may result in delays and costs that are not contemplated in the quantitative NPV analysis presented in this report.

While the considerations expressed above undoubtedly affect the feasibly of the P3 concession options, there are also qualitative factors that need to be considered for the more traditional DBB and DB options. The DBB is the most expensive option in NPV terms. This is because it is risk adjusted and therefore includes foreseen delays in schedule and associated cost increases as well as a longer construction completion schedule. In addition, the State of Hawaii has limited experience in procuring and delivering the construction of a new facility of the nature and scale of the proposed OCCC, even with traditional procurement methods— the new OCCC is expected to be the costliest facility the State has ever developed. The agency's experience with large projects is also not recent, as its last major building project was the Halawa Correctional Facility over 25 years ago, and most of the State employees that contributed to the success of that project may no longer be employed by the State. The DBB delivery method requires the public entity to take ownership of the design and this can represent an important challenge, which can lead to schedule delays. Furthermore, the DBB structure has minimal risk transfer, with a high potential for issues that will become the responsibility of the State of Hawaii.

The remaining option is DB, which is generally less expensive than traditional DBB after adjusting for risk and might be considered the best alternative for the State - it is less expensive than the DBB alternative and has lower procurement requirements and challenges than the two P3 concession options. The State would be able to transfer the design risk to the contractor, with generally higher protection against cost overruns than the DBB method. The procurement process is less complicated than the other options, allowing for ease of implementation and management by the State of Hawaii. Table 10-1 outlines the main qualitative factors that need to be considered as part of the decision-making process.

Table 10-1: Qualitative Factors

Category	Description
Project Cost	Even though the quantitative analysis of the risk-adjusted NPV identified the two P3 concession methods ("DBF+M Availability Payments" and "DBF+M 63-20 Lease-Purchase") as the options that would provide the highest Value for Money, there are several qualitative factors that may present themselves resulting in schedule delays and/or increased costs.
Cost of Capital and Funding Capacity	Funding capacity of the State is impacted under the DBB and the DB method, as the local agency is likely to source funding through loans. This is a possibility also for the DBF+M (AP), but not in the DBF+M lease/purchase option. The cost of capital is the highest for the DBF+M lease/purchase, followed by the DBF+M (AP). There is no difference between the DBB and DB methods.
Procurement	There is no recent public-sector facility development project of a nature and scale equivalent to the proposed OCCC which may posed challenges during the procurement phase. This is generally manageable for the traditional DBB, and slightly more complicated for the DB method. It is, however, quite complex for the DBF+M options. These methods require expertise and a longer lead time prior to the award of the project, however, the longer preparation time is compensated by faster design and construction by the private sector.
Risk Transfer	Retaining risk as in a traditional DBB configuration allows the State to have maximum control over design and construction, however, it must be managed with great care to minimize delays and possible cost overruns. Transferring the design risk to the contractor, as in the case of the DB option, can help contain costs by transferring the risk of cost and schedule management to the contractor. If there are conditions that lead an agency to adopt a Public Private Partnership delivery method, such as DBFM, most of the risk can be transferred to the contractor, with substantial savings in terms of cost overruns and higher efficiency in maintenance costs.
Value at End of Design Life	With high standards for maintenance and lifecycle capital investment, the DBF+M options may provide an agency a facility that has retained a value of approximately 80-85% of the initial investment.

11.0 CONCLUSION

Louis Berger was engaged to conduct a Value for Money (VfM) analysis for the proposed OCCC project. The objective of the analysis is to evaluate the suitability of project delivery options and in terms of total lifecycle cost, risk transfer, and qualitative considerations. Based on the construction cost estimates provided by Cumming, Louis Berger evaluated the traditional design-bid-build project delivery option, also known as the public sector comparator, the Design-Build option, and two Public Private Partnership (P3) options that are well suited for social infrastructure and may be feasible alternatives for this project.

The evaluation included an overview of the project and description of project baseline design and construction costs as estimated by Cumming in April 2018 followed by a description of all four project delivery options identified as the most suitable options for the OCCC project. The NPV assessment was based on estimated schedules for project delivery for each alternative and risk-adjusted values for CapEx, Lifecycle, and financing costs. All cash flows were discounted at a rate of 5% based on State of Hawaii precedents. This quantitative assessment indicated that the DBF+M (AP) option is the most cost-efficient in NPV terms, followed by the DBFM 63-20 lease/purchase option, the DB option, and lastly the DBB option. A sensitivity test was performed with alternative 3% and 10% discount rate options to evaluate the impacts on the result. While the DBF+M (AP) option is still the most cost-efficient in NPV terms under a 3% discount rate, the DBFM 63-20 lease/purchase option becomes most attractive using a 10% discount rate assumption.

Quantitative considerations take into account additional factors that indicate that the most cost-efficient alternative for the OCCC project may be the DB project delivery option. These considerations take into account the nature, scale and complexity of the proposed OCCC project and limited experience among public agencies throughout the U.S. involving the DBFM procurement processes.

Based on a comprehensive Value for Money assessment, which takes into account quantitative and qualitative considerations, the DB option may be the most efficient alternative to traditional design bid procurement that would be available for delivery of the OCCC project. This option has benefits with respect to risk transfer and increased certainty in cost and schedule once procurement has been finalized, and a record of implementation in the State of Hawaii.

The DBFM options are attractive from a cost perspective assuming that the procuring agency receives the necessary support and assistance to guide it through the negotiating process in a timely fashion along with the project management and oversight skills and resources to overcome the lack of experience with this procurement method.

12.0 NEXT STEPS

Development of a new OCCC will be among the largest and most complex building projects ever undertaken by the State of Hawaii. This will require decisions concerning each phase of the project's development to be reached only after careful and thorough analyses of each aspect of the project delivery process. By virtue of the nature and scale of the project, the decisions to be made involving design, construction, and financing methods to be employed and their implications go far beyond those of more common public works building projects undertaken in Hawaii.

As an example, among the next phase of analyses is to prepare a current project cost estimate. The latest estimate dates to April 2018 and as a result of recent increases to energy and labor costs, interest rates, new tariffs on building materials, among other economic factors, a current estimate of the cost to construct the new OCCC must be prepared. More rigorous analyses of each aspect of the facility's design, operation and maintenance program, including lifecycle cost estimates of major building systems, is also recommended. In addition, determining the willingness of the financial markets to participate in the project and the experience, capabilities, and conditions under which individual firms or teams will participate should also be determined.

This Value for Money analysis is considered the first step in the process of evaluating the many complex aspects associated with delivering this important facility in a manner that benefits the people of Hawaii. The work to date represents a high-level analysis of a number of possible options for consideration by the State's financial, legal, and procurement specialists. This report does not offer a recommendation for a specific method of financing or delivery of the OCCC project. Each option presented requires further in-depth study that goes far beyond the limitations of this report and ultimately leads to the definitive solution.

APPENDIX A: Cash Flow Waterfall Summaries

The summaries shows annual figures for the construction period (through 2023) and five-year increments thereafter from 2025 through 2050. The full Net Present Value analysis outlined in Section 9.1.4 is based on a 30-year analysis period for operations/financing from 2023 through 2053.

Appendix A-1: DBB Cash Flow

OCCC

Annual Cash Flow Waterfall

Operating Cash Flow Waterfall	Unit	Total	30-Jun-19	30-Jun-20	30-Jun-21	30-Jun-22	30-Jun-23	30-Jun-25	30-Jun-30	30-Jun-35	30-Jun-40	30-Jun-45	30-Jun-50
			2019	2020	2021	2022	2023	2025	2030	2035	2040	2045	2050
CapEx	'000		$0	$33,868	$26,030	$143,697	$150,563	$0	$0	$0	$0	$0	$0
OpEx	'000		$0	$0	$0	$0	$0	$13,298	$16,122	$19,858	$24,558	$30,441	$37,760
Cost of Debt	'000		$0	$0	$0	$43,070	$42,209	$40,486	$36,179	$31,872	$27,565	$23,258	$18,951
Total Costs	'000		$0	$33,868	$26,030	$186,768	$192,772	$53,784	$52,301	$51,730	$52,123	$53,700	$56,711
NPV (r=5%)	'000	$1,295,471											

Appendix A-2: DB Cash Flow

OCCC

Annual Cash Flow Waterfall

Operating Cash Flow Waterfall	Unit	Total	30-Jun-19	30-Jun-20	30-Jun-21	30-Jun-22	30-Jun-23	30-Jun-25	30-Jun-30	30-Jun-35	30-Jun-40	30-Jun-45	30-Jun-50
			2019	2020	2021	2022	2023	2025	2030	2035	2040	2045	2050
CapEx	'000		$0	$25,032	$19,434	$209,663	$231,348	$0	$0	$0	$0	$0	$0
OpEx	'000		$0	$0	$0	$0	$0	$14,132	$17,133	$21,104	$26,099	$32,351	$40,129
Cost of Debt	'000		$0	$0	$0	$40,456	$39,647	$38,029	$33,983	$29,938	$25,892	$21,846	$17,801
Total Costs	'000		$0	$25,032	$19,434	$250,119	$270,995	$52,161	$51,116	$51,042	$51,991	$54,198	$57,930
NPV (r=5%)	'000	$1,197,058											

Appendix A-3: DBF+M (AP) Cash Flow

OCCC

Annual Cash Flow Waterfall

Operating Cash Flow Waterfall		Unit	Total	30-Jun-19	30-Jun-20	30-Jun-21	30-Jun-22	30-Jun-23	30-Jun-25	30-Jun-30	30-Jun-35	30-Jun-40	30-Jun-45	30-Jun-50
				2019	2020	2021	2022	2023	2025	2030	2035	2040	2045	2050
CapEx (AP)		'000		$0	$0	$194,043	$194,043	$194,043	$0	$0	$0	$0	$0	$0
OpEx (AP)		'000		$0	$0	$0	$0	$15,452	$16,530	$20,040	$24,685	$30,527	$37,840	$46,937
Cost of Debt (AP)		'000		$0	$0	$72,522	$11,709	$1,110	$0	$0	$0	$0	$0	$0
Total Availability Payments		'000		$0	$0	$266,565	$205,752	$210,605	$16,530	$20,040	$24,685	$30,527	$37,840	$46,937
Project Management Costs	$17,232,460	'000		$3,446	$3,446	$3,446	$3,446	$3,446	$862	$862	$862	$862	$862	$862
Total Costs		'000		$3,446	$3,446	$270,011	$209,198	$214,051	$17,391	$20,901	$25,546	$31,389	$38,702	$47,799
NPV (r=5%)		'000	**$1,091,247**											

Appendix A-4: DBFM 63-20 Lease / Purchase Cash Flow

OCCC

Annual Cash Flow Waterfall

Operating Cash Flow Waterfall		Unit	Total	30-Jun-19	30-Jun-20	30-Jun-21	30-Jun-22	30-Jun-23	30-Jun-25	30-Jun-30	30-Jun-35	30-Jun-40	30-Jun-45	30-Jun-50
				2019	2020	2021	2022	2023	2025	2030	2035	2040	2045	2050
CapEx		'000		$0	$19,404	$19,404	$19,404	$19,404	$19,404	$19,404	$19,404	$19,404	$19,404	$0
OpEx		'000		$0	$0	$0	$0	$50,305	$50,305	$50,305	$50,305	$50,305	$50,305	$50,305
Cost of Debt		'000		$0	$34,399	$33,252	$32,105	$34,344	$32,287	$27,323	$22,608	$18,155	$14,024	$10,284
Project Management Costs	$17,232,460	'000		$3,446	$3,446	$3,446	$3,446	$3,446	$862	$862	$862	$862	$862	$862
Lease Payment incl. buy back		'000		$0	$0	$0	$0	$88,676	$88,676	$88,676	$88,676	$88,676	$88,676	$88,676
Total Cost		'000		$3,446	$3,446	$3,446	$3,446	$92,123	$89,538	$89,538	$89,538	$89,538	$89,538	$89,538
NPV (r=5%)		'000	**$1,175,266**											

APPENDIX J

TRAFFIC IMPACT ANALYSIS REPORT

Oahu Community Correctional Center

Prepared for:

State of Hawaii
Department of Accounting and General Services
Department of Public Safety

June, 2019
Reprinted from May 30, 2018

Prepared By:

WILSON OKAMOTO CORPORATION

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1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this study is to identify and assess the traffic impacts resulting from the proposed relocation of the existing Oahu Community Correctional Center (hereinafter referred to as "OCCC") in Kalihi on the island of Oahu. Four alternative sites are currently being considered as potential replacement locations for the new correctional facility. This study includes an assessment of each of the four alternative sites under consideration.

1.2 Scope of Study

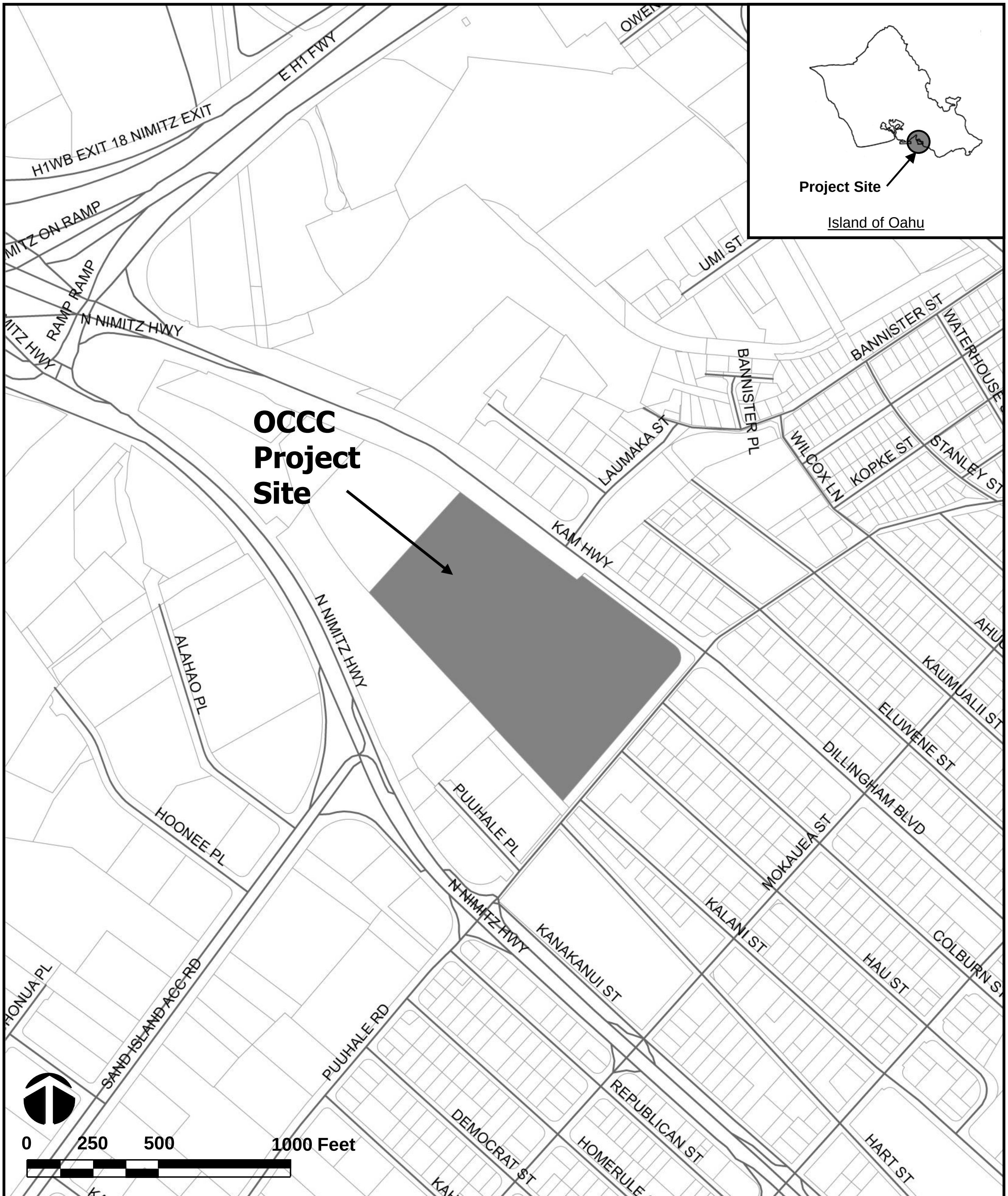
This report presents the findings and conclusions of the traffic study, the scope of which includes:

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

2.0 PROJECT DESCRIPTION

2.1 Location

The existing OCCC facility is located adjacent to Kamehameha Highway in Kalihi and is bounded by Kamehameha Highway to the north, Puuhale Road to the east, and industrial uses to the south and west (see Figure 1). The existing project site is further identified as Tax Map Keys (TMKs): 1-2-013: por. 002. The four alternative site locations under consideration include the existing OCCC facility; the Mililani Technology Park (hereinafter referred to as "MTP") in Mililani; the Halawa Correctional Facility (hereinafter referred to as "HCF"); and the Animal Quarantine Station both located in Aiea. The project site at the MTP location is adjacent to Kahelu Avenue in Mililani and is bounded by Kahelu Avenue to the north with industrial uses to the west (see Figure 2). This project site is further identified as Tax Map



OAHU COMMUNITY CORRECTIONAL CENTER

LOCATION MAP AND VICINITY MAP

FIGURE

1

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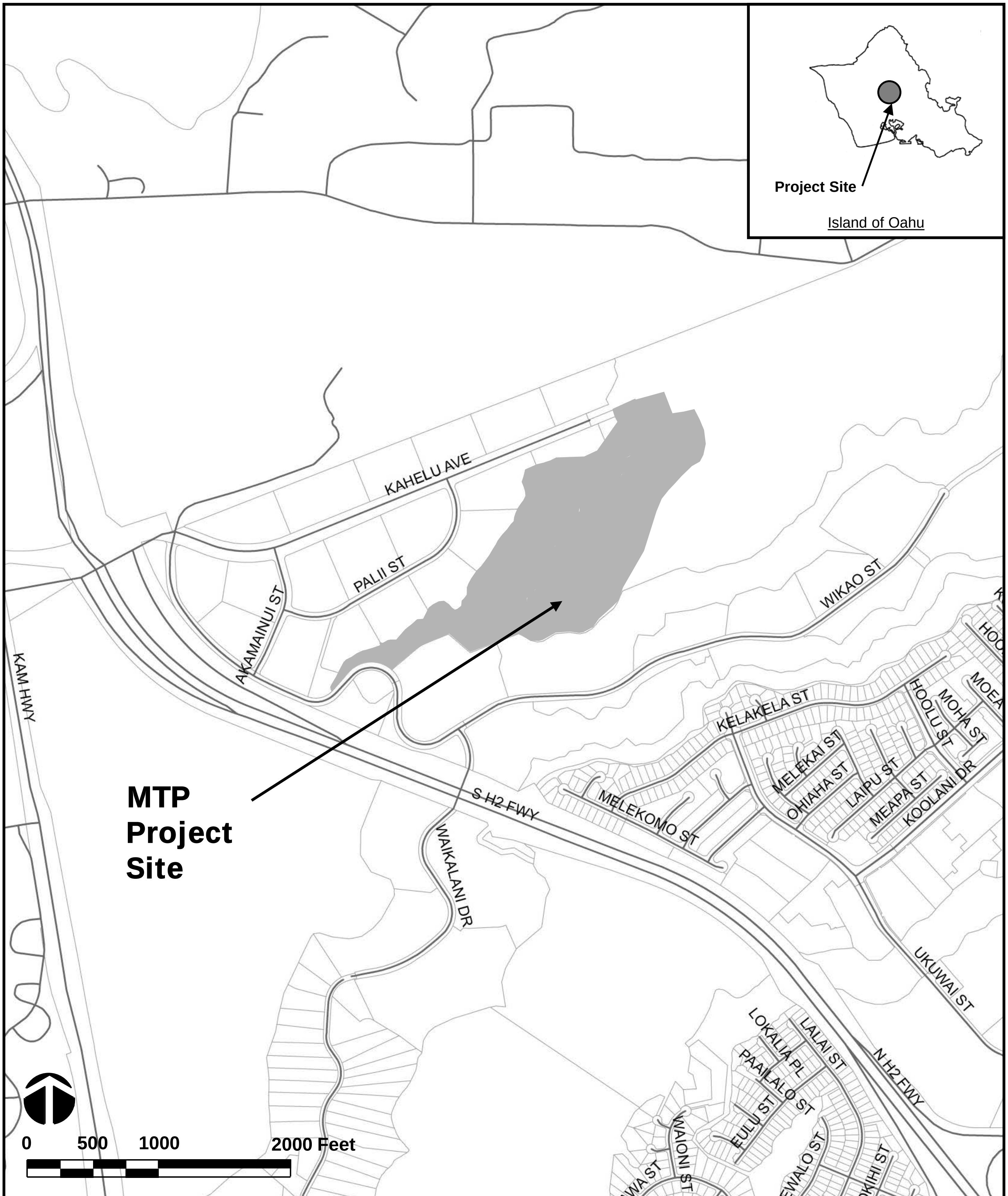

OAHU COMMUNITY CORRECTIONAL CENTER

LOCATION MAP AND VICINITY MAP

FIGURE
2

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Keys (TMKs): 9-5-046: 042. The project sites at the HCF and Animal Quarantine Station are both adjacent to Halawa Valley Street in Aiea (see Figures 3 and 4). The proposed site near HCF is expected to be located east of the existing prison and is identified as Tax Map Keys (TMKs): 9-9-010: por. 030, while the proposed site near the Animal Quarantine Station is bounded by Halawa Valley Street to the north, the Interstate H-3 Freeway to the west, and industrial uses to the south and east. That project site is further identified as Tax Map Keys (TMKs): 9-9-010: por. 006, 046, 057, and 058. In addition, it should be noted that a portion of inmates from the existing OCCC facility are expected to be transferred to the Women's Community Correctional Center (hereinafter referred to as "WCCC") regardless of which alternative site is selected. The existing WCCC facility is located adjacent to Kalanianaole Highway in Kailua and is bounded by Kalanianaole Highway to the south and residential uses to the west (see Figure 5). This project site is further identified as Tax Map Keys (TMKs): 4-2-003: 004.

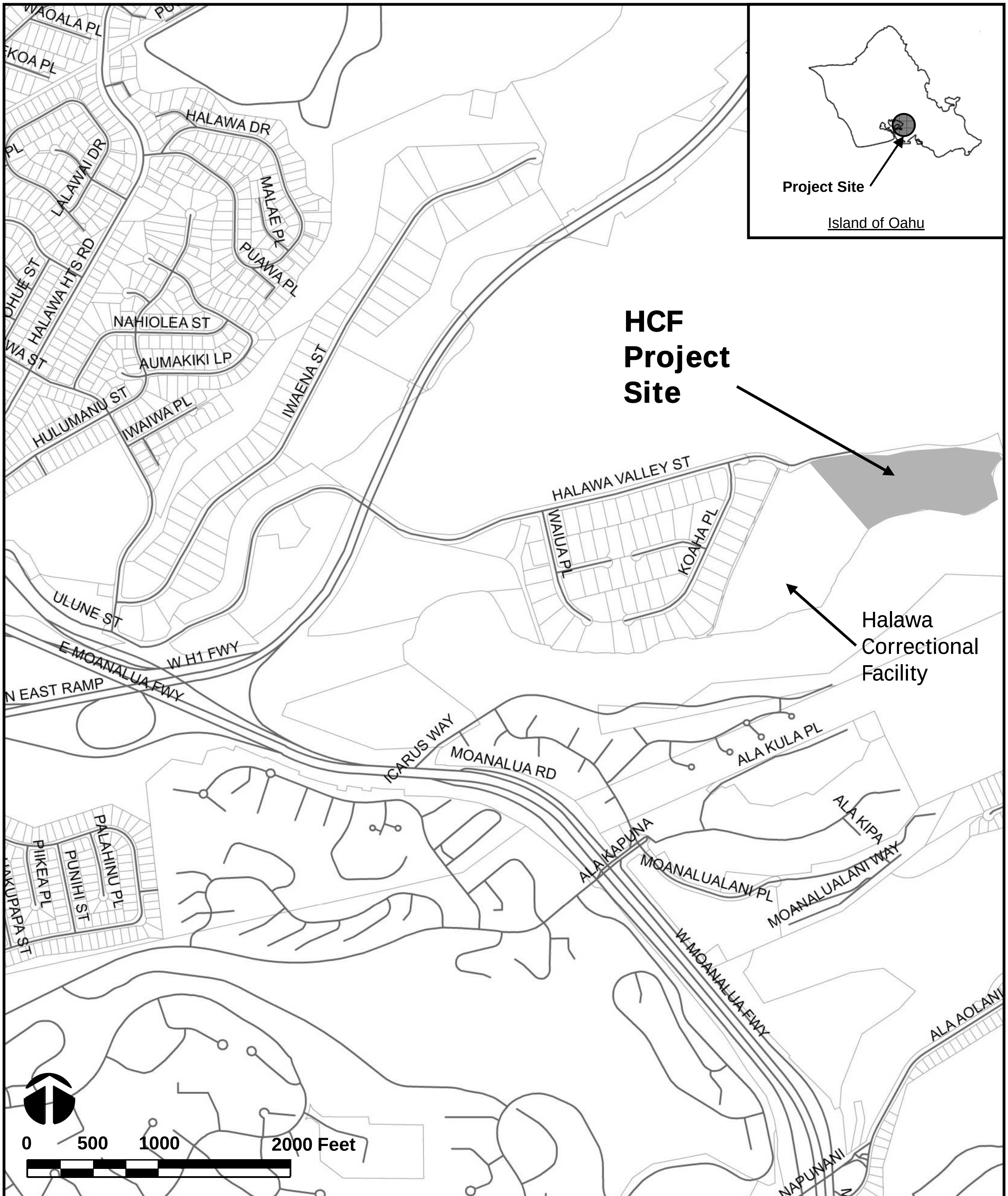
2.2 Project Characteristics

The existing Oahu Community Correctional Center is currently located on a 16-acre site in Kalihi and serves as the largest jail facility for pre-trial detainees in the State of Hawaii with an existing population of approximately 1,137 inmates. However, recent assessments of the facility have indicated that the OCCC facility is significantly overcrowded and functioning beyond its capacity. To adequately serve the facility's high demand and meet projected future needs, the Department of Public Safety (PSD) is currently considering the following alternatives:

- <u>Redevelopment of the existing OCCC facility ("Alternative 1")</u>

  This alternative entails the replacement of the existing OCCC facility and the construction of a new facility. Under Alternative 1, the existing square footage of the facility is expected to double and provide accommodation for approximately 1,480 inmates. Vehicular access to the project site is expected to continue to be provided via an existing driveway off Kamehameha Highway.
- <u>Relocation to MTP site ("Alternative 2")</u>

  Alternative 2 entails the construction of a new facility at the Mililani Tech Park in Mililani, Oahu. The new facility is expected to provide accommodations for approximately 1,380 inmates and would provide similar functions as the existing OCCC. Under this alternative, vehicular access is expected to be provided via new driveways off Kahelu Avenue.



OAHU COMMUNITY CORRECTIONAL CENTER

LOCATION MAP AND VICINITY MAP

FIGURE 3

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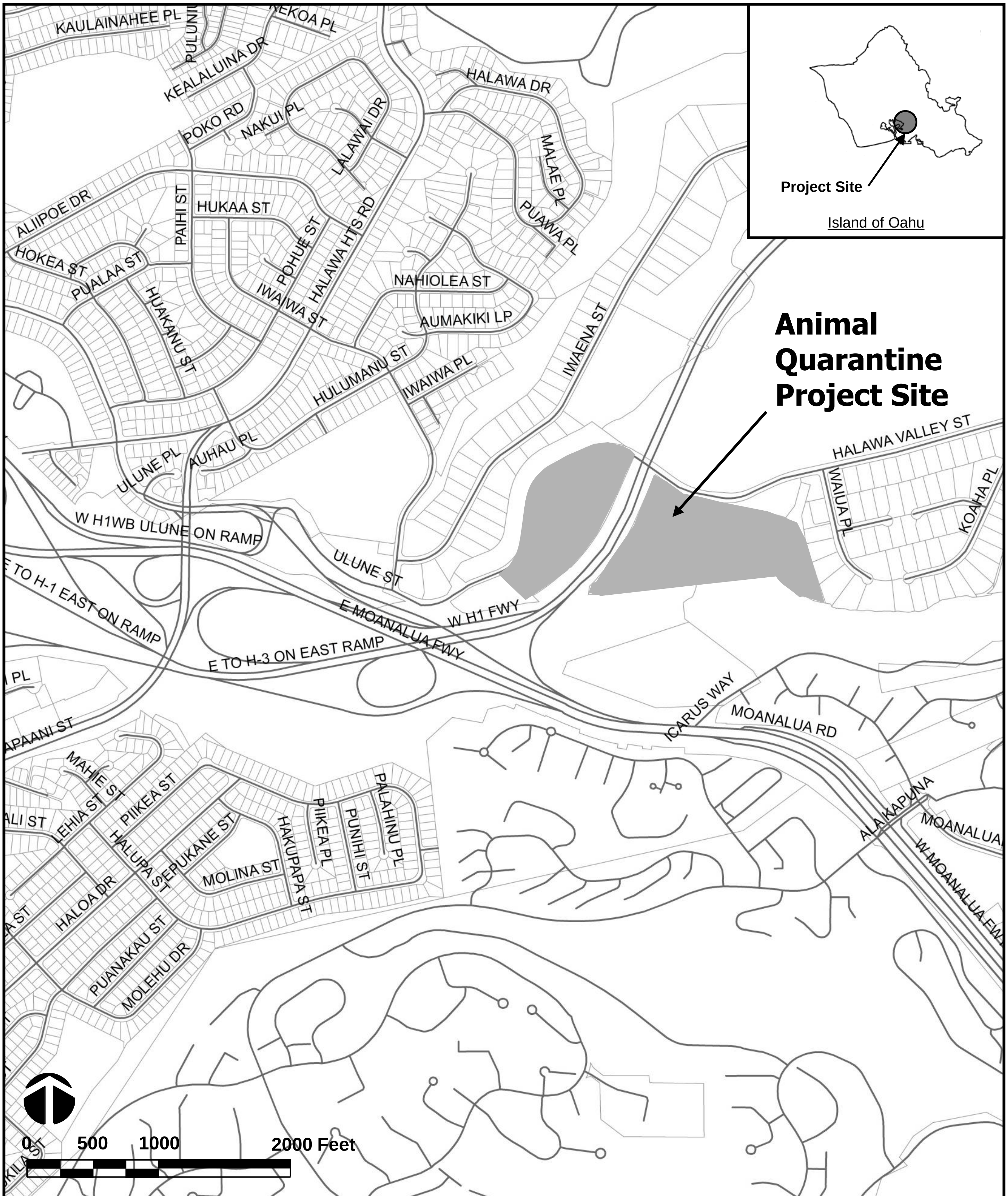

OAHU COMMUNITY CORRECTIONAL CENTER

LOCATION MAP AND VICINITY MAP

FIGURE 4

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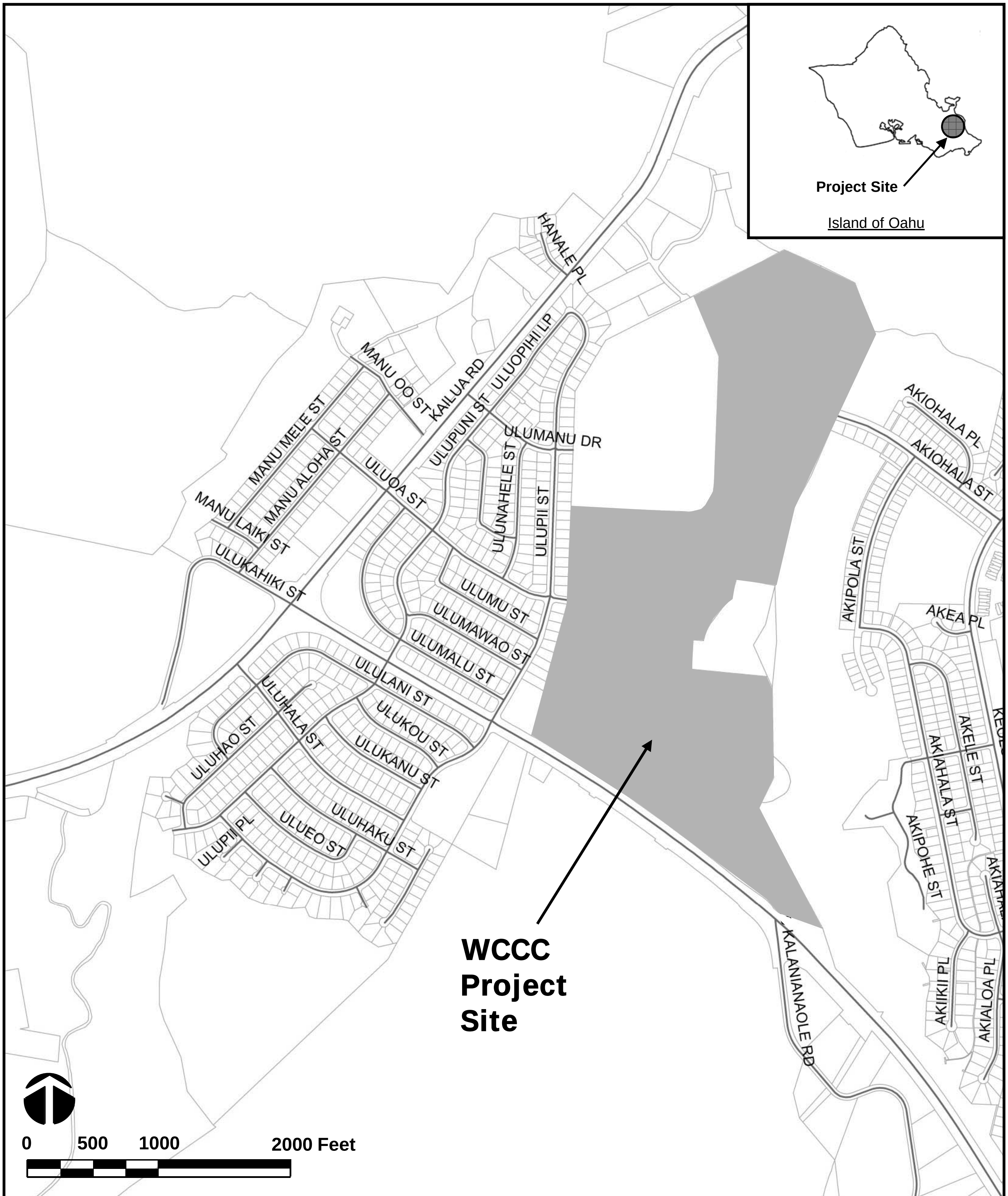

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LOCATION MAP AND VICINITY MAP

FIGURE 5

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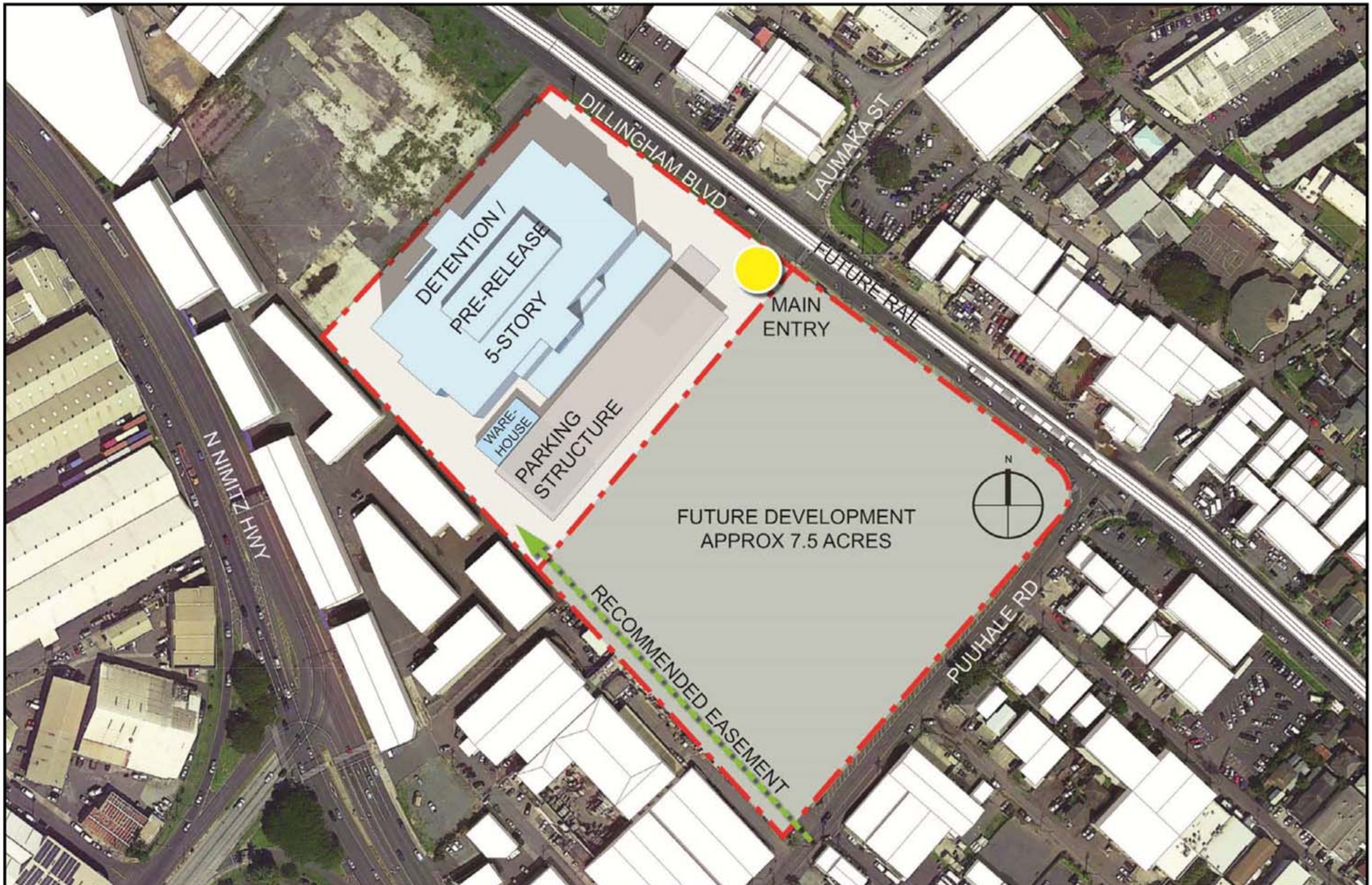
- <u>Relocation to HCF site ("Alternative 3")</u>
  Alternative 3 entails the addition of a new OCCC facility adjacent to the existing Halawa Correctional Facility which already includes a medium security prison. Similar to Alternative 2, the proposed replacement facility at HCF is also expected to provide accommodations for approximately 1,380 inmates and maintain similar functions and services provided at the existing OCCC facility in Kalihi. Vehicular access is expected to be provided via an existing driveway off Halawa Valley Street.

- <u>Relocation to Animal Quarantine Station site ("Alternative 4")</u>
  Alternative 4 entails the removal of the existing Animal Quarantine Station and development of a new OCCC on the portion of the property located east of the Interstate H-3 Freeway and development of a new Animal Quarantine Station west of the freeway. The new OCCC facility is expected to house approximately 1, 380 inmates. Similar to Alternatives 2 and 3, this location is also expected to provide the same services and functions offered at the existing OCCC location in Kalihi. Vehicular access is expected to be provided via new driveways off Halawa Valley Street.

In conjunction with the proposed project, all female inmates currently housed at the existing OCCC are to be relocated to the WCCC facility regardless of which alternative site is selected. WCCC will also be expanded to accommodate the addition of approximately 281 inmates to its existing inmate population. Access to the facility will continue to be provided via existing driveways off Kalanianaole Highway. The new expansion of WCCC and the replacement or reloaction of the existing OCCC facility are expected to be complete and occupied by the Year 2023 under all alternative scenarios. Figures 6 through 10 show the proposed project site plans for each alternative under consideration.



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PROPOSED SITE PLAN (ALTERNATIVE 1)

FIGURE 6

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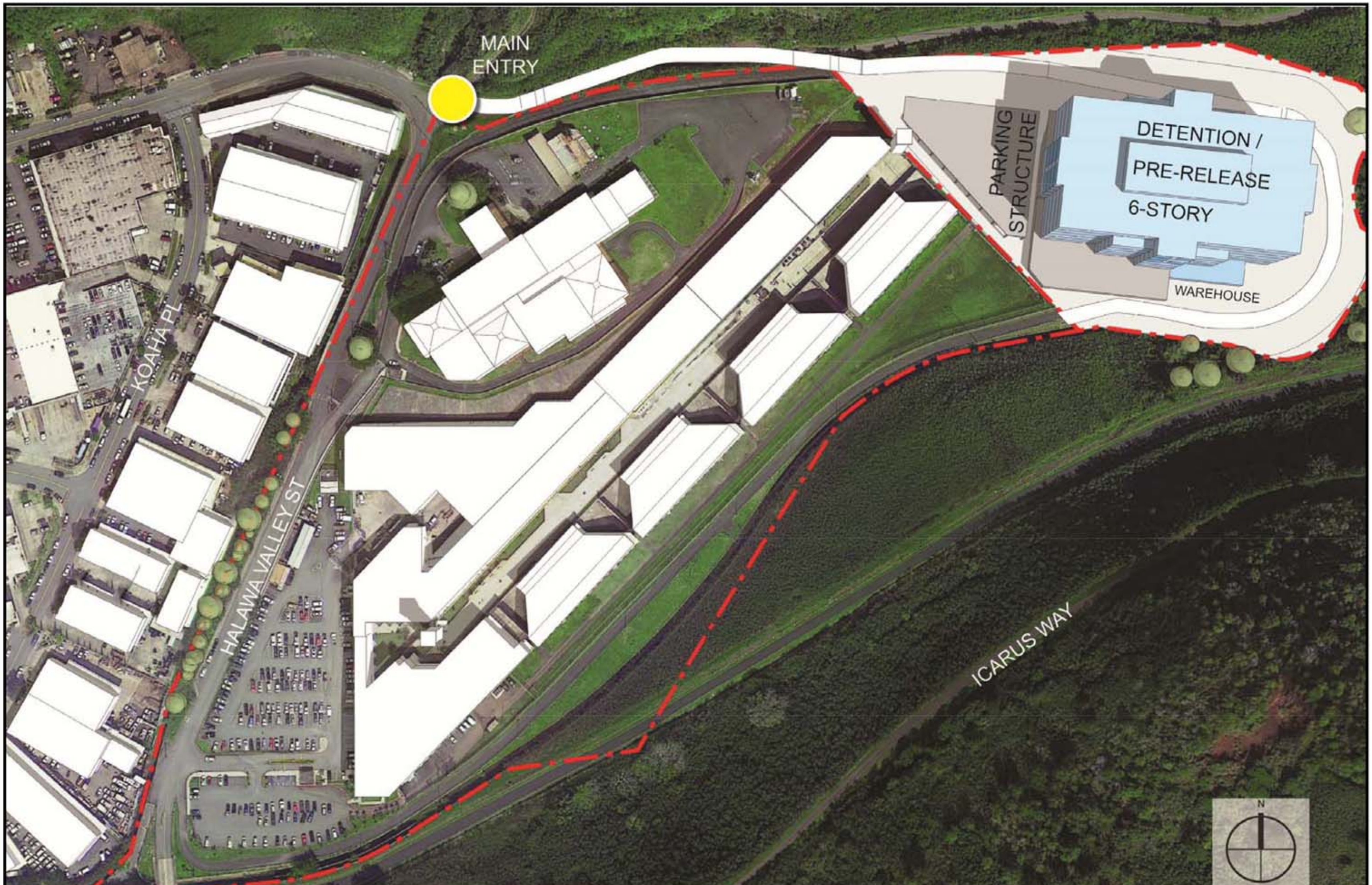
PROPOSED SITE PLAN (ALTERNATIVE 2)

FIGURE 7



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PROPOSED SITE PLAN (ALTERNATIVE 3)

FIGURE 8

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PROPOSED SITE PLAN (ALTERNATIVE 4)

FIGURE 9

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WCCC PROPOSED SITE PLAN

FIGURE 10

3.0 EXISTING TRAFFIC CONDITIONS

3.1 General

As previously mentioned, there are 4 alternatives under consideration for the replacement or relocation of the existing OCCC facility. Some of the study areas may overlap slightly; as such, the following section includes a description of all the study intersections.

3.1.1 Field Investigation

Field investigations were conducted on April 2017 and consisted of manual turning movement count surveys during the morning commuter peak hours between 6:00 AM and 9:00 AM, and the afternoon commuter peak hours between 3:00 PM and 6:00 PM.

For the Alternative 1, the field investigations were conducted at the following intersections:

- N. Nimitz Highway and Puuhale Road
- Kamehameha Highway, Dillingham Boulevard, and Puuhale Road
- Kamehameha Highway, Laumaka Street, and the OCCC driveway

For Alternative 2, field investigations were conducted at the following intersections:

- Kamehameha Highway and Leilehua Road
- Leilehua Road and the on-ramp to the Interstate H-2 Freeway
- Leilehua Road and the off-ramp from the Interstate H-2 Freeway
- Kahelu Avenue and Akamainui Street

As discussed previously, Alternatives 3 and 4 are both located in the vicinity of Halawa Valley Street. As such, field investigations were conducted at the following:

- Ulune Street and Halawa Valley Street
- Halawa Valley Street and Iwaiwa Street
- Halawa Valley Street and Waiua Place
- Halawa Valley Street and Koaha Place

It should be noted that although both Alternatives 3 and 4 are located along Halawa Valley Street, Alternative 3 is located east of Alternative 4. As such, for the purpose of analysis, the latter two intersections were included in the Alternative 3 scenario to account for the site-generated trips expected to travel to/from that proposed project site, but were not included in the Alternative 4 scenario.

In addition, regardless of which alternative is selected, a portion of the inmates currently residing at the OCCC will be relocated to the WCCC. As such, field investigations were also conducted at the following intersections:

- Kalanianaole Highway and Ulupii Street
- Kalanianaole Highway and the driveways for the WCCC facility and Olomana School

Appendix A includes the existing traffic count data.

3.1.2 Capacity Analysis Methodology

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

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

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

3.2 Alternative 1

3.2.1 Area Roadway System

In the vicinity of the proposed Alternative 1 project site, Nimitz Highway is a predominantly six lane, two-way roadway that serves as a major east-west corridor through the downtown Honolulu area. Contraflow operations are implemented along the roadway to provide an additional eastbound lane during the morning peak period. Southeast of the project site, Nimitz Highway intersects Puuhale Road. At this signalized intersection, both approaches of Nimitz Highway have an exclusive left-turn lane, two through lanes, and a shared through and right-turn lane. During the morning contraflow operations, the eastbound approach Nimitz Highway has an exclusive left-turn lane, three through lanes, and a shared through and right-turn lane while the westbound approach has one through lane and a shared through and right-turn lane. Puuhale Road originates at North King Street as a one-lane, one-way (southbound) roadway which transitions to a three-lane, two-way roadway south of the intersection with

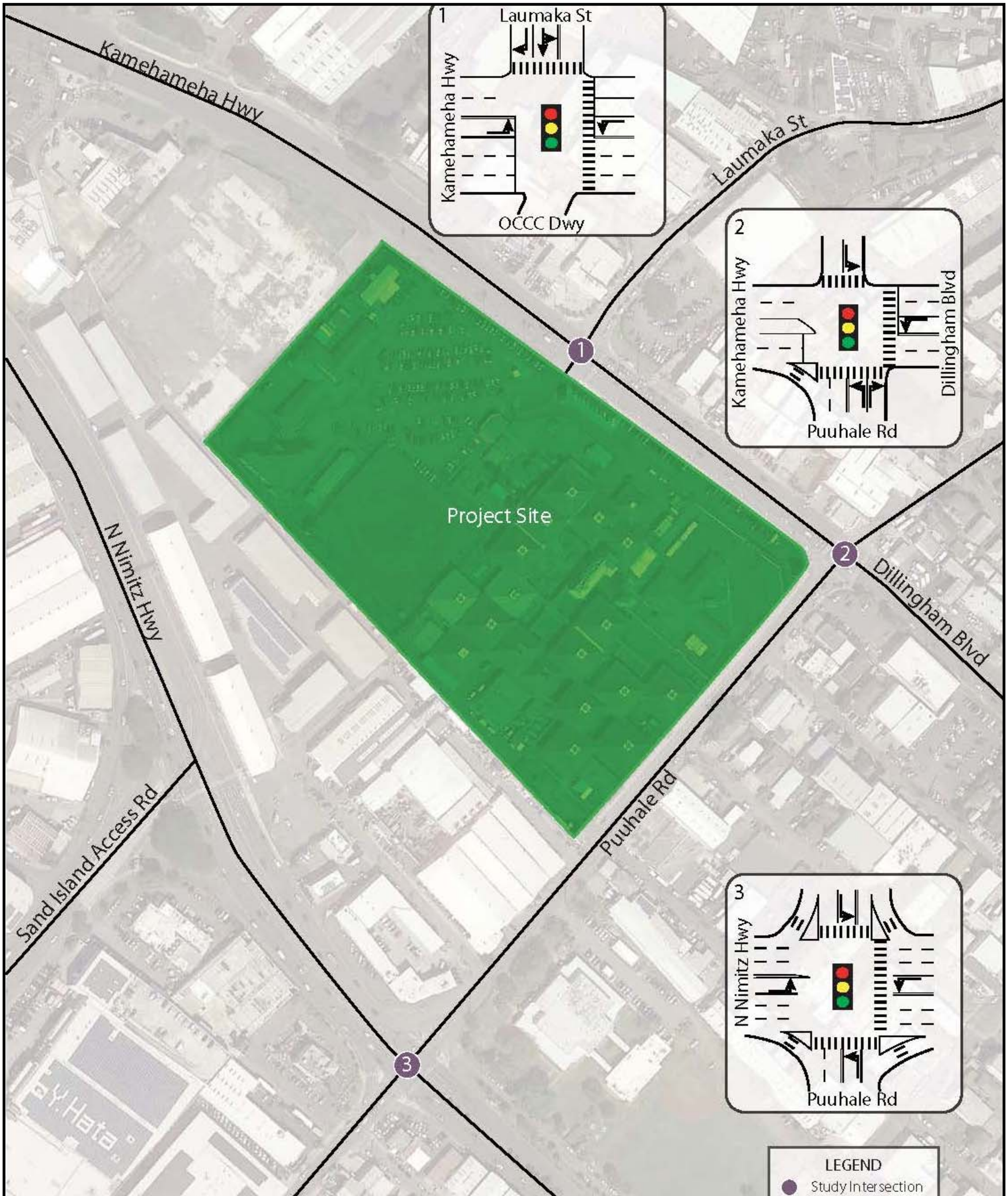
Kamehameha Highway and Dillingham Boulevard. At the intersection with Nimitz Highway, both approaches of Puuhale Road have an exclusive left-turn lane and a shared through and right-turn lane.

North of the intersection with Nimitz Highway, Puuhale Road intersects Kamehameha Highway and Dillingham Boulevard. At this signalized intersection, the northbound approach of Puuhale Road has exclusive lanes for left-turn and right-turn traffic movements while the southbound approach has an exclusive left-turn lane and a shared through and right-turn lane. Kamehameha Highway is a predominantly five-lane, two-way roadway which transitions to a four-lane, two-way roadway referred to as Dillingham Boulevard east of Puuhale Road. At the intersection with Puuhale Road, the eastbound approach of Kamehameha Highway has two through lanes and an exclusive right-turn lane while the westbound approach of Dillingham Boulevard has an exclusive left-turn lane and two through lanes.

West of the intersection with Puuhale Road, Kamehameha Highway intersects Laumaka Street. At this signalized intersection, the eastbound approach of the highway has an exclusive left-turn lane, two through lanes, and a shared through and right-turn lane while the westbound approach has an exclusive left-turn lane, one through lane, and a shared through and right-turn lane. Laumaka Street is a two-lane, two-way roadway generally oriented in the north-south direction between Bannister Street and Kamehameha Highway. At the intersection with Kamehameha Highway the southbound approach has a shared left-turn and through lane with an exclusive right-turn lane. The northbound approach is comprised of a driveway for the existing OCCC facility that has one lane which serves all traffic movements

3.2.2 Existing Peak Hour Traffic

Figures 11 and 12 show the existing lane use and peak hour traffic volumes. The morning peak hour of traffic in the vicinity of Alternative 1 generally occurs between 7:00 AM and 8:00 AM while the afternoon peak hour of traffic generally occurs between the hours of 4:00 PM and 5:00 PM. Although the peak hours of traffic generally occur around the same time periods at each of the study intersections, the absolute commuter peak hour time periods for each intersection may differ slightly. The analysis is based on these absolute commuter peak hour time periods to identify the traffic impacts resulting from the proposed project.



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EXISTING LANE CONFIGURATIONS

FIGURE 11

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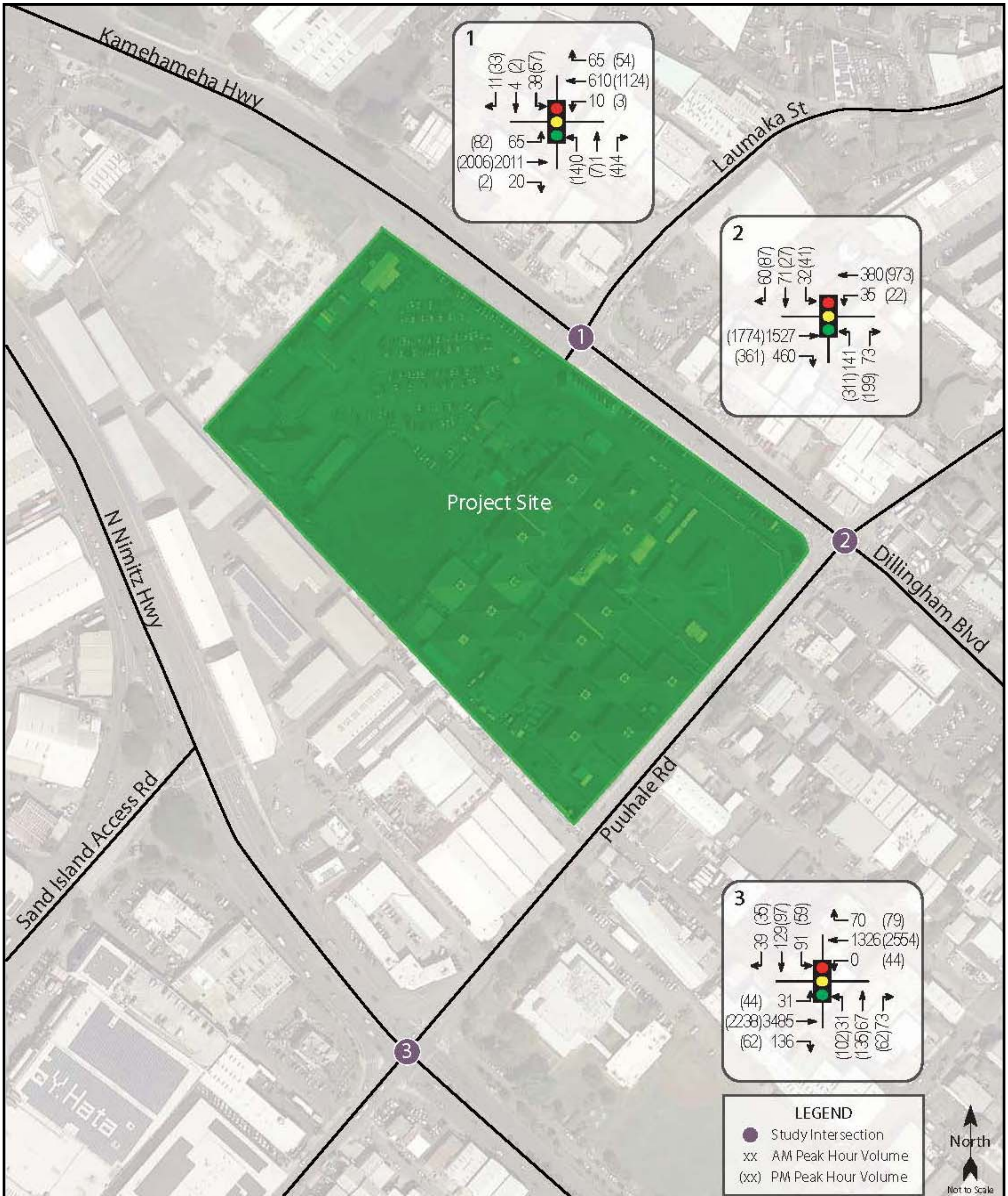

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EXISTING PEAK HOURS OF TRAFFIC

FIGURE 12

3.2.3 Traffic Volumes and Conditions

3.2.3.1 Nimitz Highway and Puuhale Road

At the intersection with Puuhale Road, N. Nimitz Highway carries 3,652 vehicles eastbound and 1,396 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is lower with Nimitz Highway carrying 2,344 vehicles eastbound and 2,677 vehicles westbound. The eastbound approach of Nimitz Highway operates at LOS “B” during both peak periods, while the westbound approach operates at LOS “B” and LOS “C” during the AM and PM peak periods, respectively.

Puuhale Road carries 171 vehicles northbound and 259 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Puuhale Road carrying 299 vehicles northbound and 191 vehicles southbound. The northbound approach of Puuhale Road operates at LOS “E” and LOS “F” during the AM and PM peak periods, respectively, while the southbound approach operates at LOS “F” during both peak periods. It should be noted that the low levels of service on the Puuhale Road approaches are primarily due to the high traffic demands resulting in long traffic signal cycle lengths at this intersection during the peak periods

3.2.3.2 Kamehameha Highway, Dillingham Boulevard, and Puuhale Road

At the intersection with Puuhale Road, Kamehameha Highway carries 1,987 vehicles eastbound while Dillingham Boulevard carries 415 vehicles westbound during the AM peak period. During the PM peak period, traffic volumes are higher with Kamehameha Highway and Dillingham Boulevard carrying 2,135 vehicles eastbound and 995 vehicles westbound, respectively. The eastbound approach of Kamehameha Highway operates at LOS “A” and LOS “C” during the AM and PM peak periods, respectively, while the westbound approach operates at LOS “A” and LOS “B” during the AM and PM peak periods, respectively.

Puuhale Road carries 214 vehicles northbound and 163 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Puuhale Road carrying 510 vehicles northbound and 155 vehicles southbound. The northbound approach operates at LOS “D” during both peak periods while the southbound approach operates at LOS “C” during both peak periods.

3.2.3.3 Kamehameha Highway, Laumaka Street, and OCCC Driveway

At the intersection with Laumaka Street, Kamehameha Highway carries 2,096 vehicles eastbound and 685 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Kamehameha Highway carrying 2,090 vehicles eastbound and 1,181 vehicles westbound. The eastbound approach of Kamehameha Highway operates at LOS “A” and LOS

"C" during the AM and PM peak periods, respectively, while the westbound approaches operates at LOS "A" and LOS "B" during the AM and PM peak periods, respectively.

Laumaka Street carries 53 vehicles southbound during the AM peak period and 92 vehicles during the PM peak period. This approach operates at LOS "D" during both peak periods. The northbound approach of the intersection is comprised of a driveway for the adjacent OCCC facility which carries a minimal volume of traffic during the AM and PM peak periods. 5 vehicles were observed on the approach during the AM peak period and 25 vehicles were observed on the approach during the PM peak period.

3.3 Alternative 2

3.3.1 Area Roadway System

In the vicinity of the proposed Alternative 2 project site, Kamehameha Highway is a predominantly four-lane, two-way roadway generally oriented in the north-south direction. West of the project site, Kamehameha Highway intersects Leilehua Road. At this signalized intersection, the northbound approach of Kamehameha Highway has two through lanes and an exclusive right-turn lane, while the southbound approach has an exclusive left-turn lane and two through lanes. Leilehua Road is a predominantly three-lane, two-way roadway which transitions to a four-lane, two-way roadway referred to as Kahelu Avenue east of the intersection with Wikao Street. At the intersection with Kamehameha Highway, the westbound approach of Leilehua Road has exclusive lanes for left-turn and right-turn traffic movements.

East of the intersection with Kamehameha Highway, Leilehua Road intersects the on-ramp to the Interstate H-2 (southbound) Freeway. At this unsignalized intersection, the eastbound approach of Leilehua Road has a shared through and right-turn lane while the westbound approach has an exclusive left-turn lane and one through lane. The south leg of the intersection is comprised of the on-ramp to the Interstate H-2 Freeway which has one (southbound) departure lane.

East of the intersection with the Interstate H-2 Freeway on-ramp, Leilehua Road intersects the off-ramp from the Interstate H-2 (northbound) Freeway. At this unsignalized intersection, the eastbound approach of Leilehua Road has one through lane while the westbound approach has two through lanes. The northbound approach of that intersection is comprised of the Interstate H-2 Freeway off-ramp which has exclusive lanes for left-turn and right-turn traffic movements.

East of the intersection with the Interstate H-2 Freeway off-ramp, Kahelu Avenue intersects Akamainui Street. At this unsignalized intersection, the eastbound approach of Kahelu Avenue has one through lane and a shared through and right-turn lane while the westbound approach has an exclusive left-turn lane, one through lane, and a shared through and right-turn lane. Akamainui Street is a two-lane, two-way roadway generally oriented in the north-south direction between Kahelu Avenue and Wikao Street. At the intersection with Kahelu Avenue, the northbound approach of Akamainui Street has exclusive lanes for left-turn and right-turn traffic movements. In addition, a refuge lane is provided within the median along Kahelu Avenue to assist vehicles turning left from Akamainui Street. The southbound approach of the intersection is comprised of a driveway for an adjacent commercial property which has one lane that serves primarily right-turn traffic movements.

3.3.2 Existing Peak Hour Traffic

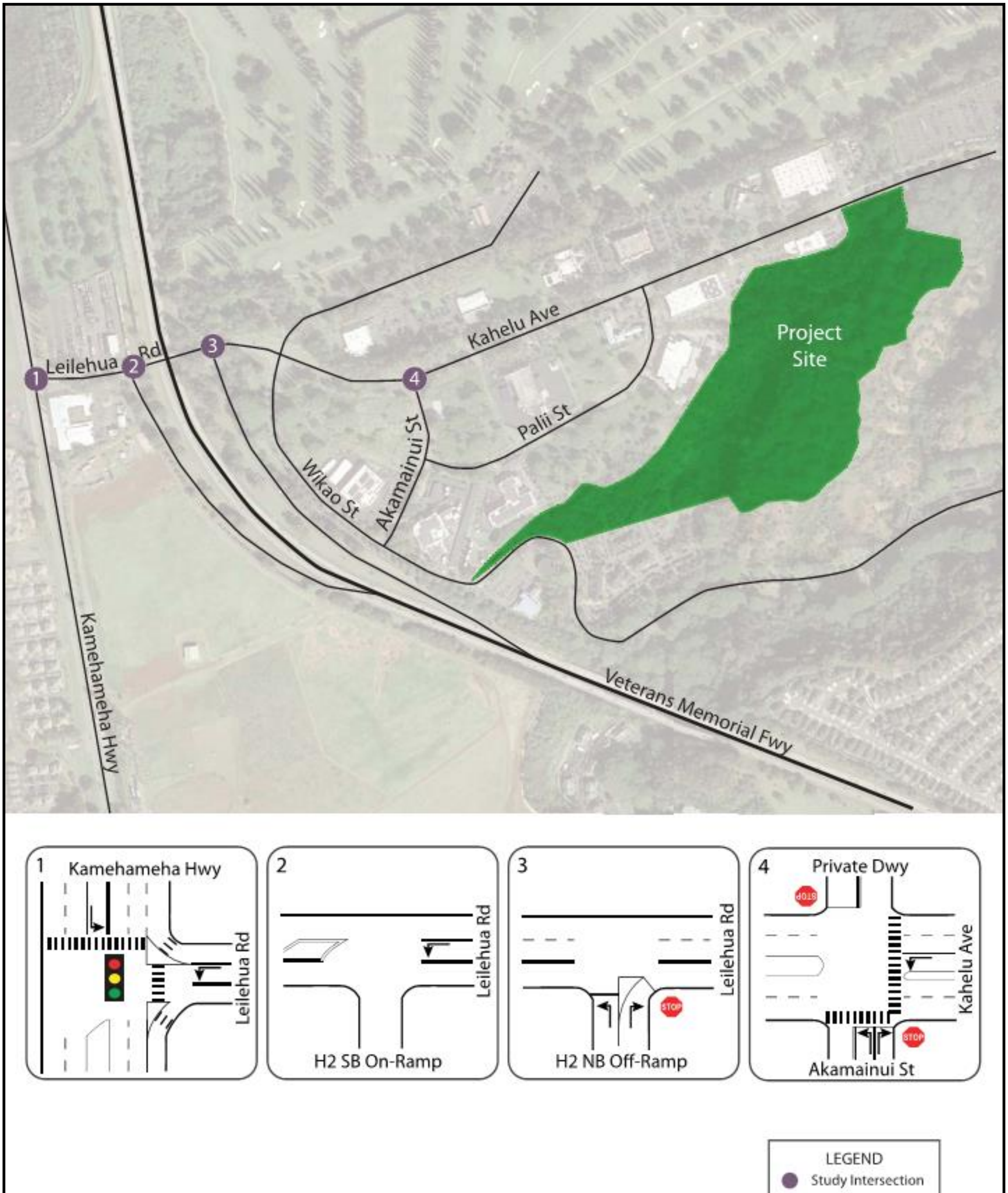
Figures 13 and 14 show the existing lane use and peak hour traffic volumes in the vicinity of the Alternative 2 site. The morning peak hour of traffic generally occurs between 7:15 AM and 8:15 AM while the afternoon peak hour of traffic generally occurs between the hours of 4:15 PM and 5:15 PM. Although the peak hours of traffic generally occur around the same time periods at each of the study intersections, the absolute commuter peak hour time periods for each intersection may differ slightly. The analysis is based on these absolute commuter peak hour time periods to identify the traffic impacts resulting from the proposed project. LOS calculations are included in Appendix B.

3.3.3 Traffic Volumes and Conditions

3.3.3.1 Kamehameha Highway and Leilehua Road

At the intersection with Leilehua Road, Kamehameha Highway carries 787 vehicles northbound and 800 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with ~~Puuhale Road~~ Leilehua Road carrying 554 vehicles northbound and 1,086 vehicles southbound. The northbound approach operates at LOS "B" and LOS "C" during the AM and PM peak periods, respectively, while the southbound approach operates at LOS "B" during both peak periods.

The westbound approach of Leilehua Road carries 1,987 vehicles during the AM peak period and 288 vehicles during the PM peak period. The Leilehua Road approach operates at LOS "C" during both the AM and PM peak periods.



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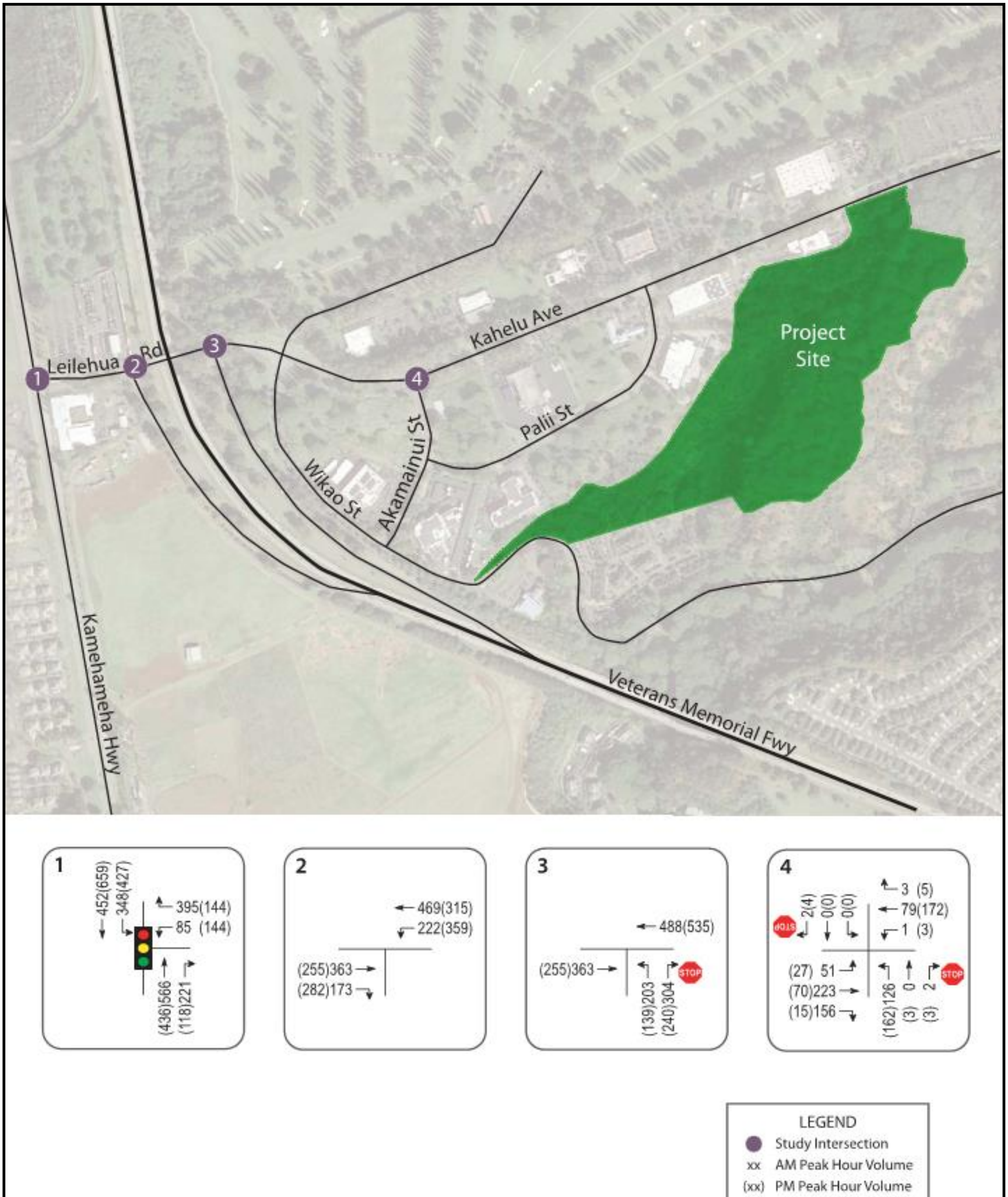
EXISTING LANE CONFIGURATIONS

FIGURE 13



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OAHU COMMUNITY CORRECTIONAL CENTER

EXISTING PEAK HOURS OF TRAFFIC

FIGURE 14

3.3.3.2 Leilehua Road and the Interstate H-2 Freeway Ramps

At the intersection with the Interstate H-2 Freeway on-ramp, Leilehua Road carries 536 vehicles eastbound and 691 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Leilehua Road carrying 537 vehicles eastbound and 674 vehicles westbound. The westbound left-turn traffic movement operates at LOS “A” and LOS “B” during the AM and PM peak periods, respectively.

At the intersection with Leilehua Road, the northbound approach of the Interstate H-2 Freeway off-ramp carries 507 vehicles during the AM peak period and 379 vehicles during the PM peak period. This approach operates at LOS “C” and LOS “B” during both the AM and PM peak periods, respectively.

3.3.3.3 Kahelu Avenue and Akamainui Street

At the intersection with Akamainui Street, Kahelu Avenue carries 430 vehicles eastbound and 83 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is lower with Kahelu Avenue carrying 112 vehicles eastbound and 180 vehicles westbound. Both approaches of Kahelue Avenue operates at LOS “A” during both peak periods.

The northbound approach of Akamainui Street carries 128 vehicles during the AM peak period and 168 vehicles during the PM peak period. This approach operates at LOS “C” and LOS “B” during the AM and PM peak periods, respectively. The southbound approach of the intersection is comprised of a private driveway which carries a minimal volume of traffic during the AM and PM peak periods. 2 vehicles were observed on the approach during the AM peak period and 4 vehicles were observed on the approach during the PM peak period. That approach operates at LOS “A” during both peak periods.

3.4 Alternatives 3 & 4

3.4.1 Area Roadway System

In the vicinity of the proposed project sites for Alternatives 3 and 4, Ulune Street is a three-lane, one-way (westbound) roadway which transitions to a five-lane, two-way roadway west of the intersection with Halawa Valley Street. West of the project sites, Ulune Street intersects Halawa Valley Street. At this signalized intersection, the eastbound approach of Ulune Street has exclusive turning lanes while the westbound approach has two through lanes and a shared through and right-turn lane. Halawa Valley Street is a three-lane, two-way roadway which transitions to a two-lane, two-way roadway east of the intersection with Iwaiwa Street. At the intersection with Ulune Street, the southbound approach of Halawa Valley Street has one through lane and an exclusive right-turn lane.

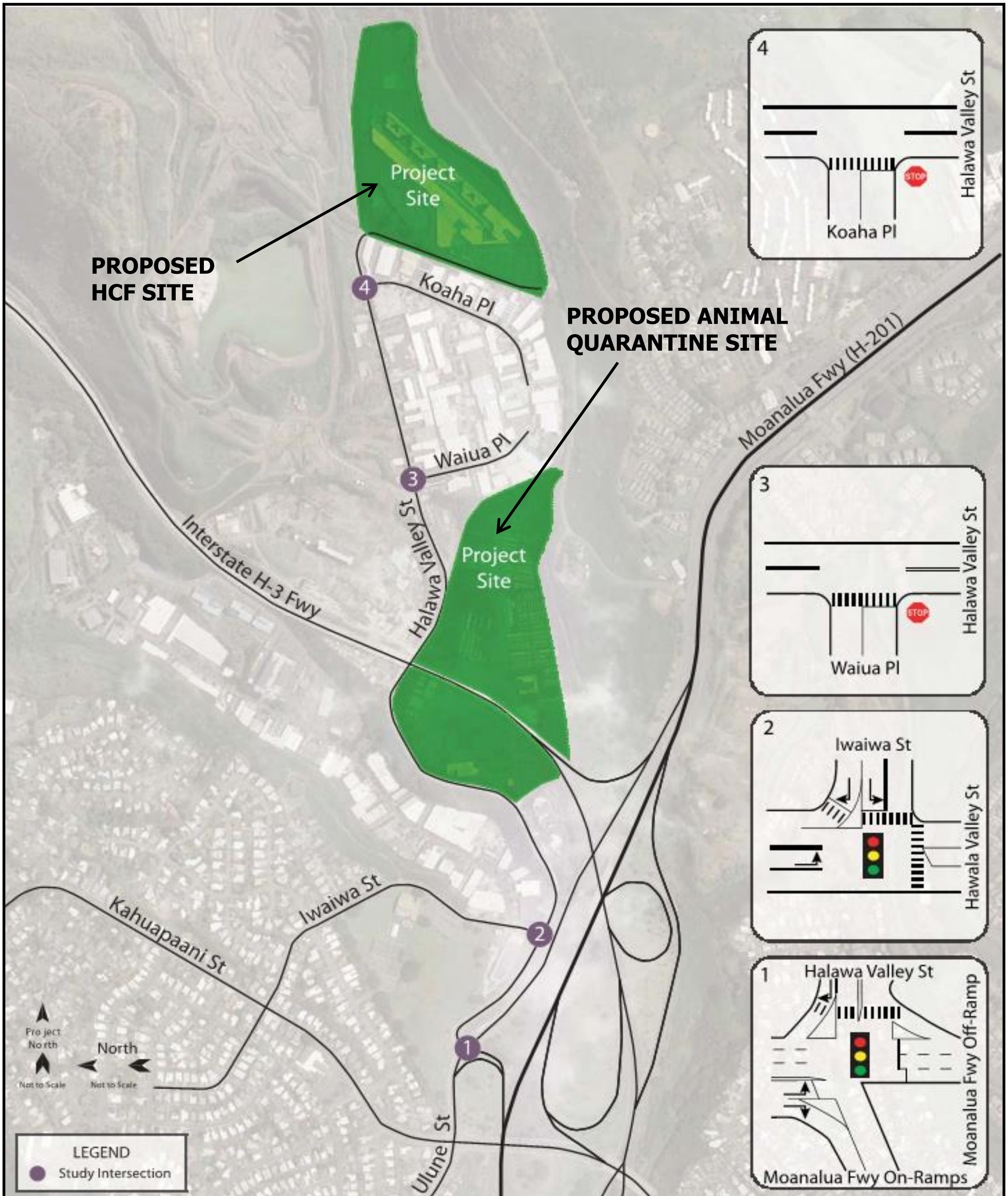
East of the intersection with Ulune Street, Halawa Valley Street intersects Iwaiwa Street. At this signalized T-intersection, the eastbound approach of Halawa Valley Street has an exclusive left-turn lane and one through lane while the westbound approach has a shared through and right-turn lane. Iwaiwa Street is a predominantly two-lane, two-way roadway generally oriented in the north-south direction. At the intersection with Halawa Valley Street, Iwaiwa Street has exclusive lanes for left-turn and right-turn traffic movements.

East of the intersection with Iwaiwa Street, Halawa Valley Street intersects Waiua Place. At this unsignalized T-intersection, the eastbound approach of Halawa Valley Street has a shared through and right-turn lane while the westbound approach has a shared left-turn and through lane. Waiua Place is a predominantly two-lane, two-way roadway which primarily serves the adjacent industrial uses. At the intersection with Halawa Valley Street, Waiua Place has one stop-controlled lane that serves left-turn and right-turn traffic movements. As previously mentioned, although both alternatives are located along Halawa Valley Street, the project site for Alternative 3 is located east of the Alternative 4 project site at the end of the corridor. As such, this intersection was included in the Alternative 3 scenario to account for the site-generated trips expected to travel to/from that proposed project site.

East of the intersection with Waiua Place, Halawa Valley Street intersects Koaha Place. At this unsignalized T-intersection, the eastbound approach of Halawa Valley Street has a shared through and right-turn lane while the westbound approach has a shared left-turn and through lane. Koaha Place is a predominantly two-lane, two-way roadway which also serves the adjacent industrial uses. At the intersection with Halawa Valley Street, Koaha Place has one stop-controlled lane that serves left-turn and right-turn traffic movements. Similar to the intersection of Iwaiwa Street with Halawa Valley Street, this intersection was only included in the Alternative 3 scenario.

3.4.2 Existing Peak Hour Traffic

Figures 15 and 16 show the existing lane use and peak hour traffic volumes. The morning peak hour of traffic generally occurs between 7:15 AM and 8:15 AM while the afternoon peak hour of traffic generally occurs between the hours of 3:15 PM and 4:15 PM. Although the peak hours of traffic generally occur around the same time periods at each of the study intersections, the absolute commuter peak hour time periods for each intersection may differ slightly. The analysis is based on these absolute commuter peak hour time periods to identify the traffic impacts resulting from the proposed project. LOS calculations are included in Appendix C.



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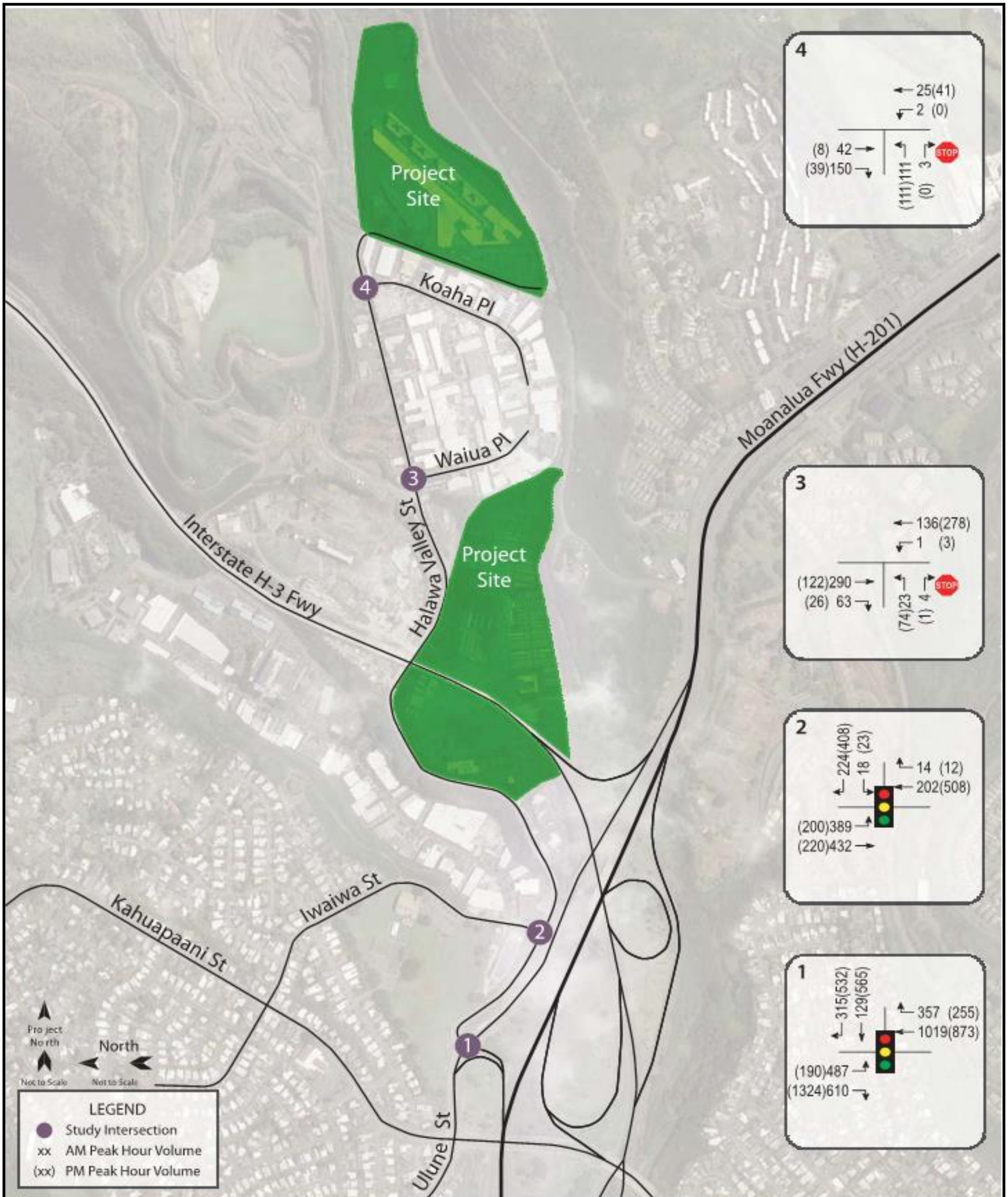
EXISTING LANE CONFIGURATIONS

FIGURE 15



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EXISTING PEAK HOURS OF TRAFFIC

FIGURE 16

3.4.3 Traffic Volumes and Conditions

3.4.3.1 Ulune Street and Halawa Valley Street

At the intersection with Halawa Valley Street, Ulune Street carries 1,097 vehicles eastbound and 1,376 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Ulune Street carrying 1,514 vehicles eastbound and 1,128 vehicles westbound. The eastbound approach of Ulune Street operates at LOS "C" and LOS "B" during the AM and PM peak periods, respectively, while the westbound approach operates at LOS "D" during both peak periods. The Halawa Valley Street approach carries 444 vehicles southbound during the AM peak period and 1,097 vehicles during the PM peak period. This approach operates at LOS "D" during both the AM and PM peak periods.

3.4.3.2 Halawa Valley Street and Iwaiwa Street

At the intersection with Iwaiwa Street, Halawa Valley Street carries 821 vehicles eastbound and 216 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is lower with Halawa Valley carrying 420 vehicles eastbound and 520 vehicles westbound. The eastbound approach of Halawa Valley Street operates at LOS "B" during both peak periods, while the westbound approach operates at LOS "C" during both peak periods. The Iwaiwa Street approach carries 242 vehicles during the AM peak period and 431 vehicles during the PM peak period. This approach operates at LOS "C" during both the AM and PM peak periods.

3.4.3.3 Halawa Valley Street and Waiua Place

At the intersection with Waiua Place, Halawa Valley Street carries 353 vehicles eastbound and 137 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is lower with Halawa Valley carrying 148 vehicles eastbound and 281 vehicles westbound. The westbound approach of Halawa Valley Street operates at LOS "A" during both peak periods. The Waiua Place approach carries 27 vehicles northbound during the AM peak period and 75 vehicles during the PM peak period. This approach operates at LOS "B" during both the AM and PM peak periods.

3.4.3.4 Halawa Valley Street and Koaha Place

At the intersection with Koaha Place, Halawa Valley Street carries 192 vehicles eastbound and 27 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is lower with Halawa Valley carrying 47 vehicles eastbound and 41 vehicles westbound. The westbound approach of Halawa Valley Street operates at LOS "A" during both peak periods. The Koaha

Place approach carries 114 vehicles northbound during the AM peak period and 111 vehicles during the PM peak period. This approach operates at LOS "B" and LOS "A" during the AM and PM peak periods, respectively.

3.5 WCCC Facility

As previously mentioned, all female inmates currently housed at the existing OCCC are to be relocated to the WCCC facility regardless of which alternative site is selected. As such, traffic impacts in the vicinity of the WCCC facility were assessed in conjunction with Alternatives 1 thru 4.

3.5.1 Area Roadway System

In the vicinity of the proposed project site, Kalanianaole Highway is a predominantly four-lane, two-way roadway generally oriented in the east-west direction. West of the project site, Kalanianaole Highway intersects Ulupii Street. At this unsignalized intersection, both approaches of the highway have an exclusive left-turn lane, one through lane, and a shared through and right-turn lane. Ulupii Street is a predominantly two-lane, two-way roadway generally oriented in the north-south direction and primarily serves the adjacent residential community. At the intersection with Kalanianaole Highway, both approaches of Ulupii Street have one stop-controlled lane that serves all traffic movements. It should be noted that although a refuge lane is not provided, vehicles were observed to utilize the wide median to cross the highway in two-stages.

East of the intersection with Ulupii Street, Kalanianaole Highway intersects the project driveway for the Women's Community Correctional Center and the Olomana School driveway. At this unsignalized intersection, the eastbound approach of Kalanianaole Highway has an exclusive left-turn lane, two through lanes, and an exclusive right-turn lane while the westbound approach has an exclusive left-turn lane, one through lane, and a shared through and right-turn lane. The southbound approach is comprised of a driveway for the Women's Community Correctional Center which has one lane that serves all traffic movements. In addition, the northbound approach is comprised of a driveway for Olomana School which also has one lane that serves all traffic movements. It should be noted that although a refuge lane is not provided, vehicles were also observed to utilize the wide median to cross the highway in two-stages.

3.5.2 Existing Peak Hour Traffic

Figures 17 and 18 show the existing lane use and peak hour traffic volumes. The morning peak hour of traffic generally occurs between 7:15 AM and 8:15 AM while the afternoon peak hour of traffic generally occurs between the hours of 4:45 PM and 5:45 PM. Although the peak hours of traffic generally occur around the same time periods at each of the study intersections, the absolute commuter peak hour time periods for each intersection may differ slightly. The analysis is based on these absolute commuter peak hour time periods to identify the traffic impacts resulting from the proposed project. LOS calculations are included in Appendix C.

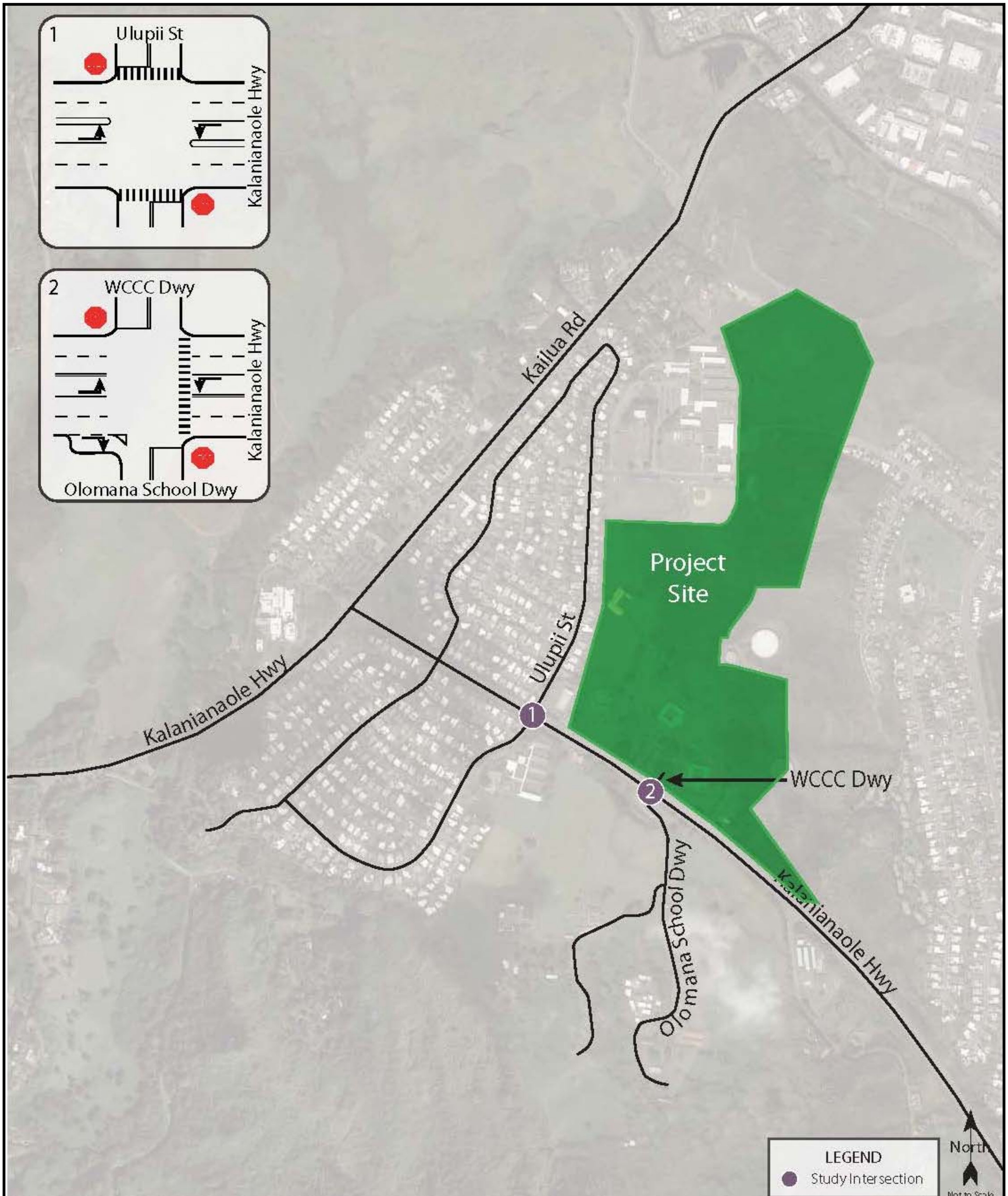
3.5.3 Traffic Volumes and Conditions

3.5.3.1 Kalanianaole Highway and Ulupii Street

At the intersection with Ulupii Street, Kalanianaole Highway carries 770 vehicles eastbound and 1,364 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Kalanianaole Highway carrying 1,416 vehicles eastbound and 937 vehicles westbound. The eastbound and westbound left-turn traffic movements along Kalanianaole Highway operate at LOS “B” during both peak periods. Ulupii Street carries 94 vehicles northbound and 67 vehicles southbound during the AM peak period. During the PM peak period, the overall traffic volume is lower with Ulupii Street carrying 53 vehicles northbound and 68 vehicles southbound. The northbound approach operates at LOS “C” during both peak periods while the southbound approach operates at LOS “D” and LOS “C” during the AM and PM peak periods, respectively.

3.5.3.2 Kalanianaole Highway and the driveways for WCCC and Olomana School

At the intersection with the driveways for the WCCC facility and Olomana School, Kalanianaole Highway carries 815 vehicles eastbound and 1,284 vehicles westbound during the AM peak period. During the PM peak period, the overall traffic volume is higher with Kalanianaole Highway carrying 1,427 vehicles eastbound and 841 vehicles westbound. The eastbound left-turn traffic movement operates at LOS “B” and LOS “A” during the AM and PM peak periods, respectively, while the westbound left-turn traffic movement operates at LOS “A” during both peak periods.



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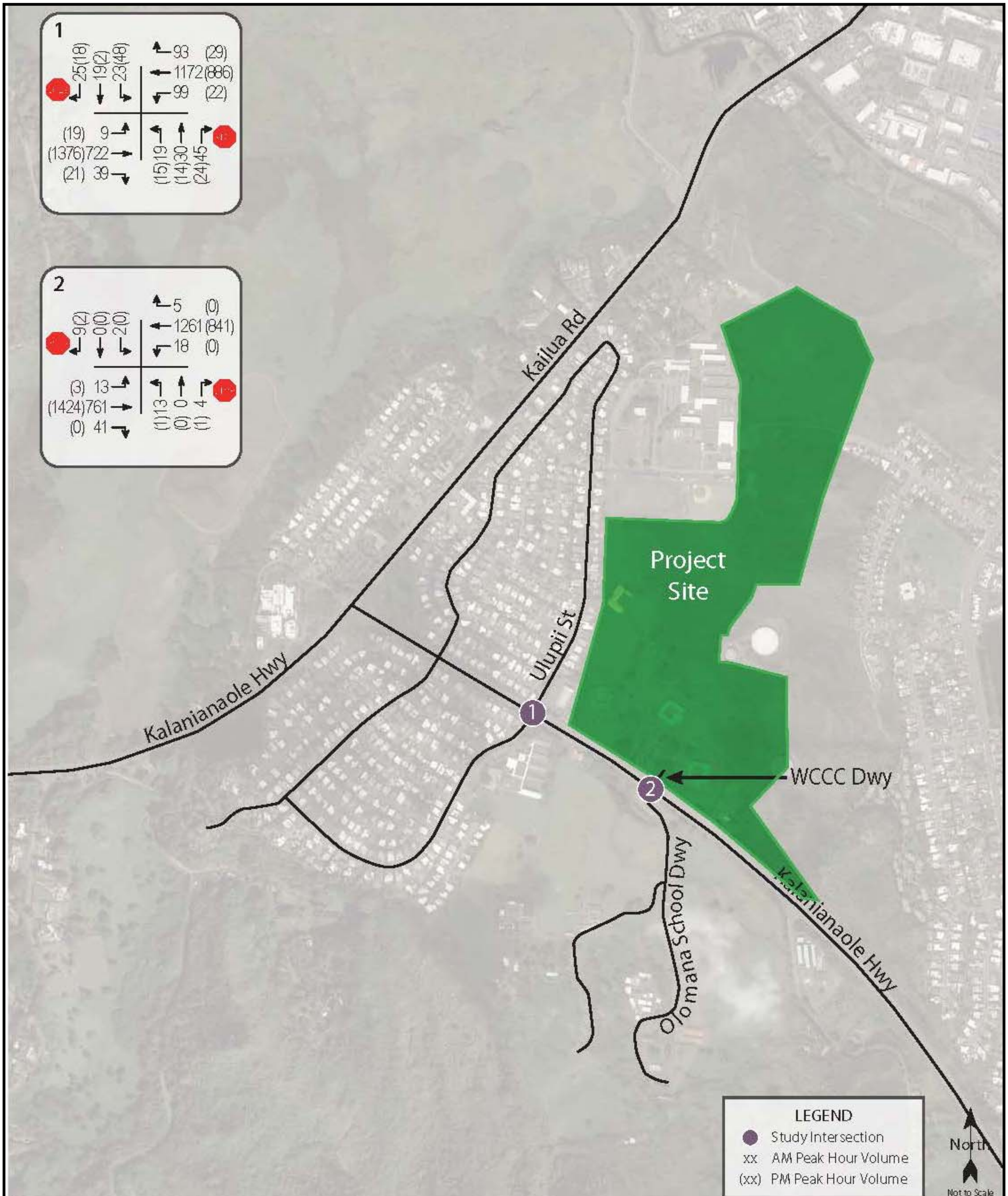
EXISTING LANE CONFIGURATIONS

FIGURE 17



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EXISTING PEAK HOURS OF TRAFFIC

FIGURE 18

The WCCC driveway carries 11 vehicles southbound during the AM peak period and 2 vehicles during the PM peak period. This approach operates at LOS “B” during both peak periods. However, although operating sufficiently based on vehicular traffic demands, turning maneuvers entering and exiting the project site driveway may be a safety hazard as result of the physical layout and configuration of the intersection at the vehicular conflict zones. The northbound approach of the intersection is comprised of a driveway for the adjacent Olomana School which carries a minimal volume of traffic during the AM and PM peak periods. 17 vehicles were observed on the approach during the AM peak period and 2 vehicles were observed on the approach during the PM peak period. This approach operates at LOS “C” during both peak periods.

4.0 PROJECTED TRAFFIC CONDITIONS

4.1 Site-Generated Traffic: Trip Generation Methodology

The trip generation methodology is typically based upon generally accepted techniques developed by the Institute of Transportation Engineers (ITE) and published in “Trip Generation, 9th Edition,” 2012. The ITE trip generation rates are developed empirically by correlating the vehicle trip generation data with various land use characteristics such as the number of vehicle trips generated per inmate. However, trip generation rates for prisons developed empirically are based on a small sample size and may not be an accurate representation of the proposed project conditions. As such, for the purpose of this report, two trip generation characteristics were used to represent a conservative analysis and both methods were applied to the AM and PM peak hours of traffic.

4.1.1 Trip Generation Method 1

The first method (referred to as “Method 1”) uses trip generation rates based on the existing trip generation characteristics at the OCCC facility from the collected field data. Table 1 summarizes the trip generation characteristics related to the proposed project site alternatives, as well as the expansion of the WCCC facility, applied to the AM and PM peak hours of traffic.

Table 1: Peak Hour Trip Generation Method 1

LAND USE: INSTITUTIONAL		Alternative 1	Alternatives 2,3, and 4	WCCC
Independent Variable	# of Additional Inmates	343	1,380	281
AM PEAK	Enter	13	54	11
	Exit	5	18	4
	Total	18	72	15
PM PEAK	Enter	3	12	3
	Exit	9	35	7
	Total	12	47	10

4.1.2 Trip Generation Method 2

Alternatively, the second method (referred to as "Method 2") uses trip generation rates based on characteristics at the OCCC facility from employee data provided by the State of Hawaii Department of Public Safety (PSD). This data included information regarding work shift schedules and corresponding employees for each shift. Based on this data of actual operations at the existing OCCC facility, corresponding trip generation rates were developed for both the morning and afternoon peak traffic periods. These rates are applied to the varying proposed inmate population sizes to reflect the associated trip generating characteristic of each proposed alternative. Table 2 summarizes the trip generation characteristics related to the proposed project alternatives, as well as the expansion of the WCCC facility, applied to the AM and PM peak hours of traffic. Since the resulting traffic volumes based on the trip generation rates derived from Method 2 are generally greater than traffic volumes derived from Method 1, the projected traffic analyses hereinafter are based on projected traffic volume derived from Method 2. As such, the conservative analyses would potentially result in better traffic operations than reported and evaluated herein.

Table 2: Peak Hour Trip Generation Method 2

LAND USE: INSTITUTIONAL		Alternative 1	Alternatives 2,3, and 4	WCCC
Independent Variable	# of Additional Inmates	343	1,380	281
AM PEAK	Enter	41	163	34
	Exit	29	117	24
	Total	70	280	58
PM PEAK	Enter	1	2	1
	Exit	25	98	20
	Total	26	100	21

4.2 Alternative 1

4.2.1 Trip Distribution

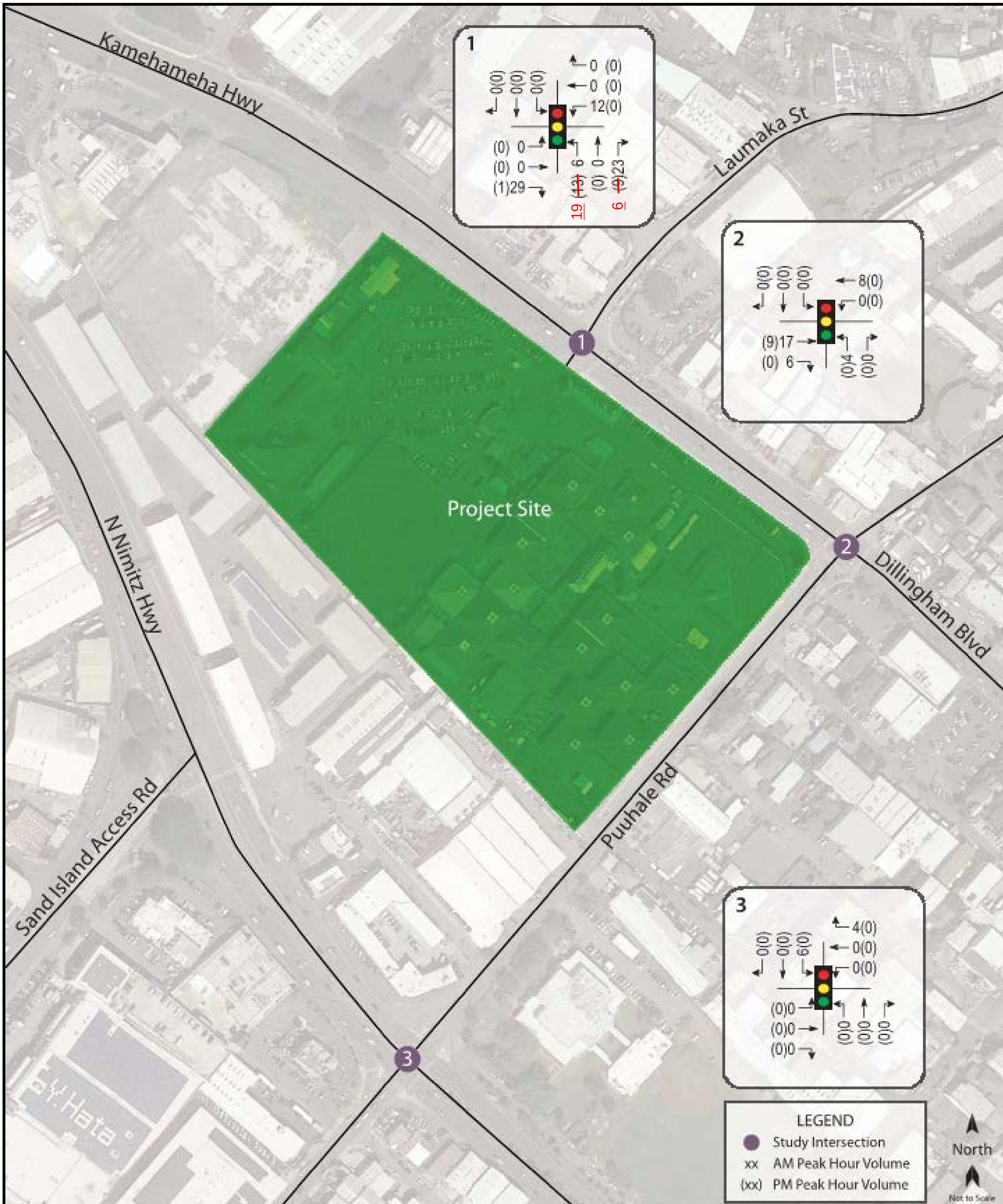
Figure 19 shows the distribution of site-generated traffic during the AM and PM peak periods. Primary access to the proposed site in Kalihi will be provided via the existing driveway off Kamehameha Highway at the intersection with Laumaka Street. The directional distribution at the intersection of Kamehameha Highway and Laumaka Street was assumed to remain similar to existing conditions. As such, 70% of entering trips were assumed to be traveling eastbound while 30% of entering trips were assumed to be traveling westbound during both peak periods. Similarly, 84% of exiting trips were assumed to be traveling eastbound with 16% assumed to be traveling westbound during the AM peak period. During the PM peak period, 24% of exiting trips were assumed to be traveling eastbound with 76% of exiting trips assumed to be traveling westbound.

4.2.2 Through Traffic Forecasting Methodology

The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located along Nimitz Highway and Kamehameha Highway (Kalihi) in the vicinity of the proposed project site. The historical data indicates relatively stable traffic volumes along the study corridors and, as such, an annual traffic growth rate of approximately 0.5 % was conservatively assumed in the project vicinity. Using 2017 as the Base Year, a growth rate factor of 1.03 was applied to the existing traffic demands in the project vicinity to achieve the projected Year 2023 traffic demands.

4.2.3 Year 2023 Total Traffic Volumes Without Project

The projected Year 2023 AM and PM peak period traffic volumes and operating conditions without the implementation of Alternative 1 is shown in Figure 20 and summarized in Table 3. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix D.



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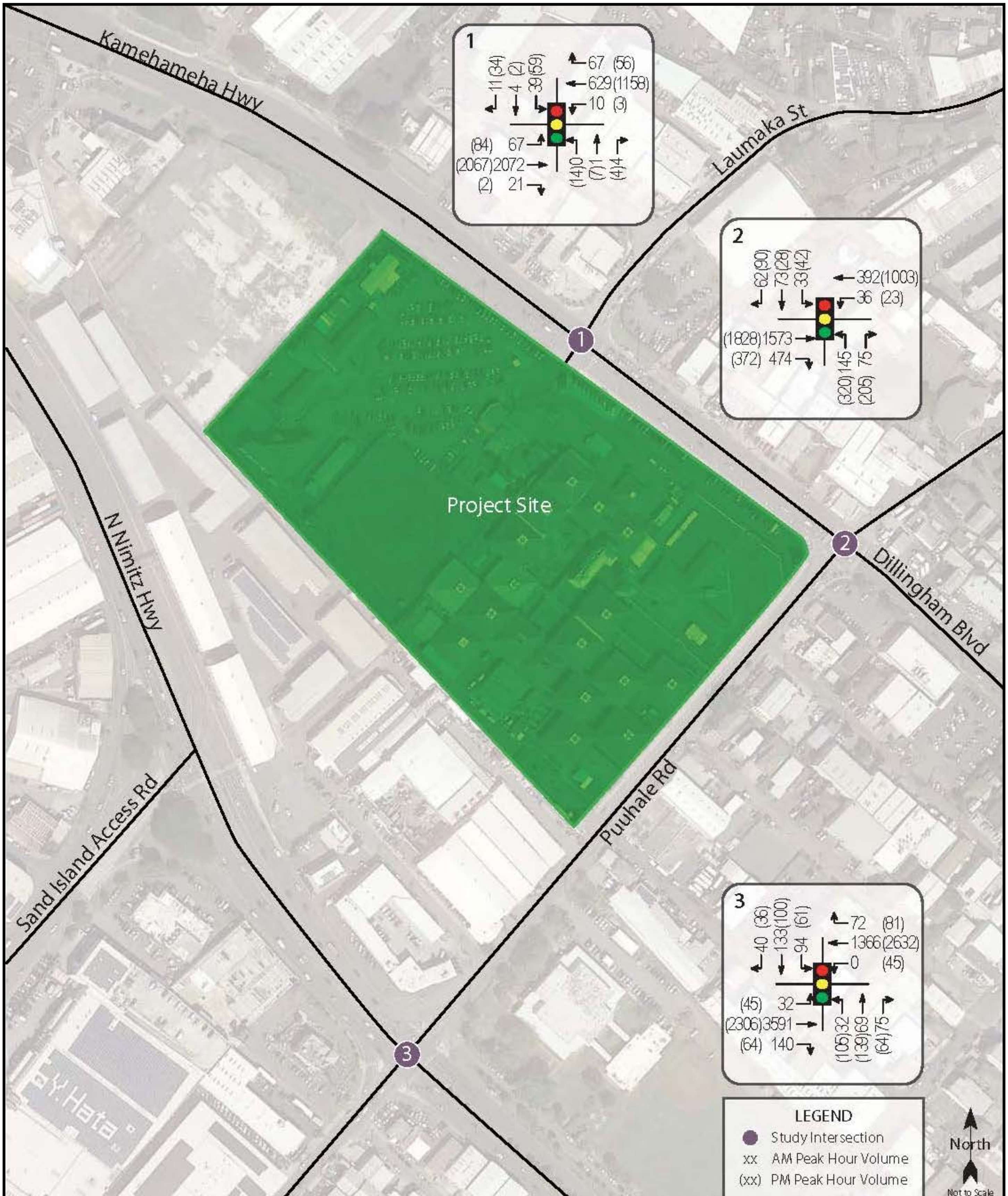
DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 1

FIGURE 19



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YEAR 2023 PEAK HOURS OF TRAFFIC WITHOUT ALTERNATIVE 1

FIGURE 20

Table 3: Existing and Projected Year 2023 (Without Project) LOS Traffic Operating Conditions

Intersection	Approach	AM		PM	
		Exist	Year 2023 w/o Proj	Exist	Year 2023 w/o Proj
N. Nimitz Hwy/ Puuhale Rd.	Eastbound	B	B	B	B
	Westbound	B	B	C	C
	Northbound	E	E	F	F
	Southbound	F	F	F	F
Kamehameha Hwy/ Dillingham Blvd/ Puuhale Rd	Eastbound	A	A	C	C
	Westbound	A	A	B	B
	Northbound	D	D	D	D
	Southbound	C	C	C	C
Kamehameha Hwy/ Laumaka St/ OCCC Dwy	Eastbound	A	A	A	A
	Westbound	A	A	A	A
	Northbound	C	D	C	C
	Southbound	D	D	D	D

Under Year 2023 without project conditions, traffic operations are expected to remain similar to existing conditions. Near the existing OCCC facility, traffic operations at the intersection of N. Nimitz Highway and Puuhale Road are expected to continue operating at LOS “C” or better during both peak periods with the exception of the side street approaches which are expected to continue operating at LOS “F” during both peak periods. As previously discussed, the low levels of service along the side streets are primarily due to the long traffic signal cycle lengths along the highway. Along Kamehameha Highway and Dillingham Boulevard, traffic operations at the other study intersections are expected to operate at LOS “D” or better during both peak periods.

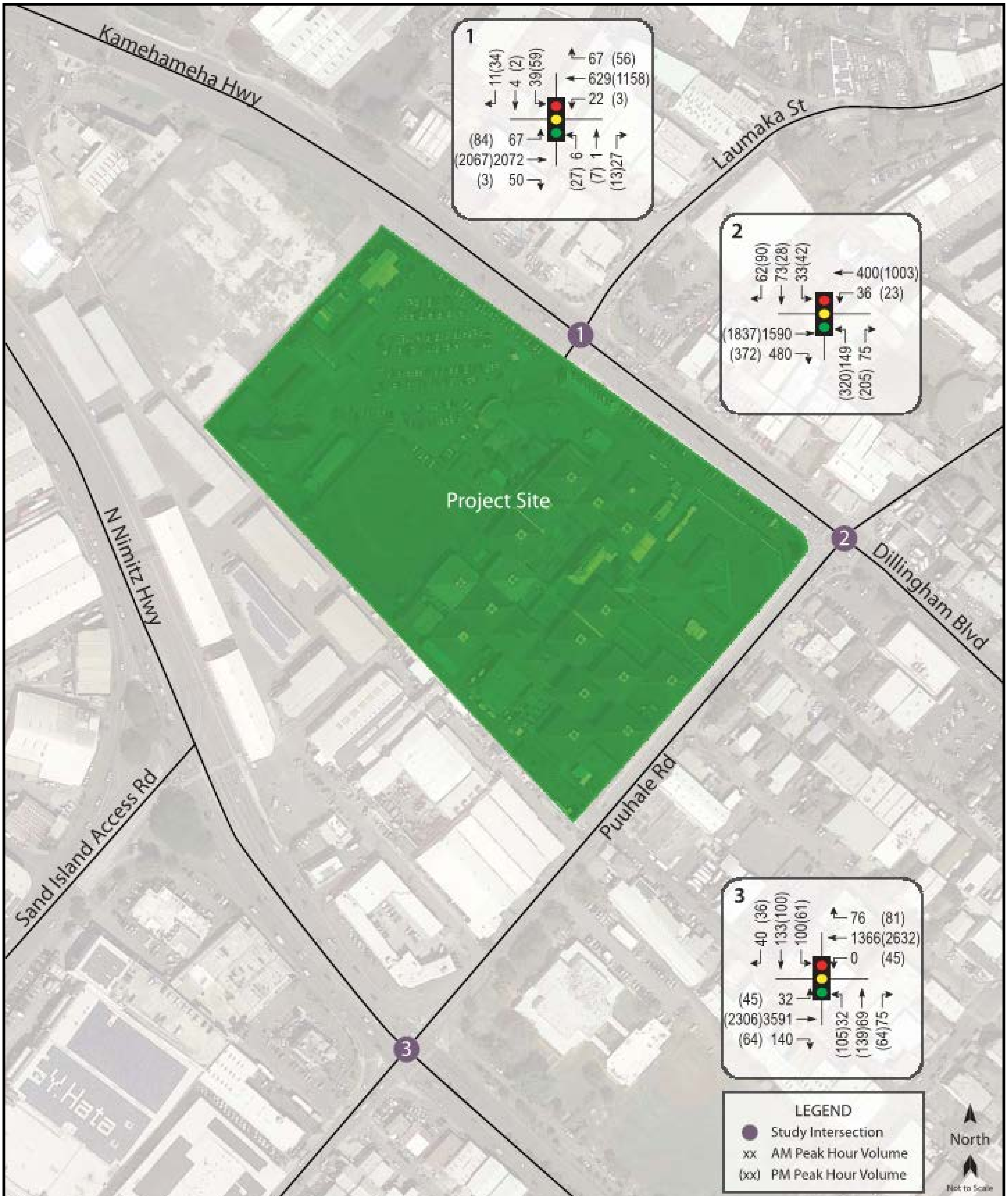
4.2.4 Year 2023 Total Traffic Volumes With Project

The Year 2023 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 1 are shown in Figures 21 and summarized in Table 4. The cumulative volumes consist of site-generated traffic superimposed over the Year 2023 projected traffic demands. The existing and projected Year 2023 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix E.

Table 4: Existing and Projected Year 2023 (Without and With Alternative 1)
LOS Traffic Operating Conditions

Intersection	Approach	AM			PM		
		Exist	Year 2023 w/out Proj	Year 2023 w/ Project	Exist	Year 2023 w/out Proj	Year 2023 w/ Project
N. Nimitz Hwy/ Puuhale Rd.	Eastbound	B	B	A	B	B	B
	Westbound	B	B	A	C	C	B
	Northbound	E	E	E	F	F	F
	Southbound	F	F	E	F	F	F
Kamehameha Hwy/ Dillingham Blvd/ Puuhale Rd	Eastbound	A	A	A	C	C	C
	Westbound	A	A	A	B	B	B
	Northbound	D	D	D	D	D	D
	Southbound	C	C	C	C	C	C
Kamehameha Hwy/ Laumaka St/ OCCC Dwy	Eastbound	A	A	A	A	A	A
	Westbound	A	A	A	A	A	A
	Northbound	C	D	D	C	C	D
	Southbound	D	D	D	D	D	D

Traffic operations with the implementation of Alternative 1 are generally expected to remain similar to without project conditions despite the addition of site-generated trips to the surrounding roadway network. Along Kamehameha Highway and Dillingham Boulevard, traffic operations at the intersection with Puuhale Road and at Laumaka Street and the OCCC driveway are expected to continue operating at LOS “D” or better during both the AM and PM peak periods. Near the existing OCCC facility, traffic operations along the N. Nimitz Highway approaches at the intersection with Puuhale Road are expected to improve to LOS “A” during the AM peak period and LOS “B” during the PM peak period. However, the northbound and southbound approaches along Puuhale Road are anticipated to continue operating at low levels of service. As previously discussed, the low levels of service along Puuhale Road are primarily due to the long traffic signal cycle lengths along the highway.



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YEAR 2023 PEAK HOURS OF TRAFFIC
WITH ALTERNATIVE 1

FIGURE
21

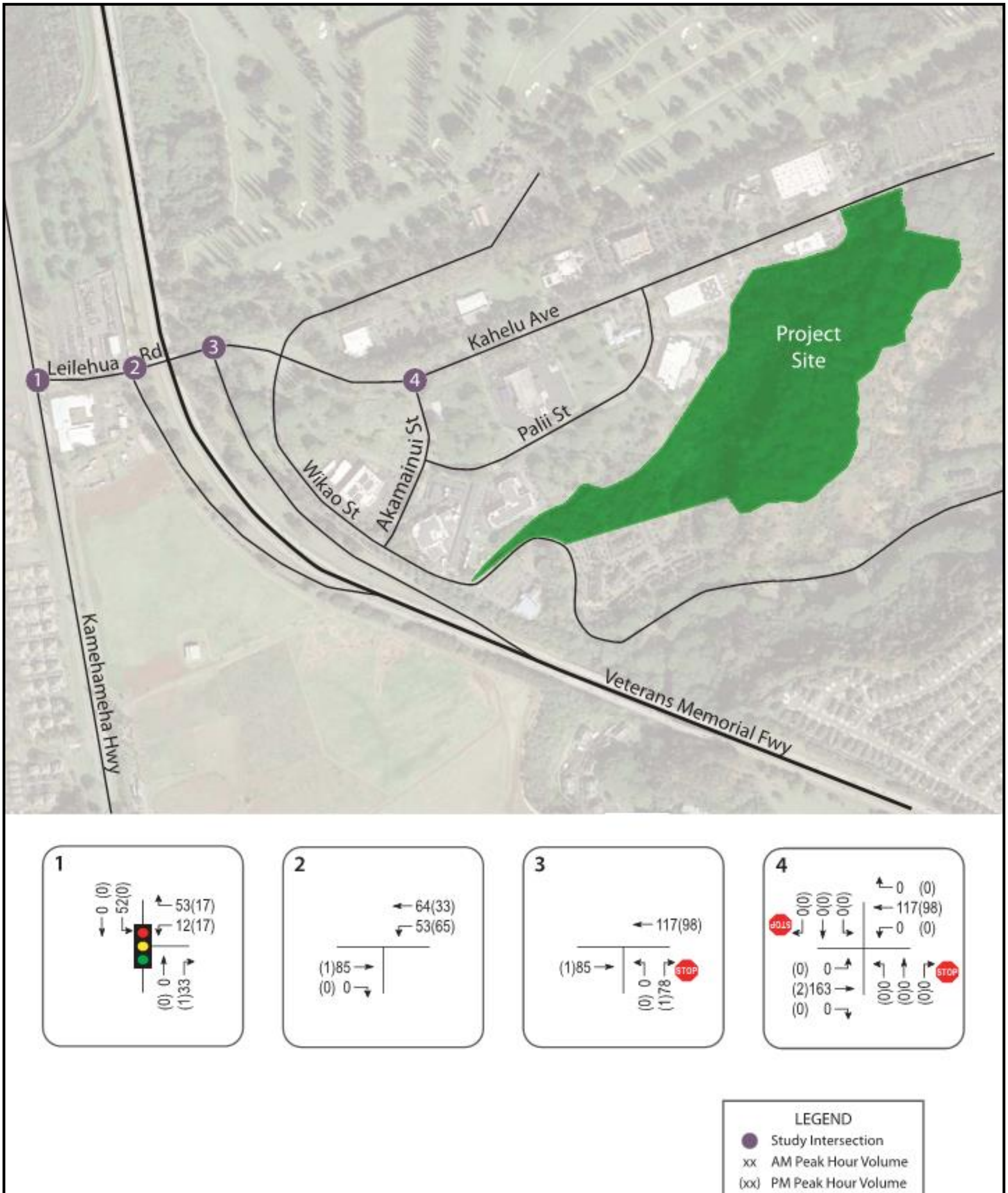
4.3 Alternative 2

4.3.1 Trip Distribution

Figure 22 shows the distribution of site-generated traffic during the AM and PM peak periods under Alternative 2. Primary access to the proposed site in Mililani will be provided via a new driveway off Kahelu Avenue. The directional distribution at the intersections of Leilehua Road and the ramps to/from the Interstate H-2 Freeway were assumed to remain similar to existing conditions. As such, 48% of entering vehicles were assumed to utilize the Interstate H-2 (northbound) off-ramp with 45% of exiting trips assumed to use the Interstate H-2 southbound on-ramp during the AM peak period. Similarly, during the PM peak period, 49% of entering vehicles were assumed to utilize the Interstate H-2 northbound off-ramp with 67% of exiting trips assumed to use the Interstate H-2 southbound on-ramp.

4.3.2 Through Traffic Forecasting Methodology

The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located along Kamehameha Highway (Mililani) in the vicinity of the proposed project sites. The historical data indicates relatively stable traffic volumes along the study corridors and, as such, an annual traffic growth rate of approximately 0.5 % was conservatively assumed in the project vicinity. Using 2017 as the Base Year, a growth rate factor of 1.03 was applied to the existing traffic demands in the project vicinity to achieve the projected Year 2023 traffic demands.



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DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 2

FIGURE 22

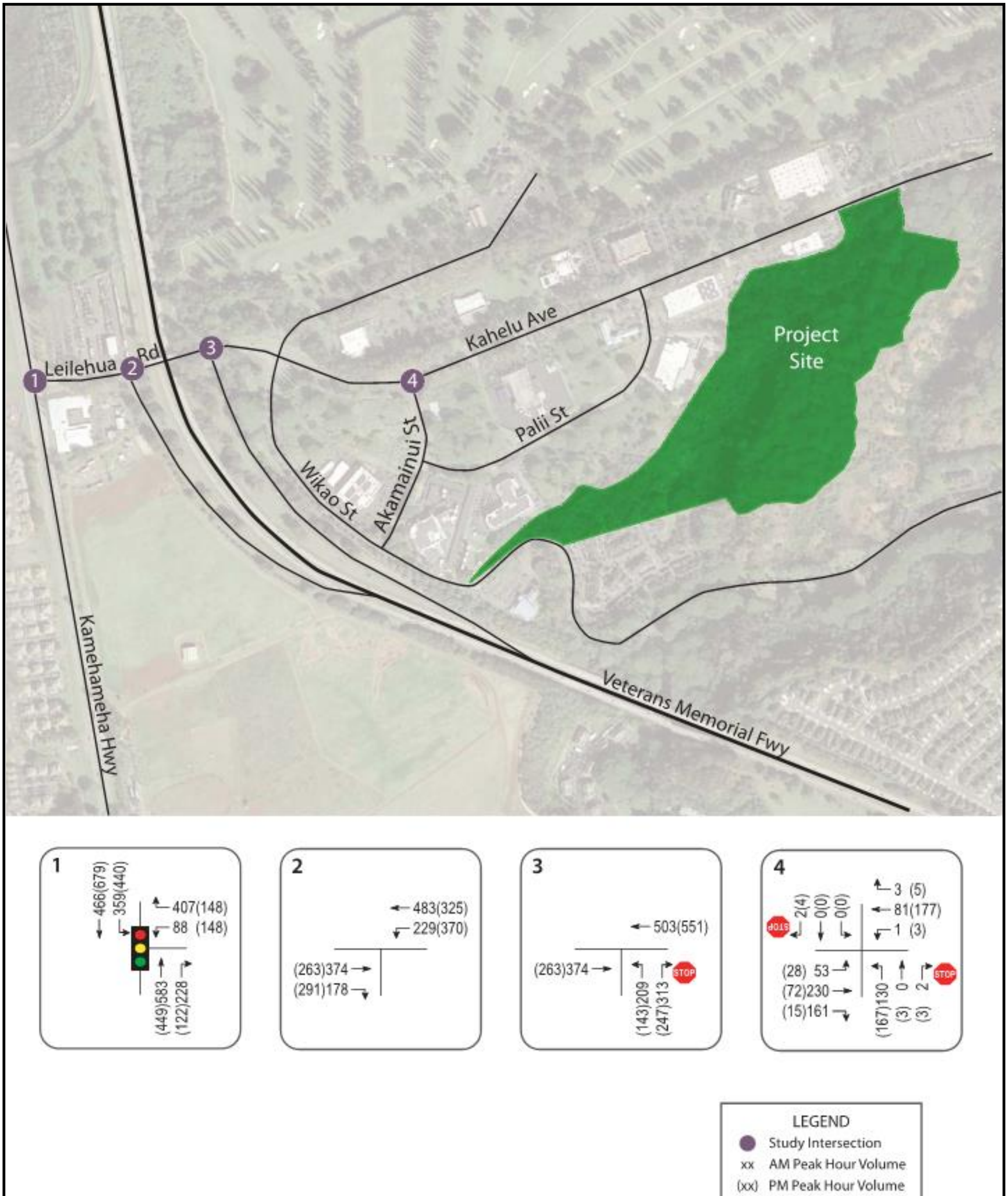
4.3.3 Year 2023 Total Traffic Volumes Without Project

The projected Year 2023 AM and PM peak period traffic volumes and operating conditions without the implementation of Alternative 2 is shown in Figure 23 and summarized in Table 5. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix F.

Table 5: Existing and Projected Year 2023 (Without Project) LOS Traffic Operating Conditions

Intersection	Approach	AM		PM	
		Exist	Year 2023 w/o Proj	Exist	Year 2023 w/o Proj
Kamehameha Hwy/ Leilehua Rd.	Westbound	C	C	C	C
	Northbound	B	B	C	C
	Southbound	B	B	B	B
Leilehua Rd./ H-2 SB On-Ramp	Westbound	A	A	B	B
Leilehua Rd/ H-2 NB Off-Ramp	Northbound	C	C	B	B
Kahelu Ave/ Akamainui St	Eastbound	A	A	A	A
	Westbound	A	A	A	A
	Northbound	C	C	B	B
	Southbound	A	A	A	A

Under Year 2023 without project conditions, traffic operations are expected to remain similar to existing conditions. At the intersection of Kamehameha Highway and Leilehua Road near the proposed MTP site, traffic operations are expected to continue operating at LOS “C” or better during both peak periods, while those at the intersection of Kahelu Avenue and Akamainui Street are expected to continue operating at LOS “C” or better during the AM peak period and LOS “B” or better during the PM peak period. At the intersections of Leilehua Road and the ramps to/from the Interstate H-2 Freeway, traffic operations are expected to continue operating at LOS “C” or better during the AM peak period and LOS “B” or better during the PM peak period.



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YEAR 2023 PEAK HOURS OF TRAFFIC
WITHOUT ALTERNATIVE 2

FIGURE
23

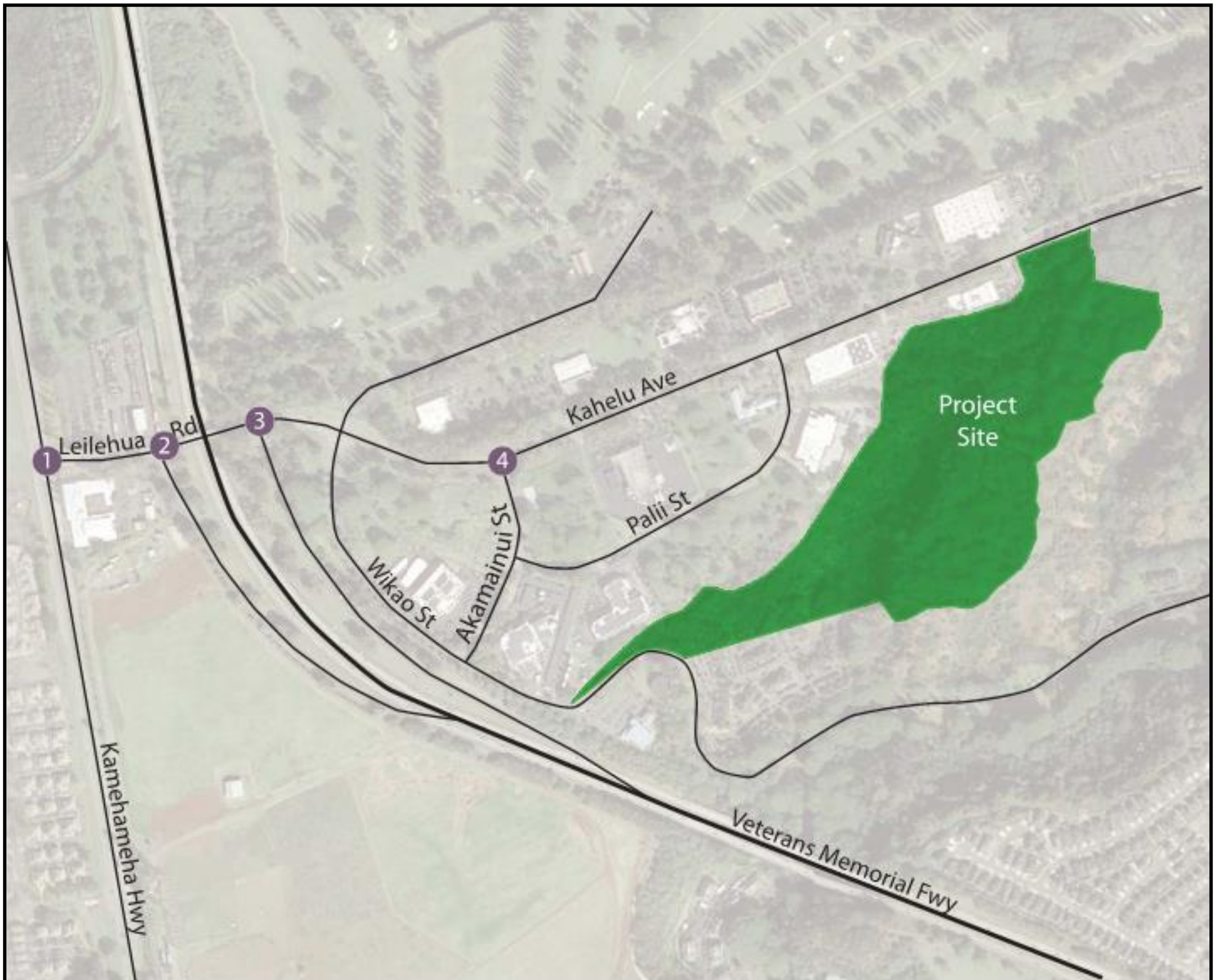
4.3.4 Year 2023 Total Traffic Volumes With Project

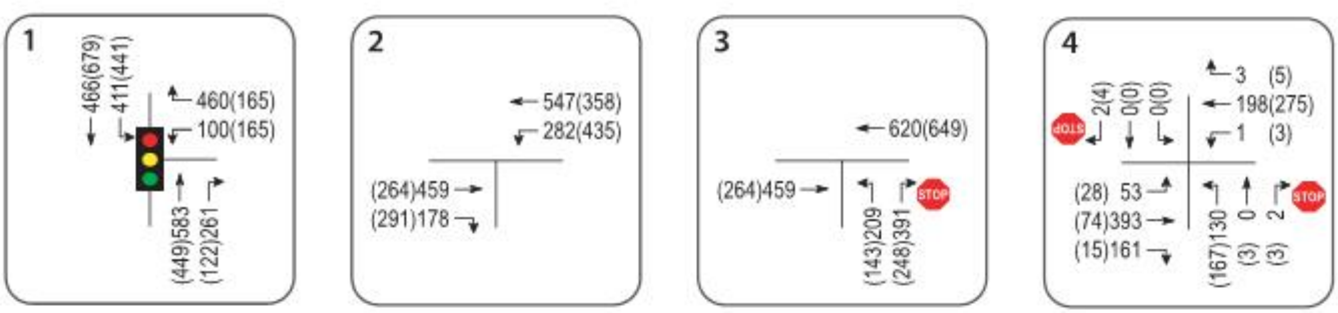
The Year 2023 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 2 is shown on Figure 24 and summarized in Table 6. The cumulative volumes consist of site-generated traffic superimposed over the Year 2023 projected traffic demands. The existing and projected Year 2023 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix G.

Table 6: Existing and Projected Year 2023 (Without and With Alternative 2) LOS Traffic Operating Conditions

Intersection	Approach	AM			PM		
		Exist	Year 2023 w/out Proj	Year 2023 w/ Project	Exist	Year 2023 w/out Proj	Year 2023 w/ Project
Kamehameha Hwy/ Leilehua Rd.	Westbound	C	C	C	C	C	C
	Northbound	B	B	C	C	C	C
	Southbound	B	B	B	B	B	B
Leilehua Rd./ H-2 SB On-Ramp	Westbound	A	A	B	B	B	B
Leilehua Rd/ H-2 NB Off-Ramp	Northbound	C	C	D	B	B	B
Kahelu Ave/ Akamainui St	Eastbound	A	A	A	A	A	A
	Westbound	A	A	A	A	A	A
	Northbound	C	C	D	B	B	B
	Southbound	A	A	A	A	A	A

Traffic operations with the implementation of Alternative 2 are generally expected to remain similar to the without project conditions despite the addition of site-generated trips to the surrounding roadway network. Traffic operations along Leilehua Road at the intersection with Kamehameha Highway near the proposed MTP site are expected to continue operating at LOS "C" or better during both AM and PM peak periods. Along the H-2 On and Off-Ramps, traffic operations are expected to continue operating similar to without project conditions with the exception of the H-2 Northbound Off-Ramp where the northbound approach is expected to change from an LOS "C" to an LOS "D" during the AM peak period. During the PM peak period, all study intersections are anticipated to remain similar to existing and without project conditions.





LEGEND

- Study Intersection
- xx AM Peak Hour Volume
- (xx) PM Peak Hour Volume

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YEAR 2023 PEAK HOURS OF TRAFFIC WITH ALTERNATIVE 2

FIGURE 24

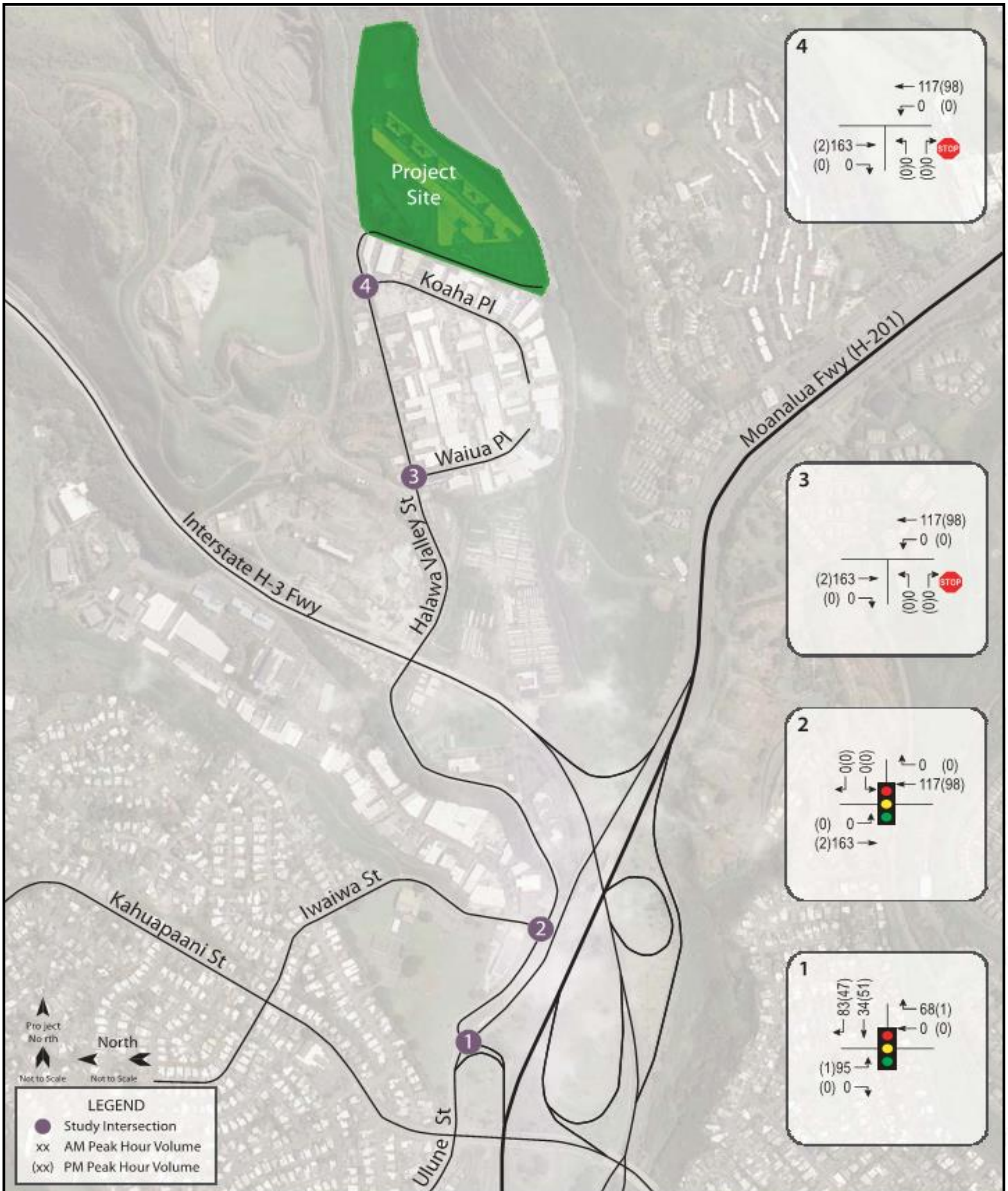
4.4 Alternative 3

4.4.1 Trip Distribution

Figure 25 shows the distribution of site-generated traffic during the AM and PM peak periods under Alternative 3. Primary access to the proposed HCF site will be provided via a new driveway off Halawa Valley Street. The directional distribution at the intersection of Ulune Street and Halawa Valley Street was assumed to remain similar to existing conditions. As such, 58% of entering trips were assumed to be traveling eastbound while 42% of entering trips were assumed to be traveling westbound during the AM peak period. Similarly, during the PM peak period, 43% of entering trips were assumed to be traveling eastbound while 57% were assumed to be traveling westbound. Exiting trips were also based on the existing directional distribution at the intersection of Ulune Street and Halawa Valley Street. As such, 71% of exiting trips were assumed to be traveling westbound at that intersection while 29% of exiting trips were assumed to be traveling southbound during the AM peak period. Similarly, during the PM peak period, 47% of exiting trips were assumed to be traveling westbound that intersection while 53% of exiting trips were assumed to be traveling southbound.

4.4.2 Through Traffic Forecasting Methodology

The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located along Halawa Valley Street in the vicinity of the proposed project sites. The historical data indicates relatively stable traffic volumes along the study corridors and, as such, an annual traffic growth rate of approximately 0.5 % was conservatively assumed in the project vicinity. Using 2017 as the Base Year, a growth rate factor of 1.03 was applied to the existing traffic demands in the project vicinity to achieve the projected Year 2023 traffic demands.



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DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 3

FIGURE 25

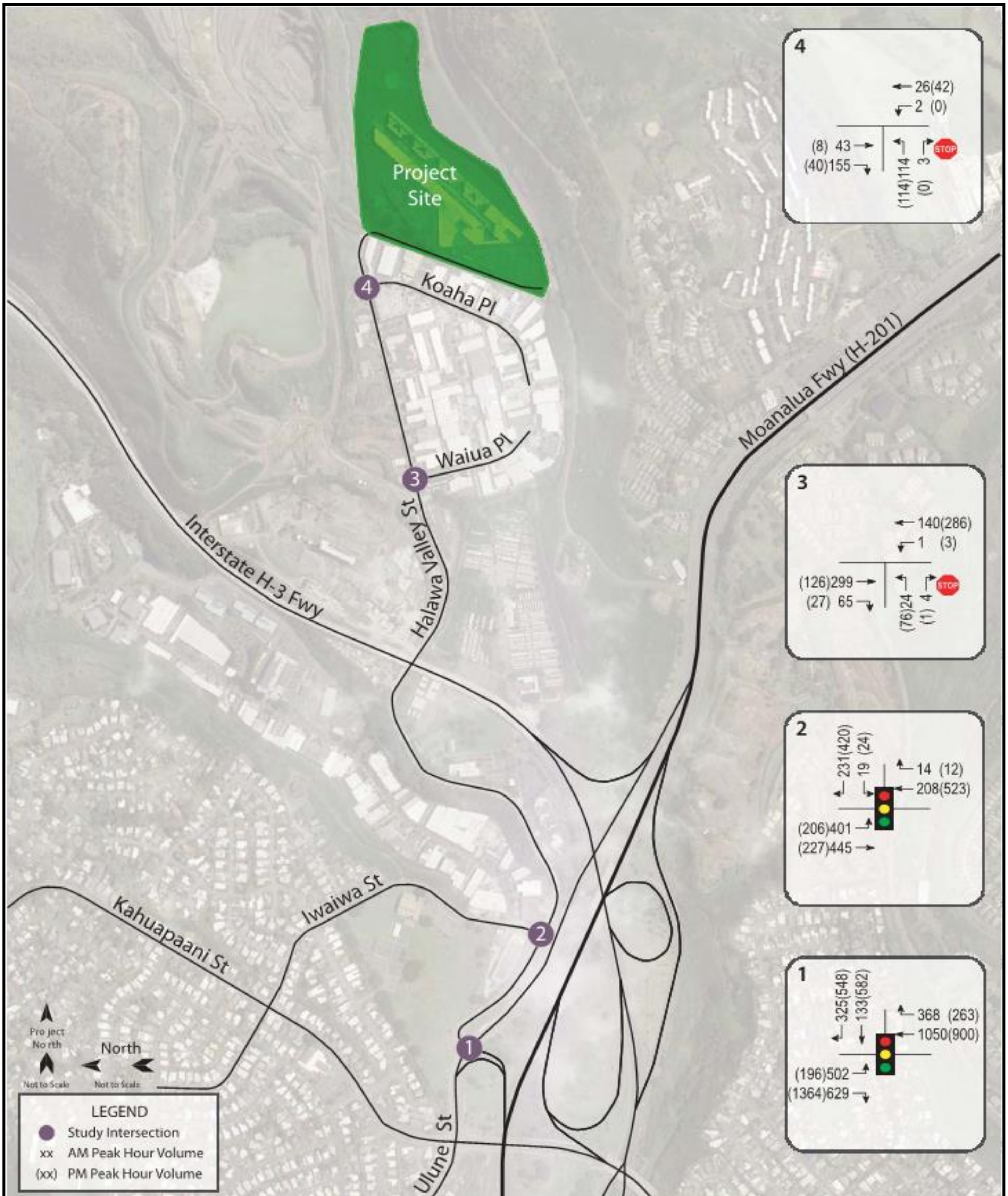
4.4.3 Year 2023 Total Traffic Volumes Without Project

The projected Year 2023 AM and PM peak period traffic volumes and operating conditions without the implementation of Alternative 3 is shown in Figure 26, and summarized in Table 7. The cumulative volumes consist of site-generated traffic previously shown in Tables 1 and 2 superimposed over the Year 2023 projected traffic demands. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix H.

Table 7: Existing and Projected Year 2023 (Without Project) LOS Traffic Operating Conditions

Intersection	Approach	AM		PM	
		Exist	Year 2023 w/o Proj	Exist	Year 2023 w/o Proj
Ulune St/ Halawa Valley St	Eastbound	C	C	B	C
	Westbound	D	D	D	D
	Southbound	D	D	D	D
Halawa Valley St/ Iwaiwa St	Eastbound	B	B	B	B
	Westbound	C	C	C	C
	Southbound	C	C	C	C
Halawa Valley St/ Waiua Pl	Westbound	A	A	A	A
	Northbound	B	B	B	B
Halawa Valley St/ Koaha Pl	Westbound	A	A	-	-
	Northbound	B	B	A	A

Under Year 2023 without project conditions, traffic operations are expected to remain generally similar to existing conditions. At the intersection of Ulune Street and Halawa Valley Street near the proposed HCF site, traffic operations are expected to continue operating at LOS “D” or better during both peak periods with the exception of the eastbound approach which is expected to deteriorate from LOS “B” to LOS “C” during the PM peak period. Along Halawa Valley Street, traffic operations at the intersection with Iwaiwa Street are expected to operate at LOS “C” or better during both peak periods, while those at the intersections with Waiua Place and Koaha Place are expected to operate at LOS “B” or better during both peak periods. It should be noted that a level of service was not included in the westbound approach of the intersection of Halawa Valley Street and Koaha Place as no vehicles were counted executing a left-turn movement at this approach



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YEAR 2023 PEAK HOURS OF TRAFFIC WITHOUT ALTERNATIVE 3

FIGURE 26

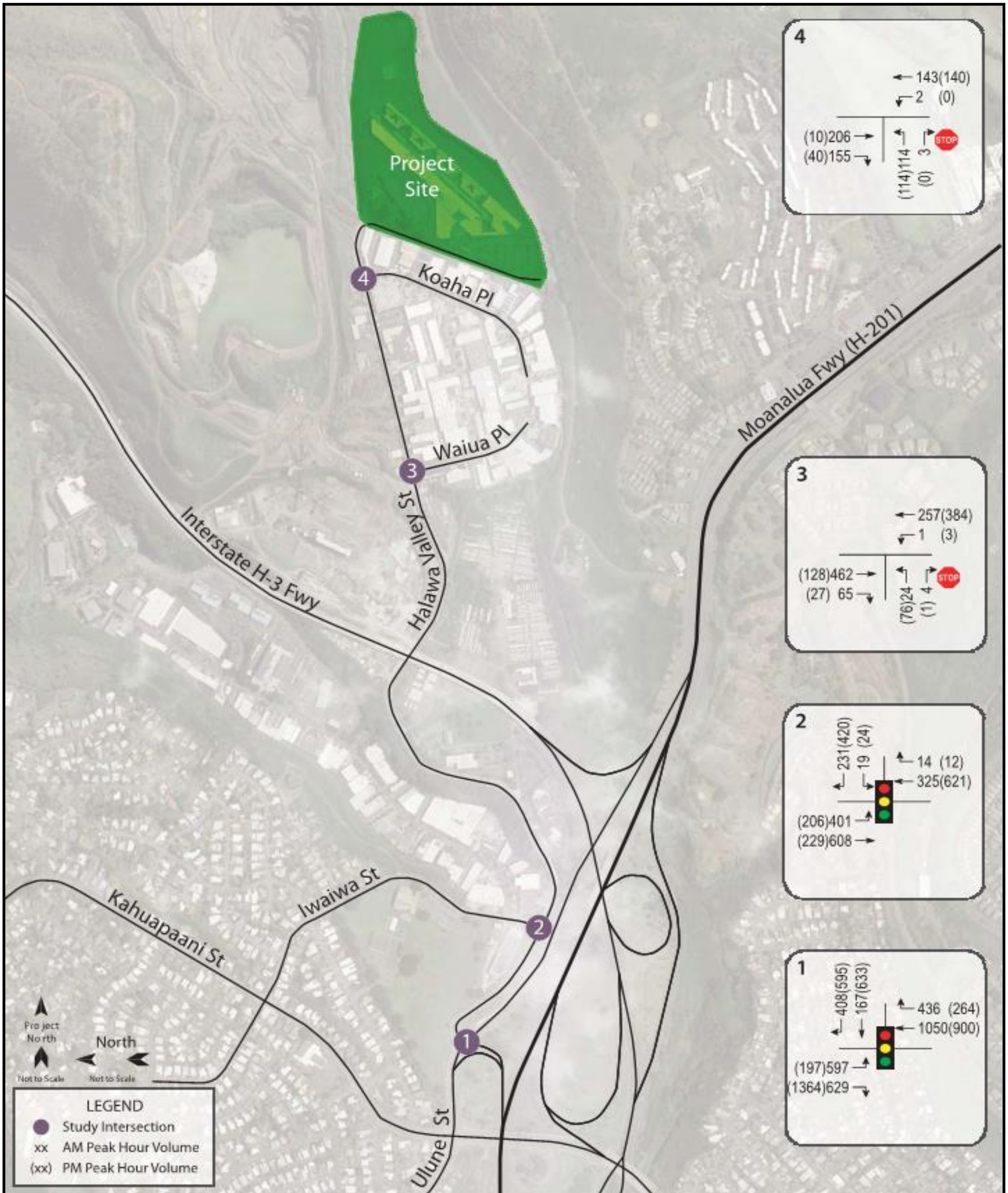
4.4.4 Year 2023 Total Traffic Volumes With Project

The Year 2023 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 3 are shown on Figure 27 and summarized in Table 8. The existing and projected Year 2023 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix I.

Table 8: Existing and Projected Year 2023 (Without and With Alternative 3) LOS Traffic Operating Conditions

Intersection	Approach	AM			PM		
		Exist	Year 2023		Exist	Year 2023	
			w/out Proj	w/ Project		w/out Proj	w/ Project
Ulune St/ Halawa Valley St	Eastbound	C	C	C	B	C	B
	Westbound	D	D	D	D	D	D
	Southbound	D	D	D	D	D	D
Halawa Valley St/ Iwaiwa St	Eastbound	B	B	B	B	B	B
	Westbound	C	C	C	C	C	C
	Southbound	C	C	C	C	C	C
Halawa Valley St/ Waiua Pl	Westbound	A	A	A	A	A	A
	Northbound	B	B	C	B	B	B
Halawa Valley St/ Koaha Pl	Westbound	A	A	A	-	-	-
	Northbound	B	B	B	A	A	B

Traffic operations with the implementation of Alternative 3 are generally expected to remain similar to without project conditions despite the addition of site-generated trips. At the intersection of Ulune Street and Halawa Valley Street near the proposed HCF site, traffic operations are expected to continue operating at LOS “D” or better during both peak periods, while those at the intersection of Halawa Valley Street and Iwaiwa Street are expected to continue operating at LOS “C” or better during both peak periods. The other study intersections along Halawa Valley are expected to continue operating similar to without project conditions during both peak periods with the exception of Waiua Place where the northbound approach is expected to change from an LOS “B” to a slightly lower, but still acceptable LOS “C” during the AM peak period. It should be noted that a level of service was not included in the westbound approach of the intersection of Halawa Valley Street and Koaha Place as no vehicles were counted executing a left-turn movement at this approach



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YEAR 2023 PEAK HOURS OF TRAFFIC WITH ALTERNATIVE 3

FIGURE 27

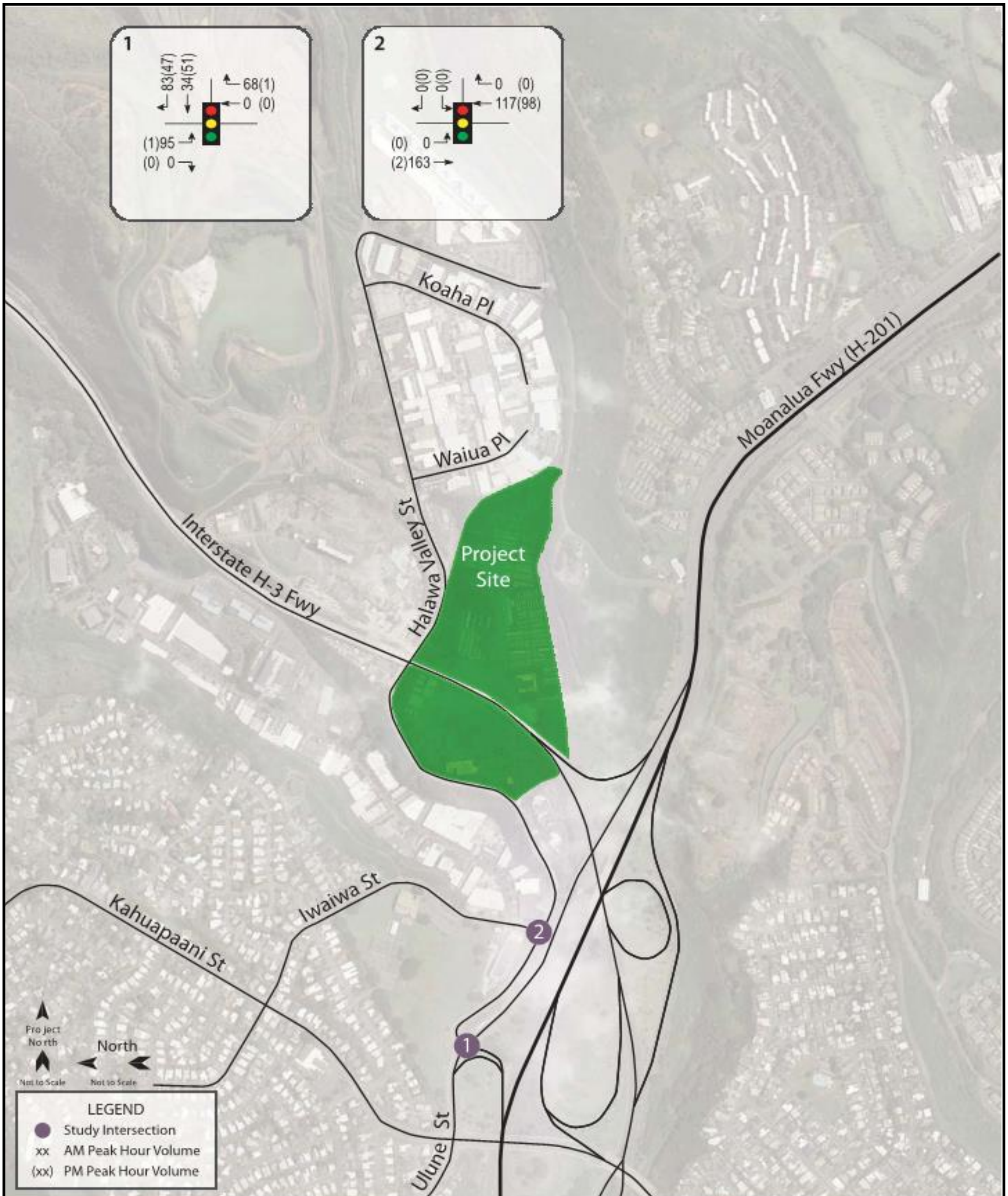
4.5 Alternative 4

4.5.1 Trip Distribution

Figure 28 shows the distribution of site-generated traffic during the AM and PM peak periods under Alternative 4. Primary access to the proposed Animal Quarantine Station site will be provided via a new driveway off Halawa Valley Street. It should be noted that the distribution of site-generated vehicles for Alternative 3 and Alternative 4 are expected to be similar due to the close proximity of the two sites, as well as the limited access points and available routes along Halawa Valley Street. The directional distribution at the intersection of Ulune Street and Halawa Valley Street was assumed to remain similar to existing conditions. As such, 58% of entering trips were assumed to be traveling eastbound while 42% of entering trips were assumed to be traveling westbound during the AM peak period. Similarly, during the PM peak period, 43% of entering trips were assumed to be traveling eastbound while 57% were assumed to be traveling westbound. Exiting trips were also based on the existing directional distribution at the intersection of Ulune Street and Halawa Valley Street. As such, 71% of exiting trips were assumed to be traveling westbound at that intersection while 29% of exiting trips were assumed to be traveling southbound during the AM peak period. Similarly, during the PM peak period, 47% of exiting trips were assumed to be traveling westbound that intersection while 53% of exiting trips were assumed to be traveling southbound

4.5.2 Through Traffic Forecasting Methodology

The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located along Halawa Valley Street in the vicinity of the proposed project sites. The historical data indicates relatively stable traffic volumes along the study corridors and, as such, an annual traffic growth rate of approximately 0.5 % was conservatively assumed in the project vicinity. Using 2017 as the Base Year, a growth rate factor of 1.03 was applied to the existing traffic demands in the project vicinity to achieve the projected Year 2023 traffic demands.



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DISTRIBUTION OF SITE-GENERATED VEHICLES WITH ALTERNATIVE 4

FIGURE 28

4.5.3 Year 2023 Total Traffic Volumes Without Project

The projected Year 2023 AM and PM peak period traffic volumes and operating conditions without the implementation of Alternative 4 is shown in Figure 29, and summarized in Table 9. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix J.

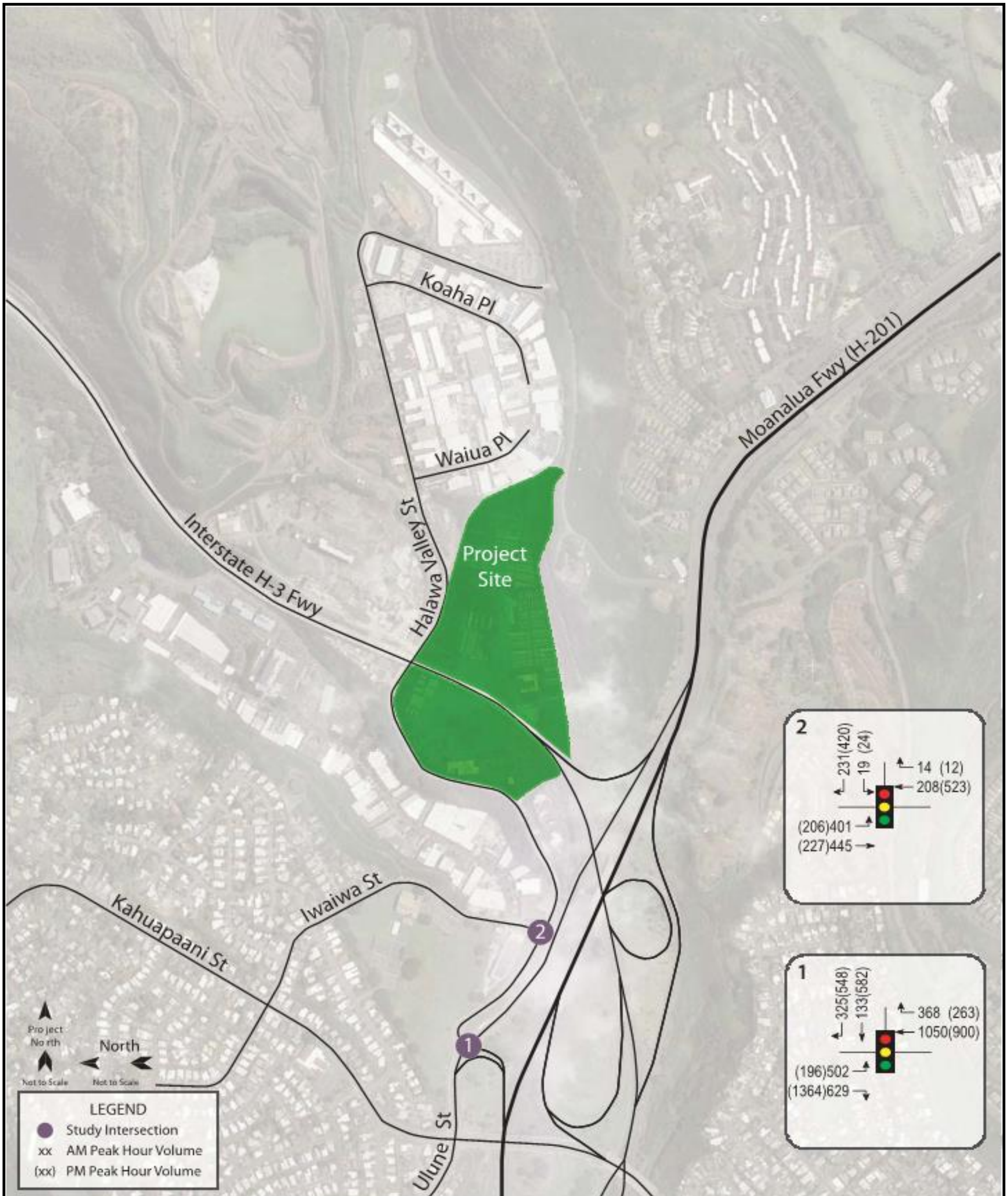
Table 9: Existing and Projected Year 2023 (Without Project) LOS Traffic Operating Conditions

Intersection	Approach	AM		PM	
		Exist	Year 2023 w/o Proj	Exist	Year 2023 w/o Proj
Ulune St/ Halawa Valley St	Eastbound	C	C	C	B
	Westbound	D	D	D	D
	Southbound	D	D	D	D
Halawa Valley St/ Iwaiwa St	Eastbound	B	B	B	B
	Westbound	C	C	C	C
	Southbound	C	C	C	C

Under Year 2023 without project conditions, traffic operations are expected to remain generally similar to existing conditions. At the intersection of Ulune Street and Halawa Valley Street near the proposed Animal Quarantine Station site, traffic operations are expected to continue operating at LOS “D” or better during both peak periods with the exception of the eastbound approach which is expected to change from LOS “B” to LOS “C” during the PM peak period. Along Halawa Valley Street, traffic operations at the intersection with Iwaiwa Street are expected to continue operating at LOS “C” or better during both peak periods.

4.5.4 Year 2023 Total Traffic Volumes With Project

The Year 2023 cumulative AM and PM peak hour traffic conditions with the implementation of Alternative 4 are shown in Figure 30 and summarized in Table 10. The cumulative volumes consist of site-generated traffic superimposed over the Year 2023 projected traffic demands. The existing and projected Year 2023 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix K.



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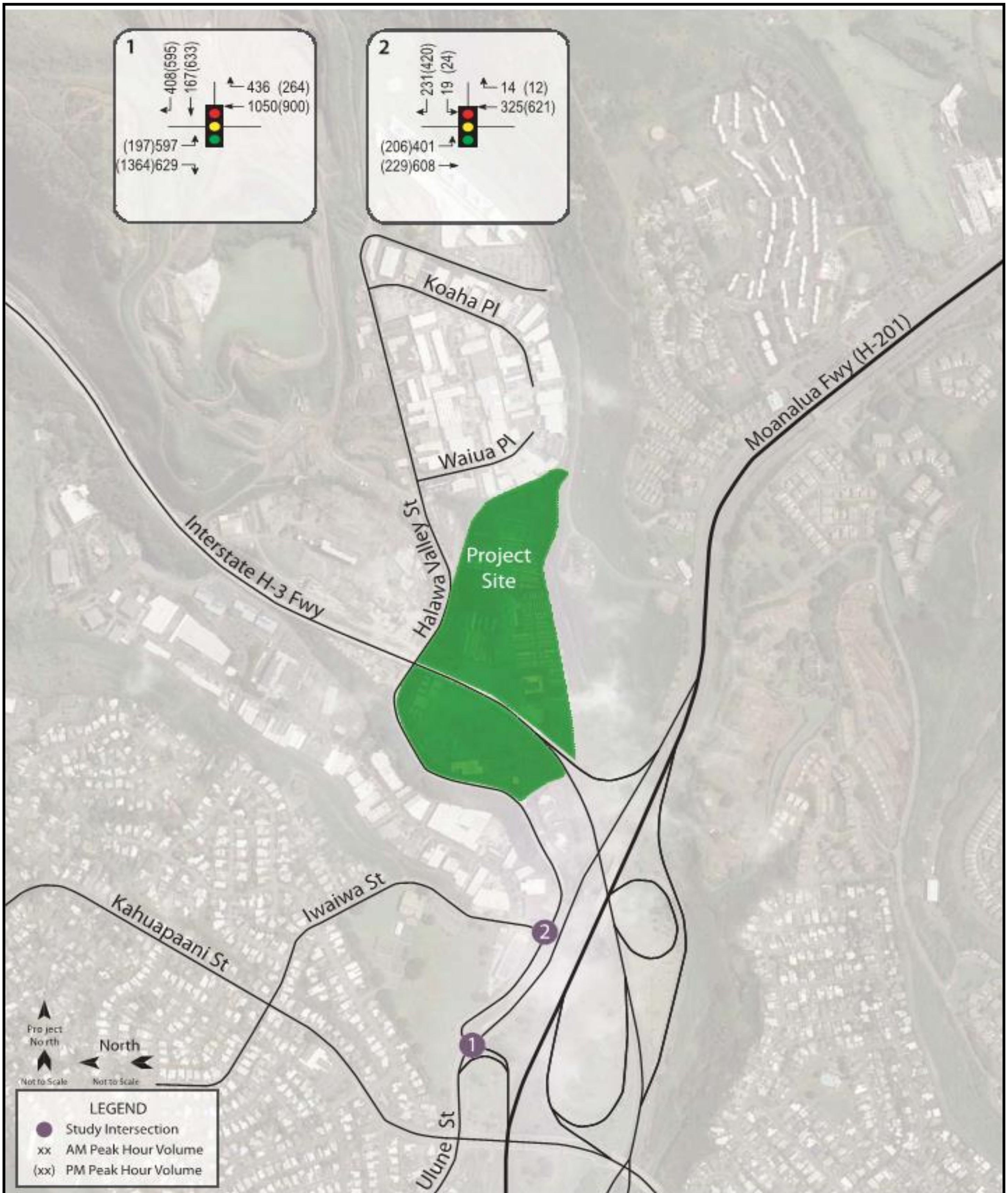
YEAR 2023 PEAK HOURS OF TRAFFIC WITHOUT ALTERNATIVE 4

FIGURE 29



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YEAR 2023 PEAK HOURS OF TRAFFIC
WITH ALTERNATIVE 4

FIGURE 30

Table 10: Existing and Projected Year 2023 (Without and With Alternative 4) LOS Traffic Operating Conditions

Intersection	Approach	AM			PM		
		Exist	Year 2023		Exist	Year 2023	
			w/out Proj	w/ Project		w/out Proj	w/ Project
Ulune St/ Halawa Valley St	Eastbound	C	C	C	B	C	B
	Westbound	D	D	D	D	D	D
	Southbound	D	D	D	D	D	D
Halawa Valley St/ Iwaiwa St	Eastbound	B	B	B	B	B	B
	Westbound	C	C	C	C	C	C
	Southbound	C	C	C	C	C	C

Traffic operations with the implementation of Alternative 4 are generally expected to remain similar to without project conditions despite the addition of site-generated trips determined from Methods 1 and 2. At the intersection of Ulune Street and Halawa Valley Street near the proposed Animal Quarantine Station site, traffic operations are expected to continue operating at LOS “D” or better during both peak periods, while those at the intersection of Halawa Valley Street and Iwaiwa Street are expected to continue operating at LOS “C” during both peak periods.

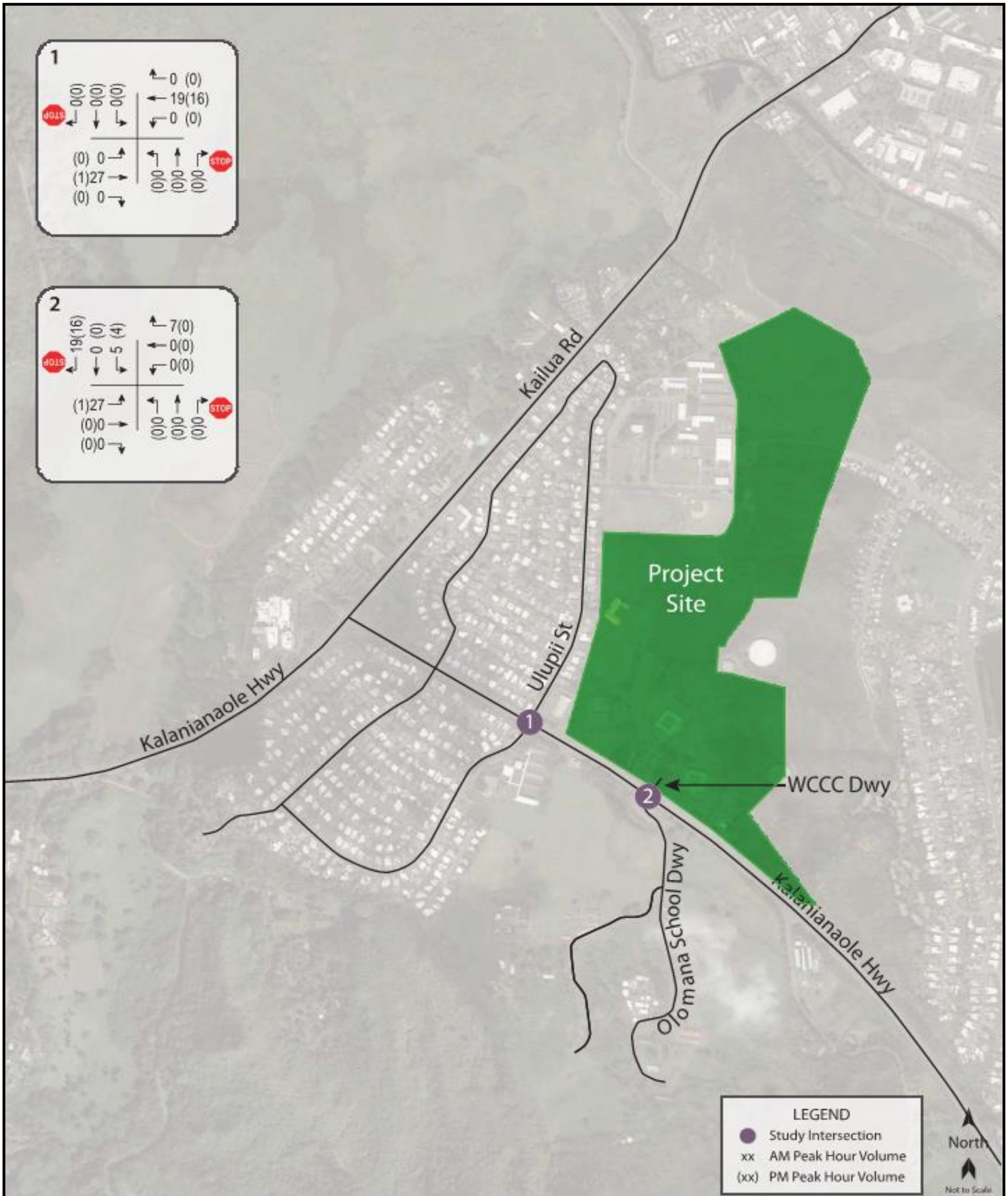
4.6 WCCC Facility

4.6.1 Trip Distribution

Figure 31 shows the distribution of site-generated traffic during the AM and PM peak periods with the proposed expansion of the WCCC facility. Primary access to the WCCC facility in Kailua will continue to be provided via the existing driveway off Kalanianaole Highway. The directional distribution at the intersection of Kalanianaole Highway and the WCCC driveway was assumed to remain similar to existing conditions. As such, 80% were assumed to be traveling to/from the west via Kalanianaole Highway while 20% were assumed to be traveling to/from the east during the AM peak period. Similarly, during the PM peak period, 86% were assumed to be traveling to/from the west via Kalanianaole Highway while 14% were assumed to be traveling to/from the east.

4.6.2 Through Traffic Forecasting Methodology

The travel forecast is based upon historical traffic count data obtained from the State DOT, Highways Division at survey stations located along Kalanianaole Highway (Kailua) in the vicinity of the proposed project site. The historical data indicates relatively stable traffic volumes along the study



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DISTRIBUTION OF SITE-GENERATED VEHICLES WITH PROJECT

FIGURE 31

corridors and, as such, an annual traffic growth rate of approximately 0.5 % was conservatively assumed in the project vicinity. Using 2017 as the Base Year, a growth rate factor of 1.03 was applied to the existing traffic demands in the project vicinity to achieve the projected Year 2023 traffic demands.

4.6.3 Year 2023 Total Traffic Volumes Without Project

The projected Year 2023 AM and PM peak period traffic volumes and operating conditions without the expansion of WCCC is shown in Figure 32, and summarized in Table 11. The existing levels of service are provided for comparison purposes. LOS calculations are included in Appendix L.

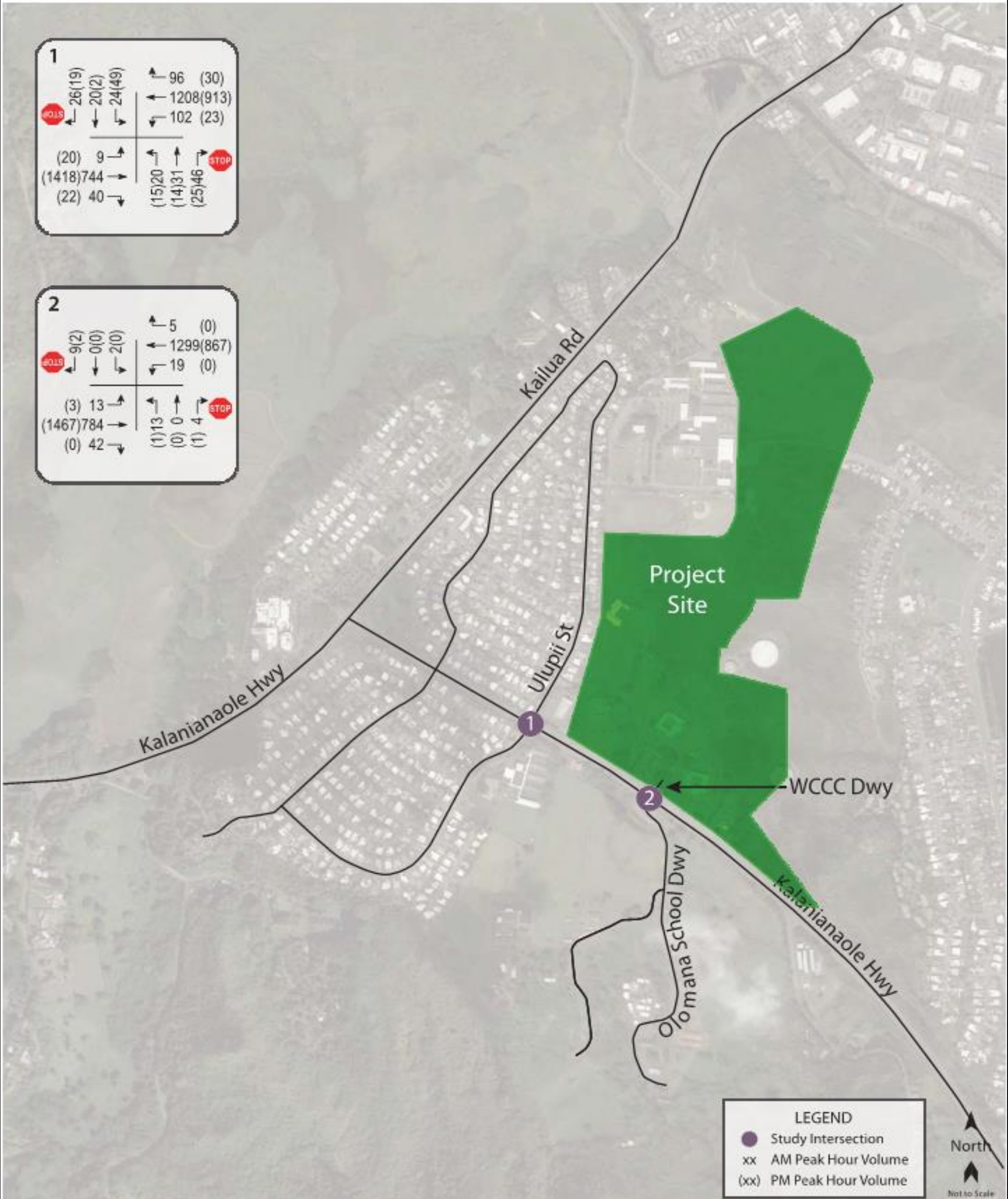
Table 11: Existing and Projected Year 2023 (Without Project) LOS Traffic Operating Conditions

Intersection	Approach	AM		PM	
		Exist	Year 2023 w/o Proj	Exist	Year 2023 w/o Proj
	~~Southbound~~	~~D~~	~~D~~	~~D~~	~~D~~
Kalanianaole Hwy/ Ulupii St	Eastbound	B	B	B	B
	Westbound	B	B	B	B
	Northbound	C	C	C	C
	Southbound	D	D	C	C
Kalanianaole Hwy/WCCC Dwy	Eastbound	B	B	A	A
	Westbound	A	A	-	-
	Northbound	C	C	C	C
	Southbound	B	B	B	B

In the vicinity of the existing WCCC facility, traffic operations at the intersections along Kalanianaole Highway are expected to continue operating at LOS “D” or better during the AM peak period and LOS “C” or better during the PM peak period. It should be noted that a level of service has not been included for the westbound approach of the intersection of Kalanianaole Highway and the WCCC Driveway during the PM peak period because no vehicles were observed executing a left-turn maneuver from this approach during the PM peak period.

4.6.4 Year 2023 Total Traffic Volumes With Project

The Year 2023 cumulative AM and PM peak hour traffic conditions with the expansion of the WCCC facility is shown in Figure 33 and summarized in Table 12. The cumulative volumes consist of site-generated traffic superimposed over the Year 2023 projected traffic demands. The existing and projected Year 2023 (Without Project) operating conditions are provided for comparison purposes. LOS calculations are included in Appendix M.



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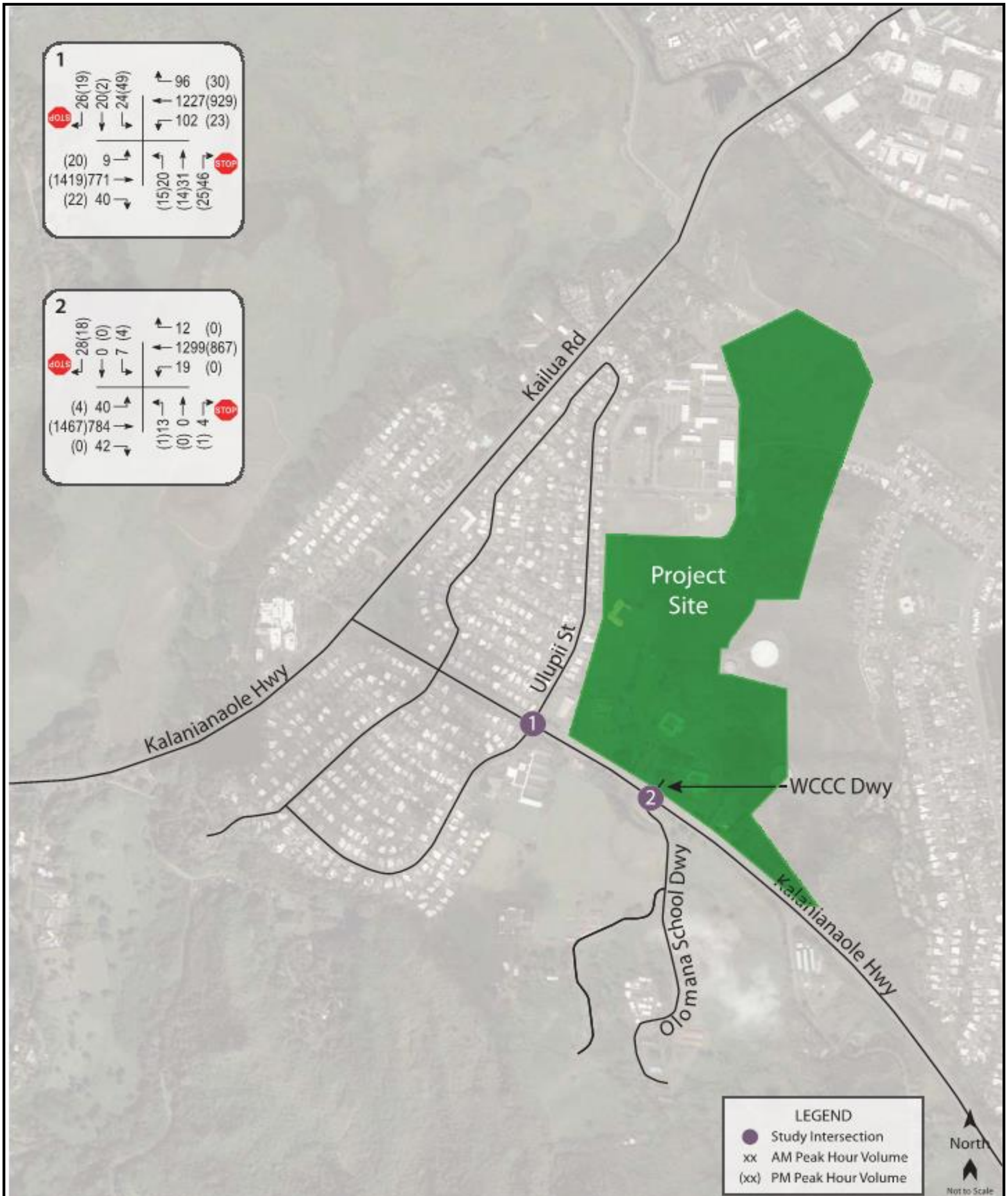
OAHU COMMUNITY CORRECTIONAL CENTER

YEAR 2023 PEAK HOURS OF TRAFFIC
WITHOUT PROJECT

FIGURE
32



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OAHU COMMUNITY CORRECTIONAL CENTER

YEAR 2023 PEAK HOURS OF TRAFFIC WITH PROJECT

FIGURE 33

Table 12: Existing and Projected Year 2023 (Without and With Alternative 4) LOS Traffic Operating Conditions

Intersection	Approach	AM			PM		
		Exist	Year 2023		Exist	Year 2023	
			w/out Proj	w/ Project		w/out Proj	w/ Project
Kalanianaole Hwy/ Ulupii St	Eastbound	B	B	B	B	B	B
	Westbound	B	B	B	B	B	B
	Northbound	C	C	C	C	C	C
	Southbound	D	D	D	C	C	C
Kalanianaole Hwy/ WCCC Dwy	Eastbound	B	B	B	A	A	B
	Westbound	A	A	B	-	-	-
	Northbound	C	C	C	C	C	C
	Southbound	B	B	C	B	B	C

With the implementation of the proposed project at the WCCC facility traffic operations are generally expected to remain similar to without project conditions despite the addition of site-generated trips. In the vicinity of the existing WCCC facility, traffic operations at the intersections along Kalanianaole Highway are expected to continue operating at LOS “D” or better during the AM peak period and LOS “C” or better during the PM peak period. It should be noted that a level of service has not been included for the westbound approach of the intersection of Kalanianaole Highway and the WCCC Driveway during the PM peak period because no vehicles were observed executing a left-turn maneuver from this approach during the PM peak period.

5.0 RECOMMENDATIONS

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

1. Maintain sufficient sight distance for motorists to safely enter and exit all project driveways.

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

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

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

5. Provide adequate on-site parking with clear way-finding instructions to properly direct employees, visitors, delivery trucks, etc.

6. If access at the entrance to the selected site is controlled, provide sufficient storage for entering vehicles at the parking area access controls (i.e., automatic gate, etc.) to ensure that queues do not extend onto the adjacent public roadways.

7. Update the Traffic Impact Report for the Oahu Community Correctional Center 6-9 months after the project is completed and occupied to verify trip generation, trip distribution, and projected operating conditions.

Based on the analysis of the traffic data and field operations, the following recommendation should be considered during the design phase for the expansion of the WCCC facility.

1. Consider providing acceleration and deceleration lanes on Kalanianole Highway at the project access driveway to maintain through traffic movements on the highway as well as to facilitate turning maneuvers entering and exiting the project site. The specific dimensions and configuration of such shall be coordinated with the State Department of Transportation during the design phase of the project.

6.0 CONCLUSION

The Department of Public Safety is currently considering several alternatives for the Oahu Community Correctional Center to alleviate the facility's overcapacity and anticipate future needs. The alternatives under consideration include either replacing the existing OCCC facility in Kalihi, or constructing a new facility either in the Mililani Technology Park, next to the existing Halawa Correctional Facility, or at the existing Animal Quarantine Station. In addition, each alternative is also expected to transfer a portion of inmates to the existing Women's Community Correctional Center in Kailua. With the implementation of the aforementioned recommendations, each of the four alternatives for the proposed Oahu Community Correctional Center are not expected to have a significant impact on traffic operations in the project vicinity. However, although traffic operations are expected to be similar to without project conditions, an update to the traffic study is recommended to be prepared 6-9 months after the completion of the proposed project to verify projected conditions.

APPENDIX A

EXISTING TRAFFIC COUNT DATA

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: AH, YS
Counter: TU-1958, TU-0652
Weather: Clear

File Name : DillPuu AM
Site Code : 00000000
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Puuhale Road Southbound					Dillingham Boulevard Westbound					Puuhale Road Northbound					Kamehameha Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	5	14	10	0	29	12	72	0	2	86	14	0	13	17	44	0	214	58	0	272	431
06:15 AM	2	17	20	0	39	5	79	0	2	86	17	0	9	13	39	0	219	68	0	287	451
06:30 AM	7	8	12	0	27	7	113	0	2	122	30	0	13	6	49	0	269	76	0	345	543
06:45 AM	4	15	12	0	31	7	95	0	1	103	29	0	14	14	57	0	340	71	0	411	602
Total	18	54	54	0	126	31	359	0	7	397	90	0	49	50	189	0	1042	273	0	1315	2027
07:00 AM	3	14	10	0	27	6	85	0	3	94	24	0	15	4	43	0	374	99	0	473	637
07:15 AM	6	24	16	0	46	7	92	0	6	105	45	0	19	13	77	0	362	84	0	446	674
07:30 AM	10	19	20	0	49	12	87	0	5	104	31	0	18	20	69	0	382	160	0	542	764
07:45 AM	13	17	14	0	44	10	107	0	2	119	27	0	17	11	55	0	387	112	0	499	717
Total	32	74	60	0	166	35	371	0	16	422	127	0	69	48	244	0	1505	455	0	1960	2792
08:00 AM	3	11	10	0	24	6	94	0	2	102	38	0	19	6	63	0	396	104	0	500	689
08:15 AM	9	13	10	0	32	12	102	0	2	116	52	0	21	5	78	0	289	72	0	361	587
08:30 AM	2	8	11	0	21	12	122	0	2	136	32	0	18	14	64	0	255	49	0	304	525
08:45 AM	3	8	11	0	22	7	120	0	0	127	29	0	21	5	55	0	240	74	0	314	518
Total	17	40	42	0	99	37	438	0	6	481	151	0	79	30	260	0	1180	299	0	1479	2319
Grand Total	67	168	156	0	391	103	1168	0	29	1300	368	0	197	128	693	0	3727	1027	0	4754	7138
Apprch %	17.1	43	39.9	0		7.9	89.8	0	2.2		53.1	0	28.4	18.5		0	78.4	21.6	0		
Total %	0.9	2.4	2.2	0	5.5	1.4	16.4	0	0.4	18.2	5.2	0	2.8	1.8	9.7	0	52.2	14.4	0	66.6	

	Puuhale Road Southbound				Dillingham Boulevard Westbound				Puuhale Road Northbound				Kamehameha Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	6	**24**	16	46	7	92	0	99	**45**	0	**19**	**64**	0	362	84	446	655
07:30 AM	10	19	**20**	**49**	**12**	87	0	99	31	0	18	49	0	382	**160**	**542**	**739**
07:45 AM	**13**	17	14	44	10	**107**	0	**117**	27	0	17	44	0	387	112	499	704
08:00 AM	3	11	10	24	6	94	0	100	38	0	19	57	0	**396**	104	500	681
Total Volume	32	71	60	163	35	380	0	415	141	0	73	214	0	1527	460	1987	2779
% App. Total	19.6	43.6	36.8		8.4	91.6	0		65.9	0	34.1		0	76.8	23.2		
PHF	.615	.740	.750	.832	.729	.888	.000	.887	.783	.000	.961	.836	.000	.964	.719	.917	.940

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

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Counter: TU-1958, TU-0652
Weather: Clear

File Name : DillPuu PM
Site Code : 00000000
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Puuhale Road Southbound					Dillingham Boulevard Westbound					Puuhale Road Northbound					Kamehameha Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	6	5	20	0	31	4	218	0	1	223	45	0	30	7	82	0	249	34	0	283	619
03:15 PM	4	4	10	0	18	5	181	0	10	196	31	0	21	9	61	0	277	57	0	334	609
03:30 PM	9	5	28	0	42	11	207	0	1	219	53	0	37	18	108	0	395	99	0	494	863
03:45 PM	5	6	23	0	34	9	233	0	2	244	58	0	37	10	105	0	479	87	0	566	949
Total	24	20	81	0	125	29	839	0	14	882	187	0	125	44	356	0	1400	277	0	1677	3040
04:00 PM	7	6	19	0	32	2	192	0	2	196	51	0	42	15	108	0	405	110	0	515	851
04:15 PM	10	2	22	0	34	7	238	0	4	249	75	0	41	7	123	0	480	118	0	598	1004
04:30 PM	16	13	22	0	51	7	240	0	5	252	70	0	79	14	163	0	459	105	0	564	1030
04:45 PM	8	6	24	0	38	6	303	0	2	311	115	0	37	4	156	0	430	28	0	458	963
Total	41	27	87	0	155	22	973	0	13	1008	311	0	199	40	550	0	1774	361	0	2135	3848
05:00 PM	11	11	28	0	50	0	201	30	3	234	64	0	34	11	109	0	394	45	0	439	832
05:15 PM	4	6	13	0	23	3	262	0	0	265	49	0	16	8	73	0	321	42	0	363	724
05:30 PM	8	6	12	0	26	3	208	0	3	214	46	0	20	7	73	0	203	18	0	221	534
Grand Total	88	70	221	0	379	57	2483	30	33	2603	657	0	394	110	1161	0	4092	743	0	4835	8978
Apprch %	23.2	18.5	58.3	0		2.2	95.4	1.2	1.3		56.6	0	33.9	9.5		0	84.6	15.4	0		
Total %	1	0.8	2.5	0	4.2	0.6	27.7	0.3	0.4	29	7.3	0	4.4	1.2	12.9	0	45.6	8.3	0	53.9	

	Puuhale Road Southbound				Dillingham Boulevard Westbound				Puuhale Road Northbound				Kamehameha Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:30 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:00 PM																	
04:00 PM	7	6	19	32	2	192	0	194	51	0	42	93	0	405	110	515	834
04:15 PM	10	2	22	34	**7**	238	0	245	75	0	41	116	0	**480**	**118**	**598**	993
04:30 PM	**16**	**13**	22	**51**	7	240	0	247	70	0	**79**	149	0	459	105	564	**1011**
04:45 PM	8	6	**24**	38	6	**303**	0	**309**	**115**	0	37	**152**	0	430	28	458	957
Total Volume	41	27	87	155	22	973	0	995	311	0	199	510	0	1774	361	2135	3795
% App. Total	26.5	17.4	56.1		2.2	97.8	0		61	0	39		0	83.1	16.9		
PHF	.641	.519	.906	.760	.786	.803	.000	.805	.676	.000	.630	.839	.000	.924	.765	.893	.938

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

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Counter: TU-0654, D4-3888
Weather: Clear

File Name : KamLau AM
Site Code : 00000001
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

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Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
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06:15 AM	9	2	1	6	18	3	97	17	5	122	7	1	7	0	15	16	283	8	0	307	462
06:30 AM	4	1	1	0	6	0	141	13	2	156	2	2	4	1	9	14	337	7	0	358	529
06:45 AM	8	2	2	1	13	1	124	19	1	145	6	0	0	1	7	26	394	5	0	425	590
Total	22	5	5	7	39	9	456	55	9	529	28	4	21	2	55	68	1268	23	1	1360	1983
07:00 AM	8	0	2	4	14	3	110	13	9	135	1	0	2	0	3	19	476	3	0	498	650
07:15 AM	9	1	3	6	19	3	162	12	5	182	0	0	2	0	2	13	517	4	0	534	737
07:30 AM	15	1	3	5	24	2	150	16	3	171	0	0	0	0	0	16	511	6	0	533	728
07:45 AM	9	1	2	0	12	2	160	21	7	190	0	0	1	0	1	18	494	6	0	518	721
Total	41	3	10	15	69	10	582	62	24	678	1	0	5	0	6	66	1998	19	0	2083	2836
08:00 AM	5	1	3	2	11	3	138	16	10	167	0	1	1	0	2	18	489	4	0	511	691
08:15 AM	14	0	3	3	20	4	147	15	5	171	1	1	1	0	3	12	359	4	0	375	569
08:30 AM	12	1	4	7	24	4	146	16	8	174	1	1	3	0	5	10	318	2	0	330	533
08:45 AM	10	0	4	1	15	6	127	20	3	156	1	0	3	0	4	15	296	2	0	313	488
Total	41	2	14	13	70	17	558	67	26	668	3	3	8	0	14	55	1462	12	0	1529	2281
Grand Total	104	10	29	35	178	36	1596	184	59	1875	32	7	34	2	75	189	4728	54	1	4972	7100
Apprch %	58.4	5.6	16.3	19.7		1.9	85.1	9.8	3.1		42.7	9.3	45.3	2.7		3.8	95.1	1.1	0		
Total %	1.5	0.1	0.4	0.5	2.5	0.5	22.5	2.6	0.8	26.4	0.5	0.1	0.5	0	1.1	2.7	66.6	0.8	0	70	

	Laumaka Street Southbound				Kamehameha Highway Westbound				OCCC Driveway Northbound				Kamehameha Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	9	**1**	**3**	13	**3**	**162**	12	177	0	0	**2**	**2**	13	**517**	4	**534**	**726**
07:30 AM	**15**	1	3	**19**	2	150	16	168	0	0	0	0	16	511	**6**	533	720
07:45 AM	9	1	2	12	2	160	**21**	**183**	0	0	1	1	**18**	494	6	518	714
08:00 AM	5	1	3	9	3	138	16	157	0	**1**	1	2	18	489	4	511	679
Total Volume	38	4	11	53	10	610	65	685	0	1	4	5	65	2011	20	2096	2839
% App. Total	71.7	7.5	20.8		1.5	89.1	9.5		0	20	80		3.1	95.9	1		
PHF	.633	1.00	.917	.697	.833	.941	.774	.936	.000	.250	.500	.625	.903	.972	.833	.981	.978

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: DY, FS
Counter: TU-0654, D4-3888
Weather: Clear

File Name : KamLau PM
Site Code : 00000002
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Laumaka Street Southbound					Kamehameha Highway Westbound					OCCC Driveway Northbound					Kamehameha Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	10	0	8	4	22	3	249	22	5	279	6	0	3	0	9	11	277	0	0	288	598
03:15 PM	13	0	12	2	27	1	215	16	1	233	3	2	2	0	7	13	385	0	0	398	665
03:30 PM	9	0	5	8	22	1	272	28	1	302	1	2	0	0	3	22	487	1	0	510	837
03:45 PM	15	1	8	0	24	0	255	12	4	271	6	2	2	1	11	20	496	0	0	516	822
Total	47	1	33	14	95	5	991	78	11	1085	16	6	7	1	30	66	1645	1	0	1712	2922
04:00 PM	14	1	11	4	30	0	274	11	3	288	1	1	0	0	2	23	514	0	0	537	857
04:15 PM	15	0	6	2	23	3	281	19	2	305	2	4	2	0	8	16	504	1	0	521	857
04:30 PM	13	0	8	3	24	0	314	12	5	331	5	0	0	0	5	23	492	1	0	516	876
04:45 PM	16	0	9	4	29	3	268	14	1	286	6	0	1	0	7	15	351	2	0	368	690
Total	58	1	34	13	106	6	1137	56	11	1210	14	5	3	0	22	77	1861	4	0	1942	3280
05:00 PM	13	1	9	1	24	1	321	15	2	339	5	0	1	0	6	14	365	1	0	380	749
05:15 PM	15	0	7	2	24	1	263	13	3	280	2	0	3	2	7	13	276	1	0	290	601
05:30 PM	14	1	5	0	20	5	284	12	1	302	3	0	4	0	7	15	225	1	0	241	570
05:45 PM	11	0	4	0	15	1	234	12	14	261	2	0	1	0	3	16	176	1	0	193	472
Total	53	2	25	3	83	8	1102	52	20	1182	12	0	9	2	23	58	1042	4	0	1104	2392
Grand Total	158	4	92	30	284	19	3230	186	42	3477	42	11	19	3	75	201	4548	9	0	4758	8594
Apprch %	55.6	1.4	32.4	10.6		0.5	92.9	5.3	1.2		56	14.7	25.3	4		4.2	95.6	0.2	0		
Total %	1.8	0	1.1	0.3	3.3	0.2	37.6	2.2	0.5	40.5	0.5	0.1	0.2	0	0.9	2.3	52.9	0.1	0	55.4	

	Laumaka Street Southbound				Kamehameha Highway Westbound				OCCC Driveway Northbound				Kamehameha Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 03:45 PM																	
03:45 PM	**15**	**1**	8	24	0	255	12	267	**6**	2	**2**	**10**	20	496	0	516	817
04:00 PM	14	1	**11**	**26**	0	274	11	285	1	1	0	2	**23**	**514**	0	**537**	850
04:15 PM	15	0	6	21	**3**	281	**19**	303	2	**4**	2	8	16	504	**1**	521	853
04:30 PM	13	0	8	21	0	**314**	12	**326**	5	0	0	5	23	492	1	516	**868**
Total Volume	57	2	33	92	3	1124	54	1181	14	7	4	25	82	2006	2	2090	3388
% App. Total	62	2.2	35.9		0.3	95.2	4.6		56	28	16		3.9	96	0.1		
PHF	.950	.500	.750	.885	.250	.895	.711	.906	.583	.438	.500	.625	.891	.976	.500	.973	.976

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: PA
Counter: D4-5677
Weather: Clear

File Name : KamOCCC AM
Site Code : 00000005
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Kamehameha Highway Westbound					OCCC Visitor Parking Driveway Northbound					Kamehameha Highway Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	2
06:15 AM	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	2
06:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
06:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	2	0	2	0	4	0	0	1	0	1	5
07:00 AM	0	1	0	0	0	1	1	0	0	0	1	0	0	4	0	4	6
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3
07:45 AM	0	1	0	0	0	1	0	0	0	0	0	0	0	3	0	3	4
Total	0	2	0	0	0	2	1	0	0	0	1	0	0	11	0	11	14
08:00 AM	0	0	0	0	0	0	1	0	3	0	4	0	0	2	0	2	6
08:15 AM	0	1	0	0	0	1	0	0	1	0	1	0	0	1	0	1	3
08:30 AM	0	1	0	0	0	1	0	0	3	0	3	0	0	1	0	1	5
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Total	0	2	0	0	0	2	1	0	7	0	8	0	0	5	0	5	15
Grand Total	0	4	0	0	0	4	4	0	9	0	13	0	0	17	0	17	34
Apprch %		100	0	0	0		30.8	0	69.2	0		0	0	100	0		
Total %	0	11.8	0	0	0	11.8	11.8	0	26.5	0	38.2	0	0	50	0	50	

	Southbound	Kamehameha Highway Westbound				OCCC Visitor Parking Driveway Northbound				Kamehameha Highway Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:45 AM														
07:45 AM	0	**1**	0	0	**1**	0	0	0	0	0	0	**3**	**3**	4
08:00 AM	0	0	0	0	0	**1**	0	**3**	**4**	0	0	2	2	**6**
08:15 AM	0	1	0	0	1	0	0	1	1	0	0	1	1	3
08:30 AM	0	1	0	0	1	0	0	3	3	0	0	1	1	5
Total Volume	0	3	0	0	3	1	0	7	8	0	0	7	7	18
% App. Total		100	0	0		12.5	0	87.5		0	0	100		
PHF	.000	.750	.000	.000	.750	.250	.000	.583	.500	.000	.000	.583	.583	.750

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: PA
Counter: D4-5677
Weather: Clear

File Name : KamOCCC PM
Site Code : 00000005
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Kamehameha Highway Westbound					OCCC Visitor Parking Driveway Northbound					Kamehameha Highway Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
03:30 PM	0	0	0	0	0	0	1	0	3	0	4	0	0	2	0	2	6
03:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	0	3	0	4	0	0	3	0	3	7
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	2
Total	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	2
05:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Grand Total	0	0	0	0	0	0	1	0	4	0	5	0	0	4	1	5	10
Apprch %		0	0	0	0		20	0	80	0		0	0	80	20		
Total %	0	0	0	0	0	0	10	0	40	0	50	0	0	40	10	50	

	Southbound	Kamehameha Highway Westbound				OCCC Visitor Parking Driveway Northbound				Kamehameha Highway Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:00 PM														
03:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	1	1	1
03:30 PM	0	0	0	0	0	**1**	0	**3**	**4**	0	0	**2**	**2**	**6**
03:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Volume	0	0	0	0	0	1	0	3	4	0	0	3	3	7
% App. Total		0	0	0		25	0	75		0	0	100		
PHF	.000	.000	.000	.000	.000	.250	.000	.250	.250	.000	.000	.375	.375	.292

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: CK, HM
Counter: TU-2049, TU-1957
Weather: Clear

File Name : NimPuu AM
Site Code : 00000003
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Puuhale Road Southbound					Nimitz Highway Westbound					Puuhale Road Northbound					Nimitz Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	9	28	16	0	53	0	234	11	15	260	9	11	10	13	43	6	520	48	0	574	930
06:15 AM	4	21	19	1	45	0	247	8	18	273	11	11	31	13	66	3	634	71	0	708	1092
06:30 AM	15	34	12	1	62	0	249	19	12	280	10	19	21	3	53	5	727	45	0	777	1172
06:45 AM	16	30	7	1	54	0	344	19	11	374	8	16	18	2	44	9	804	46	0	859	1331
Total	44	113	54	3	214	0	1074	57	56	1187	38	57	80	31	206	23	2685	210	0	2918	4525
07:00 AM	20	35	10	0	65	0	320	14	1	335	5	11	24	0	40	9	936	45	0	990	1430
07:15 AM	22	28	14	0	64	0	321	20	6	347	8	22	18	1	49	7	943	19	0	969	1429
07:30 AM	33	36	8	0	77	0	341	17	15	373	10	18	13	4	45	6	802	26	0	834	1329
07:45 AM	15	55	10	0	80	0	321	22	5	348	12	24	14	3	53	7	676	19	0	702	1183
Total	90	154	42	0	286	0	1303	73	27	1403	35	75	69	8	187	29	3357	109	0	3495	5371
08:00 AM	21	37	12	0	70	0	355	22	7	384	8	7	18	1	34	8	613	18	0	639	1127
08:15 AM	17	23	8	1	49	0	301	24	4	329	13	18	15	0	46	11	778	34	0	823	1247
08:30 AM	20	41	14	0	75	0	329	16	8	353	8	11	20	1	40	13	677	40	0	730	1198
08:45 AM	16	32	17	0	65	0	250	16	2	268	9	11	9	1	30	8	499	30	0	537	900
Total	74	133	51	1	259	0	1235	78	21	1334	38	47	62	3	150	40	2567	122	0	2729	4472
Grand Total	208	400	147	4	759	0	3612	208	104	3924	111	179	211	42	543	92	8609	441	0	9142	14368
Apprch %	27.4	52.7	19.4	0.5		0	92	5.3	2.7		20.4	33	38.9	7.7		1	94.2	4.8	0		
Total %	1.4	2.8	1	0	5.3	0	25.1	1.4	0.7	27.3	0.8	1.2	1.5	0.3	3.8	0.6	59.9	3.1	0	63.6	

	Puuhale Road Southbound				Nimitz Highway Westbound				Puuhale Road Northbound				Nimitz Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 06:45 AM																	
06:45 AM	16	30	7	53	0	**344**	19	**363**	8	16	18	42	**9**	804	**46**	859	1317
07:00 AM	20	35	10	65	0	320	14	334	5	11	**24**	40	9	936	45	**990**	**1429**
07:15 AM	22	28	**14**	64	0	321	**20**	341	8	**22**	18	**48**	7	**943**	19	969	1422
07:30 AM	**33**	**36**	8	**77**	0	341	17	358	**10**	18	13	41	6	802	26	834	1310
Total Volume	91	129	39	259	0	1326	70	1396	31	67	73	171	31	3485	136	3652	5478
% App. Total	35.1	49.8	15.1		0	95	5		18.1	39.2	42.7		0.8	95.4	3.7		
PHF	.689	.896	.696	.841	.000	.964	.875	.961	.775	.761	.760	.891	.861	.924	.739	.922	.958

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: CK, JT
Counter: TU-2049, TU-1957
Weather: Clear

File Name : NimPuu PM
Site Code : 00000003
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Puuhale Road Southbound					Nimitz Highway Westbound					Puuhale Road Northbound					Nimitz Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	13	21	0	0	34	18	488	17	2	525	24	34	11	4	73	12	489	19	0	520	1152
03:15 PM	22	21	1	0	44	29	510	7	11	557	24	29	21	0	74	10	502	20	0	532	1207
03:30 PM	18	29	20	0	67	23	627	16	10	676	18	41	21	2	82	3	460	12	0	475	1300
03:45 PM	5	37	10	0	52	8	647	17	9	681	16	31	21	0	68	8	501	22	0	531	1332
Total	58	108	31	0	197	78	2272	57	32	2439	82	135	74	6	297	33	1952	73	0	2058	4991
04:00 PM	17	20	15	0	52	19	665	15	7	706	31	38	20	2	91	2	475	13	0	490	1339
04:15 PM	15	30	9	0	54	7	638	18	0	663	29	41	19	0	89	13	505	22	0	540	1346
04:30 PM	11	29	8	0	48	12	628	13	6	659	31	44	15	0	90	11	571	4	0	586	1383
04:45 PM	18	29	9	0	56	10	618	30	16	674	25	32	12	0	69	14	563	18	0	595	1394
Total	61	108	41	0	210	48	2549	76	29	2702	116	155	66	2	339	40	2114	57	0	2211	5462
05:00 PM	17	16	9	0	42	10	682	15	5	712	21	37	23	6	87	7	542	25	0	574	1415
05:15 PM	13	23	9	0	45	12	626	21	8	667	25	22	12	3	62	12	562	15	0	589	1363
05:30 PM	10	9	6	0	25	10	686	18	5	719	15	17	9	0	41	4	507	17	0	528	1313
05:45 PM	16	9	7	0	32	10	616	12	2	640	21	17	4	0	42	9	410	17	0	436	1150
Total	56	57	31	0	144	42	2610	66	20	2738	82	93	48	9	232	32	2021	74	0	2127	5241
Grand Total	175	273	103	0	551	168	7431	199	81	7879	280	383	188	17	868	105	6087	204	0	6396	15694
Apprch %	31.8	49.5	18.7	0		2.1	94.3	2.5	1		32.3	44.1	21.7	2		1.6	95.2	3.2	0		
Total %	1.1	1.7	0.7	0	3.5	1.1	47.3	1.3	0.5	50.2	1.8	2.4	1.2	0.1	5.5	0.7	38.8	1.3	0	40.8	

	Puuhale Road Southbound				Nimitz Highway Westbound				Puuhale Road Northbound				Nimitz Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	11	**29**	8	48	**12**	628	13	653	**31**	**44**	15	**90**	11	**571**	4	586	1377
04:45 PM	**18**	29	**9**	**56**	10	618	**30**	658	25	32	12	69	**14**	563	18	**595**	1378
05:00 PM	17	16	9	42	10	**682**	15	**707**	21	37	**23**	81	7	542	**25**	574	**1404**
05:15 PM	13	23	9	45	12	626	21	659	25	22	12	59	12	562	15	589	1352
Total Volume	59	97	35	191	44	2554	79	2677	102	135	62	299	44	2238	62	2344	5511
% App. Total	30.9	50.8	18.3		1.6	95.4	3		34.1	45.2	20.7		1.9	95.5	2.6		
PHF	.819	.836	.972	.853	.917	.936	.658	.947	.823	.767	.674	.831	.786	.980	.620	.985	.981

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: BE, GH
Counter: TU-0649, TU-2050
Weather: Clear

File Name : NimSand AM
Site Code : 00000004
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Nimitz Highway Westbound					Sand Island Access Road Northbound					Nimitz Highway Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	73	167	0	6	246	67	0	27	6	100	0	615	369	0	984	1330
06:15 AM	0	65	220	0	3	288	92	0	37	3	132	0	766	332	0	1098	1518
06:30 AM	0	86	226	0	5	317	95	0	28	9	132	0	828	302	0	1130	1579
06:45 AM	0	89	268	0	7	364	124	0	38	6	168	0	880	264	0	1144	1676
Total	0	313	881	0	21	1215	378	0	130	24	532	0	3089	1267	0	4356	6103
07:00 AM	0	72	267	0	1	340	120	0	41	2	163	0	1057	270	0	1327	1830
07:15 AM	0	64	278	0	4	346	131	0	37	8	176	0	992	182	0	1174	1696
07:30 AM	0	93	290	0	7	390	95	0	38	12	145	0	797	201	0	998	1533
07:45 AM	0	87	294	0	4	385	115	0	36	1	152	0	776	202	0	978	1515
Total	0	316	1129	0	16	1461	461	0	152	23	636	0	3622	855	0	4477	6574
08:00 AM	0	88	255	0	2	345	83	0	44	2	129	0	788	200	0	988	1462
08:15 AM	0	62	278	0	4	344	93	0	40	5	138	0	812	246	0	1058	1540
08:30 AM	0	88	309	0	3	400	98	0	36	3	137	0	690	213	0	903	1440
08:45 AM	0	63	225	0	0	288	118	0	42	1	161	0	554	181	0	735	1184
Total	0	301	1067	0	9	1377	392	0	162	11	565	0	2844	840	0	3684	5626
Grand Total	0	930	3077	0	46	4053	1231	0	444	58	1733	0	9555	2962	0	12517	18303
Apprch %		22.9	75.9	0	1.1		71	0	25.6	3.3		0	76.3	23.7	0		
Total %	0	5.1	16.8	0	0.3	22.1	6.7	0	2.4	0.3	9.5	0	52.2	16.2	0	68.4	

	Southbound	Nimitz Highway Westbound				Sand Island Access Road Northbound				Nimitz Highway Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 06:30 AM														
06:30 AM	0	86	226	0	312	95	0	28	123	0	828	**302**	1130	1565
06:45 AM	0	**89**	268	0	**357**	124	0	38	162	0	880	264	1144	1663
07:00 AM	0	72	267	0	339	120	0	**41**	161	0	**1057**	270	**1327**	**1827**
07:15 AM	0	64	**278**	0	342	**131**	0	37	**168**	0	992	182	1174	1684
Total Volume	0	311	1039	0	1350	470	0	144	614	0	3757	1018	4775	6739
% App. Total		23	77	0		76.5	0	23.5		0	78.7	21.3		
PHF	.000	.874	.934	.000	.945	.897	.000	.878	.914	.000	.889	.843	.900	.922

Wilson Okamoto Corporation
1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: BE, GH
Counter: TU-0649, TU-2050
Weather: Clear

File Name : NimSand PM
Site Code : 00000004
Start Date : 4/11/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Nimtiz Highway Westbound					Sand Island Access Road Northbound					Nimtiz Highway Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	43	519	0	10	572	219	0	50	16	285	0	481	138	0	619	1476
03:15 PM	0	39	561	0	5	605	191	0	56	3	250	0	548	170	0	718	1573
03:30 PM	0	70	586	0	5	661	185	0	58	4	247	0	518	139	0	657	1565
03:45 PM	0	45	648	0	8	701	185	0	52	8	245	0	553	135	0	688	1634
Total	0	197	2314	0	28	2539	780	0	216	31	1027	0	2100	582	0	2682	6248
04:00 PM	0	39	689	0	5	733	178	0	49	5	232	0	534	135	0	669	1634
04:15 PM	0	34	651	0	5	690	151	2	71	8	232	0	507	131	0	638	1560
04:30 PM	0	36	616	0	12	664	163	0	62	16	241	0	552	118	0	670	1575
04:45 PM	0	31	645	0	4	680	127	0	59	2	188	0	555	143	0	698	1566
Total	0	140	2601	0	26	2767	619	2	241	31	893	0	2148	527	0	2675	6335
05:00 PM	0	45	667	0	2	714	141	0	55	3	199	0	524	80	0	604	1517
05:15 PM	0	28	636	0	0	664	132	0	56	0	188	0	562	77	0	639	1491
05:30 PM	0	43	626	0	6	675	89	0	45	6	140	0	489	78	0	567	1382
05:45 PM	0	38	605	0	4	647	85	0	32	6	123	0	441	61	0	502	1272
Total	0	154	2534	0	12	2700	447	0	188	15	650	0	2016	296	0	2312	5662
Grand Total	0	491	7449	0	66	8006	1846	2	645	77	2570	0	6264	1405	0	7669	18245
Apprch %		6.1	93	0	0.8		71.8	0.1	25.1	3		0	81.7	18.3	0		
Total %	0	2.7	40.8	0	0.4	43.9	10.1	0	3.5	0.4	14.1	0	34.3	7.7	0	42	

	Southbound	Nimtiz Highway Westbound				Sand Island Access Road Northbound				Nimtiz Highway Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:15 PM														
03:15 PM	0	39	561	0	600	**191**	0	56	**247**	0	548	**170**	**718**	1565
03:30 PM	0	**70**	586	0	656	185	0	**58**	243	0	518	139	657	1556
03:45 PM	0	45	648	0	693	185	0	52	237	0	**553**	135	688	1618
04:00 PM	0	39	**689**	0	**728**	178	0	49	227	0	534	135	669	**1624**
Total Volume	0	193	2484	0	2677	739	0	215	954	0	2153	579	2732	6363
% App. Total		7.2	92.8	0		77.5	0	22.5		0	78.8	21.2		
PHF	.000	.689	.901	.000	.919	.967	.000	.927	.966	.000	.973	.851	.951	.980

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: AH, GH
Counter: D4-3888, TU-0652
Weather: Clear

File Name : KamLei AM
Site Code : 00000001
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Kamehameha Highway Southbound					Leilehua Road Westbound					Kamehameha Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
06:00 AM	59	54	0	0	113	4	0	105	0	109	0	127	48	0	175	0	397
06:15 AM	39	59	0	0	98	9	0	77	0	86	0	105	26	0	131	0	315
06:30 AM	48	69	0	1	118	10	0	84	2	96	0	130	43	0	173	0	387
06:45 AM	79	86	0	2	167	8	0	110	1	119	0	136	35	0	171	0	457
Total	225	268	0	3	496	31	0	376	3	410	0	498	152	0	650	0	1556
07:00 AM	44	88	0	0	132	12	0	105	0	117	0	164	38	0	202	0	451
07:15 AM	81	111	0	0	192	18	0	114	0	132	0	133	47	0	180	0	504
07:30 AM	79	127	0	1	207	27	0	114	1	142	0	154	54	0	208	0	557
07:45 AM	120	118	0	0	238	17	0	81	0	98	0	153	66	0	219	0	555
Total	324	444	0	1	769	74	0	414	1	489	0	604	205	0	809	0	2067
08:00 AM	68	96	0	0	164	23	0	86	0	109	0	126	54	0	180	0	453
08:15 AM	69	107	0	0	176	22	0	74	0	96	0	112	26	0	138	0	410
08:30 AM	61	73	0	0	134	14	0	95	0	109	0	118	29	0	147	0	390
08:45 AM	73	85	0	0	158	15	0	74	0	89	0	102	24	0	126	0	373
Total	271	361	0	0	632	74	0	329	0	403	0	458	133	0	591	0	1626
Grand Total	820	1073	0	4	1897	179	0	1119	4	1302	0	1560	490	0	2050	0	5249
Apprch %	43.2	56.6	0	0.2		13.7	0	85.9	0.3		0	76.1	23.9	0			
Total %	15.6	20.4	0	0.1	36.1	3.4	0	21.3	0.1	24.8	0	29.7	9.3	0	39.1	0	

	Kamehameha Highway Southbound				Leilehua Road Westbound				Kamehameha Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:15 AM														
07:15 AM	81	111	0	192	18	0	**114**	132	0	133	47	180	0	504
07:30 AM	79	**127**	0	206	**27**	0	114	**141**	0	**154**	54	208	0	**555**
07:45 AM	**120**	118	0	**238**	17	0	81	98	0	153	**66**	**219**	0	555
08:00 AM	68	96	0	164	23	0	86	109	0	126	54	180	0	453
Total Volume	348	452	0	800	85	0	395	480	0	566	221	787	0	2067
% App. Total	43.5	56.5	0		17.7	0	82.3		0	71.9	28.1			
PHF	.725	.890	.000	.840	.787	.000	.866	.851	.000	.919	.837	.898	.000	.931

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: FS, GH
Counter: D4-3888, TU-0652
Weather: Clear

File Name : KamLei PM
Site Code : 00000001
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Kamehameha Highway Southbound					Leilehua Road Westbound					Kamehameha Highway Northbound					Eastbound	
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
03:00 PM	114	115	0	0	229	22	0	20	0	42	0	121	33	0	154	0	425
03:15 PM	85	156	0	0	241	32	0	21	1	54	0	129	37	0	166	0	461
03:30 PM	136	157	0	0	293	25	0	32	0	57	0	81	29	0	110	0	460
03:45 PM	93	156	0	0	249	29	0	30	0	59	0	129	36	0	165	0	473
Total	428	584	0	0	1012	108	0	103	1	212	0	460	135	0	595	0	1819
04:00 PM	135	162	0	0	297	36	0	26	0	62	0	104	19	0	123	0	482
04:15 PM	86	171	0	0	257	32	0	38	1	71	0	122	40	0	162	0	490
04:30 PM	108	156	0	0	264	35	0	41	0	76	0	110	28	0	138	0	478
04:45 PM	98	170	0	0	268	41	0	39	0	80	0	100	31	0	131	0	479
Total	427	659	0	0	1086	144	0	144	1	289	0	436	118	0	554	0	1929
05:00 PM	111	144	0	0	255	31	0	53	0	84	0	91	25	0	116	0	455
05:15 PM	104	161	0	0	265	22	0	41	0	63	0	96	29	0	125	0	453
05:30 PM	89	163	0	0	252	27	0	30	0	57	0	125	28	0	153	0	462
05:45 PM	62	126	0	0	188	23	0	40	0	63	0	104	30	0	134	0	385
Total	366	594	0	0	960	103	0	164	0	267	0	416	112	0	528	0	1755
Grand Total	1221	1837	0	0	3058	355	0	411	2	768	0	1312	365	0	1677	0	5503
Apprch %	39.9	60.1	0	0		46.2	0	53.5	0.3		0	78.2	21.8	0			
Total %	22.2	33.4	0	0	55.6	6.5	0	7.5	0	14	0	23.8	6.6	0	30.5	0	

	Kamehameha Highway Southbound				Leilehua Road Westbound				Kamehameha Highway Northbound				Eastbound	
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 04:00 PM														
04:00 PM	**135**	162	0	**297**	36	0	26	62	0	104	19	123	0	482
04:15 PM	86	**171**	0	257	32	0	38	70	0	**122**	**40**	**162**	0	**489**
04:30 PM	108	156	0	264	35	0	**41**	76	0	110	28	138	0	478
04:45 PM	98	170	0	268	**41**	0	39	**80**	0	100	31	131	0	479
Total Volume	427	659	0	1086	144	0	144	288	0	436	118	554	0	1928
% App. Total	39.3	60.7	0		50	0	50		0	78.7	21.3			
PHF	.791	.963	.000	.914	.878	.000	.878	.900	.000	.893	.738	.855	.000	.986

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: BE
Counter: D4-5676
Weather: Clear

File Name : H-2 On-Ramp AM
Site Code : 00000002
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Leilehua Road Westbound					Northbound	Leilehua Road Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	55	99	0	0	154	0	0	28	69	0	97	251
06:15 AM	0	47	83	0	0	130	0	0	35	32	0	67	197
06:30 AM	0	48	95	0	0	143	0	0	34	57	0	91	234
06:45 AM	0	50	106	0	0	156	0	0	47	44	0	91	247
Total	0	200	383	0	0	583	0	0	144	202	0	346	929
07:00 AM	0	70	107	0	0	177	0	0	31	45	0	76	253
07:15 AM	0	54	129	0	0	183	0	0	76	53	0	129	312
07:30 AM	0	50	130	0	0	180	0	0	92	38	0	130	310
07:45 AM	0	52	106	0	0	158	0	0	124	44	0	168	326
Total	0	226	472	0	0	698	0	0	323	180	0	503	1201
08:00 AM	0	66	104	0	0	170	0	0	71	38	0	109	279
08:15 AM	0	48	91	0	0	139	0	0	42	52	0	94	233
08:30 AM	0	48	114	0	0	162	0	0	48	40	0	88	250
08:45 AM	0	43	89	0	0	132	0	0	48	39	0	87	219
Total	0	205	398	0	0	603	0	0	209	169	0	378	981
Grand Total	0	631	1253	0	0	1884	0	0	676	551	0	1227	3111
Apprch %		33.5	66.5	0	0			0	55.1	44.9	0		
Total %	0	20.3	40.3	0	0	60.6	0	0	21.7	17.7	0	39.4	

	Southbound	Leilehua Road Westbound				Northbound	Leilehua Road Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 07:15 AM											
07:15 AM	0	54	129	0	**183**	0	0	76	**53**	129	312
07:30 AM	0	50	**130**	0	180	0	0	92	38	130	310
07:45 AM	0	52	106	0	158	0	0	**124**	44	**168**	**326**
08:00 AM	0	**66**	104	0	170	0	0	71	38	109	279
Total Volume	0	222	469	0	691	0	0	363	173	536	1227
% App. Total		32.1	67.9	0			0	67.7	32.3		
PHF	.000	.841	.902	.000	.944	.000	.000	.732	.816	.798	.941

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: BE
Counter: D4-5676
Weather: Clear

File Name : H-2 On-Ramp PM
Site Code : 00000002
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Leilehua Road Westbound					Northbound	Leilehua Road Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	66	79	0	0	145	0	0	59	69	0	128	273
03:15 PM	0	65	66	0	0	131	0	0	49	81	0	130	261
03:30 PM	0	76	78	0	0	154	0	0	45	117	0	162	316
03:45 PM	0	67	74	0	0	141	0	0	63	89	0	152	293
Total	0	274	297	0	0	571	0	0	216	356	0	572	1143
04:00 PM	0	90	85	0	0	175	0	0	53	89	0	142	317
04:15 PM	0	53	72	0	0	125	0	0	59	63	0	122	247
04:30 PM	0	92	83	0	0	175	0	0	58	75	0	133	308
04:45 PM	0	88	81	0	0	169	0	0	78	55	0	133	302
Total	0	323	321	0	0	644	0	0	248	282	0	530	1174
05:00 PM	0	113	89	0	0	202	0	0	59	79	0	138	340
05:15 PM	0	66	62	0	0	128	0	0	60	73	0	133	261
05:30 PM	0	87	63	0	0	150	0	0	56	63	0	119	269
05:45 PM	0	58	57	0	0	115	0	0	61	40	0	101	216
Total	0	324	271	0	0	595	0	0	236	255	0	491	1086
Grand Total	0	921	889	0	0	1810	0	0	700	893	0	1593	3403
Apprch %		50.9	49.1	0	0			0	43.9	56.1	0		
Total %	0	27.1	26.1	0	0	53.2	0	0	20.6	26.2	0	46.8	

	Southbound	Leilehua Road Westbound				Northbound	Leilehua Road Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 04:30 PM											
04:30 PM	0	92	83	0	175	0	0	58	75	133	308
04:45 PM	0	88	81	0	169	0	0	**78**	55	133	302
05:00 PM	0	**113**	**89**	0	**202**	0	0	59	**79**	**138**	**340**
05:15 PM	0	66	62	0	128	0	0	60	73	133	261
Total Volume	0	359	315	0	674	0	0	255	282	537	1211
% App. Total		53.3	46.7	0			0	47.5	52.5		
PHF	.000	.794	.885	.000	.834	.000	.000	.817	.892	.973	.890

Wilson Okamoto Corporation
1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: BE
Counter: D4-5676
Weather: Clear

File Name : H-2 Off-Ramp AM
Site Code : 00000002
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Westbound	H-2 Off-Ramp Northbound					Eastbound	
Start Time	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
06:00 AM	0	0	48	0	14	0	62	0	62
06:15 AM	0	0	38	0	34	0	72	0	72
06:30 AM	0	0	52	0	37	0	89	0	89
06:45 AM	0	0	45	0	31	0	76	0	76
Total	0	0	183	0	116	0	299	0	299
07:00 AM	0	0	49	0	63	0	112	0	112
07:15 AM	0	0	55	0	65	0	120	0	120
07:30 AM	0	0	56	0	82	0	138	0	138
07:45 AM	0	0	43	0	94	0	137	0	137
Total	0	0	203	0	304	0	507	0	507
08:00 AM	0	0	42	0	47	0	89	0	89
08:15 AM	0	0	39	0	72	0	111	0	111
08:30 AM	0	0	46	0	53	0	99	0	99
08:45 AM	0	0	27	0	54	0	81	0	81
Total	0	0	154	0	226	0	380	0	380
Grand Total	0	0	540	0	646	0	1186	0	1186
Apprch %			45.5	0	54.5	0			
Total %	0	0	45.5	0	54.5	0	100	0	

	Southbound	Westbound	H-2 Off-Ramp Northbound				Eastbound	
Start Time	App. Total	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1								
Peak Hour for Entire Intersection Begins at 07:00 AM								
07:00 AM	0	0	49	0	63	112	0	112
07:15 AM	0	0	55	0	65	120	0	120
07:30 AM	0	0	**56**	0	82	**138**	0	**138**
07:45 AM	0	0	43	0	**94**	137	0	137
Total Volume	0	0	203	0	304	507	0	507
% App. Total			40	0	60			
PHF	.000	.000	.906	.000	.809	.918	.000	.918

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: AH
Counter: TU-0654
Weather: Clear

File Name : H-2 Off-Ramp PM
Site Code : 00000002
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Westbound	H-2 Off-Ramp Northbound					Eastbound	
Start Time	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Int. Total
03:00 PM	0	0	30	0	60	0	90	0	90
03:15 PM	0	0	36	0	63	0	99	0	99
03:30 PM	0	0	41	0	42	0	83	0	83
03:45 PM	0	0	35	0	62	0	97	0	97
Total	0	0	142	0	227	0	369	0	369
04:00 PM	0	0	39	0	52	0	91	0	91
04:15 PM	0	0	30	0	59	1	90	0	90
04:30 PM	0	0	33	0	65	0	98	0	98
04:45 PM	0	0	37	0	64	0	101	0	101
Total	0	0	139	0	240	1	380	0	380
05:00 PM	0	0	40	0	50	0	90	0	90
05:15 PM	0	0	29	0	57	0	86	0	86
05:30 PM	0	0	24	0	51	0	75	0	75
05:45 PM	0	0	28	0	54	0	82	0	82
Total	0	0	121	0	212	0	333	0	333
Grand Total	0	0	402	0	679	1	1082	0	1082
Apprch %			37.2	0	62.8	0.1			
Total %	0	0	37.2	0	62.8	0.1	100	0	

	Southbound	Westbound	H-2 Off-Ramp Northbound				Eastbound	
Start Time	App. Total	App. Total	Left	Thru	Right	App. Total	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1								
Peak Hour for Entire Intersection Begins at 04:00 PM								
04:00 PM	0	0	**39**	0	52	91	0	91
04:15 PM	0	0	30	0	59	89	0	89
04:30 PM	0	0	33	0	**65**	98	0	98
04:45 PM	0	0	37	0	64	**101**	0	**101**
Total Volume	0	0	139	0	240	379	0	379
% App. Total			36.7	0	63.3			
PHF	.000	.000	.891	.000	.923	.938	.000	.938

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: YS
Counter: TU-1958
Weather: Clear

File Name : KahAka AM
Site Code : 00000004
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Castle&Cooke Driveway Southbound					Kahelu Avenue Westbound					Akamaunui Street Northbound					Kahelu Avenue Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	0	0	0	0	1	10	0	1	12	5	0	4	0	9	1	22	4	2	29	50
06:15 AM	0	0	0	0	0	0	8	1	2	11	6	0	0	0	6	0	30	8	2	40	57
06:30 AM	0	0	0	0	0	0	7	0	3	10	16	0	0	0	16	6	36	21	3	66	92
06:45 AM	0	0	0	0	0	0	7	0	0	7	19	0	0	0	19	6	48	30	1	85	111
Total	0	0	0	0	0	1	32	1	6	40	46	0	4	0	50	13	136	63	8	220	310
07:00 AM	0	0	0	1	1	0	21	0	0	21	23	1	0	0	24	3	40	31	0	74	120
07:15 AM	0	0	1	0	1	1	15	1	1	18	40	0	0	0	40	2	59	34	2	97	156
07:30 AM	0	0	1	0	1	0	22	0	0	22	40	0	1	0	41	15	49	39	1	104	168
07:45 AM	0	0	0	0	0	0	20	2	0	22	26	0	0	0	26	21	66	57	0	144	192
Total	0	0	2	1	3	1	78	3	1	83	129	1	1	0	131	41	214	161	3	419	636
08:00 AM	0	0	0	0	0	0	22	0	2	24	20	0	1	1	22	13	49	26	0	88	134
08:15 AM	0	0	0	0	0	0	20	1	0	21	14	0	1	0	15	8	27	37	0	72	108
08:30 AM	0	0	1	0	1	2	16	0	0	18	8	0	0	0	8	11	33	23	0	67	94
08:45 AM	0	0	2	0	2	0	11	2	0	13	5	0	2	1	8	7	34	19	1	61	84
Total	0	0	3	0	3	2	69	3	2	76	47	0	4	2	53	39	143	105	1	288	420
Grand Total	0	0	5	1	6	4	179	7	9	199	222	1	9	2	234	93	493	329	12	927	1366
Apprch %	0	0	83.3	16.7		2	89.9	3.5	4.5		94.9	0.4	3.8	0.9		10	53.2	35.5	1.3		
Total %	0	0	0.4	0.1	0.4	0.3	13.1	0.5	0.7	14.6	16.3	0.1	0.7	0.1	17.1	6.8	36.1	24.1	0.9	67.9	

	Castle&Cooke Driveway Southbound				Kahelu Avenue Westbound				Akamaunui Street Northbound				Kahelu Avenue Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	0	0	**1**	**1**	**1**	15	1	17	**40**	0	0	40	2	59	34	95	153
07:30 AM	0	0	1	1	0	**22**	0	**22**	40	0	**1**	**41**	15	49	39	103	167
07:45 AM	0	0	0	0	0	20	**2**	22	26	0	0	26	**21**	**66**	**57**	**144**	**192**
08:00 AM	0	0	0	0	0	22	0	22	20	0	1	21	13	49	26	88	131
Total Volume	0	0	2	2	1	79	3	83	126	0	2	128	51	223	156	430	643
% App. Total	0	0	100		1.2	95.2	3.6		98.4	0	1.6		11.9	51.9	36.3		
PHF	.000	.000	.500	.500	.250	.898	.375	.943	.788	.000	.500	.780	.607	.845	.684	.747	.837

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: YS
Counter: TU-1958
Weather: Clear

File Name : KahAka PM
Site Code : 00000004
Start Date : 4/27/2017
Page No : 1

Groups Printed- Unshifted

	Castle&Cooke Driveway Southbound					Kahelu Avenue Westbound					Akamainui Street Northbound					Kahelu Avenue Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	1	0	1	0	2	1	25	4	0	30	12	0	0	0	12	6	5	6	0	17	61
03:15 PM	0	0	1	0	1	0	15	1	0	16	15	0	0	0	15	4	9	5	0	18	50
03:30 PM	0	0	0	0	0	0	26	0	0	26	12	0	2	0	14	7	5	5	0	17	57
03:45 PM	0	0	2	0	2	0	19	0	0	19	6	0	0	0	6	5	9	2	0	16	43
Total	1	0	4	0	5	1	85	5	0	91	45	0	2	0	47	22	28	18	0	68	211
04:00 PM	0	0	0	0	0	0	37	0	0	37	38	0	2	0	40	1	17	5	0	23	100
04:15 PM	0	0	0	0	0	0	20	1	1	22	22	1	2	2	27	6	12	5	5	28	77
04:30 PM	0	0	0	0	0	0	46	0	0	46	39	0	3	0	42	4	19	6	2	31	119
04:45 PM	0	0	0	0	0	2	47	0	0	49	31	2	0	0	33	19	17	5	2	43	125
Total	0	0	0	0	0	2	150	1	1	154	130	3	7	2	142	30	65	21	9	125	421
05:00 PM	0	0	1	0	1	0	40	3	1	44	64	1	0	0	65	3	17	4	0	24	134
05:15 PM	0	0	3	0	3	1	39	2	0	42	28	0	0	0	28	1	17	0	5	23	96
05:30 PM	0	0	1	0	1	1	37	0	0	38	44	0	2	0	46	3	12	2	2	19	104
05:45 PM	0	0	2	0	2	1	24	0	0	25	20	0	2	0	22	4	25	3	0	32	81
Total	0	0	7	0	7	3	140	5	1	149	156	1	4	0	161	11	71	9	7	98	415
Grand Total	1	0	11	0	12	6	375	11	2	394	331	4	13	2	350	63	164	48	16	291	1047
Apprch %	8.3	0	91.7	0		1.5	95.2	2.8	0.5		94.6	1.1	3.7	0.6		21.6	56.4	16.5	5.5		
Total %	0.1	0	1.1	0	1.1	0.6	35.8	1.1	0.2	37.6	31.6	0.4	1.2	0.2	33.4	6	15.7	4.6	1.5	27.8	

	Castle&Cooke Driveway Southbound				Kahelu Avenue Westbound				Akamainui Street Northbound				Kahelu Avenue Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:30 PM																	
04:30 PM	0	0	0	0	0	46	0	46	39	0	**3**	42	4	**19**	**6**	29	117
04:45 PM	0	0	0	0	**2**	**47**	0	**49**	31	**2**	0	33	**19**	17	5	**41**	123
05:00 PM	0	0	1	1	0	40	**3**	43	**64**	1	0	**65**	3	17	4	24	**133**
05:15 PM	0	0	**3**	**3**	1	39	2	42	28	0	0	28	1	17	0	18	91
Total Volume	0	0	4	4	3	172	5	180	162	3	3	168	27	70	15	112	464
% App. Total	0	0	100		1.7	95.6	2.8		96.4	1.8	1.8		24.1	62.5	13.4		
PHF	.000	.000	.333	.333	.375	.915	.417	.918	.633	.375	.250	.646	.355	.921	.625	.683	.872

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: AH
Counter: D4-5673
Weather: Clear

File Name : HalWai AM
Site Code : 00000003
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Halawa Valley Street Westbound					Waiua Place Northbound					Halawa Valley Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	0	42	0	0	42	6	0	0	0	6	0	73	12	0	85	133
06:15 AM	0	2	33	0	0	35	9	0	0	0	9	0	58	16	1	75	119
06:30 AM	0	0	47	0	0	47	6	0	0	0	6	0	74	13	1	88	141
06:45 AM	0	0	32	0	0	32	9	0	0	0	9	0	66	13	0	79	120
Total	0	2	154	0	0	156	30	0	0	0	30	0	271	54	2	327	513
07:00 AM	0	0	30	0	0	30	3	0	1	0	4	0	66	13	1	80	114
07:15 AM	0	0	31	0	0	31	6	0	2	0	8	0	61	17	0	78	117
07:30 AM	0	1	36	0	0	37	8	0	0	0	8	0	67	18	0	85	130
07:45 AM	0	0	39	0	0	39	6	0	1	0	7	0	96	15	0	111	157
Total	0	1	136	0	0	137	23	0	4	0	27	0	290	63	1	354	518
08:00 AM	0	0	21	0	0	21	6	0	0	0	6	0	61	17	1	79	106
08:15 AM	0	0	37	0	0	37	4	0	1	0	5	0	57	23	1	81	123
08:30 AM	0	1	15	0	0	16	6	0	1	0	7	0	18	9	1	28	51
Grand Total	0	4	363	0	0	367	69	0	6	0	75	0	697	166	6	869	1311
Apprch %		1.1	98.9	0	0		92	0	8	0		0	80.2	19.1	0.7		
Total %	0	0.3	27.7	0	0	28	5.3	0	0.5	0	5.7	0	53.2	12.7	0.5	66.3	

	Southbound	Halawa Valley Street Westbound				Waiua Place Northbound				Halawa Valley Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:30 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:00 AM														
07:00 AM	0	0	30	0	30	3	0	1	4	0	66	13	79	113
07:15 AM	0	0	31	0	31	6	0	**2**	**8**	0	61	17	78	117
07:30 AM	0	**1**	36	0	37	**8**	0	0	8	0	67	**18**	85	130
07:45 AM	0	0	**39**	0	**39**	6	0	1	7	0	**96**	15	**111**	**157**
Total Volume	0	1	136	0	137	23	0	4	27	0	290	63	353	517
% App. Total		0.7	99.3	0		85.2	0	14.8		0	82.2	17.8		
PHF	.000	.250	.872	.000	.878	.719	.000	.500	.844	.000	.755	.875	.795	.823

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: AH
Counter: D4-5673
Weather: Clear

File Name : HalWai PM
Site Code : 00000003
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Halawa Valley Street Westbound					Waiua Place Northbound					Halawa Valley Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	44	0	0	44	11	0	0	0	11	0	32	8	0	40	95
03:15 PM	0	2	69	0	0	71	15	0	0	0	15	0	39	10	0	49	135
03:30 PM	0	0	75	0	0	75	20	0	1	0	21	0	38	5	0	43	139
03:45 PM	0	0	66	0	0	66	22	0	0	0	22	0	23	2	0	25	113
Total	0	2	254	0	0	256	68	0	1	0	69	0	132	25	0	157	482
04:00 PM	0	1	68	0	0	69	17	0	0	0	17	0	22	9	0	31	117
04:15 PM	0	0	59	0	0	59	24	0	1	0	25	0	20	6	1	27	111
04:30 PM	0	0	76	0	0	76	23	0	0	0	23	0	16	11	0	27	126
04:45 PM	0	0	30	0	0	30	13	0	0	0	13	0	13	10	0	23	66
Total	0	1	233	0	0	234	77	0	1	0	78	0	71	36	1	108	420
05:00 PM	0	0	70	0	0	70	16	0	0	0	16	0	12	13	2	27	113
05:15 PM	0	0	42	0	0	42	19	0	0	0	19	0	15	4	0	19	80
05:30 PM	0	0	38	0	0	38	7	0	0	2	9	0	6	1	0	7	54
05:45 PM	0	1	33	0	0	34	5	0	0	2	7	0	11	3	0	14	55
Total	0	1	183	0	0	184	47	0	0	4	51	0	44	21	2	67	302
Grand Total	0	4	670	0	0	674	192	0	2	4	198	0	247	82	3	332	1204
Apprch %		0.6	99.4	0	0		97	0	1	2		0	74.4	24.7	0.9		
Total %	0	0.3	55.6	0	0	56	15.9	0	0.2	0.3	16.4	0	20.5	6.8	0.2	27.6	

	Southbound	Halawa Valley Street Westbound				Waiua Place Northbound				Halawa Valley Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:15 PM														
03:15 PM	0	**2**	69	0	71	15	0	0	15	0	**39**	**10**	**49**	135
03:30 PM	0	0	**75**	0	**75**	20	0	**1**	21	0	38	5	43	**139**
03:45 PM	0	0	66	0	66	**22**	0	0	**22**	0	23	2	25	113
04:00 PM	0	1	68	0	69	17	0	0	17	0	22	9	31	117
Total Volume	0	3	278	0	281	74	0	1	75	0	122	26	148	504
% App. Total		1.1	98.9	0		98.7	0	1.3		0	82.4	17.6		
PHF	.000	.375	.927	.000	.937	.841	.000	.250	.852	.000	.782	.650	.755	.906

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: FS, DY
Counter: D4-3889, D4-5676
Weather: Clear

File Name : HalUlu AM
Site Code : 00000001
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Halawa Valley Street Southbound					Ulune Street Westbound					Northbound	Ulune Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	30	56	0	86	0	212	81	0	293	0	98	0	100	0	198	577
06:15 AM	0	17	50	0	67	0	245	100	0	345	0	122	0	107	0	229	641
06:30 AM	0	24	69	0	93	0	210	122	0	332	0	112	0	120	0	232	657
06:45 AM	0	26	77	0	103	0	263	111	0	374	0	107	0	116	0	223	700
Total	0	97	252	0	349	0	930	414	0	1344	0	439	0	443	0	882	2575
07:00 AM	0	26	54	0	80	0	256	81	0	337	0	97	0	141	0	238	655
07:15 AM	0	23	76	0	99	0	268	82	0	350	0	96	0	163	0	259	708
07:30 AM	0	57	100	0	157	0	281	90	0	371	0	114	0	159	0	273	801
07:45 AM	0	23	85	0	108	0	214	104	0	318	0	180	0	147	0	327	753
Total	0	129	315	0	444	0	1019	357	0	1376	0	487	0	610	0	1097	2917
08:00 AM	0	23	89	0	112	0	237	97	1	335	0	95	0	109	0	204	651
08:15 AM	0	24	83	0	107	0	221	76	0	297	0	116	0	109	0	225	629
08:30 AM	0	29	69	1	99	0	214	74	0	288	0	79	0	107	0	186	573
08:45 AM	0	33	67	0	100	0	209	70	0	279	0	76	0	111	0	187	566
Total	0	109	308	1	418	0	881	317	1	1199	0	366	0	436	0	802	2419
Grand Total	0	335	875	1	1211	0	2830	1088	1	3919	0	1292	0	1489	0	2781	7911
Apprch %	0	27.7	72.3	0.1		0	72.2	27.8	0			46.5	0	53.5	0		
Total %	0	4.2	11.1	0	15.3	0	35.8	13.8	0	49.5	0	16.3	0	18.8	0	35.2	

	Halawa Valley Street Southbound				Ulune Street Westbound				Northbound	Ulune Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:00 AM														
07:00 AM	0	26	54	80	0	256	81	337	0	97	0	141	238	655
07:15 AM	0	23	76	99	0	268	82	350	0	96	0	**163**	259	708
07:30 AM	0	**57**	**100**	**157**	0	**281**	90	**371**	0	114	0	159	273	**801**
07:45 AM	0	23	85	108	0	214	**104**	318	0	**180**	0	147	**327**	753
Total Volume	0	129	315	444	0	1019	357	1376	0	487	0	610	1097	2917
% App. Total	0	29.1	70.9		0	74.1	25.9			44.4	0	55.6		
PHF	.000	.566	.788	.707	.000	.907	.858	.927	.000	.676	.000	.936	.839	.910

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: FS, DY
Counter: D4-3889, D4-5676
Weather: Clear

File Name : HalUlu PM
Site Code : 00000001
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Halawa Valley Street Southbound					Ulune Street Westbound					Northbound	Ulune Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	109	114	0	223	0	176	59	0	235	0	42	0	337	0	379	837
03:15 PM	0	105	111	0	216	0	218	75	0	293	0	54	0	335	0	389	898
03:30 PM	0	182	145	0	327	0	217	57	0	274	0	37	0	289	0	326	927
03:45 PM	0	125	141	3	269	0	231	55	0	286	0	35	0	427	0	462	1017
Total	0	521	511	3	1035	0	842	246	0	1088	0	168	0	1388	0	1556	3679
04:00 PM	0	153	135	0	288	0	207	68	0	275	0	64	0	273	0	337	900
04:15 PM	0	141	96	0	237	0	200	71	0	271	0	33	0	297	0	330	838
04:30 PM	0	163	164	1	328	0	202	74	0	276	0	30	0	282	0	312	916
04:45 PM	0	116	84	0	200	0	269	74	0	343	0	47	0	327	0	374	917
Total	0	573	479	1	1053	0	878	287	0	1165	0	174	0	1179	0	1353	3571
05:00 PM	0	148	137	0	285	0	262	65	0	327	0	37	0	311	0	348	960
05:15 PM	0	134	88	0	222	0	245	76	1	322	0	48	0	276	0	324	868
05:30 PM	0	94	91	0	185	0	218	51	0	269	0	39	0	294	0	333	787
05:45 PM	0	88	78	0	166	0	273	70	1	344	0	46	0	191	0	237	747
Total	0	464	394	0	858	0	998	262	2	1262	0	170	0	1072	0	1242	3362
Grand Total	0	1558	1384	4	2946	0	2718	795	2	3515	0	512	0	3639	0	4151	10612
Apprch %	0	52.9	47	0.1		0	77.3	22.6	0.1			12.3	0	87.7	0		
Total %	0	14.7	13	0	27.8	0	25.6	7.5	0	33.1	0	4.8	0	34.3	0	39.1	

	Halawa Valley Street Southbound				Ulune Street Westbound				Northbound	Ulune Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:15 PM														
03:15 PM	0	105	111	216	0	218	**75**	**293**	0	54	0	335	389	898
03:30 PM	0	**182**	**145**	**327**	0	217	57	274	0	37	0	289	326	927
03:45 PM	0	125	141	266	0	**231**	55	286	0	35	0	**427**	**462**	**1014**
04:00 PM	0	153	135	288	0	207	68	275	0	**64**	0	273	337	900
Total Volume	0	565	532	1097	0	873	255	1128	0	190	0	1324	1514	3739
% App. Total	0	51.5	48.5		0	77.4	22.6			12.5	0	87.5		
PHF	.000	.776	.917	.839	.000	.945	.850	.962	.000	.742	.000	.775	.819	.922

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: YS
Counter: D4-5677
Weather: Clear

File Name : HalKoa AM
Site Code : 00000000
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Halawa Valley Street Westbound					Koaha Place Northbound					Halawa Valley Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	0	20	0	0	20	16	0	1	0	17	0	17	25	0	42	79
06:15 AM	0	0	3	0	0	3	19	0	3	0	22	0	12	22	0	34	59
06:30 AM	0	0	7	0	0	7	39	0	0	0	39	0	12	39	0	51	97
06:45 AM	0	0	8	0	0	8	26	0	1	0	27	0	14	38	0	52	87
Total	0	0	38	0	0	38	100	0	5	0	105	0	55	124	0	179	322
07:00 AM	0	2	5	0	0	7	20	0	1	0	21	0	9	32	0	41	69
07:15 AM	0	0	5	0	0	5	26	0	1	0	27	0	7	41	0	48	80
07:30 AM	0	0	5	0	0	5	18	0	3	0	21	0	14	20	0	34	60
07:45 AM	0	0	14	0	0	14	24	0	1	0	25	0	20	37	0	57	96
Total	0	2	29	0	0	31	88	0	6	0	94	0	50	130	0	180	305
08:00 AM	0	1	3	0	0	4	19	0	1	0	20	0	6	28	0	34	58
08:15 AM	0	1	7	0	0	8	18	0	0	0	18	0	14	25	0	39	65
08:30 AM	0	0	3	0	0	3	11	0	1	0	12	0	9	13	0	22	37
08:45 AM	0	0	3	0	0	3	22	0	1	0	23	0	9	24	0	33	59
Total	0	2	16	0	0	18	70	0	3	0	73	0	38	90	0	128	219
Grand Total	0	4	83	0	0	87	258	0	14	0	272	0	143	344	0	487	846
Apprch %		4.6	95.4	0	0		94.9	0	5.1	0		0	29.4	70.6	0		
Total %	0	0.5	9.8	0	0	10.3	30.5	0	1.7	0	32.2	0	16.9	40.7	0	57.6	

	Southbound	Halawa Valley Street Westbound				Koaha Place Northbound				Halawa Valley Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 06:30 AM														
06:30 AM	0	0	7	0	7	**39**	0	0	**39**	0	12	39	51	**97**
06:45 AM	0	0	**8**	0	**8**	26	0	**1**	27	0	**14**	38	**52**	87
07:00 AM	0	**2**	5	0	7	20	0	1	21	0	9	32	41	69
07:15 AM	0	0	5	0	5	26	0	1	27	0	7	**41**	48	80
Total Volume	0	2	25	0	27	111	0	3	114	0	42	150	192	333
% App. Total		7.4	92.6	0		97.4	0	2.6		0	21.9	78.1		
PHF	.000	.250	.781	.000	.844	.712	.000	.750	.731	.000	.750	.915	.923	.858

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: YS
Counter: D4-5677
Weather: Clear

File Name : HalKoa PM
Site Code : 00000000
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Southbound	Halawa Valley Street Westbound					Koaha Place Northbound					Halawa Valley Street Eastbound					
Start Time	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	10	0	0	10	18	0	0	0	18	0	2	10	0	12	40
03:15 PM	0	0	11	0	0	11	28	0	0	0	28	0	4	9	0	13	52
03:30 PM	0	0	11	0	0	11	20	0	0	0	20	0	1	11	0	12	43
03:45 PM	0	0	10	0	0	10	30	0	0	0	30	0	1	8	0	9	49
Total	0	0	42	0	0	42	96	0	0	0	96	0	8	38	0	46	184
04:00 PM	0	0	9	0	0	9	33	0	0	0	33	0	2	11	0	13	55
04:15 PM	0	0	2	0	0	2	23	0	0	0	23	0	0	6	0	6	31
04:30 PM	0	0	6	0	0	6	17	0	0	0	17	0	0	4	0	4	27
04:45 PM	0	0	7	0	0	7	18	0	0	0	18	0	0	7	0	7	32
Total	0	0	24	0	0	24	91	0	0	0	91	0	2	28	0	30	145
05:00 PM	0	1	14	0	0	15	41	0	0	0	41	0	2	5	0	7	63
05:15 PM	0	1	13	0	0	14	21	0	0	0	21	0	1	6	0	7	42
05:30 PM	0	0	3	0	0	3	14	0	0	0	14	0	2	0	0	2	19
05:45 PM	0	0	6	0	0	6	17	0	0	0	17	0	2	3	0	5	28
Total	0	2	36	0	0	38	93	0	0	0	93	0	7	14	0	21	152
Grand Total	0	2	102	0	0	104	280	0	0	0	280	0	17	80	0	97	481
Apprch %		1.9	98.1	0	0		100	0	0	0		0	17.5	82.5	0		
Total %	0	0.4	21.2	0	0	21.6	58.2	0	0	0	58.2	0	3.5	16.6	0	20.2	

	Southbound	Halawa Valley Street Westbound				Koaha Place Northbound				Halawa Valley Street Eastbound				
Start Time	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:15 PM														
03:15 PM	0	0	**11**	0	**11**	28	0	0	28	0	**4**	9	**13**	52
03:30 PM	0	0	11	0	11	20	0	0	20	0	1	**11**	12	43
03:45 PM	0	0	10	0	10	30	0	0	30	0	1	8	9	49
04:00 PM	0	0	9	0	9	**33**	0	0	**33**	0	2	11	13	**55**
Total Volume	0	0	41	0	41	111	0	0	111	0	8	39	47	199
% App. Total		0	100	0		100	0	0		0	17	83		
PHF	.000	.000	.932	.000	.932	.841	.000	.000	.841	.000	.500	.886	.904	.905

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: GH, BE
Counter: TU-0650, D4-3890
Weather: Clear

File Name : Hallwa AM
Site Code : 00000002
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Iwaiwa Street Southbound					Halawa Valley Street Westbound					Northbound	Halawa Valley Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	4	0	38	1	43	0	45	4	1	50	0	81	98	0	0	179	272
06:15 AM	1	0	23	1	25	0	43	0	0	43	0	101	109	0	0	210	278
06:30 AM	2	0	34	0	36	0	56	0	0	56	0	94	123	0	0	217	309
06:45 AM	3	0	43	1	47	0	49	1	0	50	0	97	113	0	0	210	307
Total	10	0	138	3	151	0	193	5	1	199	0	373	443	0	0	816	1166
07:00 AM	5	0	40	1	46	0	44	2	0	46	0	76	99	0	0	175	267
07:15 AM	4	0	38	0	42	0	54	4	0	58	0	85	95	0	0	180	280
07:30 AM	5	0	55	0	60	0	67	2	0	69	0	75	110	0	0	185	314
07:45 AM	5	0	55	0	60	0	47	4	0	51	0	121	134	0	0	255	366
Total	19	0	188	1	208	0	212	12	0	224	0	357	438	0	0	795	1227
08:00 AM	6	0	50	0	56	0	45	3	0	48	0	102	98	0	0	200	304
08:15 AM	2	0	64	1	67	0	43	5	0	48	0	91	90	0	0	181	296
08:30 AM	4	0	57	0	61	0	35	5	0	40	0	76	75	0	0	151	252
08:45 AM	4	0	46	0	50	0	53	6	0	59	0	64	80	0	0	144	253
Total	16	0	217	1	234	0	176	19	0	195	0	333	343	0	0	676	1105
Grand Total	45	0	543	5	593	0	581	36	1	618	0	1063	1224	0	0	2287	3498
Apprch %	7.6	0	91.6	0.8		0	94	5.8	0.2			46.5	53.5	0	0		
Total %	1.3	0	15.5	0.1	17	0	16.6	1	0	17.7	0	30.4	35	0	0	65.4	

	Iwaiwa Street Southbound				Halawa Valley Street Westbound				Northbound	Halawa Valley Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 07:30 AM														
07:30 AM	5	0	55	60	0	**67**	2	**69**	0	75	110	0	185	314
07:45 AM	5	0	55	60	0	47	4	51	0	**121**	**134**	0	**255**	**366**
08:00 AM	**6**	0	50	56	0	45	3	48	0	102	98	0	200	304
08:15 AM	2	0	**64**	**66**	0	43	**5**	48	0	91	90	0	181	295
Total Volume	18	0	224	242	0	202	14	216	0	389	432	0	821	1279
% App. Total	7.4	0	92.6		0	93.5	6.5			47.4	52.6	0		
PHF	.750	.000	.875	.917	.000	.754	.700	.783	.000	.804	.806	.000	.805	.874

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: GH, BE
Counter: TU-0650, D4-3890
Weather: Clear

File Name : Hallwa PM
Site Code : 00000002
Start Date : 4/12/2017
Page No : 1

Groups Printed- Unshifted

	Iwaiwa Street Southbound					Halawa Valley Street Westbound					Northbound	Halawa Valley Street Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	4	0	126	1	131	0	79	3	0	82	0	45	53	0	0	98	311
03:15 PM	3	0	85	1	89	0	111	4	0	115	0	60	65	0	0	125	329
03:30 PM	4	0	145	0	149	0	132	3	0	135	0	39	51	0	1	91	375
03:45 PM	11	0	78	5	94	0	138	1	0	139	0	51	41	0	0	92	325
Total	22	0	434	7	463	0	460	11	0	471	0	195	210	0	1	406	1340
04:00 PM	5	0	100	0	105	0	127	4	0	131	0	50	63	0	0	113	349
04:15 PM	5	0	77	0	82	0	123	6	0	129	0	51	52	0	0	103	314
04:30 PM	6	0	118	1	125	0	149	5	0	154	0	50	42	0	0	92	371
04:45 PM	4	0	66	3	73	0	102	8	0	110	0	66	42	0	0	108	291
Total	20	0	361	4	385	0	501	23	0	524	0	217	199	0	0	416	1325
05:00 PM	3	0	156	0	159	0	117	5	0	122	0	53	34	0	0	87	368
05:15 PM	3	0	60	1	64	0	96	5	0	101	0	47	53	0	0	100	265
05:30 PM	1	0	78	0	79	0	84	5	0	89	0	50	29	0	0	79	247
05:45 PM	1	0	73	0	74	0	72	1	0	73	0	53	41	0	0	94	241
Total	8	0	367	1	376	0	369	16	0	385	0	203	157	0	0	360	1121
Grand Total	50	0	1162	12	1224	0	1330	50	0	1380	0	615	566	0	1	1182	3786
Apprch %	4.1	0	94.9	1		0	96.4	3.6	0			52	47.9	0	0.1		
Total %	1.3	0	30.7	0.3	32.3	0	35.1	1.3	0	36.5	0	16.2	14.9	0	0	31.2	

	Iwaiwa Street Southbound				Halawa Valley Street Westbound				Northbound	Halawa Valley Street Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1														
Peak Hour for Entire Intersection Begins at 03:15 PM														
03:15 PM	3	0	85	88	0	111	**4**	115	0	**60**	**65**	0	**125**	328
03:30 PM	4	0	**145**	**149**	0	132	3	135	0	39	51	0	90	**374**
03:45 PM	**11**	0	78	89	0	**138**	1	**139**	0	51	41	0	92	320
04:00 PM	5	0	100	105	0	127	4	131	0	50	63	0	113	349
Total Volume	23	0	408	431	0	508	12	520	0	200	220	0	420	1371
% App. Total	5.3	0	94.7		0	97.7	2.3			47.6	52.4	0		
PHF	.523	.000	.703	.723	.000	.920	.750	.935	.000	.833	.846	.000	.840	.916

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: CK, GH
Counter: D4-5673,TU-2049
Weather: Clear

File Name : KalWCCC AM
Site Code : 00000001
Start Date : 4/25/2017
Page No : 1

Groups Printed- Unshifted

	Women's Correctional Driveway Southbound					Kalanianaole Highway Westbound					Olomana School Driveway Northbound					Kalanianaole Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	0	0	3	0	3	1	424	0	0	425	0	0	0	0	0	4	69	1	0	74	502
06:15 AM	0	0	4	0	4	2	370	1	0	373	0	0	0	0	0	4	91	1	0	96	473
06:30 AM	0	0	4	0	4	2	329	0	0	331	0	0	1	0	1	4	117	3	0	124	460
06:45 AM	0	0	0	0	0	2	288	0	0	290	0	0	0	0	0	2	114	2	0	118	408
Total	0	0	11	0	11	7	1411	1	0	1419	0	0	1	0	1	14	391	7	0	412	1843
07:00 AM	1	0	0	0	1	0	312	2	0	314	0	0	0	0	0	0	151	7	0	158	473
07:15 AM	2	0	1	0	3	1	357	2	0	360	0	0	0	0	0	2	187	7	0	196	559
07:30 AM	0	0	4	0	4	6	322	1	1	330	4	0	0	0	4	1	176	10	0	187	525
07:45 AM	0	0	1	0	1	7	307	0	1	315	5	0	2	0	7	6	207	16	0	229	552
Total	3	0	6	0	9	14	1298	5	2	1319	9	0	2	0	11	9	721	40	0	770	2109
08:00 AM	0	0	3	0	3	4	275	2	3	284	4	0	2	0	6	4	191	8	0	203	496
08:15 AM	1	0	2	0	3	0	308	0	0	308	3	0	1	0	4	4	157	5	0	166	481
08:30 AM	0	0	1	0	1	3	273	0	0	276	1	0	1	0	2	5	192	2	0	199	478
08:45 AM	1	0	0	0	1	0	204	2	0	206	4	0	1	0	5	3	150	3	0	156	368
Total	2	0	6	0	8	7	1060	4	3	1074	12	0	5	0	17	16	690	18	0	724	1823
Grand Total	5	0	23	0	28	28	3769	10	5	3812	21	0	8	0	29	39	1802	65	0	1906	5775
Apprch %	17.9	0	82.1	0		0.7	98.9	0.3	0.1		72.4	0	27.6	0		2	94.5	3.4	0		
Total %	0.1	0	0.4	0	0.5	0.5	65.3	0.2	0.1	66	0.4	0	0.1	0	0.5	0.7	31.2	1.1	0	33	

	Women's Correctional Driveway Southbound				Kalanianaole Highway Westbound				Olomana School Driveway Northbound				Kalanianaole Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	**2**	0	1	3	1	**357**	**2**	**360**	0	0	0	0	2	187	7	196	**559**
07:30 AM	0	0	**4**	**4**	6	322	1	329	4	0	0	4	1	176	10	187	524
07:45 AM	0	0	1	1	**7**	307	0	314	**5**	0	**2**	**7**	**6**	**207**	**16**	**229**	551
08:00 AM	0	0	3	3	4	275	2	281	4	0	2	6	4	191	8	203	493
Total Volume	2	0	9	11	18	1261	5	1284	13	0	4	17	13	761	41	815	2127
% App. Total	18.2	0	81.8		1.4	98.2	0.4		76.5	0	23.5		1.6	93.4	5		
PHF	.250	.000	.563	.688	.643	.883	.625	.892	.650	.000	.500	.607	.542	.919	.641	.890	.951

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: GH
Counter: TU-2049
Weather: Clear

File Name : KalWCCC PM
Site Code : 00000001
Start Date : 4/25/2017
Page No : 1

Groups Printed- Unshifted

	Women's Correctional Driveway Southbound					Kalanianaole Highway Westbound					Olomana School Driveway Northbound					Kalanianaole Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	0	0	7	0	7	0	220	1	14	235	12	0	5	0	17	5	292	0	0	297	556
03:15 PM	0	0	2	0	2	1	173	0	0	174	5	0	3	0	8	1	353	1	0	355	539
03:30 PM	1	0	3	0	4	0	206	0	0	206	2	0	2	0	4	1	336	1	0	338	552
03:45 PM	1	0	2	0	3	0	233	1	0	234	8	0	0	0	8	2	338	0	0	340	585
Total	2	0	14	0	16	1	832	2	14	849	27	0	10	0	37	9	1319	2	0	1330	2232
04:00 PM	0	0	8	0	8	0	236	0	0	236	6	0	1	0	7	3	316	2	0	321	572
04:15 PM	0	0	1	0	1	0	202	1	0	203	6	0	0	0	6	1	333	0	0	334	544
04:30 PM	1	0	7	0	8	0	182	0	0	182	3	0	1	0	4	1	362	0	0	363	557
04:45 PM	0	0	0	0	0	0	216	0	0	216	0	0	0	0	0	0	339	0	0	339	555
Total	1	0	16	0	17	0	836	1	0	837	15	0	2	0	17	5	1350	2	0	1357	2228
05:00 PM	0	0	1	0	1	0	199	0	0	199	0	0	0	0	0	1	369	0	0	370	570
05:15 PM	0	0	0	0	0	0	221	0	0	221	0	0	1	0	1	0	364	0	0	364	586
05:30 PM	0	0	1	0	1	0	205	0	0	205	1	0	0	0	1	2	352	0	0	354	561
05:45 PM	0	0	0	0	0	0	200	0	0	200	1	0	0	0	1	2	337	0	0	339	540
Total	0	0	2	0	2	0	825	0	0	825	2	0	1	0	3	5	1422	0	0	1427	2257
Grand Total	3	0	32	0	35	1	2493	3	14	2511	44	0	13	0	57	19	4091	4	0	4114	6717
Apprch %	8.6	0	91.4	0		0	99.3	0.1	0.6		77.2	0	22.8	0		0.5	99.4	0.1	0		
Total %	0	0	0.5	0	0.5	0	37.1	0	0.2	37.4	0.7	0	0.2	0	0.8	0.3	60.9	0.1	0	61.2	

	Women's Correctional Driveway Southbound				Kalanianaole Highway Westbound				Olomana School Driveway Northbound				Kalanianaole Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	0	0	0	0	0	216	0	216	0	0	0	0	0	339	0	339	555
05:00 PM	0	0	**1**	**1**	0	199	0	199	0	0	0	0	1	**369**	0	**370**	570
05:15 PM	0	0	0	0	0	**221**	0	**221**	0	0	**1**	**1**	0	364	0	364	**586**
05:30 PM	0	0	1	1	0	205	0	205	**1**	0	0	1	**2**	352	0	354	561
Total Volume	0	0	2	2	0	841	0	841	1	0	1	2	3	1424	0	1427	2272
% App. Total	0	0	100		0	100	0		50	0	50		0.2	99.8	0		
PHF	.000	.000	.500	.500	.000	.951	.000	.951	.250	.000	.250	.500	.375	.965	.000	.964	.969

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: BE, YS
Counter: TU-0649, TU-2050
Weather: Clear

File Name : KalUlu AM
Site Code : 00000002
Start Date : 4/25/2017
Page No : 1

Groups Printed- Unshifted

	Ulupii Street Southbound					Kalanianaole Highway Westbound					Ulupii Street Northbound					Kalanianaole Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
06:00 AM	4	1	4	0	9	2	384	2	0	388	0	2	0	0	2	4	71	3	0	78	477
06:15 AM	3	2	3	0	8	5	357	8	0	370	0	0	2	0	2	2	94	1	0	97	477
06:30 AM	2	1	3	0	6	25	381	5	0	411	1	0	1	0	2	1	117	6	0	124	543
06:45 AM	2	0	1	0	3	14	326	12	0	352	0	3	6	0	9	2	101	9	0	112	476
Total	11	4	11	0	26	46	1448	27	0	1521	1	5	9	0	15	9	383	19	0	411	1973
07:00 AM	4	3	3	0	10	14	278	3	0	295	2	6	11	0	19	3	148	10	0	161	485
07:15 AM	5	5	1	0	11	30	307	6	0	343	3	7	12	0	22	3	179	9	0	191	567
07:30 AM	5	6	1	21	33	35	306	30	0	371	9	9	16	3	37	3	167	19	0	189	630
07:45 AM	6	6	7	16	35	25	292	34	1	352	3	10	10	9	32	2	199	8	0	209	628
Total	20	20	12	37	89	104	1183	73	1	1361	17	32	49	12	110	11	693	46	0	750	2310
08:00 AM	7	2	16	0	25	9	267	23	0	299	4	4	7	0	15	1	177	3	0	181	520
08:15 AM	15	8	16	0	39	6	301	31	0	338	0	2	6	0	8	5	146	2	0	153	538
08:30 AM	4	4	3	1	12	3	277	13	0	293	1	1	2	0	4	2	172	4	0	178	487
08:45 AM	2	1	1	0	4	0	205	2	0	207	3	1	4	0	8	2	154	3	0	159	378
Total	28	15	36	1	80	18	1050	69	0	1137	8	8	19	0	35	10	649	12	0	671	1923
Grand Total	59	39	59	38	195	168	3681	169	1	4019	26	45	77	12	160	30	1725	77	0	1832	6206
Apprch %	30.3	20	30.3	19.5		4.2	91.6	4.2	0		16.2	28.1	48.1	7.5		1.6	94.2	4.2	0		
Total %	1	0.6	1	0.6	3.1	2.7	59.3	2.7	0	64.8	0.4	0.7	1.2	0.2	2.6	0.5	27.8	1.2	0	29.5	

	Ulupii Street Southbound				Kalanianaole Highway Westbound				Ulupii Street Northbound				Kalanianaole Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 08:45 AM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	5	5	1	11	30	**307**	6	343	3	7	12	22	**3**	179	9	191	567
07:30 AM	5	**6**	1	12	**35**	306	30	**371**	**9**	9	**16**	**34**	3	167	**19**	189	**606**
07:45 AM	6	6	7	19	25	292	**34**	351	3	**10**	10	23	2	**199**	8	**209**	602
08:00 AM	**7**	2	**16**	**25**	9	267	23	299	4	4	7	15	1	177	3	181	520
Total Volume	23	19	25	67	99	1172	93	1364	19	30	45	94	9	722	39	770	2295
% App. Total	34.3	28.4	37.3		7.3	85.9	6.8		20.2	31.9	47.9		1.2	93.8	5.1		
PHF	.821	.792	.391	.670	.707	.954	.684	.919	.528	.750	.703	.691	.750	.907	.513	.921	.947

Wilson Okamoto Corporation

1907 S. Beretania Street Suite 400
Honolulu, Hi 96826

Counted By: DY, YS
Counter: TU-0649, TU-2050
Weather: Clear

File Name : KalUlu PM
Site Code : 00000002
Start Date : 4/25/2017
Page No : 1

Groups Printed- Unshifted

	Ulupii Street Southbound					Kalanianaole Highway Westbound					Ulupii Street Northbound					Kalanianaole Highway Eastbound					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
03:00 PM	12	4	4	2	22	1	194	4	0	199	8	2	6	0	16	10	292	3	1	306	543
03:15 PM	12	1	4	0	17	5	159	4	0	168	8	4	11	0	23	6	332	2	0	340	548
03:30 PM	20	0	16	1	37	5	171	13	0	189	7	4	7	0	18	5	311	9	0	325	569
03:45 PM	10	1	5	0	16	4	251	3	0	258	5	2	9	0	16	7	330	6	0	343	633
Total	54	6	29	3	92	15	775	24	0	814	28	12	33	0	73	28	1265	20	1	1314	2293
04:00 PM	21	1	2	0	24	7	207	4	0	218	6	5	7	0	18	2	306	4	0	312	572
04:15 PM	7	1	2	0	10	6	218	6	0	230	8	5	4	0	17	4	323	7	0	334	591
04:30 PM	10	0	4	0	14	8	154	8	0	170	11	3	8	0	22	4	346	11	0	361	567
04:45 PM	4	0	5	0	9	4	298	7	0	309	3	2	4	0	9	4	340	4	0	348	675
Total	42	2	13	0	57	25	877	25	0	927	28	15	23	0	66	14	1315	26	0	1355	2405
05:00 PM	14	0	6	1	21	3	194	10	0	207	4	6	6	0	16	4	357	8	0	369	613
05:15 PM	13	2	5	0	20	3	214	7	0	224	5	4	6	0	15	4	345	5	0	354	613
05:30 PM	17	0	2	1	20	12	180	5	0	197	3	2	8	0	13	7	334	4	0	345	575
05:45 PM	8	0	5	0	13	6	179	7	0	192	5	4	6	1	16	5	330	5	0	340	561
Total	52	2	18	2	74	24	767	29	0	820	17	16	26	1	60	20	1366	22	0	1408	2362
Grand Total	148	10	60	5	223	64	2419	78	0	2561	73	43	82	1	199	62	3946	68	1	4077	7060
Apprch %	66.4	4.5	26.9	2.2		2.5	94.5	3	0		36.7	21.6	41.2	0.5		1.5	96.8	1.7	0		
Total %	2.1	0.1	0.8	0.1	3.2	0.9	34.3	1.1	0	36.3	1	0.6	1.2	0	2.8	0.9	55.9	1	0	57.7	

	Ulupii Street Southbound				Kalanianaole Highway Westbound				Ulupii Street Northbound				Kalanianaole Highway Eastbound				
Start Time	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Left	Thru	Right	App. Total	Int. Total
Peak Hour Analysis From 03:00 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	4	0	5	9	4	**298**	7	**309**	3	2	4	9	4	340	4	348	**675**
05:00 PM	14	0	**6**	**20**	3	194	**10**	207	4	**6**	6	**16**	4	**357**	**8**	**369**	612
05:15 PM	13	**2**	5	20	3	214	7	224	**5**	4	6	15	4	345	5	354	613
05:30 PM	**17**	0	2	19	**12**	180	5	197	3	2	**8**	13	**7**	334	4	345	574
Total Volume	48	2	18	68	22	886	29	937	15	14	24	53	19	1376	21	1416	2474
% App. Total	70.6	2.9	26.5		2.3	94.6	3.1		28.3	26.4	45.3		1.3	97.2	1.5		
PHF	.706	.250	.750	.850	.458	.743	.725	.758	.750	.583	.750	.828	.679	.964	.656	.959	.916

APPENDIX B

LEVEL OF SERVICE DEFINITIONS

LEVEL OF SERVICE DEFINITIONS

LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of Service (LOS) for signalized intersections is defined in terms of delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average control delay per vehicle, typically a 15-min analysis period. The criteria are given in the following table.

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

Level of Service	Control Delay per Vehicle (sec/veh)
A	≤10.0
B	>10.0 and ≤20.0
C	>20.0 and ≤35.0
D	>35.0 and ≤55.0
E	>55.0 and ≤80.0
F	>80.0

Delay is a complex measure and depends on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group.

Level of Service A describes operations with low control delay, up to 10 sec per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.

Level of Service B describes operations with control delay greater than 10 and up to 20 sec per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of delay.

Level of Service C describes operations with control delay greater than 20 and up to 35 sec per vehicle. These higher delays may result from only fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. Cycle failure occurs when a given green phase does not serve queued vehicles and overflows occur. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

Level of Service D describes operations with control delay greater than 35 and up to 55 sec per vehicle. At level of service 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.

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

Level of Service E describes operation with control delay greater than 55 and up to 80 sec per vehicle. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent.

Level of Service F describes operations with control delay in excess of 80 sec per vehicle. This level, considered to be unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity lane groups. It may also occur at high v/c ratios with many individual cycle failures. Poor progression and long cycle lengths may also contribute significantly to high delay levels.

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

LEVEL OF SERVICE DEFINITIONS

LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS

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

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

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

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

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

APPENDIX C

CAPACITY ANALYSIS CALCULATIONS
EXISTING PEAK HOUR TRAFFIC ANALYSIS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	65	2011	20	10	610	65	0	1	4	38	4	11
Future Volume (vph)	65	2011	20	10	610	65	0	1	4	38	4	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	0.91		1.00	0.95			1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	1.00
Flpb, ped/bikes	0.99	1.00		1.00	1.00			1.00			0.98	1.00
Frt	1.00	1.00		1.00	0.99			0.89			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.96	1.00
Satd. Flow (prot)	1756	5078		1770	3475			1616			1745	1583
Flt Permitted	0.39	1.00		0.08	1.00			1.00			0.74	1.00
Satd. Flow (perm)	720	5078		140	3475			1616			1355	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	66	2052	20	10	622	66	0	1	4	39	4	11
RTOR Reduction (vph)	0	0	0	0	5	0	0	4	0	0	0	10
Lane Group Flow (vph)	66	2072	0	10	683	0	0	1	0	0	43	1
Confl. Peds. (#/hr)	13					13			25	25		
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	Perm
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	68.3	68.3		68.3	68.3			10.1			10.1	10.1
Effective Green, g (s)	68.3	68.3		68.3	68.3			10.1			10.1	10.1
Actuated g/C Ratio	0.77	0.77		0.77	0.77			0.11			0.11	0.11
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	556	3923		108	2684			184			154	180
v/s Ratio Prot		c0.41			0.20			0.00				
v/s Ratio Perm	0.09			0.07							c0.03	0.00
v/c Ratio	0.12	0.53		0.09	0.25			0.01			0.28	0.01
Uniform Delay, d1	2.5	3.9		2.5	2.8			34.7			35.8	34.7
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	0.1		0.4	0.1			0.0			1.0	0.0
Delay (s)	2.6	4.0		2.8	2.9			34.7			36.8	34.7
Level of Service	A	A		A	A			C			D	C
Approach Delay (s)		3.9			2.9			34.7			36.4	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	4.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	88.4	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	82	2006	2	3	1124	54	14	7	4	57	2	33
Future Volume (vph)	82	2006	2	3	1124	54	14	7	4	57	2	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	0.91		1.00	0.95			1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			0.99	1.00
Frt	1.00	1.00		1.00	0.99			0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	1766	5084		1769	3510			1766			1755	1583
Flt Permitted	0.21	1.00		0.07	1.00			0.84			0.71	1.00
Satd. Flow (perm)	389	5084		140	3510			1531			1315	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	84	2047	2	3	1147	55	14	7	4	58	2	34
RTOR Reduction (vph)	0	0	0	0	2	0	0	3	0	0	0	29
Lane Group Flow (vph)	84	2049	0	3	1200	0	0	22	0	0	60	5
Confl. Peds. (#/hr)	9		1	1		9			14	14		
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	Perm
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	67.6	67.6		67.6	67.6			12.6			12.6	12.6
Effective Green, g (s)	67.6	67.6		67.6	67.6			12.6			12.6	12.6
Actuated g/C Ratio	0.75	0.75		0.75	0.75			0.14			0.14	0.14
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	291	3810		104	2630			213			183	221
v/s Ratio Prot		c0.40			0.34							
v/s Ratio Perm	0.22			0.02				0.01			c0.05	0.00
v/c Ratio	0.29	0.54		0.03	0.46			0.10			0.33	0.02
Uniform Delay, d1	3.6	4.7		2.9	4.3			33.9			35.0	33.5
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.6	0.1		0.1	0.1			0.2			1.1	0.0
Delay (s)	4.2	4.9		3.0	4.4			34.1			36.0	33.5
Level of Service	A	A		A	A			C			D	C
Approach Delay (s)		4.9			4.4			34.1			35.1	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.2	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↱	↰	↑↑		↰		↱	↰	↱	
Traffic Volume (vph)	0	1527	460	35	380	0	141	0	73	32	71	60
Future Volume (vph)	0	1527	460	35	380	0	141	0	73	32	71	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		1.00		1.00	1.00	1.00	
Frpb, ped/bikes		1.00	0.93	1.00	1.00		1.00		0.97	1.00	0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		0.99		1.00	0.99	1.00	
Frt		1.00	0.85	1.00	1.00		1.00		0.85	1.00	0.93	
Flt Protected		1.00	1.00	0.95	1.00		0.95		1.00	0.95	1.00	
Satd. Flow (prot)		3539	1472	1764	3539		1749		1542	1744	1714	
Flt Permitted		1.00	1.00	0.10	1.00		0.63		1.00	0.95	1.00	
Satd. Flow (perm)		3539	1472	191	3539		1152		1542	1744	1714	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1624	489	37	404	0	150	0	78	34	76	64
RTOR Reduction (vph)	0	0	152	0	0	0	0	0	24	0	27	0
Lane Group Flow (vph)	0	1624	337	37	404	0	150	0	54	34	113	0
Confl. Peds. (#/hr)	50		50	50		50	15		15	15		15
Turn Type		NA	Perm	Perm	NA		Perm		Perm	Perm	NA	
Protected Phases		2			6						4	
Permitted Phases			2	6			8		8	4		
Actuated Green, G (s)		63.1	63.1	63.1	63.1		18.4		18.4	18.4	18.4	
Effective Green, g (s)		63.1	63.1	63.1	63.1		18.4		18.4	18.4	18.4	
Actuated g/C Ratio		0.69	0.69	0.69	0.69		0.20		0.20	0.20	0.20	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)		2440	1015	131	2440		231		310	350	344	
v/s Ratio Prot		c0.46			0.11						0.07	
v/s Ratio Perm			0.23	0.19			c0.13		0.04	0.02		
v/c Ratio		0.67	0.33	0.28	0.17		0.65		0.17	0.10	0.33	
Uniform Delay, d1		8.1	5.7	5.5	5.0		33.6		30.3	29.8	31.3	
Progression Factor		1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.00	
Incremental Delay, d2		0.7	0.2	1.2	0.0		6.2		0.3	0.1	0.6	
Delay (s)		8.8	5.9	6.7	5.0		39.8		30.5	29.9	31.8	
Level of Service		A	A	A	A		D		C	C	C	
Approach Delay (s)		8.2			5.1			36.6			31.4	
Approach LOS		A			A			D			C	

Intersection Summary			
HCM 2000 Control Delay	11.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	91.5	Sum of lost time (s)	10.0
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↱	↰	↑↑		↰		↱	↰	↱	
Traffic Volume (vph)	0	1774	361	22	973	0	311	0	199	41	27	87
Future Volume (vph)	0	1774	361	22	973	0	311	0	199	41	27	87
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		1.00		1.00	1.00	1.00	
Frpb, ped/bikes		1.00	0.93	1.00	1.00		1.00		0.97	1.00	0.98	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		0.99		1.00	0.98	1.00	
Frt		1.00	0.85	1.00	1.00		1.00		0.85	1.00	0.89	
Flt Protected		1.00	1.00	0.95	1.00		0.95		1.00	0.95	1.00	
Satd. Flow (prot)		3539	1473	1770	3539		1747		1541	1743	1616	
Flt Permitted		1.00	1.00	0.06	1.00		0.66		1.00	0.95	1.00	
Satd. Flow (perm)		3539	1473	109	3539		1222		1541	1743	1616	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1887	384	23	1035	0	331	0	212	44	29	93
RTOR Reduction (vph)	0	0	123	0	0	0	0	0	13	0	62	0
Lane Group Flow (vph)	0	1887	261	23	1035	0	331	0	199	44	60	0
Confl. Peds. (#/hr)	40		40	40		40	13		13	13		13
Turn Type		NA	Perm	Perm	NA		Perm		Perm	Perm	NA	
Protected Phases		2			6						4	
Permitted Phases			2	6			8		8	4		
Actuated Green, G (s)		68.5	68.5	68.5	68.5		34.4		34.4	34.4	34.4	
Effective Green, g (s)		68.5	68.5	68.5	68.5		34.4		34.4	34.4	34.4	
Actuated g/C Ratio		0.61	0.61	0.61	0.61		0.30		0.30	0.30	0.30	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)		2147	893	66	2147		372		469	531	492	
v/s Ratio Prot		c0.53			0.29						0.04	
v/s Ratio Perm			0.18	0.21			c0.27		0.13	0.03		
v/c Ratio		0.88	0.29	0.35	0.48		0.89		0.43	0.08	0.12	
Uniform Delay, d1		18.7	10.6	11.1	12.3		37.4		31.4	28.0	28.3	
Progression Factor		1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.00	
Incremental Delay, d2		4.5	0.2	3.2	0.2		21.9		0.6	0.1	0.1	
Delay (s)		23.2	10.8	14.2	12.5		59.3		32.0	28.1	28.5	
Level of Service		C	B	B	B		E		C	C	C	
Approach Delay (s)		21.1			12.5			48.7			28.4	
Approach LOS		C			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	22.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	112.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	83.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	31	3485	136	0	1326	70	31	67	73	91	129	39
Future Volume (vph)	31	3485	136	0	1326	70	31	67	73	91	129	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.86			0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00		1.00	0.97		1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00		1.00	1.00		0.97	1.00	
Frt	1.00	0.99			0.99		1.00	0.92		1.00	0.96	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1597	5751			3167		1597	1503		1542	1622	
Flt Permitted	0.95	1.00			1.00		0.39	1.00		0.48	1.00	
Satd. Flow (perm)	1597	5751			3167		654	1503		773	1622	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	32	3630	142	0	1381	73	32	70	76	95	134	41
RTOR Reduction (vph)	0	3	0	0	2	0	0	1	0	0	8	0
Lane Group Flow (vph)	32	3769	0	0	1452	0	32	145	0	95	167	0
Confl. Peds. (#/hr)	1					1			33	33		
Heavy Vehicles (%)	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Turn Type	Prot	NA			NA		Perm	NA		Perm	NA	
Protected Phases	5	2			6			8			4	
Permitted Phases							8			4		
Actuated Green, G (s)	4.1	112.3			103.2		20.5	20.5		20.5	20.5	
Effective Green, g (s)	4.1	112.3			103.2		20.5	20.5		20.5	20.5	
Actuated g/C Ratio	0.03	0.79			0.72		0.14	0.14		0.14	0.14	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	45	4522			2288		93	215		110	232	
v/s Ratio Prot	0.02	c0.66			0.46			0.10			0.10	
v/s Ratio Perm							0.05			c0.12		
v/c Ratio	0.71	0.83			0.63		0.34	0.68		0.86	0.72	
Uniform Delay, d1	68.8	9.5			10.1		55.1	58.0		59.8	58.4	
Progression Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	41.4	1.4			0.6		2.2	8.1		46.0	10.5	
Delay (s)	110.1	10.9			10.7		57.3	66.1		105.8	68.9	
Level of Service	F	B			B		E	E		F	E	
Approach Delay (s)		11.7			10.7			64.5			81.9	
Approach LOS		B			B			E			F	

Intersection Summary			
HCM 2000 Control Delay	16.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	142.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	90.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	44	2238	62	44	2554	79	102	135	62	59	97	35
Future Volume (vph)	44	2238	62	44	2554	79	102	135	62	59	97	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.97		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		0.96	1.00	
Frt	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1597	4563		1597	4570		1597	1561		1535	1614	
Flt Permitted	0.95	1.00		0.95	1.00		0.48	1.00		0.31	1.00	
Satd. Flow (perm)	1597	4563		1597	4570		814	1561		496	1614	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	45	2284	63	45	2606	81	104	138	63	60	99	36
RTOR Reduction (vph)	0	1	0	0	1	0	0	7	0	0	6	0
Lane Group Flow (vph)	45	2346	0	45	2686	0	104	194	0	60	129	0
Confl. Peds. (#/hr)			9						35	35		
Heavy Vehicles (%)	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			8			4	
Permitted Phases							8			4		
Actuated Green, G (s)	9.1	151.9		9.1	151.9		33.3	33.3		33.3	33.3	
Effective Green, g (s)	9.1	151.9		9.1	151.9		33.3	33.3		33.3	33.3	
Actuated g/C Ratio	0.04	0.73		0.04	0.73		0.16	0.16		0.16	0.16	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	69	3311		69	3316		129	248		78	256	
v/s Ratio Prot	c0.03	0.51		0.03	c0.59			0.12			0.08	
v/s Ratio Perm							c0.13			0.12		
v/c Ratio	0.65	0.71		0.65	0.81		0.81	0.78		0.77	0.50	
Uniform Delay, d1	98.5	16.2		98.5	19.1		84.9	84.5		84.3	80.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	20.0	0.7		20.0	1.5		29.5	14.8		35.7	1.6	
Delay (s)	118.5	16.9		118.5	20.6		114.4	99.4		120.0	82.0	
Level of Service	F	B		F	C		F	F		F	F	
Approach Delay (s)		18.8			22.3			104.5			93.7	
Approach LOS		B			C			F			F	

Intersection Summary			
HCM 2000 Control Delay	27.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	209.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	89.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑	↱	↰	↑↑
Traffic Volume (vph)	85	395	566	221	348	452
Future Volume (vph)	85	395	566	221	348	452
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1549	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1549	1770	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	91	425	609	238	374	486
RTOR Reduction (vph)	0	352	0	168	0	0
Lane Group Flow (vph)	91	73	609	70	374	486
Confl. Peds. (#/hr)				1		
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	10.7	10.7	18.3	18.3	18.6	41.9
Effective Green, g (s)	10.7	10.7	18.3	18.3	18.6	41.9
Actuated g/C Ratio	0.17	0.17	0.29	0.29	0.30	0.67
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	302	270	1034	452	525	2368
v/s Ratio Prot	c0.05		c0.17		c0.21	0.14
v/s Ratio Perm		0.05		0.04		
v/c Ratio	0.30	0.27	0.59	0.15	0.71	0.21
Uniform Delay, d1	22.7	22.6	18.9	16.4	19.6	4.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6	0.5	0.9	0.2	4.5	0.0
Delay (s)	23.2	23.1	19.8	16.6	24.2	4.0
Level of Service	C	C	B	B	C	A
Approach Delay (s)	23.1		18.9			12.8
Approach LOS	C		B			B

Intersection Summary			
HCM 2000 Control Delay	17.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	62.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	144	144	436	118	427	659
Future Volume (vph)	144	144	436	118	427	659
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1549	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1549	1770	3539
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	145	145	440	119	431	666
RTOR Reduction (vph)	0	117	0	90	0	0
Lane Group Flow (vph)	145	28	440	29	431	666
Confl. Peds. (#/hr)				1		
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	12.8	12.8	16.3	16.3	23.3	44.6
Effective Green, g (s)	12.8	12.8	16.3	16.3	23.3	44.6
Actuated g/C Ratio	0.19	0.19	0.24	0.24	0.35	0.66
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	336	300	855	374	611	2341
v/s Ratio Prot	c0.08		c0.12		c0.24	0.19
v/s Ratio Perm		0.02		0.02		
v/c Ratio	0.43	0.09	0.51	0.08	0.71	0.28
Uniform Delay, d1	24.1	22.5	22.1	19.7	19.1	4.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	0.1	0.5	0.1	3.7	0.1
Delay (s)	25.0	22.6	22.7	19.8	22.8	4.8
Level of Service	C	C	C	B	C	A
Approach Delay (s)	23.8		22.0			11.9
Approach LOS	C		C			B

Intersection Summary			
HCM 2000 Control Delay	16.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	67.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	363	173	222	469	0	0
Future Volume (Veh/h)	363	173	222	469	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	386	184	236	499	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	537					
pX, platoon unblocked						
vC, conflicting volume			570		1449	478
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			570		1449	478
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			76		100	100
cM capacity (veh/h)			1002		110	587

Direction, Lane #	EB 1	WB 1	WB 2
Volume Total	570	236	499
Volume Left	0	236	0
Volume Right	184	0	0
cSH	1700	1002	1700
Volume to Capacity	0.34	0.24	0.29
Queue Length 95th (ft)	0	23	0
Control Delay (s)	0.0	9.7	0.0
Lane LOS		A	
Approach Delay (s)	0.0	3.1	
Approach LOS			

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	48.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	255	282	359	315	0	0
Future Volume (Veh/h)	255	282	359	315	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	287	317	403	354	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	537					
pX, platoon unblocked						
vC, conflicting volume			604		1606	446
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			604		1606	446
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			59		100	100
cM capacity (veh/h)			974		68	613

Direction, Lane #	EB 1	WB 1	WB 2
Volume Total	604	403	354
Volume Left	0	403	0
Volume Right	317	0	0
cSH	1700	974	1700
Volume to Capacity	0.36	0.41	0.21
Queue Length 95th (ft)	0	51	0
Control Delay (s)	0.0	11.3	0.0
Lane LOS		B	
Approach Delay (s)	0.0	6.0	
Approach LOS			

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	57.2%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑↑	↰	↱
Traffic Volume (veh/h)	363	0	0	488	203	304
Future Volume (Veh/h)	363	0	0	488	203	304
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	386	0	0	519	216	323
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1031					
pX, platoon unblocked						
vC, conflicting volume			386		646	386
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			386		646	386
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		47	47
cM capacity (veh/h)			1169		405	612

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	386	260	260	216	323
Volume Left	0	0	0	216	0
Volume Right	0	0	0	0	323
cSH	1700	1700	1700	405	612
Volume to Capacity	0.23	0.15	0.15	0.53	0.53
Queue Length 95th (ft)	0	0	0	76	77
Control Delay (s)	0.0	0.0	0.0	23.6	17.3
Lane LOS				C	C
Approach Delay (s)	0.0	0.0		19.8	
Approach LOS				C	

Intersection Summary			
Average Delay	7.4		
Intersection Capacity Utilization	48.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑↑	↰	↱
Traffic Volume (veh/h)	255	0	0	535	139	240
Future Volume (Veh/h)	255	0	0	535	139	240
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	271	0	0	569	148	255
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1031					
pX, platoon unblocked						
vC, conflicting volume			271		556	271
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			271		556	271
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		68	65
cM capacity (veh/h)			1289		461	727

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	271	284	284	148	255
Volume Left	0	0	0	148	0
Volume Right	0	0	0	0	255
cSH	1700	1700	1700	461	727
Volume to Capacity	0.16	0.17	0.17	0.32	0.35
Queue Length 95th (ft)	0	0	0	34	39
Control Delay (s)	0.0	0.0	0.0	16.4	12.6
Lane LOS				C	B
Approach Delay (s)	0.0	0.0		14.0	
Approach LOS				B	

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	57.2%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑↱		↰		↱		↰↑↱	
Traffic Volume (veh/h)	51	223	156	1	79	3	126	0	2	0	0	2
Future Volume (Veh/h)	51	223	156	1	79	3	126	0	2	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	61	265	186	1	94	4	150	0	2	0	0	2
Pedestrians					3			1				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			0				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	98			452			532	581	230	358	672	49
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	98			452			532	581	230	358	672	49
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			100			64	100	100	100	100	100
cM capacity (veh/h)	1493			1104			415	406	770	551	360	1009

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total	194	318	1	63	35	150	2	2
Volume Left	61	0	1	0	0	150	0	0
Volume Right	0	186	0	0	4	0	2	2
cSH	1493	1700	1104	1700	1700	415	770	1009
Volume to Capacity	0.04	0.19	0.00	0.04	0.02	0.36	0.00	0.00
Queue Length 95th (ft)	3	0	0	0	0	40	0	0
Control Delay (s)	2.6	0.0	8.3	0.0	0.0	18.5	9.7	8.6
Lane LOS	A		A			C	A	A
Approach Delay (s)	1.0		0.1			18.4		8.6
Approach LOS						C		A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	36.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	27	70	15	3	172	5	162	0	3	0	0	4
Future Volume (Veh/h)	27	70	15	3	172	5	162	0	3	0	0	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	31	80	17	3	198	6	186	0	3	0	0	5
Pedestrians					1							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	204			97			260	360	50	313	366	102
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	204			97			260	360	50	313	366	102
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			100			72	100	100	100	100	99
cM capacity (veh/h)	1365			1494			655	551	1007	602	547	933

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total	71	57	3	132	72	186	3	5
Volume Left	31	0	3	0	0	186	0	0
Volume Right	0	17	0	0	6	0	3	5
cSH	1365	1700	1494	1700	1700	655	1007	933
Volume to Capacity	0.02	0.03	0.00	0.08	0.04	0.28	0.00	0.01
Queue Length 95th (ft)	2	0	0	0	0	29	0	0
Control Delay (s)	3.5	0.0	7.4	0.0	0.0	12.7	8.6	8.9
Lane LOS	A		A			B	A	A
Approach Delay (s)	1.9		0.1			12.6		8.9
Approach LOS						B		A

Intersection Summary			
Average Delay	5.1		
Intersection Capacity Utilization	33.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰		↱		↑↑↱						↑	↱
Traffic Volume (vph)	487	0	610	0	1049	357	0	0	0	0	129	315
Future Volume (vph)	487	0	610	0	1049	357	0	0	0	0	129	315
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frt	1.00		0.85		0.96						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1583		1583		4750						1667	1417
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1583		1583		4750						1667	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	535	0	670	0	1153	392	0	0	0	0	142	346
RTOR Reduction (vph)	0	0	0	0	40	0	0	0	0	0	0	300
Lane Group Flow (vph)	535	0	670	0	1505	0	0	0	0	0	142	46
Heavy Vehicles (%)	14%	2%	2%	2%	2%	14%	2%	2%	2%	14%	14%	14%
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	49.5		132.8		50.8						17.5	17.5
Effective Green, g (s)	49.5		132.8		50.8						17.5	17.5
Actuated g/C Ratio	0.37		1.00		0.38						0.13	0.13
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	590		1583		1817						219	186
v/s Ratio Prot	c0.34				c0.32						c0.09	
v/s Ratio Perm			0.42									0.03
v/c Ratio	0.91		0.42		0.83						0.65	0.25
Uniform Delay, d1	39.5		0.0		37.1						54.7	51.7
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	17.6		0.8		3.3						6.5	0.7
Delay (s)	57.0		0.8		40.3						61.2	52.4
Level of Service	E		A		D						E	D
Approach Delay (s)		25.8			40.3			0.0			55.0	
Approach LOS		C			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	37.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	132.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	73.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰		↱		↑↑↱						↑	↱
Traffic Volume (vph)	190	0	1324	0	873	255	0	0	0	0	565	532
Future Volume (vph)	190	0	1324	0	873	255	0	0	0	0	565	532
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frpb, ped/bikes	1.00		1.00		0.99						1.00	1.00
Flpb, ped/bikes	1.00		1.00		1.00						1.00	1.00
Frt	1.00		0.85		0.97						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1583		1583		4756						1667	1417
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1583		1583		4756						1667	1417
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	207	0	1439	0	949	277	0	0	0	0	614	578
RTOR Reduction (vph)	0	0	0	0	29	0	0	0	0	0	0	213
Lane Group Flow (vph)	207	0	1439	0	1197	0	0	0	0	0	614	365
Confl. Peds. (#/hr)						3						
Heavy Vehicles (%)	14%	2%	2%	2%	2%	14%	2%	2%	2%	14%	14%	14%
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	25.4		153.1		47.2						65.5	65.5
Effective Green, g (s)	25.4		153.1		47.2						65.5	65.5
Actuated g/C Ratio	0.17		1.00		0.31						0.43	0.43
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	262		1583		1466						713	606
v/s Ratio Prot	0.13				0.25						0.37	
v/s Ratio Perm			c0.91									0.26
v/c Ratio	0.79		0.91		0.82						0.86	0.60
Uniform Delay, d1	61.3		0.0		48.9						39.7	33.7
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	14.9		9.3		3.6						10.4	1.7
Delay (s)	76.2		9.3		52.6						50.1	35.4
Level of Service	E		A		D						D	D
Approach Delay (s)		17.7			52.6			0.0			43.0	
Approach LOS		B			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	35.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	153.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	389	432	202	14	18	224
Future Volume (vph)	389	432	202	14	18	224
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1650		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1650		1583	1417
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	447	497	232	16	21	257
RTOR Reduction (vph)	0	0	3	0	0	223
Lane Group Flow (vph)	447	497	245	0	21	34
Confl. Peds. (#/hr)				1		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	22.7	42.7	15.0		7.9	7.9
Effective Green, g (s)	22.7	42.7	15.0		7.9	7.9
Actuated g/C Ratio	0.37	0.70	0.25		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	592	1174	408		206	184
v/s Ratio Prot	c0.28	0.30	c0.15		0.01	
v/s Ratio Perm						c0.02
v/c Ratio	0.76	0.42	0.60		0.10	0.18
Uniform Delay, d1	16.5	3.8	20.2		23.2	23.5
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.4	0.2	2.5		0.2	0.5
Delay (s)	22.0	4.0	22.6		23.4	24.0
Level of Service	C	A	C		C	C
Approach Delay (s)		12.5	22.6		23.9	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	16.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	60.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	200	220	508	12	23	408
Future Volume (vph)	200	220	508	12	23	408
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	1.00		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1660		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1660		1583	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	220	242	558	13	25	448
RTOR Reduction (vph)	0	0	1	0	0	389
Lane Group Flow (vph)	220	242	570	0	25	59
Confl. Peds. (#/hr)				6		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	16.9	55.0	33.1		9.8	9.8
Effective Green, g (s)	16.9	55.0	33.1		9.8	9.8
Actuated g/C Ratio	0.23	0.74	0.44		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	357	1225	734		207	185
v/s Ratio Prot	c0.14	0.15	c0.34		0.02	
v/s Ratio Perm						c0.04
v/c Ratio	0.62	0.20	0.78		0.12	0.32
Uniform Delay, d1	26.0	3.1	17.7		28.7	29.5
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	3.1	0.1	5.2		0.3	1.0
Delay (s)	29.2	3.1	22.9		29.0	30.5
Level of Service	C	A	C		C	C
Approach Delay (s)		15.5	22.9		30.4	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	74.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	290	63	1	136	23	4
Future Volume (Veh/h)	290	63	1	136	23	4
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	354	77	1	166	28	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			431		560	392
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			431		560	392
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		94	99
cM capacity (veh/h)			1067		469	631

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	431	167	33
Volume Left	0	1	28
Volume Right	77	0	5
cSH	1700	1067	488
Volume to Capacity	0.25	0.00	0.07
Queue Length 95th (ft)	0	0	5
Control Delay (s)	0.0	0.1	12.9
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	12.9
Approach LOS			B

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	29.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	122	26	3	278	74	1
Future Volume (Veh/h)	122	26	3	278	74	1
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	134	29	3	305	81	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			163		460	148
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			163		460	148
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		85	100
cM capacity (veh/h)			1346		537	867

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	163	308	82
Volume Left	0	3	81
Volume Right	29	0	1
cSH	1700	1346	540
Volume to Capacity	0.10	0.00	0.15
Queue Length 95th (ft)	0	0	13
Control Delay (s)	0.0	0.1	12.9
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	12.9
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	27.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	42	150	2	25	111	3
Future Volume (Veh/h)	42	150	2	25	111	3
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	49	174	2	29	129	3
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			223		169	136
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			223		169	136
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		84	100
cM capacity (veh/h)			1278		793	882

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	223	31	132
Volume Left	0	2	129
Volume Right	174	0	3
cSH	1700	1278	795
Volume to Capacity	0.13	0.00	0.17
Queue Length 95th (ft)	0	0	15
Control Delay (s)	0.0	0.5	10.4
Lane LOS		A	B
Approach Delay (s)	0.0	0.5	10.4
Approach LOS			B

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	24.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	8	39	0	41	111	0
Future Volume (Veh/h)	8	39	0	41	111	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	9	43	0	45	122	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			52		76	30
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			52		76	30
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		86	100
cM capacity (veh/h)			1480		899	1010

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	52	45	122
Volume Left	0	0	122
Volume Right	43	0	0
cSH	1700	1480	899
Volume to Capacity	0.03	0.00	0.14
Queue Length 95th (ft)	0	0	12
Control Delay (s)	0.0	0.0	9.6
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	5.4		
Intersection Capacity Utilization	16.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	487	0	610	0	1049	357	0	0	0	0	129	315
Future Volume (vph)	487	0	610	0	1049	357	0	0	0	0	129	315
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frt	1.00		0.85		0.96						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1583		1583		4750						1667	1417
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1583		1583		4750						1667	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	535	0	670	0	1153	392	0	0	0	0	142	346
RTOR Reduction (vph)	0	0	0	0	40	0	0	0	0	0	0	300
Lane Group Flow (vph)	535	0	670	0	1505	0	0	0	0	0	142	46
Heavy Vehicles (%)	14%	2%	2%	2%	2%	14%	2%	2%	2%	14%	14%	14%
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	49.5		132.8		50.8						17.5	17.5
Effective Green, g (s)	49.5		132.8		50.8						17.5	17.5
Actuated g/C Ratio	0.37		1.00		0.38						0.13	0.13
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	590		1583		1817						219	186
v/s Ratio Prot	c0.34				c0.32						c0.09	
v/s Ratio Perm			0.42									0.03
v/c Ratio	0.91		0.42		0.83						0.65	0.25
Uniform Delay, d1	39.5		0.0		37.1						54.7	51.7
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	17.6		0.8		3.3						6.5	0.7
Delay (s)	57.0		0.8		40.3						61.2	52.4
Level of Service	E		A		D						E	D
Approach Delay (s)		25.8			40.3			0.0			55.0	
Approach LOS		C			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	37.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	132.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	73.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	190	0	1324	0	873	255	0	0	0	0	565	532
Future Volume (vph)	190	0	1324	0	873	255	0	0	0	0	565	532
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frpb, ped/bikes	1.00		1.00		0.99						1.00	1.00
Flpb, ped/bikes	1.00		1.00		1.00						1.00	1.00
Frt	1.00		0.85		0.97						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1583		1583		4756						1667	1417
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1583		1583		4756						1667	1417
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	207	0	1439	0	949	277	0	0	0	0	614	578
RTOR Reduction (vph)	0	0	0	0	29	0	0	0	0	0	0	213
Lane Group Flow (vph)	207	0	1439	0	1197	0	0	0	0	0	614	365
Confl. Peds. (#/hr)						3						
Heavy Vehicles (%)	14%	2%	2%	2%	2%	14%	2%	2%	2%	14%	14%	14%
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	25.4		153.1		47.2						65.5	65.5
Effective Green, g (s)	25.4		153.1		47.2						65.5	65.5
Actuated g/C Ratio	0.17		1.00		0.31						0.43	0.43
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	262		1583		1466						713	606
v/s Ratio Prot	0.13				0.25						0.37	
v/s Ratio Perm			c0.91									0.26
v/c Ratio	0.79		0.91		0.82						0.86	0.60
Uniform Delay, d1	61.3		0.0		48.9						39.7	33.7
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	14.9		9.3		3.6						10.4	1.7
Delay (s)	76.2		9.3		52.6						50.1	35.4
Level of Service	E		A		D						D	D
Approach Delay (s)		17.7			52.6			0.0			43.0	
Approach LOS		B			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	35.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	153.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	389	432	202	14	18	224
Future Volume (vph)	389	432	202	14	18	224
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1650		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1650		1583	1417
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	447	497	232	16	21	257
RTOR Reduction (vph)	0	0	3	0	0	223
Lane Group Flow (vph)	447	497	245	0	21	34
Confl. Peds. (#/hr)				1		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	22.7	42.7	15.0		7.9	7.9
Effective Green, g (s)	22.7	42.7	15.0		7.9	7.9
Actuated g/C Ratio	0.37	0.70	0.25		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	592	1174	408		206	184
v/s Ratio Prot	c0.28	0.30	c0.15		0.01	
v/s Ratio Perm						c0.02
v/c Ratio	0.76	0.42	0.60		0.10	0.18
Uniform Delay, d1	16.5	3.8	20.2		23.2	23.5
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.4	0.2	2.5		0.2	0.5
Delay (s)	22.0	4.0	22.6		23.4	24.0
Level of Service	C	A	C		C	C
Approach Delay (s)		12.5	22.6		23.9	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	16.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	60.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	200	220	508	12	23	408
Future Volume (vph)	200	220	508	12	23	408
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	1.00		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1660		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1660		1583	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	220	242	558	13	25	448
RTOR Reduction (vph)	0	0	1	0	0	389
Lane Group Flow (vph)	220	242	570	0	25	59
Confl. Peds. (#/hr)				6		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	16.9	55.0	33.1		9.8	9.8
Effective Green, g (s)	16.9	55.0	33.1		9.8	9.8
Actuated g/C Ratio	0.23	0.74	0.44		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	357	1225	734		207	185
v/s Ratio Prot	c0.14	0.15	c0.34		0.02	
v/s Ratio Perm						c0.04
v/c Ratio	0.62	0.20	0.78		0.12	0.32
Uniform Delay, d1	26.0	3.1	17.7		28.7	29.5
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	3.1	0.1	5.2		0.3	1.0
Delay (s)	29.2	3.1	22.9		29.0	30.5
Level of Service	C	A	C		C	C
Approach Delay (s)		15.5	22.9		30.4	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	74.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	9	722	39	99	1172	93	19	30	45	23	19	25
Future Volume (Veh/h)	9	722	39	99	1172	93	19	30	45	23	19	25
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	9	760	41	104	1234	98	20	32	47	24	20	26
Pedestrians					1			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			1				
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1332			813			1672	2350	414	1953	2322	666
vC1, stage 1 conf vol							810	810		1491	1491	
vC2, stage 2 conf vol							861	1540		462	831	
vCu, unblocked vol	1332			813			1672	2350	414	1953	2322	666
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			87			92	84	93	85	90	95
cM capacity (veh/h)	514			800			247	206	654	160	208	487

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	9	507	294	104	823	509	99	70
Volume Left	9	0	0	104	0	0	20	24
Volume Right	0	0	41	0	0	98	47	26
cSH	514	1700	1700	800	1700	1700	322	234
Volume to Capacity	0.02	0.30	0.17	0.13	0.48	0.30	0.31	0.30
Queue Length 95th (ft)	1	0	0	11	0	0	32	30
Control Delay (s)	12.1	0.0	0.0	10.2	0.0	0.0	21.1	26.8
Lane LOS	B			B			C	D
Approach Delay (s)	0.1			0.7			21.1	26.8
Approach LOS							C	D

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	55.1%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	19	1376	21	22	886	29	15	14	24	48	2	18
Future Volume (Veh/h)	19	1376	21	22	886	29	15	14	24	48	2	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	21	1496	23	24	963	32	16	15	26	52	2	20
Pedestrians											1	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	996			1519			2100	2594	760	1852	2589	498
vC1, stage 1 conf vol							1550	1550		1028	1028	
vC2, stage 2 conf vol							550	1044		824	1561	
vCu, unblocked vol	996			1519			2100	2594	760	1852	2589	498
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			94			90	93	94	78	99	97
cM capacity (veh/h)	690			435			168	212	434	235	201	597

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	21	997	522	24	642	353	57	74
Volume Left	21	0	0	24	0	0	16	52
Volume Right	0	0	23	0	0	32	26	20
cSH	690	1700	1700	435	1700	1700	252	279
Volume to Capacity	0.03	0.59	0.31	0.06	0.38	0.21	0.23	0.26
Queue Length 95th (ft)	2	0	0	4	0	0	21	26
Control Delay (s)	10.4	0.0	0.0	13.7	0.0	0.0	23.4	22.5
Lane LOS	B			B			C	C
Approach Delay (s)	0.1			0.3			23.4	22.5
Approach LOS							C	C

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑↱			✣			✣	
Traffic Volume (veh/h)	13	761	41	18	1261	5	13	0	4	2	0	9
Future Volume (Veh/h)	13	761	41	18	1261	5	13	0	4	2	0	9
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	14	801	43	19	1327	5	14	0	4	2	0	9
Pedestrians					5							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1332			801			1540	2199	406	1805	2196	666
vC1, stage 1 conf vol							829	829		1368	1368	
vC2, stage 2 conf vol							710	1370		438	829	
vCu, unblocked vol	1332			801			1540	2199	406	1805	2196	666
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	*6.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		5.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			96	100	99	99	100	98
cM capacity (veh/h)	514			818			315	170	666	211	178	487

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	14	400	400	43	19	885	447	18	11
Volume Left	14	0	0	0	19	0	0	14	2
Volume Right	0	0	0	43	0	0	5	4	9
cSH	514	1700	1700	1700	818	1700	1700	357	393
Volume to Capacity	0.03	0.24	0.24	0.03	0.02	0.52	0.26	0.05	0.03
Queue Length 95th (ft)	2	0	0	0	2	0	0	4	2
Control Delay (s)	12.2	0.0	0.0	0.0	9.5	0.0	0.0	15.6	14.4
Lane LOS	B				A			C	B
Approach Delay (s)	0.2				0.1			15.6	14.4
Approach LOS								C	B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	3	1424	0	0	841	0	1	0	1	0	0	2
Future Volume (Veh/h)	3	1424	0	0	841	0	1	0	1	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	3	1468	0	0	867	0	1	0	1	0	0	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	867			1468			1910	2341	734	1608	2341	434
vC1, stage 1 conf vol							1474	1474		867	867	
vC2, stage 2 conf vol							436	867		741	1474	
vCu, unblocked vol	867			1468			1910	2341	734	1608	2341	434
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	7.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		6.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	100	100	100	100	100
cM capacity (veh/h)	772			456			192	165	448	243	165	646

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	3	734	734	0	0	578	289	2	2
Volume Left	3	0	0	0	0	0	0	1	0
Volume Right	0	0	0	0	0	0	0	1	2
cSH	772	1700	1700	1700	1700	1700	1700	269	646
Volume to Capacity	0.00	0.43	0.43	0.00	0.00	0.34	0.17	0.01	0.00
Queue Length 95th (ft)	0	0	0	0	0	0	0	1	0
Control Delay (s)	9.7	0.0	0.0	0.0	0.0	0.0	0.0	18.5	10.6
Lane LOS	A							C	B
Approach Delay (s)	0.0				0.0			18.5	10.6
Approach LOS								C	B

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

APPENDIX D

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT ALTERNATIVE 1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	67	2072	21	10	629	67	0	1	4	39	4	11
Future Volume (vph)	67	2072	21	10	629	67	0	1	4	39	4	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	0.91		1.00	0.95			1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	1.00
Flpb, ped/bikes	0.99	1.00		1.00	1.00			1.00			0.98	1.00
Frt	1.00	1.00		1.00	0.99			0.89			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.96	1.00
Satd. Flow (prot)	1756	5078		1770	3475			1615			1744	1583
Flt Permitted	0.38	1.00		0.07	1.00			1.00			0.74	1.00
Satd. Flow (perm)	702	5078		129	3475			1615			1353	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	68	2114	21	10	642	68	0	1	4	40	4	11
RTOR Reduction (vph)	0	0	0	0	4	0	0	4	0	0	0	10
Lane Group Flow (vph)	68	2135	0	10	706	0	0	1	0	0	44	1
Confl. Peds. (#/hr)	13					13			25	25		
Turn Type	Perm	NA		Perm	NA			NA		Perm	NA	Perm
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	70.5	70.5		70.5	70.5			10.3			10.3	10.3
Effective Green, g (s)	70.5	70.5		70.5	70.5			10.3			10.3	10.3
Actuated g/C Ratio	0.78	0.78		0.78	0.78			0.11			0.11	0.11
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	545	3942		100	2698			183			153	179
v/s Ratio Prot		c0.42			0.20			0.00				
v/s Ratio Perm	0.10			0.08							c0.03	0.00
v/c Ratio	0.12	0.54		0.10	0.26			0.01			0.29	0.01
Uniform Delay, d1	2.5	3.9		2.5	2.8			35.7			36.9	35.7
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	0.2		0.4	0.1			0.0			1.0	0.0
Delay (s)	2.6	4.1		2.9	2.9			35.7			37.9	35.7
Level of Service	A	A		A	A			D			D	D
Approach Delay (s)		4.0			2.9			35.7			37.5	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	4.4	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	84	2067	2	3	1158	56	14	7	4	59	2	34
Future Volume (vph)	84	2067	2	3	1158	56	14	7	4	59	2	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	0.91		1.00	0.95			1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			0.99	1.00
Frt	1.00	1.00		1.00	0.99			0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	1766	5084		1769	3509			1766			1755	1583
Flt Permitted	0.20	1.00		0.07	1.00			0.84			0.71	1.00
Satd. Flow (perm)	371	5084		129	3509			1530			1315	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	86	2109	2	3	1182	57	14	7	4	60	2	35
RTOR Reduction (vph)	0	0	0	0	2	0	0	3	0	0	0	30
Lane Group Flow (vph)	86	2111	0	3	1237	0	0	22	0	0	62	5
Confl. Peds. (#/hr)	9		1	1		9			14	14		
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	Perm
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	69.3	69.3		69.3	69.3			12.8			12.8	12.8
Effective Green, g (s)	69.3	69.3		69.3	69.3			12.8			12.8	12.8
Actuated g/C Ratio	0.75	0.75		0.75	0.75			0.14			0.14	0.14
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	279	3825		97	2640			212			182	220
v/s Ratio Prot		c0.42			0.35							
v/s Ratio Perm	0.23			0.02				0.01			c0.05	0.00
v/c Ratio	0.31	0.55		0.03	0.47			0.10			0.34	0.02
Uniform Delay, d1	3.7	4.8		2.9	4.4			34.6			35.8	34.2
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.6	0.2		0.1	0.1			0.2			1.1	0.0
Delay (s)	4.3	5.0		3.0	4.5			34.8			37.0	34.3
Level of Service	A	A		A	A			C			D	C
Approach Delay (s)		5.0			4.5			34.8			36.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM 2000 Control Delay	5.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	92.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1573	474	36	392	0	145	0	75	33	73	62
Future Volume (vph)	0	1573	474	36	392	0	145	0	75	33	73	62
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		1.00		1.00	1.00	1.00	
Frpb, ped/bikes		1.00	0.93	1.00	1.00		1.00		0.97	1.00	0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		0.99		1.00	0.99	1.00	
Frt		1.00	0.85	1.00	1.00		1.00		0.85	1.00	0.93	
Flt Protected		1.00	1.00	0.95	1.00		0.95		1.00	0.95	1.00	
Satd. Flow (prot)		3539	1468	1770	3539		1749		1541	1743	1714	
Flt Permitted		1.00	1.00	0.09	1.00		0.61		1.00	0.95	1.00	
Satd. Flow (perm)		3539	1468	176	3539		1124		1541	1743	1714	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1673	504	38	417	0	154	0	80	35	78	66
RTOR Reduction (vph)	0	0	155	0	0	0	0	0	22	0	27	0
Lane Group Flow (vph)	0	1673	349	38	417	0	154	0	58	35	117	0
Confl. Peds. (#/hr)	50		50	50		50	15		15	15		15
Turn Type		NA	Perm	Perm	NA		Perm		Perm	Perm	NA	
Protected Phases		2			6						4	
Permitted Phases			2	6			8		8	4		
Actuated Green, G (s)		65.8	65.8	65.8	65.8		19.3		19.3	19.3	19.3	
Effective Green, g (s)		65.8	65.8	65.8	65.8		19.3		19.3	19.3	19.3	
Actuated g/C Ratio		0.69	0.69	0.69	0.69		0.20		0.20	0.20	0.20	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)		2448	1015	121	2448		228		312	353	347	
v/s Ratio Prot		c0.47			0.12						0.07	
v/s Ratio Perm			0.24	0.22			c0.14		0.04	0.02		
v/c Ratio		0.68	0.34	0.31	0.17		0.68		0.18	0.10	0.34	
Uniform Delay, d1		8.6	5.9	5.8	5.1		35.0		31.4	30.8	32.4	
Progression Factor		1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.00	
Incremental Delay, d2		0.8	0.2	1.5	0.0		7.7		0.3	0.1	0.6	
Delay (s)		9.4	6.1	7.3	5.1		42.7		31.7	31.0	33.0	
Level of Service		A	A	A	A		D		C	C	C	
Approach Delay (s)		8.6			5.3			38.9			32.6	
Approach LOS		A			A			D			C	

Intersection Summary			
HCM 2000 Control Delay	11.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	95.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1828	372	23	1003	0	320	0	205	42	28	90
Future Volume (vph)	0	1828	372	23	1003	0	320	0	205	42	28	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		1.00		1.00	1.00	1.00	
Frpb, ped/bikes		1.00	0.93	1.00	1.00		1.00		0.97	1.00	0.98	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		0.99		1.00	0.98	1.00	
Frt		1.00	0.85	1.00	1.00		1.00		0.85	1.00	0.89	
Flt Protected		1.00	1.00	0.95	1.00		0.95		1.00	0.95	1.00	
Satd. Flow (prot)		3539	1470	1770	3539		1747		1540	1742	1616	
Flt Permitted		1.00	1.00	0.06	1.00		0.66		1.00	0.95	1.00	
Satd. Flow (perm)		3539	1470	105	3539		1206		1540	1742	1616	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1945	396	24	1067	0	340	0	218	45	30	96
RTOR Reduction (vph)	0	0	125	0	0	0	0	0	13	0	60	0
Lane Group Flow (vph)	0	1945	271	24	1067	0	340	0	205	45	66	0
Confl. Peds. (#/hr)	40		40	40		40	13		13	13		13
Turn Type		NA	Perm	Perm	NA		Perm		Perm	Perm	NA	
Protected Phases		2			6						4	
Permitted Phases			2	6			8		8	4		
Actuated Green, G (s)		70.7	70.7	70.7	70.7		35.4		35.4	35.4	35.4	
Effective Green, g (s)		70.7	70.7	70.7	70.7		35.4		35.4	35.4	35.4	
Actuated g/C Ratio		0.61	0.61	0.61	0.61		0.30		0.30	0.30	0.30	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)		2155	895	63	2155		367		469	531	492	
v/s Ratio Prot		c0.55			0.30						0.04	
v/s Ratio Perm			0.18	0.23			c0.28		0.13	0.03		
v/c Ratio		0.90	0.30	0.38	0.50		0.93		0.44	0.08	0.13	
Uniform Delay, d1		19.7	10.9	11.6	12.7		39.1		32.4	28.8	29.2	
Progression Factor		1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.00	
Incremental Delay, d2		5.7	0.2	3.8	0.2		28.8		0.7	0.1	0.1	
Delay (s)		25.5	11.1	15.4	12.9		67.9		33.0	28.9	29.4	
Level of Service		C	B	B	B		E		C	C	C	
Approach Delay (s)		23.0			12.9			54.3			29.2	
Approach LOS		C			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	24.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	116.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	3591	140	0	1366	72	32	69	75	94	133	40
Future Volume (vph)	32	3591	140	0	1366	72	32	69	75	94	133	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.86			0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00		1.00	0.97		1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00		1.00	1.00		0.97	1.00	
Frt	1.00	0.99			0.99		1.00	0.92		1.00	0.97	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1597	5751			3167		1597	1503		1542	1623	
Flt Permitted	0.95	1.00			1.00		0.38	1.00		0.47	1.00	
Satd. Flow (perm)	1597	5751			3167		635	1503		761	1623	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	33	3741	146	0	1423	75	33	72	78	98	139	42
RTOR Reduction (vph)	0	3	0	0	2	0	0	1	0	0	8	0
Lane Group Flow (vph)	33	3884	0	0	1496	0	33	149	0	98	173	0
Confl. Peds. (#/hr)	1					1			33	33		
Heavy Vehicles (%)	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Turn Type	Prot	NA			NA		Perm	NA		Perm	NA	
Protected Phases	5	2			6			8			4	
Permitted Phases							8			4		
Actuated Green, G (s)	4.1	112.3			103.2		21.0	21.0		21.0	21.0	
Effective Green, g (s)	4.1	112.3			103.2		21.0	21.0		21.0	21.0	
Actuated g/C Ratio	0.03	0.78			0.72		0.15	0.15		0.15	0.15	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	45	4506			2280		93	220		111	237	
v/s Ratio Prot	0.02	c0.68			0.47			0.10			0.11	
v/s Ratio Perm							0.05			c0.13		
v/c Ratio	0.73	0.86			0.66		0.35	0.68		0.88	0.73	
Uniform Delay, d1	69.1	10.3			10.6		55.1	57.9		59.9	58.5	
Progression Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	46.2	1.9			0.7		2.3	8.0		50.5	11.0	
Delay (s)	115.3	12.2			11.3		57.4	66.0		110.4	69.5	
Level of Service	F	B			B		E	E		F	E	
Approach Delay (s)		13.1			11.3			64.4			83.9	
Approach LOS		B			B			E			F	

Intersection Summary			
HCM 2000 Control Delay	17.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	143.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	92.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	45	2306	64	45	2632	81	105	139	64	61	100	36
Future Volume (vph)	45	2306	64	45	2632	81	105	139	64	61	100	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.97		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		0.96	1.00	
Frt	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1597	4563		1597	4570		1597	1560		1536	1614	
Flt Permitted	0.95	1.00		0.95	1.00		0.47	1.00		0.29	1.00	
Satd. Flow (perm)	1597	4563		1597	4570		791	1560		466	1614	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	46	2353	65	46	2686	83	107	142	65	62	102	37
RTOR Reduction (vph)	0	1	0	0	1	0	0	8	0	0	6	0
Lane Group Flow (vph)	46	2417	0	46	2768	0	107	199	0	62	133	0
Confl. Peds. (#/hr)			9						35	35		
Heavy Vehicles (%)	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			8			4	
Permitted Phases							8			4		
Actuated Green, G (s)	9.2	155.8		9.2	155.8		34.0	34.0		34.0	34.0	
Effective Green, g (s)	9.2	155.8		9.2	155.8		34.0	34.0		34.0	34.0	
Actuated g/C Ratio	0.04	0.73		0.04	0.73		0.16	0.16		0.16	0.16	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	68	3322		68	3327		125	247		74	256	
v/s Ratio Prot	c0.03	0.53		0.03	c0.61			0.13			0.08	
v/s Ratio Perm							c0.14			0.13		
v/c Ratio	0.68	0.73		0.68	0.83		0.86	0.81		0.84	0.52	
Uniform Delay, d1	100.9	16.8		100.9	20.1		87.6	86.8		87.3	82.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	23.5	0.8		23.5	1.9		40.2	17.3		53.0	1.8	
Delay (s)	124.4	17.6		124.4	22.0		127.8	104.2		140.3	84.3	
Level of Service	F	B		F	C		F	F		F	F	
Approach Delay (s)		19.6			23.6			112.2			101.6	
Approach LOS		B			C			F			F	

Intersection Summary			
HCM 2000 Control Delay	29.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	214.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	90.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX E

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	67	2072	30	14	629	67	1	1	8	39	4	11
Future Volume (vph)	67	2072	30	14	629	67	1	1	8	39	4	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	0.91		1.00	0.95			1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	1.00
Flpb, ped/bikes	0.99	1.00		1.00	1.00			1.00			0.98	1.00
Frt	1.00	1.00		1.00	0.99			0.89			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.96	1.00
Satd. Flow (prot)	1756	5074		1770	3475			1607			1744	1583
Flt Permitted	0.38	1.00		0.07	1.00			0.98			0.74	1.00
Satd. Flow (perm)	702	5074		128	3475			1576			1346	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	68	2114	31	14	642	68	1	1	8	40	4	11
RTOR Reduction (vph)	0	1	0	0	4	0	0	7	0	0	0	10
Lane Group Flow (vph)	68	2144	0	14	706	0	0	3	0	0	44	1
Confl. Peds. (#/hr)	13					13			25	25		
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	Perm
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	70.6	70.6		70.6	70.6			10.3			10.3	10.3
Effective Green, g (s)	70.6	70.6		70.6	70.6			10.3			10.3	10.3
Actuated g/C Ratio	0.78	0.78		0.78	0.78			0.11			0.11	0.11
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	545	3940		99	2698			178			152	179
v/s Ratio Prot		c0.42			0.20							
v/s Ratio Perm	0.10			0.11				0.00			c0.03	0.00
v/c Ratio	0.12	0.54		0.14	0.26			0.02			0.29	0.01
Uniform Delay, d1	2.5	3.9		2.5	2.8			35.8			36.9	35.8
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	0.2		0.7	0.1			0.0			1.1	0.0
Delay (s)	2.6	4.1		3.2	2.9			35.8			38.0	35.8
Level of Service	A	A		A	A			D			D	D
Approach Delay (s)		4.0			2.9			35.8			37.6	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	4.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	84	2067	3	3	1158	56	27	7	13	59	2	34
Future Volume (vph)	84	2067	3	3	1158	56	27	7	13	59	2	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Lane Util. Factor	1.00	0.91		1.00	0.95			1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.99			1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			0.99	1.00
Frt	1.00	1.00		1.00	0.99			0.96			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	1766	5084		1769	3509			1732			1755	1583
Flt Permitted	0.20	1.00		0.07	1.00			0.81			0.70	1.00
Satd. Flow (perm)	371	5084		129	3509			1441			1284	1583
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	86	2109	3	3	1182	57	28	7	13	60	2	35
RTOR Reduction (vph)	0	0	0	0	2	0	0	11	0	0	0	30
Lane Group Flow (vph)	86	2112	0	3	1237	0	0	37	0	0	62	5
Confl. Peds. (#/hr)	9		1	1		9			14	14		
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	Perm
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	68.7	68.7		68.7	68.7			12.8			12.8	12.8
Effective Green, g (s)	68.7	68.7		68.7	68.7			12.8			12.8	12.8
Actuated g/C Ratio	0.75	0.75		0.75	0.75			0.14			0.14	0.14
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	5.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	278	3817		96	2634			201			179	221
v/s Ratio Prot		c0.42			0.35							
v/s Ratio Perm	0.23			0.02				0.03			c0.05	0.00
v/c Ratio	0.31	0.55		0.03	0.47			0.18			0.35	0.02
Uniform Delay, d1	3.7	4.9		2.9	4.4			34.7			35.6	34.0
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.6	0.2		0.1	0.1			0.4			1.2	0.0
Delay (s)	4.3	5.0		3.0	4.5			35.2			36.7	34.0
Level of Service	A	A		A	A			D			D	C
Approach Delay (s)		5.0			4.5			35.2			35.7	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	6.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	91.5	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	1576	475	36	395	0	146	0	75	33	73	62
Future Volume (vph)	0	1576	475	36	395	0	146	0	75	33	73	62
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		1.00		1.00	1.00	1.00	
Frpb, ped/bikes		1.00	0.93	1.00	1.00		1.00		0.97	1.00	0.99	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		0.99		1.00	0.99	1.00	
Frt		1.00	0.85	1.00	1.00		1.00		0.85	1.00	0.93	
Flt Protected		1.00	1.00	0.95	1.00		0.95		1.00	0.95	1.00	
Satd. Flow (prot)		3539	1468	1770	3539		1749		1541	1743	1714	
Flt Permitted		1.00	1.00	0.09	1.00		0.61		1.00	0.95	1.00	
Satd. Flow (perm)		3539	1468	175	3539		1122		1541	1743	1714	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1677	505	38	420	0	155	0	80	35	78	66
RTOR Reduction (vph)	0	0	155	0	0	0	0	0	22	0	27	0
Lane Group Flow (vph)	0	1677	350	38	420	0	155	0	58	35	117	0
Confl. Peds. (#/hr)	50		50	50		50	15		15	15		15
Turn Type		NA	Perm	Perm	NA		Perm		Perm	Perm	NA	
Protected Phases		2			6						4	
Permitted Phases			2	6			8		8	4		
Actuated Green, G (s)		66.1	66.1	66.1	66.1		19.4		19.4	19.4	19.4	
Effective Green, g (s)		66.1	66.1	66.1	66.1		19.4		19.4	19.4	19.4	
Actuated g/C Ratio		0.69	0.69	0.69	0.69		0.20		0.20	0.20	0.20	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)		2449	1016	121	2449		227		313	354	348	
v/s Ratio Prot		c0.47			0.12						0.07	
v/s Ratio Perm			0.24	0.22			c0.14		0.04	0.02		
v/c Ratio		0.68	0.34	0.31	0.17		0.68		0.18	0.10	0.34	
Uniform Delay, d1		8.6	5.9	5.8	5.1		35.2		31.5	30.9	32.5	
Progression Factor		1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.00	
Incremental Delay, d2		0.8	0.2	1.5	0.0		8.2		0.3	0.1	0.6	
Delay (s)		9.4	6.1	7.3	5.2		43.4		31.8	31.1	33.1	
Level of Service		A	A	A	A		D		C	C	C	
Approach Delay (s)		8.7			5.3			39.4			32.7	
Approach LOS		A			A			D			C	

Intersection Summary			
HCM 2000 Control Delay	11.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	95.5	Sum of lost time (s)	10.0
Intersection Capacity Utilization	78.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↱	↰	↑↑		↰		↱	↰	↱	
Traffic Volume (vph)	0	1837	372	23	1003	0	320	0	205	42	28	90
Future Volume (vph)	0	1837	372	23	1003	0	320	0	205	42	28	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Lane Util. Factor		0.95	1.00	1.00	0.95		1.00		1.00	1.00	1.00	
Frpb, ped/bikes		1.00	0.93	1.00	1.00		1.00		0.97	1.00	0.98	
Flpb, ped/bikes		1.00	1.00	1.00	1.00		0.99		1.00	0.98	1.00	
Frt		1.00	0.85	1.00	1.00		1.00		0.85	1.00	0.89	
Flt Protected		1.00	1.00	0.95	1.00		0.95		1.00	0.95	1.00	
Satd. Flow (prot)		3539	1470	1770	3539		1747		1540	1742	1616	
Flt Permitted		1.00	1.00	0.06	1.00		0.66		1.00	0.95	1.00	
Satd. Flow (perm)		3539	1470	105	3539		1205		1540	1742	1616	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	1954	396	24	1067	0	340	0	218	45	30	96
RTOR Reduction (vph)	0	0	124	0	0	0	0	0	13	0	60	0
Lane Group Flow (vph)	0	1954	272	24	1067	0	340	0	205	45	66	0
Confl. Peds. (#/hr)	40		40	40		40	13		13	13		13
Turn Type		NA	Perm	Perm	NA		Perm		Perm	Perm	NA	
Protected Phases		2			6						4	
Permitted Phases			2	6			8		8	4		
Actuated Green, G (s)		70.8	70.8	70.8	70.8		35.4		35.4	35.4	35.4	
Effective Green, g (s)		70.8	70.8	70.8	70.8		35.4		35.4	35.4	35.4	
Actuated g/C Ratio		0.61	0.61	0.61	0.61		0.30		0.30	0.30	0.30	
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0		5.0	5.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)		2156	895	63	2156		367		469	530	492	
v/s Ratio Prot		c0.55			0.30						0.04	
v/s Ratio Perm			0.18	0.23			c0.28		0.13	0.03		
v/c Ratio		0.91	0.30	0.38	0.49		0.93		0.44	0.08	0.13	
Uniform Delay, d1		19.8	10.9	11.5	12.7		39.1		32.4	28.8	29.3	
Progression Factor		1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.00	
Incremental Delay, d2		5.9	0.2	3.8	0.2		28.8		0.7	0.1	0.1	
Delay (s)		25.8	11.1	15.4	12.9		67.9		33.1	28.9	29.4	
Level of Service		C	B	B	B		E		C	C	C	
Approach Delay (s)		23.3			12.9			54.3			29.3	
Approach LOS		C			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	25.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	116.2	Sum of lost time (s)	10.0
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	3591	140	0	1366	73	32	69	75	95	133	40
Future Volume (vph)	32	3591	140	0	1366	73	32	69	75	95	133	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.86			0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00		1.00	0.97		1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00		1.00	1.00		0.97	1.00	
Frt	1.00	0.99			0.99		1.00	0.92		1.00	0.97	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	6372			3508		1770	1667		1711	1798	
Flt Permitted	0.95	1.00			1.00		0.37	1.00		0.46	1.00	
Satd. Flow (perm)	1770	6372			3508		682	1667		830	1798	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	33	3741	146	0	1423	76	33	72	78	99	139	42
RTOR Reduction (vph)	0	3	0	0	2	0	0	1	0	0	8	0
Lane Group Flow (vph)	33	3884	0	0	1497	0	33	149	0	99	173	0
Confl. Peds. (#/hr)	1					1			33	33		
Turn Type	Prot	NA			NA		Perm	NA		Perm	NA	
Protected Phases	5	2			6			8			4	
Permitted Phases							8			4		
Actuated Green, G (s)	4.1	111.4			102.3		19.9	19.9		19.9	19.9	
Effective Green, g (s)	4.1	111.4			102.3		19.9	19.9		19.9	19.9	
Actuated g/C Ratio	0.03	0.79			0.72		0.14	0.14		0.14	0.14	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	51	5023			2539		96	234		116	253	
v/s Ratio Prot	0.02	c0.61			0.43			0.09			0.10	
v/s Ratio Perm							0.05			c0.12		
v/c Ratio	0.65	0.77			0.59		0.34	0.64		0.85	0.68	
Uniform Delay, d1	67.9	8.1			9.4		54.8	57.3		59.3	57.7	
Progression Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	24.8	0.8			0.4		2.1	5.6		42.0	7.5	
Delay (s)	92.7	8.9			9.7		56.9	62.9		101.2	65.2	
Level of Service	F	A			A		E	E		F	E	
Approach Delay (s)		9.6			9.7			61.8			77.9	
Approach LOS		A			A			E			E	

Intersection Summary			
HCM 2000 Control Delay	14.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	141.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	92.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↱		↰	↑↑↱		↰	↱		↰	↱	
Traffic Volume (vph)	45	2306	64	45	2632	81	105	139	64	61	100	36
Future Volume (vph)	45	2306	64	45	2632	81	105	139	64	61	100	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.97		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		0.96	1.00	
Frt	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	5055		1770	5062		1770	1730		1704	1788	
Flt Permitted	0.95	1.00		0.95	1.00		0.46	1.00		0.27	1.00	
Satd. Flow (perm)	1770	5055		1770	5062		858	1730		482	1788	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	46	2353	65	46	2686	83	107	142	65	62	102	37
RTOR Reduction (vph)	0	1	0	0	1	0	0	8	0	0	6	0
Lane Group Flow (vph)	46	2417	0	46	2768	0	107	199	0	62	133	0
Confl. Peds. (#/hr)			9						35	35		
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			8			4	
Permitted Phases							8			4		
Actuated Green, G (s)	8.6	150.5		8.6	150.5		30.8	30.8		30.8	30.8	
Effective Green, g (s)	8.6	150.5		8.6	150.5		30.8	30.8		30.8	30.8	
Actuated g/C Ratio	0.04	0.73		0.04	0.73		0.15	0.15		0.15	0.15	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	74	3712		74	3718		128	260		72	268	
v/s Ratio Prot	c0.03	0.48		0.03	c0.55			0.12			0.07	
v/s Ratio Perm							0.12			c0.13		
v/c Ratio	0.62	0.65		0.62	0.74		0.84	0.77		0.86	0.50	
Uniform Delay, d1	96.5	13.8		96.5	15.9		84.6	83.6		85.0	79.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	15.1	0.4		15.1	0.8		35.3	12.7		60.9	1.4	
Delay (s)	111.7	14.3		111.7	16.8		119.9	96.3		145.9	81.4	
Level of Service	F	B		F	B		F	F		F	F	
Approach Delay (s)		16.1			18.3			104.3			101.3	
Approach LOS		B			B			F			F	

Intersection Summary			
HCM 2000 Control Delay	24.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	204.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	90.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX F

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT ALTERNATIVE 2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	88	407	583	228	359	466
Future Volume (vph)	88	407	583	228	359	466
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1549	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1549	1770	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	95	438	627	245	386	501
RTOR Reduction (vph)	0	363	0	173	0	0
Lane Group Flow (vph)	95	75	627	72	386	501
Confl. Peds. (#/hr)				1		
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	10.9	10.9	18.6	18.6	19.0	42.6
Effective Green, g (s)	10.9	10.9	18.6	18.6	19.0	42.6
Actuated g/C Ratio	0.17	0.17	0.29	0.29	0.30	0.67
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	303	271	1036	453	529	2374
v/s Ratio Prot	c0.05		c0.18		c0.22	0.14
v/s Ratio Perm		0.05		0.05		
v/c Ratio	0.31	0.28	0.61	0.16	0.73	0.21
Uniform Delay, d1	23.0	22.9	19.3	16.6	19.9	4.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6	0.6	1.0	0.2	5.0	0.0
Delay (s)	23.6	23.4	20.3	16.8	25.0	4.1
Level of Service	C	C	C	B	C	A
Approach Delay (s)	23.5		19.3			13.1
Approach LOS	C		B			B

Intersection Summary			
HCM 2000 Control Delay	17.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	63.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	148	148	449	122	440	679
Future Volume (vph)	148	148	449	122	440	679
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1549	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1549	1770	3539
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	149	149	454	123	444	686
RTOR Reduction (vph)	0	121	0	93	0	0
Lane Group Flow (vph)	149	28	454	30	444	686
Confl. Peds. (#/hr)				1		
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	13.1	13.1	16.9	16.9	24.3	46.2
Effective Green, g (s)	13.1	13.1	16.9	16.9	24.3	46.2
Actuated g/C Ratio	0.19	0.19	0.24	0.24	0.35	0.67
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	334	299	863	377	620	2359
v/s Ratio Prot	c0.08		c0.13		c0.25	0.19
v/s Ratio Perm		0.02		0.02		
v/c Ratio	0.45	0.09	0.53	0.08	0.72	0.29
Uniform Delay, d1	24.9	23.2	22.7	20.2	19.5	4.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.0	0.1	0.6	0.1	3.9	0.1
Delay (s)	25.8	23.3	23.3	20.3	23.4	4.8
Level of Service	C	C	C	C	C	A
Approach Delay (s)	24.6		22.7			12.2
Approach LOS	C		C			B

Intersection Summary			
HCM 2000 Control Delay	17.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	69.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	57.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	374	178	229	483	0	0
Future Volume (Veh/h)	374	178	229	483	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	398	189	244	514	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	537					
pX, platoon unblocked						
vC, conflicting volume			587		1494	492
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			587		1494	492
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			75		100	100
cM capacity (veh/h)			988		102	576

Direction, Lane #	EB 1	WB 1	WB 2
Volume Total	587	244	514
Volume Left	0	244	0
Volume Right	189	0	0
cSH	1700	988	1700
Volume to Capacity	0.35	0.25	0.30
Queue Length 95th (ft)	0	24	0
Control Delay (s)	0.0	9.8	0.0
Lane LOS		A	
Approach Delay (s)	0.0	3.2	
Approach LOS			

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	263	291	370	325	0	0
Future Volume (Veh/h)	263	291	370	325	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	296	327	416	365	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	537					
pX, platoon unblocked						
vC, conflicting volume			623		1656	460
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			623		1656	460
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			57		100	100
cM capacity (veh/h)			958		61	602

Direction, Lane #	EB 1	WB 1	WB 2
Volume Total	623	416	365
Volume Left	0	416	0
Volume Right	327	0	0
cSH	1700	958	1700
Volume to Capacity	0.37	0.43	0.21
Queue Length 95th (ft)	0	56	0
Control Delay (s)	0.0	11.6	0.0
Lane LOS		B	
Approach Delay (s)	0.0	6.2	
Approach LOS			

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	58.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑↑	↰	↱
Traffic Volume (veh/h)	374	0	0	503	209	313
Future Volume (Veh/h)	374	0	0	503	209	313
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	398	0	0	535	222	333
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1031					
pX, platoon unblocked						
vC, conflicting volume			398		666	398
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			398		666	398
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		43	45
cM capacity (veh/h)			1157		393	601

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	398	268	268	222	333
Volume Left	0	0	0	222	0
Volume Right	0	0	0	0	333
cSH	1700	1700	1700	393	601
Volume to Capacity	0.23	0.16	0.16	0.57	0.55
Queue Length 95th (ft)	0	0	0	84	85
Control Delay (s)	0.0	0.0	0.0	25.4	18.2
Lane LOS				D	C
Approach Delay (s)	0.0	0.0		21.1	
Approach LOS				C	

Intersection Summary			
Average Delay	7.9		
Intersection Capacity Utilization	49.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑↑	↰	↱
Traffic Volume (veh/h)	263	0	0	551	143	247
Future Volume (Veh/h)	263	0	0	551	143	247
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	280	0	0	586	152	263
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1031					
pX, platoon unblocked						
vC, conflicting volume			280		573	280
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			280		573	280
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		66	63
cM capacity (veh/h)			1280		450	717

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	280	293	293	152	263
Volume Left	0	0	0	152	0
Volume Right	0	0	0	0	263
cSH	1700	1700	1700	450	717
Volume to Capacity	0.16	0.17	0.17	0.34	0.37
Queue Length 95th (ft)	0	0	0	37	42
Control Delay (s)	0.0	0.0	0.0	17.0	12.9
Lane LOS				C	B
Approach Delay (s)	0.0	0.0		14.4	
Approach LOS				B	

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	58.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	53	230	161	1	81	3	130	0	2	0	0	2
Future Volume (Veh/h)	53	230	161	1	81	3	130	0	2	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	63	274	192	1	96	4	155	0	2	0	0	2
Pedestrians					3			1				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			0				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	100			467			549	599	237	368	693	50
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	100			467			549	599	237	368	693	50
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			100			62	100	100	100	100	100
cM capacity (veh/h)	1490			1090			403	395	762	541	349	1008

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total	200	329	1	64	36	155	2	2
Volume Left	63	0	1	0	0	155	0	0
Volume Right	0	192	0	0	4	0	2	2
cSH	1490	1700	1090	1700	1700	403	762	1008
Volume to Capacity	0.04	0.19	0.00	0.04	0.02	0.38	0.00	0.00
Queue Length 95th (ft)	3	0	0	0	0	44	0	0
Control Delay (s)	2.6	0.0	8.3	0.0	0.0	19.4	9.7	8.6
Lane LOS	A		A			C	A	A
Approach Delay (s)	1.0		0.1			19.3		8.6
Approach LOS						C		A

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	37.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	28	72	15	3	177	5	167	0	3	0	0	4
Future Volume (Veh/h)	28	72	15	3	177	5	167	0	3	0	0	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	32	83	17	3	203	6	192	0	3	0	0	5
Pedestrians					1							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	209			100			268	370	51	322	376	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	209			100			268	370	51	322	376	104
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			100			70	100	100	100	100	99
cM capacity (veh/h)	1359			1490			647	544	1005	594	540	930

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total	74	58	3	135	74	192	3	5
Volume Left	32	0	3	0	0	192	0	0
Volume Right	0	17	0	0	6	0	3	5
cSH	1359	1700	1490	1700	1700	647	1005	930
Volume to Capacity	0.02	0.03	0.00	0.08	0.04	0.30	0.00	0.01
Queue Length 95th (ft)	2	0	0	0	0	31	0	0
Control Delay (s)	3.5	0.0	7.4	0.0	0.0	12.9	8.6	8.9
Lane LOS	A		A			B	A	A
Approach Delay (s)	1.9		0.1			12.8		8.9
Approach LOS						B		A

Intersection Summary			
Average Delay	5.2		
Intersection Capacity Utilization	34.3%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX G

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	100	460	583	261	411	466
Future Volume (vph)	100	460	583	261	411	466
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1549	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1549	1770	3539
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	108	495	627	281	442	501
RTOR Reduction (vph)	0	410	0	202	0	0
Lane Group Flow (vph)	108	85	627	79	442	501
Confl. Peds. (#/hr)				1		
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	11.6	11.6	19.1	19.1	22.0	46.1
Effective Green, g (s)	11.6	11.6	19.1	19.1	22.0	46.1
Actuated g/C Ratio	0.17	0.17	0.28	0.28	0.32	0.68
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	303	271	998	437	575	2409
v/s Ratio Prot	c0.06		c0.18		c0.25	0.14
v/s Ratio Perm		0.05		0.05		
v/c Ratio	0.36	0.31	0.63	0.18	0.77	0.21
Uniform Delay, d1	24.8	24.6	21.2	18.4	20.6	4.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	0.7	1.2	0.2	6.1	0.0
Delay (s)	25.5	25.2	22.4	18.6	26.7	4.1
Level of Service	C	C	C	B	C	A
Approach Delay (s)	25.3		21.3			14.7
Approach LOS	C		C			B

Intersection Summary			
HCM 2000 Control Delay	19.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	67.7	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (vph)	165	165	449	122	441	679
Future Volume (vph)	165	165	449	122	441	679
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
Frpb, ped/bikes	1.00	1.00	1.00	0.98	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	3539	1549	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1583	3539	1549	1770	3539
Peak-hour factor, PHF	0.99	0.99	0.99	0.99	0.99	0.99
Adj. Flow (vph)	167	167	454	123	445	686
RTOR Reduction (vph)	0	135	0	93	0	0
Lane Group Flow (vph)	167	32	454	30	445	686
Confl. Peds. (#/hr)				1		
Turn Type	Prot	Perm	NA	Perm	Prot	NA
Protected Phases	8		2		1	6
Permitted Phases		8		2		
Actuated Green, G (s)	13.7	13.7	17.1	17.1	24.6	46.7
Effective Green, g (s)	13.7	13.7	17.1	17.1	24.6	46.7
Actuated g/C Ratio	0.19	0.19	0.24	0.24	0.35	0.66
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	344	308	859	376	618	2347
v/s Ratio Prot	c0.09		c0.13		c0.25	0.19
v/s Ratio Perm		0.02		0.02		
v/c Ratio	0.49	0.11	0.53	0.08	0.72	0.29
Uniform Delay, d1	25.2	23.3	23.1	20.6	19.9	4.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.1	0.2	0.6	0.1	4.1	0.1
Delay (s)	26.3	23.5	23.7	20.7	24.0	5.0
Level of Service	C	C	C	C	C	A
Approach Delay (s)	24.9		23.1			12.5
Approach LOS	C		C			B

Intersection Summary			
HCM 2000 Control Delay	17.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	70.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	58.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

	→	↘	↙	←	↖	↗
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↱		↰	↑		
Traffic Volume (veh/h)	459	178	282	547	0	0
Future Volume (Veh/h)	459	178	282	547	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	488	189	300	582	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	537					
pX, platoon unblocked						
vC, conflicting volume			677		1764	582
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			677		1764	582
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			67		100	100
cM capacity (veh/h)			915		62	513

Direction, Lane #	EB 1	WB 1	WB 2
Volume Total	677	300	582
Volume Left	0	300	0
Volume Right	189	0	0
cSH	1700	915	1700
Volume to Capacity	0.40	0.33	0.34
Queue Length 95th (ft)	0	36	0
Control Delay (s)	0.0	10.8	0.0
Lane LOS		B	
Approach Delay (s)	0.0	3.7	
Approach LOS			

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	264	291	435	358	0	0
Future Volume (Veh/h)	264	291	435	358	0	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	297	327	489	402	0	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	537					
pX, platoon unblocked						
vC, conflicting volume			624		1840	460
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			624		1840	460
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			49		100	100
cM capacity (veh/h)			957		41	601

Direction, Lane #	EB 1	WB 1	WB 2
Volume Total	624	489	402
Volume Left	0	489	0
Volume Right	327	0	0
cSH	1700	957	1700
Volume to Capacity	0.37	0.51	0.24
Queue Length 95th (ft)	0	75	0
Control Delay (s)	0.0	12.6	0.0
Lane LOS		B	
Approach Delay (s)	0.0	6.9	
Approach LOS			

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑↑	↰	↱
Traffic Volume (veh/h)	459	0	0	620	209	391
Future Volume (Veh/h)	459	0	0	620	209	391
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	499	0	0	674	227	425
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1031					
pX, platoon unblocked						
vC, conflicting volume			499		836	499
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			499		836	499
tC, single (s)			4.1		*5.9	*5.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		40	29
cM capacity (veh/h)			1061		380	597

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	499	337	337	227	425
Volume Left	0	0	0	227	0
Volume Right	0	0	0	0	425
cSH	1700	1700	1700	380	597
Volume to Capacity	0.29	0.20	0.20	0.60	0.71
Queue Length 95th (ft)	0	0	0	93	146
Control Delay (s)	0.0	0.0	0.0	27.5	24.5
Lane LOS				D	C
Approach Delay (s)	0.0	0.0		25.6	
Approach LOS				D	

Intersection Summary			
Average Delay	9.1		
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑↑	↰	↱
Traffic Volume (veh/h)	264	0	0	649	143	248
Future Volume (Veh/h)	264	0	0	649	143	248
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	281	0	0	690	152	264
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1031					
pX, platoon unblocked						
vC, conflicting volume			281		626	281
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			281		626	281
tC, single (s)			4.1		*5.9	*5.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		69	66
cM capacity (veh/h)			1278		490	777

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	NB 2
Volume Total	281	345	345	152	264
Volume Left	0	0	0	152	0
Volume Right	0	0	0	0	264
cSH	1700	1700	1700	490	777
Volume to Capacity	0.17	0.20	0.20	0.31	0.34
Queue Length 95th (ft)	0	0	0	33	38
Control Delay (s)	0.0	0.0	0.0	15.6	12.0
Lane LOS				C	B
Approach Delay (s)	0.0	0.0		13.3	
Approach LOS				B	

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	53	393	161	1	198	3	130	0	2	0	0	2
Future Volume (Veh/h)	53	393	161	1	198	3	130	0	2	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Hourly flow rate (vph)	63	468	192	1	236	4	155	0	2	0	0	2
Pedestrians					3			1				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			0				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	240			661			813	933	334	605	1027	120
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	240			661			813	933	334	605	1027	120
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	7.5	6.5	*5.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			100			53	100	100	100	100	100
cM capacity (veh/h)	1324			922			328	252	726	365	221	941

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total	297	426	1	157	83	155	2	2
Volume Left	63	0	1	0	0	155	0	0
Volume Right	0	192	0	0	4	0	2	2
cSH	1324	1700	922	1700	1700	328	726	941
Volume to Capacity	0.05	0.25	0.00	0.09	0.05	0.47	0.00	0.00
Queue Length 95th (ft)	4	0	0	0	0	61	0	0
Control Delay (s)	2.0	0.0	8.9	0.0	0.0	25.5	10.0	8.8
Lane LOS	A		A			D	A	A
Approach Delay (s)	0.8		0.0			25.3		8.8
Approach LOS						D		A

Intersection Summary			
Average Delay	4.1		
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	28	74	15	3	275	5	167	3	3	0	0	4
Future Volume (Veh/h)	28	74	15	3	275	5	167	3	3	0	0	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	32	85	17	3	316	6	192	3	3	0	0	5
Pedestrians					1							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	322			102			326	486	52	437	491	161
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	322			102			326	486	52	437	491	161
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	7.5	6.5	*5.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			100			70	99	100	100	100	99
cM capacity (veh/h)	1235			1488			645	467	1019	488	463	896

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1
Volume Total	74	60	3	211	111	192	6	5
Volume Left	32	0	3	0	0	192	0	0
Volume Right	0	17	0	0	6	0	3	5
cSH	1235	1700	1488	1700	1700	645	640	896
Volume to Capacity	0.03	0.04	0.00	0.12	0.07	0.30	0.01	0.01
Queue Length 95th (ft)	2	0	0	0	0	31	1	0
Control Delay (s)	3.6	0.0	7.4	0.0	0.0	12.9	10.7	9.0
Lane LOS	A		A			B	B	A
Approach Delay (s)	2.0		0.1			12.9		9.0
Approach LOS						B		A

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	Err%	ICU Level of Service	H
Analysis Period (min)	15		

* User Entered Value

APPENDIX H

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT ALTERNATIVE 3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	401	445	208	14	19	231
Future Volume (vph)	401	445	208	14	19	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1650		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1650		1583	1417
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	461	511	239	16	22	266
RTOR Reduction (vph)	0	0	2	0	0	232
Lane Group Flow (vph)	461	511	253	0	22	34
Confl. Peds. (#/hr)				1		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	23.7	44.0	15.3		8.0	8.0
Effective Green, g (s)	23.7	44.0	15.3		8.0	8.0
Actuated g/C Ratio	0.38	0.71	0.25		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	605	1183	407		204	182
v/s Ratio Prot	c0.29	0.31	c0.15		0.01	
v/s Ratio Perm						c0.02
v/c Ratio	0.76	0.43	0.62		0.11	0.19
Uniform Delay, d1	16.7	3.8	20.8		23.8	24.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.6	0.3	2.9		0.2	0.5
Delay (s)	22.3	4.0	23.7		24.1	24.6
Level of Service	C	A	C		C	C
Approach Delay (s)		12.7	23.7		24.6	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	16.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	62.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	50.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↱		↰	↱
Traffic Volume (vph)	206	227	523	12	24	420
Future Volume (vph)	206	227	523	12	24	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	1.00		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1661		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1661		1583	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	226	249	575	13	26	462
RTOR Reduction (vph)	0	0	1	0	0	403
Lane Group Flow (vph)	226	249	587	0	26	59
Confl. Peds. (#/hr)				6		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	17.6	57.2	34.6		9.9	9.9
Effective Green, g (s)	17.6	57.2	34.6		9.9	9.9
Actuated g/C Ratio	0.23	0.74	0.45		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	361	1236	745		203	181
v/s Ratio Prot	c0.14	0.15	c0.35		0.02	
v/s Ratio Perm						c0.04
v/c Ratio	0.63	0.20	0.79		0.13	0.33
Uniform Delay, d1	26.8	3.0	18.1		29.8	30.6
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	3.4	0.1	5.6		0.3	1.1
Delay (s)	30.2	3.1	23.7		30.1	31.6
Level of Service	C	A	C		C	C
Approach Delay (s)		16.0	23.7		31.6	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	23.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	77.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	299	65	1	140	24	4
Future Volume (Veh/h)	299	65	1	140	24	4
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	365	79	1	171	29	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			444		578	404
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			444		578	404
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		94	99
cM capacity (veh/h)			1055		458	621

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	444	172	34
Volume Left	0	1	29
Volume Right	79	0	5
cSH	1700	1055	477
Volume to Capacity	0.26	0.00	0.07
Queue Length 95th (ft)	0	0	6
Control Delay (s)	0.0	0.1	13.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	13.1
Approach LOS			B

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	29.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	126	27	3	286	76	1
Future Volume (Veh/h)	126	27	3	286	76	1
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	138	30	3	314	84	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			168		473	153
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			168		473	153
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		84	100
cM capacity (veh/h)			1340		527	862

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	168	317	85
Volume Left	0	3	84
Volume Right	30	0	1
cSH	1700	1340	530
Volume to Capacity	0.10	0.00	0.16
Queue Length 95th (ft)	0	0	14
Control Delay (s)	0.0	0.1	13.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	13.1
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	43	155	2	26	114	3
Future Volume (Veh/h)	43	155	2	26	114	3
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	50	180	2	30	133	3
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			230		174	140
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			230		174	140
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		83	100
cM capacity (veh/h)			1270		788	877

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	230	32	136
Volume Left	0	2	133
Volume Right	180	0	3
cSH	1700	1270	790
Volume to Capacity	0.14	0.00	0.17
Queue Length 95th (ft)	0	0	15
Control Delay (s)	0.0	0.5	10.5
Lane LOS		A	B
Approach Delay (s)	0.0	0.5	10.5
Approach LOS			B

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	8	40	0	42	114	0
Future Volume (Veh/h)	8	40	0	42	114	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	9	44	0	46	125	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			53		77	31
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			53		77	31
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			100		86	100
cM capacity (veh/h)			1479		897	1010

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	53	46	125
Volume Left	0	0	125
Volume Right	44	0	0
cSH	1700	1479	897
Volume to Capacity	0.03	0.00	0.14
Queue Length 95th (ft)	0	0	12
Control Delay (s)	0.0	0.0	9.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.7
Approach LOS			A

Intersection Summary			
Average Delay	5.4		
Intersection Capacity Utilization	16.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	9	744	40	102	1208	96	20	31	46	24	20	26
Future Volume (Veh/h)	9	744	40	102	1208	96	20	31	46	24	20	26
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	9	783	42	107	1272	101	21	33	48	25	21	27
Pedestrians					1			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			1				
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1373			837			1722	2421	426	2012	2392	686
vC1, stage 1 conf vol							834	834		1536	1536	
vC2, stage 2 conf vol							888	1587		475	855	
vCu, unblocked vol	1373			837			1722	2421	426	2012	2392	686
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			86			91	83	93	83	89	94
cM capacity (veh/h)	496			784			236	197	645	151	199	475

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	9	522	303	107	848	525	102	73
Volume Left	9	0	0	107	0	0	21	25
Volume Right	0	0	42	0	0	101	48	27
cSH	496	1700	1700	784	1700	1700	308	222
Volume to Capacity	0.02	0.31	0.18	0.14	0.50	0.31	0.33	0.33
Queue Length 95th (ft)	1	0	0	12	0	0	35	34
Control Delay (s)	12.4	0.0	0.0	10.3	0.0	0.0	22.4	28.9
Lane LOS	B			B			C	D
Approach Delay (s)	0.1			0.7			22.4	28.9
Approach LOS							C	D

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	56.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	1418	22	23	913	30	15	14	25	49	2	19
Future Volume (Veh/h)	20	1418	22	23	913	30	15	14	25	49	2	19
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	22	1541	24	25	992	33	16	15	27	53	2	21
Pedestrians											1	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1026			1565			2165	2673	782	1908	2668	514
vC1, stage 1 conf vol							1597	1597		1060	1060	
vC2, stage 2 conf vol							568	1076		849	1609	
vCu, unblocked vol	1026			1565			2165	2673	782	1908	2668	514
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			94			90	93	94	76	99	96
cM capacity (veh/h)	672			418			159	203	422	224	191	586

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	22	1027	538	25	661	364	58	76
Volume Left	22	0	0	25	0	0	16	53
Volume Right	0	0	24	0	0	33	27	21
cSH	672	1700	1700	418	1700	1700	243	269
Volume to Capacity	0.03	0.60	0.32	0.06	0.39	0.21	0.24	0.28
Queue Length 95th (ft)	3	0	0	5	0	0	23	28
Control Delay (s)	10.5	0.0	0.0	14.2	0.0	0.0	24.4	23.6
Lane LOS	B			B			C	C
Approach Delay (s)	0.1			0.3			24.4	23.6
Approach LOS							C	C

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱			✥			✥	
Traffic Volume (veh/h)	13	784	42	19	1299	5	13	0	4	2	0	9
Future Volume (Veh/h)	13	784	42	19	1299	5	13	0	4	2	0	9
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	14	825	44	20	1367	5	14	0	4	2	0	9
Pedestrians					5							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1372			825			1586	2265	418	1859	2262	686
vC1, stage 1 conf vol							853	853		1410	1410	
vC2, stage 2 conf vol							732	1412		450	853	
vCu, unblocked vol	1372			825			1586	2265	418	1859	2262	686
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	*6.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		5.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			95	100	99	99	100	98
cM capacity (veh/h)	496			801			305	162	656	201	170	475

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	14	412	412	44	20	911	461	18	11
Volume Left	14	0	0	0	20	0	0	14	2
Volume Right	0	0	0	44	0	0	5	4	9
cSH	496	1700	1700	1700	801	1700	1700	346	381
Volume to Capacity	0.03	0.24	0.24	0.03	0.02	0.54	0.27	0.05	0.03
Queue Length 95th (ft)	2	0	0	0	2	0	0	4	2
Control Delay (s)	12.5	0.0	0.0	0.0	9.6	0.0	0.0	16.0	14.7
Lane LOS	B				A			C	B
Approach Delay (s)	0.2				0.1			16.0	14.7
Approach LOS								C	B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	47.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱			✣			✣	
Traffic Volume (veh/h)	3	1467	0	0	867	0	1	0	1	0	0	2
Future Volume (Veh/h)	3	1467	0	0	867	0	1	0	1	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	3	1512	0	0	894	0	1	0	1	0	0	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	894			1512			1967	2412	756	1657	2412	447
vC1, stage 1 conf vol							1518	1518		894	894	
vC2, stage 2 conf vol							449	894		763	1518	
vCu, unblocked vol	894			1512			1967	2412	756	1657	2412	447
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	7.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		6.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	100	100	100	100	100
cM capacity (veh/h)	755			438			183	157	436	234	157	636

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	3	756	756	0	0	596	298	2	2
Volume Left	3	0	0	0	0	0	0	1	0
Volume Right	0	0	0	0	0	0	0	1	2
cSH	755	1700	1700	1700	1700	1700	1700	258	636
Volume to Capacity	0.00	0.44	0.44	0.00	0.00	0.35	0.18	0.01	0.00
Queue Length 95th (ft)	0	0	0	0	0	0	0	1	0
Control Delay (s)	9.8	0.0	0.0	0.0	0.0	0.0	0.0	19.1	10.7
Lane LOS	A							C	B
Approach Delay (s)	0.0				0.0			19.1	10.7
Approach LOS								C	B

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

APPENDIX I

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	597	0	629	0	1050	436	0	0	0	0	167	408
Future Volume (vph)	597	0	629	0	1050	436	0	0	0	0	167	408
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frt	1.00		0.85		0.96						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1770		1583		4862						1863	1583
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1770		1583		4862						1863	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	656	0	691	0	1154	479	0	0	0	0	184	448
RTOR Reduction (vph)	0	0	0	0	56	0	0	0	0	0	0	390
Lane Group Flow (vph)	656	0	691	0	1577	0	0	0	0	0	184	58
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	48.6		123.6		43.9						16.1	16.1
Effective Green, g (s)	48.6		123.6		43.9						16.1	16.1
Actuated g/C Ratio	0.39		1.00		0.36						0.13	0.13
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	695		1583		1726						242	206
v/s Ratio Prot	c0.37				c0.32						c0.10	
v/s Ratio Perm			0.44									0.04
v/c Ratio	0.94		0.44		0.91						0.76	0.28
Uniform Delay, d1	36.2		0.0		38.0						51.9	48.5
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	21.3		0.9		7.9						13.1	0.8
Delay (s)	57.5		0.9		45.9						65.0	49.3
Level of Service	E		A		D						E	D
Approach Delay (s)		28.5			45.9			0.0			53.9	
Approach LOS		C			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	40.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	123.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	83.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: Ulune Ext & Halawa Valley St

10/04/2017

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	197	0	1364	0	900	264	0	0	0	0	633	595
Future Volume (vph)	197	0	1364	0	900	264	0	0	0	0	633	595
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frpb, ped/bikes	1.00		1.00		0.99						1.00	1.00
Flpb, ped/bikes	1.00		1.00		1.00						1.00	1.00
Frt	1.00		0.85		0.97						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1770		1583		4881						1863	1583
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1770		1583		4881						1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	214	0	1483	0	978	287	0	0	0	0	688	647
RTOR Reduction (vph)	0	0	0	0	29	0	0	0	0	0	0	213
Lane Group Flow (vph)	214	0	1483	0	1236	0	0	0	0	0	688	434
Confl. Peds. (#/hr)						3						
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	23.8		153.5		48.0						66.7	66.7
Effective Green, g (s)	23.8		153.5		48.0						66.7	66.7
Actuated g/C Ratio	0.16		1.00		0.31						0.43	0.43
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	274		1583		1526						809	687
v/s Ratio Prot	0.12				0.25						0.37	
v/s Ratio Perm			c0.94									0.27
v/c Ratio	0.78		0.94		0.81						0.85	0.63
Uniform Delay, d1	62.3		0.0		48.6						38.9	33.8
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	13.4		11.9		3.4						8.5	1.9
Delay (s)	75.8		11.9		51.9						47.5	35.7
Level of Service	E		B		D						D	D
Approach Delay (s)		19.9			51.9			0.0			41.8	
Approach LOS		B			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	36.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	153.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	79.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	401	608	325	14	19	231
Future Volume (vph)	401	608	325	14	19	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1863	1851		1770	1583
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1770	1863	1851		1770	1583
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	461	699	374	16	22	266
RTOR Reduction (vph)	0	0	2	0	0	233
Lane Group Flow (vph)	461	699	388	0	22	33
Confl. Peds. (#/hr)				1		
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	21.2	43.8	17.6		7.5	7.5
Effective Green, g (s)	21.2	43.8	17.6		7.5	7.5
Actuated g/C Ratio	0.35	0.71	0.29		0.12	0.12
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	612	1331	531		216	193
v/s Ratio Prot	c0.26	0.38	c0.21		0.01	
v/s Ratio Perm						c0.02
v/c Ratio	0.75	0.53	0.73		0.10	0.17
Uniform Delay, d1	17.7	4.0	19.7		23.9	24.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.2	0.4	5.1		0.2	0.4
Delay (s)	23.0	4.4	24.8		24.1	24.5
Level of Service	C	A	C		C	C
Approach Delay (s)		11.8	24.8		24.5	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	16.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	61.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	206	229	621	12	24	420
Future Volume (vph)	206	229	621	12	24	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	1.00		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1863	1857		1770	1583
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1770	1863	1857		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	224	249	675	13	26	457
RTOR Reduction (vph)	0	0	1	0	0	364
Lane Group Flow (vph)	224	249	687	0	26	93
Confl. Peds. (#/hr)				6		
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	16.2	57.5	36.3		10.6	10.6
Effective Green, g (s)	16.2	57.5	36.3		10.6	10.6
Actuated g/C Ratio	0.21	0.74	0.46		0.14	0.14
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	367	1371	863		240	214
v/s Ratio Prot	c0.13	0.13	c0.37		0.01	
v/s Ratio Perm						c0.06
v/c Ratio	0.61	0.18	0.80		0.11	0.44
Uniform Delay, d1	28.1	3.1	17.8		29.6	31.0
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	3.0	0.1	5.2		0.2	1.4
Delay (s)	31.1	3.2	22.9		29.8	32.4
Level of Service	C	A	C		C	C
Approach Delay (s)		16.4	22.9		32.3	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	23.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	78.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	462	65	1	257	24	4
Future Volume (Veh/h)	462	65	1	257	24	4
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	563	79	1	313	29	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			642		918	602
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			642		918	602
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		90	99
cM capacity (veh/h)			943		301	499

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	642	314	34
Volume Left	0	1	29
Volume Right	79	0	5
cSH	1700	943	320
Volume to Capacity	0.38	0.00	0.11
Queue Length 95th (ft)	0	0	9
Control Delay (s)	0.0	0.0	17.6
Lane LOS		A	C
Approach Delay (s)	0.0	0.0	17.6
Approach LOS			C

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	38.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	128	27	3	384	76	1
Future Volume (Veh/h)	128	27	3	384	76	1
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	141	30	3	422	84	1
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			171		584	156
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			171		584	156
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		82	100
cM capacity (veh/h)			1406		473	890

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	171	425	85
Volume Left	0	3	84
Volume Right	30	0	1
cSH	1700	1406	476
Volume to Capacity	0.10	0.00	0.18
Queue Length 95th (ft)	0	0	16
Control Delay (s)	0.0	0.1	14.2
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	14.2
Approach LOS			B

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	33.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	206	155	2	143	114	3
Future Volume (Veh/h)	206	155	2	143	114	3
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	240	180	2	166	133	3
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			420		500	330
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			420		500	330
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		75	100
cM capacity (veh/h)			1139		529	712

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	420	168	136
Volume Left	0	2	133
Volume Right	180	0	3
cSH	1700	1139	532
Volume to Capacity	0.25	0.00	0.26
Queue Length 95th (ft)	0	0	25
Control Delay (s)	0.0	0.1	14.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.1	14.1
Approach LOS			B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	33.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	10	40	0	140	114	0
Future Volume (Veh/h)	10	40	0	140	114	0
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	11	44	0	154	125	0
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			55		187	33
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			55		187	33
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		84	100
cM capacity (veh/h)			1550		802	1041

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	55	154	125
Volume Left	0	0	125
Volume Right	44	0	0
cSH	1700	1550	802
Volume to Capacity	0.03	0.00	0.16
Queue Length 95th (ft)	0	0	14
Control Delay (s)	0.0	0.0	10.3
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.3
Approach LOS			B

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	20.4%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX J

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT ALTERNATIVE 4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	502	0	629	0	1050	368	0	0	0	0	133	325
Future Volume (vph)	502	0	629	0	1050	368	0	0	0	0	133	325
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frt	1.00		0.85		0.96						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1583		1583		4743						1667	1417
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1583		1583		4743						1667	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	552	0	691	0	1154	404	0	0	0	0	146	357
RTOR Reduction (vph)	0	0	0	0	40	0	0	0	0	0	0	309
Lane Group Flow (vph)	552	0	691	0	1518	0	0	0	0	0	146	48
Heavy Vehicles (%)	14%	2%	2%	2%	2%	14%	2%	2%	2%	14%	14%	14%
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	50.9		132.6		49.0						17.7	17.7
Effective Green, g (s)	50.9		132.6		49.0						17.7	17.7
Actuated g/C Ratio	0.38		1.00		0.37						0.13	0.13
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	607		1583		1752						222	189
v/s Ratio Prot	c0.35				c0.32						c0.09	
v/s Ratio Perm			0.44									0.03
v/c Ratio	0.91		0.44		0.87						0.66	0.25
Uniform Delay, d1	38.7		0.0		38.8						54.6	51.5
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	17.5		0.9		4.8						6.9	0.7
Delay (s)	56.2		0.9		43.6						61.4	52.2
Level of Service	E		A		D						E	D
Approach Delay (s)		25.4			43.6			0.0			54.9	
Approach LOS		C			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	38.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	132.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	75.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	196	0	1364	0	900	263	0	0	0	0	582	548
Future Volume (vph)	196	0	1364	0	900	263	0	0	0	0	582	548
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frpb, ped/bikes	1.00		1.00		0.99						1.00	1.00
Flpb, ped/bikes	1.00		1.00		1.00						1.00	1.00
Frt	1.00		0.85		0.97						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1583		1583		4755						1667	1417
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1583		1583		4755						1667	1417
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	213	0	1483	0	978	286	0	0	0	0	633	596
RTOR Reduction (vph)	0	0	0	0	29	0	0	0	0	0	0	210
Lane Group Flow (vph)	213	0	1483	0	1235	0	0	0	0	0	633	386
Confl. Peds. (#/hr)						3						
Heavy Vehicles (%)	14%	2%	2%	2%	2%	14%	2%	2%	2%	14%	14%	14%
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	26.3		160.2		50.4						68.5	68.5
Effective Green, g (s)	26.3		160.2		50.4						68.5	68.5
Actuated g/C Ratio	0.16		1.00		0.31						0.43	0.43
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	259		1583		1495						712	605
v/s Ratio Prot	0.13				0.26						0.38	
v/s Ratio Perm			c0.94									0.27
v/c Ratio	0.82		0.94		0.83						0.89	0.64
Uniform Delay, d1	64.7		0.0		50.8						42.3	36.1
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	18.6		11.9		3.9						13.0	2.2
Delay (s)	83.3		11.9		54.7						55.3	38.3
Level of Service	F		B		D						E	D
Approach Delay (s)		20.9			54.7			0.0			47.1	
Approach LOS		C			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	38.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	160.2	Sum of lost time (s)	15.0
Intersection Capacity Utilization	76.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	401	445	208	14	19	231
Future Volume (vph)	401	445	208	14	19	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1650		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1650		1583	1417
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	461	511	239	16	22	266
RTOR Reduction (vph)	0	0	2	0	0	232
Lane Group Flow (vph)	461	511	253	0	22	34
Confl. Peds. (#/hr)				1		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	23.7	44.0	15.3		8.0	8.0
Effective Green, g (s)	23.7	44.0	15.3		8.0	8.0
Actuated g/C Ratio	0.38	0.71	0.25		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	605	1183	407		204	182
v/s Ratio Prot	c0.29	0.31	c0.15		0.01	
v/s Ratio Perm						c0.02
v/c Ratio	0.76	0.43	0.62		0.11	0.19
Uniform Delay, d1	16.7	3.8	20.8		23.8	24.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.6	0.3	2.9		0.2	0.5
Delay (s)	22.3	4.0	23.7		24.1	24.6
Level of Service	C	A	C		C	C
Approach Delay (s)		12.7	23.7		24.6	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	16.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	62.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	50.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	206	227	523	12	24	420
Future Volume (vph)	206	227	523	12	24	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	1.00		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1583	1667	1661		1583	1417
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1583	1667	1661		1583	1417
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	226	249	575	13	26	462
RTOR Reduction (vph)	0	0	1	0	0	403
Lane Group Flow (vph)	226	249	587	0	26	59
Confl. Peds. (#/hr)				6		
Heavy Vehicles (%)	14%	14%	14%	14%	14%	14%
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	17.6	57.2	34.6		9.9	9.9
Effective Green, g (s)	17.6	57.2	34.6		9.9	9.9
Actuated g/C Ratio	0.23	0.74	0.45		0.13	0.13
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	361	1236	745		203	181
v/s Ratio Prot	c0.14	0.15	c0.35		0.02	
v/s Ratio Perm						c0.04
v/c Ratio	0.63	0.20	0.79		0.13	0.33
Uniform Delay, d1	26.8	3.0	18.1		29.8	30.6
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	3.4	0.1	5.6		0.3	1.1
Delay (s)	30.2	3.1	23.7		30.1	31.6
Level of Service	C	A	C		C	C
Approach Delay (s)		16.0	23.7		31.6	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	23.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	77.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	9	744	40	102	1208	96	20	31	46	24	20	26
Future Volume (Veh/h)	9	744	40	102	1208	96	20	31	46	24	20	26
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	9	783	42	107	1272	101	21	33	48	25	21	27
Pedestrians					1			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			1				
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1373			837			1722	2421	426	2012	2392	686
vC1, stage 1 conf vol							834	834		1536	1536	
vC2, stage 2 conf vol							888	1587		475	855	
vCu, unblocked vol	1373			837			1722	2421	426	2012	2392	686
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			86			91	83	93	83	89	94
cM capacity (veh/h)	496			784			236	197	645	151	199	475

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	9	522	303	107	848	525	102	73
Volume Left	9	0	0	107	0	0	21	25
Volume Right	0	0	42	0	0	101	48	27
cSH	496	1700	1700	784	1700	1700	308	222
Volume to Capacity	0.02	0.31	0.18	0.14	0.50	0.31	0.33	0.33
Queue Length 95th (ft)	1	0	0	12	0	0	35	34
Control Delay (s)	12.4	0.0	0.0	10.3	0.0	0.0	22.4	28.9
Lane LOS	B			B			C	D
Approach Delay (s)	0.1			0.7			22.4	28.9
Approach LOS							C	D

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	56.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱			✣			✣	
Traffic Volume (veh/h)	20	1418	22	23	913	30	15	14	25	49	2	19
Future Volume (Veh/h)	20	1418	22	23	913	30	15	14	25	49	2	19
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	22	1541	24	25	992	33	16	15	27	53	2	21
Pedestrians											1	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1026			1565			2165	2673	782	1908	2668	514
vC1, stage 1 conf vol							1597	1597		1060	1060	
vC2, stage 2 conf vol							568	1076		849	1609	
vCu, unblocked vol	1026			1565			2165	2673	782	1908	2668	514
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			94			90	93	94	76	99	96
cM capacity (veh/h)	672			418			159	203	422	224	191	586

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	22	1027	538	25	661	364	58	76
Volume Left	22	0	0	25	0	0	16	53
Volume Right	0	0	24	0	0	33	27	21
cSH	672	1700	1700	418	1700	1700	243	269
Volume to Capacity	0.03	0.60	0.32	0.06	0.39	0.21	0.24	0.28
Queue Length 95th (ft)	3	0	0	5	0	0	23	28
Control Delay (s)	10.5	0.0	0.0	14.2	0.0	0.0	24.4	23.6
Lane LOS	B			B			C	C
Approach Delay (s)	0.1			0.3			24.4	23.6
Approach LOS							C	C

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↱			✣			✣	
Traffic Volume (veh/h)	13	784	42	19	1299	5	13	0	4	2	0	9
Future Volume (Veh/h)	13	784	42	19	1299	5	13	0	4	2	0	9
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	14	825	44	20	1367	5	14	0	4	2	0	9
Pedestrians					5							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1372			825			1586	2265	418	1859	2262	686
vC1, stage 1 conf vol							853	853		1410	1410	
vC2, stage 2 conf vol							732	1412		450	853	
vCu, unblocked vol	1372			825			1586	2265	418	1859	2262	686
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	*6.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		5.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			95	100	99	99	100	98
cM capacity (veh/h)	496			801			305	162	656	201	170	475

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	14	412	412	44	20	911	461	18	11
Volume Left	14	0	0	0	20	0	0	14	2
Volume Right	0	0	0	44	0	0	5	4	9
cSH	496	1700	1700	1700	801	1700	1700	346	381
Volume to Capacity	0.03	0.24	0.24	0.03	0.02	0.54	0.27	0.05	0.03
Queue Length 95th (ft)	2	0	0	0	2	0	0	4	2
Control Delay (s)	12.5	0.0	0.0	0.0	9.6	0.0	0.0	16.0	14.7
Lane LOS	B				A			C	B
Approach Delay (s)	0.2				0.1			16.0	14.7
Approach LOS								C	B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	47.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑↱			✥			✥	
Traffic Volume (veh/h)	3	1467	0	0	867	0	1	0	1	0	0	2
Future Volume (Veh/h)	3	1467	0	0	867	0	1	0	1	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	3	1512	0	0	894	0	1	0	1	0	0	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	894			1512			1967	2412	756	1657	2412	447
vC1, stage 1 conf vol							1518	1518		894	894	
vC2, stage 2 conf vol							449	894		763	1518	
vCu, unblocked vol	894			1512			1967	2412	756	1657	2412	447
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	7.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		6.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	100	100	100	100	100
cM capacity (veh/h)	755			438			183	157	436	234	157	636

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	3	756	756	0	0	596	298	2	2
Volume Left	3	0	0	0	0	0	0	1	0
Volume Right	0	0	0	0	0	0	0	1	2
cSH	755	1700	1700	1700	1700	1700	1700	258	636
Volume to Capacity	0.00	0.44	0.44	0.00	0.00	0.35	0.18	0.01	0.00
Queue Length 95th (ft)	0	0	0	0	0	0	0	1	0
Control Delay (s)	9.8	0.0	0.0	0.0	0.0	0.0	0.0	19.1	10.7
Lane LOS	A							C	B
Approach Delay (s)	0.0				0.0			19.1	10.7
Approach LOS								C	B

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

APPENDIX K

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITH ALTERNATIVE 4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰		↱		↑↑↱						↑	↱
Traffic Volume (vph)	597	0	629	0	1050	436	0	0	0	0	167	408
Future Volume (vph)	597	0	629	0	1050	436	0	0	0	0	167	408
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frt	1.00		0.85		0.96						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1770		1583		4862						1863	1583
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1770		1583		4862						1863	1583
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	656	0	691	0	1154	479	0	0	0	0	184	448
RTOR Reduction (vph)	0	0	0	0	56	0	0	0	0	0	0	390
Lane Group Flow (vph)	656	0	691	0	1577	0	0	0	0	0	184	58
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	48.6		123.6		43.9						16.1	16.1
Effective Green, g (s)	48.6		123.6		43.9						16.1	16.1
Actuated g/C Ratio	0.39		1.00		0.36						0.13	0.13
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	695		1583		1726						242	206
v/s Ratio Prot	c0.37				c0.32						c0.10	
v/s Ratio Perm			0.44									0.04
v/c Ratio	0.94		0.44		0.91						0.76	0.28
Uniform Delay, d1	36.2		0.0		38.0						51.9	48.5
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	21.3		0.9		7.9						13.1	0.8
Delay (s)	57.5		0.9		45.9						65.0	49.3
Level of Service	E		A		D						E	D
Approach Delay (s)		28.5			45.9			0.0			53.9	
Approach LOS		C			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	40.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	123.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	83.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: Ulune Ext & Halawa Valley St

10/04/2017

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰		↱		↑↑↱						↑	↱
Traffic Volume (vph)	197	0	1364	0	900	264	0	0	0	0	633	595
Future Volume (vph)	197	0	1364	0	900	264	0	0	0	0	633	595
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		4.0		5.0						5.0	5.0
Lane Util. Factor	1.00		1.00		0.91						1.00	1.00
Frpb, ped/bikes	1.00		1.00		0.99						1.00	1.00
Flpb, ped/bikes	1.00		1.00		1.00						1.00	1.00
Frt	1.00		0.85		0.97						1.00	0.85
Flt Protected	0.95		1.00		1.00						1.00	1.00
Satd. Flow (prot)	1770		1583		4881						1863	1583
Flt Permitted	0.95		1.00		1.00						1.00	1.00
Satd. Flow (perm)	1770		1583		4881						1863	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	214	0	1483	0	978	287	0	0	0	0	688	647
RTOR Reduction (vph)	0	0	0	0	29	0	0	0	0	0	0	213
Lane Group Flow (vph)	214	0	1483	0	1236	0	0	0	0	0	688	434
Confl. Peds. (#/hr)						3						
Turn Type	Prot		Free		NA						NA	Perm
Protected Phases	5				6						4	
Permitted Phases			Free									4
Actuated Green, G (s)	23.8		153.5		48.0						66.7	66.7
Effective Green, g (s)	23.8		153.5		48.0						66.7	66.7
Actuated g/C Ratio	0.16		1.00		0.31						0.43	0.43
Clearance Time (s)	5.0				5.0						5.0	5.0
Vehicle Extension (s)	3.0				3.0						3.0	3.0
Lane Grp Cap (vph)	274		1583		1526						809	687
v/s Ratio Prot	0.12				0.25						0.37	
v/s Ratio Perm			c0.94									0.27
v/c Ratio	0.78		0.94		0.81						0.85	0.63
Uniform Delay, d1	62.3		0.0		48.6						38.9	33.8
Progression Factor	1.00		1.00		1.00						1.00	1.00
Incremental Delay, d2	13.4		11.9		3.4						8.5	1.9
Delay (s)	75.8		11.9		51.9						47.5	35.7
Level of Service	E		B		D						D	D
Approach Delay (s)		19.9			51.9			0.0			41.8	
Approach LOS		B			D			A			D	

Intersection Summary			
HCM 2000 Control Delay	36.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	153.5	Sum of lost time (s)	15.0
Intersection Capacity Utilization	79.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	401	608	325	14	19	231
Future Volume (vph)	401	608	325	14	19	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1863	1851		1770	1583
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1770	1863	1851		1770	1583
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	461	699	374	16	22	266
RTOR Reduction (vph)	0	0	2	0	0	233
Lane Group Flow (vph)	461	699	388	0	22	33
Confl. Peds. (#/hr)				1		
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	21.2	43.8	17.6		7.5	7.5
Effective Green, g (s)	21.2	43.8	17.6		7.5	7.5
Actuated g/C Ratio	0.35	0.71	0.29		0.12	0.12
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	612	1331	531		216	193
v/s Ratio Prot	c0.26	0.38	c0.21		0.01	
v/s Ratio Perm						c0.02
v/c Ratio	0.75	0.53	0.73		0.10	0.17
Uniform Delay, d1	17.7	4.0	19.7		23.9	24.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	5.2	0.4	5.1		0.2	0.4
Delay (s)	23.0	4.4	24.8		24.1	24.5
Level of Service	C	A	C		C	C
Approach Delay (s)		11.8	24.8		24.5	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	16.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	61.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↰	↑	↱		↰	↱
Traffic Volume (vph)	206	229	621	12	24	420
Future Volume (vph)	206	229	621	12	24	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	1.00		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1770	1863	1857		1770	1583
Flt Permitted	0.95	1.00	1.00		0.95	1.00
Satd. Flow (perm)	1770	1863	1857		1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	224	249	675	13	26	457
RTOR Reduction (vph)	0	0	1	0	0	364
Lane Group Flow (vph)	224	249	687	0	26	93
Confl. Peds. (#/hr)				6		
Turn Type	Prot	NA	NA		Prot	Perm
Protected Phases	5	2	6		4	
Permitted Phases						4
Actuated Green, G (s)	16.2	57.5	36.3		10.6	10.6
Effective Green, g (s)	16.2	57.5	36.3		10.6	10.6
Actuated g/C Ratio	0.21	0.74	0.46		0.14	0.14
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	367	1371	863		240	214
v/s Ratio Prot	c0.13	0.13	c0.37		0.01	
v/s Ratio Perm						c0.06
v/c Ratio	0.61	0.18	0.80		0.11	0.44
Uniform Delay, d1	28.1	3.1	17.8		29.6	31.0
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	3.0	0.1	5.2		0.2	1.4
Delay (s)	31.1	3.2	22.9		29.8	32.4
Level of Service	C	A	C		C	C
Approach Delay (s)		16.4	22.9		32.3	
Approach LOS		B	C		C	

Intersection Summary			
HCM 2000 Control Delay	23.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	78.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX L

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITHOUT PROJECT

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	9	744	40	102	1208	96	20	31	46	24	20	26
Future Volume (Veh/h)	9	744	40	102	1208	96	20	31	46	24	20	26
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	9	783	42	107	1272	101	21	33	48	25	21	27
Pedestrians					1			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			1				
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1373			837			1722	2421	426	2012	2392	686
vC1, stage 1 conf vol							834	834		1536	1536	
vC2, stage 2 conf vol							888	1587		475	855	
vCu, unblocked vol	1373			837			1722	2421	426	2012	2392	686
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			86			91	83	93	83	89	94
cM capacity (veh/h)	496			784			236	197	645	151	199	475

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	9	522	303	107	848	525	102	73
Volume Left	9	0	0	107	0	0	21	25
Volume Right	0	0	42	0	0	101	48	27
cSH	496	1700	1700	784	1700	1700	308	222
Volume to Capacity	0.02	0.31	0.18	0.14	0.50	0.31	0.33	0.33
Queue Length 95th (ft)	1	0	0	12	0	0	35	34
Control Delay (s)	12.4	0.0	0.0	10.3	0.0	0.0	22.4	28.9
Lane LOS	B			B			C	D
Approach Delay (s)	0.1			0.7			22.4	28.9
Approach LOS							C	D

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	56.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	1418	22	23	913	30	15	14	25	49	2	19
Future Volume (Veh/h)	20	1418	22	23	913	30	15	14	25	49	2	19
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	22	1541	24	25	992	33	16	15	27	53	2	21
Pedestrians											1	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1026			1565			2165	2673	782	1908	2668	514
vC1, stage 1 conf vol							1597	1597		1060	1060	
vC2, stage 2 conf vol							568	1076		849	1609	
vCu, unblocked vol	1026			1565			2165	2673	782	1908	2668	514
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			94			90	93	94	76	99	96
cM capacity (veh/h)	672			418			159	203	422	224	191	586

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	22	1027	538	25	661	364	58	76
Volume Left	22	0	0	25	0	0	16	53
Volume Right	0	0	24	0	0	33	27	21
cSH	672	1700	1700	418	1700	1700	243	269
Volume to Capacity	0.03	0.60	0.32	0.06	0.39	0.21	0.24	0.28
Queue Length 95th (ft)	3	0	0	5	0	0	23	28
Control Delay (s)	10.5	0.0	0.0	14.2	0.0	0.0	24.4	23.6
Lane LOS	B			B			C	C
Approach Delay (s)	0.1			0.3			24.4	23.6
Approach LOS							C	C

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑↱			✥			✥	
Traffic Volume (veh/h)	13	784	42	19	1299	5	13	0	4	2	0	9
Future Volume (Veh/h)	13	784	42	19	1299	5	13	0	4	2	0	9
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	14	825	44	20	1367	5	14	0	4	2	0	9
Pedestrians					5							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1372			825			1586	2265	418	1859	2262	686
vC1, stage 1 conf vol							853	853		1410	1410	
vC2, stage 2 conf vol							732	1412		450	853	
vCu, unblocked vol	1372			825			1586	2265	418	1859	2262	686
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	*6.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		5.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			95	100	99	99	100	98
cM capacity (veh/h)	496			801			305	162	656	201	170	475

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	14	412	412	44	20	911	461	18	11
Volume Left	14	0	0	0	20	0	0	14	2
Volume Right	0	0	0	44	0	0	5	4	9
cSH	496	1700	1700	1700	801	1700	1700	346	381
Volume to Capacity	0.03	0.24	0.24	0.03	0.02	0.54	0.27	0.05	0.03
Queue Length 95th (ft)	2	0	0	0	2	0	0	4	2
Control Delay (s)	12.5	0.0	0.0	0.0	9.6	0.0	0.0	16.0	14.7
Lane LOS	B				A			C	B
Approach Delay (s)	0.2				0.1			16.0	14.7
Approach LOS								C	B

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	47.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	3	1467	0	0	867	0	1	0	1	0	0	2
Future Volume (Veh/h)	3	1467	0	0	867	0	1	0	1	0	0	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	3	1512	0	0	894	0	1	0	1	0	0	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	894			1512			1967	2412	756	1657	2412	447
vC1, stage 1 conf vol							1518	1518		894	894	
vC2, stage 2 conf vol							449	894		763	1518	
vCu, unblocked vol	894			1512			1967	2412	756	1657	2412	447
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	7.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		6.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	100	100	100	100	100
cM capacity (veh/h)	755			438			183	157	436	234	157	636

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	3	756	756	0	0	596	298	2	2
Volume Left	3	0	0	0	0	0	0	1	0
Volume Right	0	0	0	0	0	0	0	1	2
cSH	755	1700	1700	1700	1700	1700	1700	258	636
Volume to Capacity	0.00	0.44	0.44	0.00	0.00	0.35	0.18	0.01	0.00
Queue Length 95th (ft)	0	0	0	0	0	0	0	1	0
Control Delay (s)	9.8	0.0	0.0	0.0	0.0	0.0	0.0	19.1	10.7
Lane LOS	A							C	B
Approach Delay (s)	0.0				0.0			19.1	10.7
Approach LOS								C	B

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

APPENDIX M

CAPACITY ANALYSIS CALCULATIONS
PROJECTED YEAR 2023 PEAK HOUR TRAFFIC
ANALYSIS WITH PROJECT

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↱		↰	↑↱			✥			✥	
Traffic Volume (veh/h)	26	9	771	40	102	1227	20	20	31	46	24	20
Future Volume (Veh/h)	26	9	771	40	102	1227	20	20	31	46	24	20
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	27	9	812	42	107	1292	21	21	33	48	25	21
Pedestrians					1			12				
Lane Width (ft)					12.0			12.0				
Walking Speed (ft/s)					3.5			3.5				
Percent Blockage					0			1				
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1399			833			652	1964	424	940	1724	700
vC1, stage 1 conf vol							481	481		837	837	
vC2, stage 2 conf vol							171	1483		103	887	
vCu, unblocked vol	1399			833			652	1964	424	940	1724	700
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			95			96	91	95	87	92	96
cM capacity (veh/h)	484			787			516	230	646	374	315	468

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	27	6	815	42	71	1328	75	94
Volume Left	27	0	0	42	0	0	21	48
Volume Right	0	0	812	0	0	1292	33	21
cSH	484	1700	1700	787	1700	1700	409	372
Volume to Capacity	0.06	0.00	0.48	0.05	0.04	0.78	0.18	0.25
Queue Length 95th (ft)	4	0	0	4	0	0	17	25
Control Delay (s)	12.9	0.0	0.0	9.8	0.0	0.0	15.8	17.9
Lane LOS	B			A			C	C
Approach Delay (s)	0.4			0.3			15.8	17.9
Approach LOS							C	C

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	58.2%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

HCM Unsignalized Intersection Capacity Analysis
1: Ulupii St & Kalanianaole Hwy

10/04/2017

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	1419	22	23	929	30	15	14	25	49	2	19
Future Volume (Veh/h)	20	1419	22	23	929	30	15	14	25	49	2	19
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	22	1542	24	25	1010	33	16	15	27	53	2	21
Pedestrians											1	
Lane Width (ft)											12.0	
Walking Speed (ft/s)											3.5	
Percent Blockage											0	
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1044			1566			2175	2692	783	1927	2688	522
vC1, stage 1 conf vol							1598	1598		1078	1078	
vC2, stage 2 conf vol							577	1094		850	1610	
vCu, unblocked vol	1044			1566			2175	2692	783	1927	2688	522
tC, single (s)	4.1			4.1			*6.5	*5.5	*5.9	*6.5	*5.5	*5.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			94			90	93	94	76	99	96
cM capacity (veh/h)	661			418			158	201	422	221	190	580

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	22	1028	538	25	673	370	58	76
Volume Left	22	0	0	25	0	0	16	53
Volume Right	0	0	24	0	0	33	27	21
cSH	661	1700	1700	418	1700	1700	242	266
Volume to Capacity	0.03	0.60	0.32	0.06	0.40	0.22	0.24	0.29
Queue Length 95th (ft)	3	0	0	5	0	0	23	29
Control Delay (s)	10.6	0.0	0.0	14.2	0.0	0.0	24.5	23.9
Lane LOS	B			B			C	C
Approach Delay (s)	0.1			0.3			24.5	23.9
Approach LOS							C	C

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	28	40	784	42	19	1299	13	13	0	4	7	0
Future Volume (Veh/h)	28	40	784	42	19	1299	13	13	0	4	7	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			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
Hourly flow rate (vph)	29	42	825	44	20	1367	14	14	0	4	7	0
Pedestrians					5							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1387			42			202	1575	26	882	892	694
vC1, stage 1 conf vol							100	100		792	792	
vC2, stage 2 conf vol							102	1475		91	100	
vCu, unblocked vol	1387			42			202	1575	26	882	892	694
tC, single (s)	4.1			4.1			*6.5	*5.5	6.9	*6.5	*5.5	6.9
tC, 2 stage (s)							5.5	4.5		5.5	4.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	94			97			98	94	100	99	98	100
cM capacity (veh/h)	490			1565			795	244	1039	407	461	386

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	29	21	21	825	44	13	1374	28	11
Volume Left	29	0	0	0	44	0	0	14	4
Volume Right	0	0	0	825	0	0	1367	0	0
cSH	490	1700	1700	1700	1565	1700	1700	373	440
Volume to Capacity	0.06	0.01	0.01	0.49	0.03	0.01	0.81	0.07	0.02
Queue Length 95th (ft)	5	0	0	0	2	0	0	6	2
Control Delay (s)	12.8	0.0	0.0	0.0	7.4	0.0	0.0	15.4	13.4
Lane LOS	B				A			C	B
Approach Delay (s)	0.4				0.2			15.4	13.4
Approach LOS								C	B

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

* User Entered Value

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	4	1467	0	0	867	0	1	0	1	4	0	18
Future Volume (Veh/h)	4	1467	0	0	867	0	1	0	1	4	0	18
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	4	1512	0	0	894	0	1	0	1	4	0	19
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	894			1512			1986	2414	756	1659	2414	447
vC1, stage 1 conf vol							1520	1520		894	894	
vC2, stage 2 conf vol							466	894		765	1520	
vCu, unblocked vol	894			1512			1986	2414	756	1659	2414	447
tC, single (s)	4.1			4.1			*6.5	6.5	*5.9	*6.5	6.5	*5.9
tC, 2 stage (s)							5.5	5.5		5.5	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			99	100	100	99	100	97
cM capacity (veh/h)	755			438			181	156	436	304	157	636

Direction, Lane #	EB 1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	NB 1	SB 1
Volume Total	4	756	756	0	0	596	298	2	23
Volume Left	4	0	0	0	0	0	0	1	4
Volume Right	0	0	0	0	0	0	0	1	19
cSH	755	1700	1700	1700	1700	1700	1700	256	535
Volume to Capacity	0.01	0.44	0.44	0.00	0.00	0.35	0.18	0.01	0.04
Queue Length 95th (ft)	0	0	0	0	0	0	0	1	3
Control Delay (s)	9.8	0.0	0.0	0.0	0.0	0.0	0.0	19.2	12.0
Lane LOS	A							C	B
Approach Delay (s)	0.0				0.0			19.2	12.0
Approach LOS								C	B

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

* User Entered Value

APPENDIX K

PHASE I ENVIRONMENTAL SITE ASSESSMENT

Oahu Community Correctional Center

Prepared for:

State of Hawaii
Department of Accounting and General Services
Department of Public Safety

June, 2019
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Prepared By:

Louis Berger

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LIST OF ABBREVIATIONS AND ACRONYMS

AST	Aboveground Storage Tank
ASTM	ASTM International
AUL	Activity and Use Limitation
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CESQG	Conditionally Exempt Small Quantity Generator
CIP	Capital Improvement Plan
CORRACTS	Corrective Action Reports
CREC	Controlled Recognized Environmental Condition
DAGS	Hawaii Department of Accounting and General Services
DLNR	Hawaii Department of Land and Natural Resources
DOD	Department of Defense
EAL	Environmental Action Level
ECHO	Enforcement and Compliance History Online
EDR	Environmental Data Resources, Inc.
EIS	Environmental Impact Statement
ERNS	Emergency Response Notification System
ESA	Environmental Site Assessment
FEMA	Federal Emergency Management Agency
FUDS	Formerly Used Defense Site
HDOA	Hawaii Department of Agriculture
HDOH	Hawaii Department of Health
HEER	Hazard Evaluation and Emergency Response Office
HREC	Historical Recognized Environmental Condition
HRS	Hazard Ranking System
ICIS	Integrated Compliance Information System
LQG	Large Quantity Generator
LUC	Land Use Control
LUST	Leaking Underground Storage Tank
MWR	Morale, Welfare and Recreation
NFRAP	CERCLIS No Further Remedial Action Planned
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
OCCC	Oahu Community Correctional Center
PCB	Polychlorinated Biphenyl
pCi/L	picocuries per liter
PSD	Hawaii Department of Public Safety
RCRA	Resource Conservation and Recovery Act

RCRAInfo	Resource Conservation and Recovery Act Information Database
REC	Recognized Environmental Condition
ROD	Record of Decision
SEMS	Superfund Enterprise Management System
SHWS	State Hazardous Waste Site
SQG	Small Quantity Generator
SWF/LF	Solid Waste Facilities/Landfill Sites
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRIS	Toxic Release Inventory System
TSDF	Treatment, Storage and Disposal Facility
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VCP	State Voluntary Cleanup Program Agreement Sites

EXECUTIVE SUMMARY

This report presents the findings of a Phase I Environmental Site Assessment (ESA) prepared by Louis Berger U.S., Inc. (Louis Berger) for an approximately 35-acre property comprising the Animal Quarantine Station located at 99-951 Halawa Valley Street in Honolulu (Halawa Ahupuaa, Ewa District), Hawaii (Site).

Four sites located on the island of Oahu were identified as potential locations for development of a new Oahu Community Correctional Center (OCCC) to replace the existing OCCC, with the Animal Quarantine Station site in Halawa selected as the preferred location for new OCCC development. To develop the new OCCC, relocation and replacement of the current Animal Quarantine Station facility must also occur; therefore, the proposed OCCC project includes development of a new Animal Quarantine Station. Both the proposed OCCC and Animal Quarantine Station facilities would be co-located within the Animal Quarantine Station site; the new OCCC would be located east of the elevated H-3 Freeway, and the new Animal Quarantine Station would be located west of H-3 (together "the proposed OCCC project"). Assisting the Hawaii Department of Public Safety (PSD) with this effort is the Hawaii Department of Accounting and General Services (DAGS).

The Animal Quarantine Station property, owned by the State of Hawaii and operated by the Hawaii Department of Agriculture (HDOA), has been developed with over 1,600 dog animal kennels (most are not in use), nine cat buildings, administrative and support structures, maintenance and storage buildings, a livestock corral and pasture, and vehicle parking areas. The few undeveloped areas within the overall property consist of a large pasture devoted to horse and cattle grazing, grassed areas for small animal use, and vacant areas located on the periphery of the property. Approximately 3.47 acres of the overall site are owned by the U.S. Navy, which has provided HDOA with a right-of-entry to use its lands as part of the Animal Quarantine Station operation. An elevated portion of the H-3 Freeway bisects the Animal Quarantine Station site from southwest to northeast.

The Phase I ESA was performed in general accordance with the scope and limitations of the ASTM International (ASTM) Standard E 1527-13, S*tandard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* and the "due diligence" regulations of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 9601 (35)(b) of the Superfund Amendments and Reauthorization Act.

The Phase I ESA was based on a Site inspection, a review of available files and historical records and reports, communication and coordination with Federal and State agencies, interviews with knowledgeable local officials, and the findings of an environmental database report. The purpose of the Phase I ESA is to identify potential Recognized Environmental Conditions (RECs), Historical RECs (HRECS), or Controlled RECs (CRECs) associated with the Site.

Based on information obtained during records review, the Site reconnaissance, and interviews with persons familiar with the Site, the following REC was identified at the Site:

- Two severely corroded and leaking drums containing a white powder were observed on the north-central edge of the Site under the elevated H-3 Freeway. Louis Berger recommends removal and offsite disposal of the drums and their contents, along with waste characterization analysis to facilitate proper disposal. Sampling of the soil beneath and in the vicinity of the drums is recommended to evaluate whether there have been any impacts from the leaking contents.

The following HRECs were identified at the Site:

- In 1975, HDOA sought and received permission from the U.S. Environmental Protection Agency (USEPA) to dispose of an unknown quantity of old and degradable pesticides (primarily malathion and tomato dust, possibly others) by burial on the Site. USEPA has confirmed that the disposal was performed in accordance with its Regulations for Acceptance and Recommended Procedures for Disposal and Storage of May 1, 1974, and Proposed Pesticide Disposal and Storage Regulations of October 15, 1974. In a letter dated May 24, 2005, the Hawaii Department of Health (HDOH) Hazard Evaluation and Emergency Response (HEER) Office stated that no excavation or construction work must be performed near, around, or in the pesticide burial pit and if the cover over the Site is disturbed such that contaminated soil is brought to the surface, HEER should be immediately notified. However, in an interview with a long-time HDOA employee, Mr. Harrison Hoe, in May 2018, he indicated that the pesticides were buried on the western side of the Site in a concrete bunker and the bunker and pesticides were removed and disposed of in 1978 during construction of the HDOA Animal Industry Division building. The building is constructed over the location of the former pesticide bunker. Furthermore, the proposed OCCC development would not occur in this location; therefore, Louis Berger recommends no further action with respect to the formerly buried pesticides.
- The Site was listed in the SPILLS database with Case Number 19951012 for a release of 30 gallons of non-Polychlorinated Biphenyl (PCB) transformer oil. The final result was reported as a State On-Scene Coordinator (SOSC) No Further Action. Therefore, no further action is recommended.
- An enforcement action was filed against the facility on March 9, 2017 (Case Number HI-IU0104870001) in violation of the Clean Water Act. The violation was associated with an overflow of the onsite wastewater treatment facility and a state/local penalty of $465,000 was assessed. According to Dr. Isaac Maeda (HDOA, Animal Quarantine Station), HDOA has taken corrective actions and a wastewater facility Capital Improvement Plan (CIP) project is in process. Therefore, no further action is recommended.

The following CREC was identified at the Site:

- A tar-like material has been discovered emanating up from the western edge of the Animal Industry Division parking lot, as well as the nearby soil. Previous investigative activities revealed no risks to human health or the environment are anticipated, therefore, the material can be left in place with controls. The HDOH, HEER Office issued a No Further Action Letter – Restricted Use (Document Number 2006-418-DE) on July 18, 2006. Controls are required to manage the contamination and consist of an institutional control (i.e., HDOH Letter issued) and the following engineering controls: maintenance staff will conduct surface removal of the tar-like product in areas where it reaches the surface and the HEER Office will be notified and consulted if the tar-like material is to be excavated. Based on the issuance of a No Further Action Letter, and the fact that the proposed OCCC development will not extend to this area, Louis Berger recommends no further action with respect to the tar-like material in the parking lot.

The following other environmental concerns were identified at the Site:

- The U.S. Navy property to the south of the Animal Quarantine Station Site is currently part of an environmental investigation for potential contamination from a former oily waste disposal site. This investigation will be conducted by the Navy under the Navy's Environmental Restoration Program. Proposed use of a portion of TMK 9-9-010-006 for the OCCC relocation would require DAGS and/or PSD to acknowledge that there is potential subsurface contamination, grant access to the Navy to conduct future investigation/monitoring/environmental maintenance and adhere to potential future Land Use Control actions at the site. Layout of future facilities should consider these environmental requirements. No action is recommended at this time.
- Drums of waste oil are stored on spill containment and wooden pallets at the HDOA Maintenance Building.
- Small quantities of disinfectants, bleach, cleaners, lubricants, paints, grease, petroleum products and various other chemicals are stored at the Animal Quarantine Station office building, U.S. Army Morale, Welfare and Recreation (MWR) area and the HDOA Maintenance Building. In general, the materials were neatly stored and there was evidence of only *de minimis* spills and staining.
- Waste piles containing tires, compressed gas cylinders, discarded household appliances, wood and metal debris, and construction materials were observed in several locations throughout the Site, including the abandoned caretaker’s cottage and northeastern section of the property, north-central edge of Site under elevated H-3 Freeway, and Hawaii Department of Land and Natural Resources (DLNR) area in the western-central portion of the Site.

Louis Berger recommends that all waste piles be immediately removed for off-site disposal. Drums of used oil, cleaners and other chemicals which are in current use should be properly removed from the Site prior to redevelopment activities. Sampling may be warranted if evidence of a release is observed during removal activities.

1.0 INTRODUCTION

The Hawaii Department of Public Safety (PSD) operates the Oahu Community Correctional Center (OCCC), which acts as the local detention center for the First Circuit Court on Oahu. Located at 2199 Kamehameha Highway in Honolulu, the OCCC is currently the largest jail facility in the state of Hawaii. With increasingly aged, overcrowded, and obsolete correctional facilities, PSD is proposing to improve its corrections infrastructure through modernization of existing facilities when possible and construction of new institutions to replace others when necessary. Among its priority projects is the replacement of OCCC.

Four sites located on the island of Oahu were identified as potential locations for the proposed OCCC facility with the Animal Quarantine Station site in Halawa selected as the preferred location for new OCCC development. However, in order to develop the new OCCC, relocation and replacement of the current Animal Quarantine Station facility must also occur. Therefore, the proposed OCCC project also includes development of a new Animal Quarantine Station that would meet the future quarantine needs of the State of Hawaii. Both the proposed OCCC and Animal Quarantine Station facilities would be co-located within the Animal Quarantine Station site; the new OCCC would be located east of the elevated H-3 Freeway and the new Animal Quarantine Station would be located west of H-3 (together "the proposed OCCC project"). Assisting PSD with this effort is the Hawaii Department of Accounting and General Services (DAGS).

The Animal Quarantine Station property, owned by the State of Hawaii and operated by the Hawaii Department of Agriculture (HDOA), has been developed with over 1,600 dog animal kennels (most are not in use), nine cat buildings, administrative and support structures, maintenance and storage buildings, a livestock corral and pasture, and vehicle parking areas. The few undeveloped areas within the overall property consist of a large pasture devoted to horse and cattle grazing, grassed areas for small animal use, and vacant areas located on the periphery of the property. Approximately 3.47 acres of the overall site are owned by the U.S. Navy which has provided HDOA with a right-of-entry to use their lands as part of the Animal Quarantine Station operation. An elevated portion of the H-3 Freeway bisects the Animal Quarantine Station site from southwest to northeast.

The earliest owner of record of what is now the Animal Quarantine Station property was the Emma Kaleleonalani Estate. Records show that the U.S. Navy owned the property from 1941 and during the 1940s and 1950s, the property was occupied by the U.S. Navy. Historical aerial photos taken in 1944 and 1952 show various structures situated on the property but by 1965, many of the Navy buildings had been removed. In 1968, the State of Hawaii acquired the property to develop the Animal Quarantine Station. Prior to construction of the Animal Quarantine Station in 1968, the elevation of the Animal Industry Division parking lot was approximately 70 feet above mean sea level (amsl). The topography changed in 1969 with the ground surface raised to between 85 and 90 feel amsl. During the 1970s, a HDOA Disease Education Building, a U.S. Department of Agriculture building, and two corrals were constructed and later demolished in 1999 to build the current Animal Industry Division parking lot.

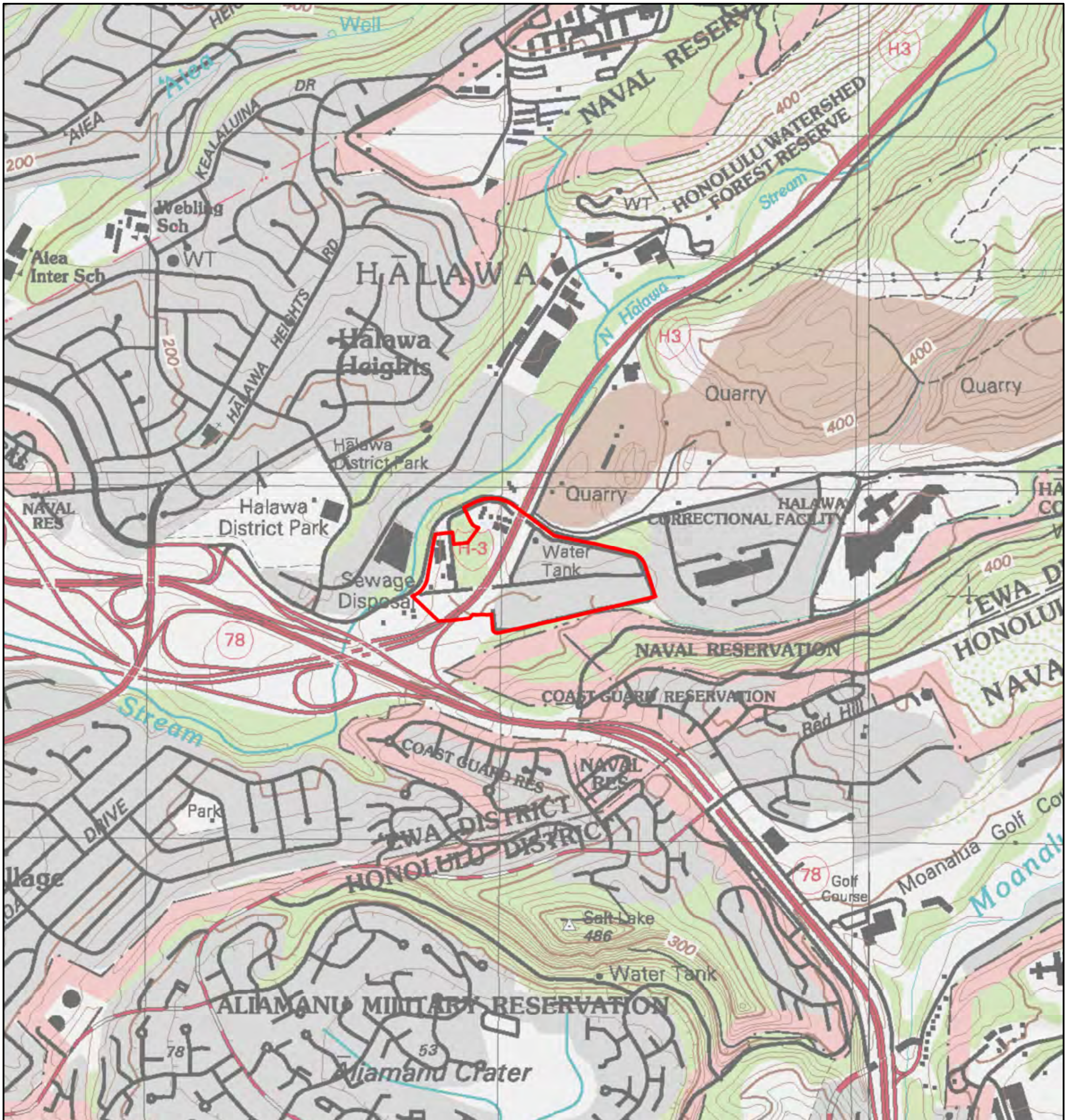
Research conducted as part of OCCC Draft Environmental Impact Statement (EIS) preparation (*November 8, 2017*), revealed that pesticides were reportedly disposed of at the Animal Quarantine Station property in the 1970s. The pesticides needed disposing due to the deteriorating condition of the containers holding the pesticides with contents leaking or spilling; workers being exposed to the pesticides; the lack of any acceptable incinerators available in Hawaii; and no approved sanitary landfill for pesticide disposal available locally. The amount of chemicals requiring disposal was sufficient to fill three 55-gallon steel drums containing Rtu 10 percent DDT and six 5-gallon drums of 10 percent DDT. Other pesticides, including Malathion and tomato dust, appear to have been buried within an underground oubliette and were covered with soil and aggregate and a solid lid. Correspondence from the Hawaii Department of Health (HDOH) reported that the DDT, originally thought to have been buried with other pesticides, was in fact shipped to Oregon for disposal by a contractor. According to records dating to the 1970s and 1980s, the decision to dispose of pesticides at the Animal Quarantine Station (burial) was made following consultations with various state and federal agencies.

In the early 2000s, a black, viscous, tar-like substance was observed on a small area of the Animal Industry Division parking lot surface. The source of the substance was uncertain. In June 2003, Muranaka Environmental Consultants, Inc. collected two composite samples of the tar-like substance which were analyzed for polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPH) in diesel, TPH in gasoline, volatile compounds, semi-volatile compounds and eight Resource Conservation and Recovery Act (RCRA) metals. Laboratory results indicated that the sample taken from the parking lot stalls contained detectable levels of acetone, barium, cadmium, and chromium while the sample taken from the west side of the parking lot was found to contain barium, cadmium, chromium, and lead at detectable concentrations. Two samples were analyzed for Toxic Characteristic Leaching Procedure (TCLP) for the eight RCRA metals, volatile compounds, and semi-volatile compounds. Only barium and chromium were detected above the method detection limits for TCLP and the laboratory results indicated TCLP levels did not exceed U.S. Environmental Protection Agency (USEPA) regulatory limits. Based on the laboratory results, the material was not considered a hazardous substance.

Since the U.S. Navy owns a 3.47-acre portion of the Animal Quarantine Station property (as part of larger land holdings extending south of the Animal Quarantine Station), meetings and discussions concerning the proposed OCCC project have been held with U.S. Navy officials throughout 2017 and 2018. During one such meeting (January 30, 2018), it was revealed that the Navy is undertaking an Environmental Restoration Program project involving a former oily waste disposal site under its control and ownership. The Navy's oily waste disposal site had been closed in 2005 after which the Navy was issued a letter stating no further action needed under its Environmental Restoration Program. However, monitoring wells installed as part of that program on Navy property have recently detected a constituent likely to be petroleum. The U.S. Navy's disposal site is located upgradient from the Animal Quarantine Station Site and there is a likelihood that the U.S. Navy will need to install one or more monitoring wells on their 3.47-acre portion of the Site. Wells will be monitored until there are no further detections and the HDOH confirms that no further action is needed.

1.1 Purpose

This report presents the findings of a Phase I Environmental Site Assessment (ESA) prepared by Louis Berger for the Animal Quarantine Station site, located at 99-951 Halawa Valley Street in Honolulu (Halawa Ahupuaa, Ewa District), Hawaii (i.e., Site), as shown in Figure 1. The purpose of the Phase I ESA was to



Animal Quarantine Station Site

Source:
USGS Topo, 2000.

June 2018

KEY MAP

Oahu

0 5 10 Miles

Figure 1
Site Location
Future Oahu Community Correctional Center

State of Hawaii
Department of Public Safety

N

0 625 1,250 Feet

identify the presence of any Recognized Environmental Conditions (RECs)[1], Historical Recognized Environmental Conditions (HREC)[2], and/or Controlled Recognized Environmental Conditions (CREC)[3] as defined by ASTM International (ASTM) Standard Practice E1527-13, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* with respect to the Site. This report has been prepared for, and at the request of, DAGS and PSD, with PSD designated by the term "User," within the context of ASTM Standard Practice E1527-13.

The general application of ASTM Standard Practice E1527-13 in the preparation of this report is intended to permit the designated User of this report to satisfy one of the requirements to qualify for the innocent landowner, contiguous property owner, or bona fide prospective purchaser (collectively, "landowner liability protections") limitations on liability with respect to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This report, therefore, intends to represent "all appropriate inquiry" into the previous ownership and uses of the Site, consistent with good commercial or customary practice, as defined by CERCLA in 42 U.S.C. §9601(35)(B).

1.2 Scope of Services

Louis Berger's scope of services for the Phase I ESA consisted of the following components, as further detailed in subsequent sections of this report:

- Data collection and records review;
- Site visit and reconnaissance;
- Coordination with Federal and State agencies;
- Interviews with present and past owners, operators, and occupants of the property; and
- Evaluation of information and preparation of a Phase I ESA report.

The User's responsibilities, as set forth in Section 6 of ASTM Standard Practice E1527-13 with respect to the identification of RECs in connection with the Site, comprise an additional scope of inquiry. These

[1] ASTM Standard E1527-13 defines "Recognized Environmental Conditions" as follows: "the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment." *De minimis* conditions are not recognized environmental conditions. The term is not intended to include *de minimis* conditions that generally do not present a threat to human health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies."

[2] ASTM Standard E1527-13 defines "Historical Recognized Environmental Condition" as follows: "a past release of any hazardous substances or petroleum products that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authority or meeting unrestricted use criteria established by a regulatory authority, without subjecting the property to any required controls (for example, property use restrictions, activity and use limitations, institutional controls, or engineering controls)."

3 ASTM Standard E1527-13 defines "Controlled Recognized Environmental Conditions" as follows: a recognized environmental condition resulting from a past release of hazardous substances or petroleum products that has been addressed to the satisfaction of the applicable regulatory authority (for example, as evidenced by the issuance of a no further action letter or equivalent, or meeting risk-based criteria established by regulatory authority), with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls (for example, property use restrictions, activity and use limitations, institutional controls, or engineering controls).

responsibilities consist of the following tasks and information sources, as further discussed in Section 3.0 of this Phase I ESA:

- Review of Title and Judicial Records for Environmental Liens or Activity and Use Limitations ("AULs");
- Specialized Knowledge or Experience of the User;
- Actual Knowledge of the User;
- Commonly Known or Reasonably Ascertainable Information; and
- Reason for Requesting a Phase I ESA.

1.3 Significant Assumptions

Louis Berger has assumed in the conduct of the Phase I ESA that respondents to its inquiries offered information in good faith and that, through its research, it obtained reasonably correct and accurate information from the sources consulted.

1.4 Limitations on Use of Report

This Phase I ESA Report [Report] has been prepared for the sole use of Louis Berger's Client, the Hawaii Department of Accounting and General Services. The purpose of this Report is to provide information to the Client on the environmental conditions of the subject property, *Animal Quarantine Station site, located at 99-951 Halawa Valley Street in Honolulu (Halawa Ahupuaa, Ewa District), Hawaii.*

The use of and reliance on this Report, by any person or entity other than the Client, is not authorized without an agreement between the user and Louis Berger. Without an agreement with Louis Berger, the use of this Report by an unauthorized user is for their information only and *shall be solely at the unauthorized user's risk*.

Louis Berger's work presented in this Report was performed pursuant to a Scope of Services between Louis Berger and the Hawaii Department of Accounting and General Services dated February 22, 2018. Any modifications, deviations or exceptions to the services proposed or limitations in the scope of the Phase I ESA arising out of site access issues and the actual availability of data and information related to the Site are as described in Section 10.0 of this Report.

The conclusions in this Report have been based, in part, on information obtained from third parties including historical aerial photographs, environmental agency records, previous studies of the property, and other public records regarding the Site obtained from various sources. Unless noted, Louis Berger has not independently evaluated or verified the accuracy or completeness of such third party information. Visual observations of the Site only represent conditions at the time of the site visit. Louis Berger makes no warranties that the on-site observations made during the Phase I ESA are representative of historical or future conditions at the Site. Louis Berger performed its services and prepared this Report at the level customary for other prudent and competent environmental professionals performing such services at the time and place where the services are provided. The Report shall be construed neither as a legal opinion nor as compliance with any environmental law. *Louis Berger makes no other warranty, expressed or implied.*

2.0 SITE DESCRIPTION

This section provides general information on the ownership and location of the Site, as well as current uses of the Site and surrounding properties.

2.1 Location and Legal Description

The Animal Quarantine Station Site comprises approximately 35 acres distributed across several TMK parcels in Halawa Valley (TMK: 9-9-010:054, 9-9-010:057, 9-9-010:058, 9-9-010:006, 9-9-010:046). The majority of the Site, located at 99-951 Halawa Valley Street in Honolulu (Halawa Ahupuaa, Ewa District), is owned by the State of Hawaii (Hawaii Department of Land and Natural Resources (DLNR) is the fee title owner) and operated by the Hawaii Department of Agriculture (HDOA). However, a 3.47-acre portion is owned by the U.S. Navy which has granted HDOA a right-of-entry to use the parcel as part of the operation of the Animal Quarantine Station. The Site boundaries are depicted in Figure 2, which also shows the elevated portion of the H-3 Freeway that bisects the Site.

2.2 Site and Vicinity General Characteristics

The Site is situated within a highly developed area of Halawa with surrounding properties occupied by industrial and quarry operations, warehouse facilities, and major transportation arteries.

2.3 Current Use of the Site

The Animal Quarantine Station property, owned by the State of Hawaii and operated by HDOA, has been developed with over 1,600 dog animal kennels (most are not in use), nine cat buildings, administrative and support structures, maintenance and storage buildings, a livestock corral and pasture, and vehicle parking areas. The few undeveloped areas within the overall property consist of a large pasture devoted to horse and cattle grazing, grassed areas for small animal use, and vacant areas located on the periphery of the property. Approximately 3.47 acres of the overall site are owned by the U.S. Navy which has provided HDOA with a right-of-entry to use their lands as part of the Animal Quarantine Station operation. An elevated portion of the H-3 Freeway bisects the Animal Quarantine Station Site from southwest to northeast. A summary of the Site buildings and their function is provided in Table 2-1.

Animal Quarantine Station Site

DLNR - Hawaii Department of Land and Natural Resources
PSD - Hawaii Department of Public Safety
USDA-PPQ - United States Department of Agriculture-Plant Protection & Quarantine
CBP - Customs and Border Protection
MWR - Morale, Welfare and Recreation
HDOA-PQ - Hawaii Department of Agriculture Plant Quarantine

Sources:
ESRI BING Imagery Service, obtained 2018.

June 2018

KEY MAP

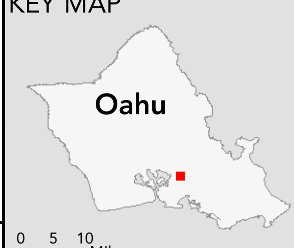


Figure 2
Site Plan
Future Oahu Community Correctional Center

State of Hawaii
Department of Public Safety

N

0 150 300 Feet

Table 2-1: Summary of Animal Quarantine Station Structures

Building/Area Name	Year	Description
Animal Quarantine Office	circa 1995	1-story irregularly shaped concrete structure with hipped roof
HDOA Maintenance Building	circa 1995	U-shaped concrete block sheds and work bays with corrugated metal siding and roofing
HDOA Animal Industry Division Building (used for Administration; Veterinary Laboratory; Animal Disease Control Branch; and Aquaculture and Livestock Support Services) aka Vector Control Facility, HDOA Laboratory Building, and HDOA Administration Building	circa 1975	1-story concrete and wood structure with flat-topped mansard roof with shingles.
HDOH Environmental Health Division Buildings (Building A – Administration; Building B – Food Safety and Vector Control Branch; Building C – Indoor and RAD Health Branch; Building D – Maintenance; Building E – Warehouse)	1990-2005	5 modern buildings of various sizes, constructed of concrete with metal gabled roofs
Necropsy/Incinerator	circa 1975	1-story industrial concrete structure with a flat roof and single-pane windows located high on the west and east faces
Large Animal Handling/Holding Facilities	Unknown	There are 9 sheds, consisting of a fenced area (of various dimensions) with a corrugated metal roof. These sheds are located to the north of a pasture area.
Kennels, Style 1	1970-2000s	Chain-link enclosure with a wood or corrugated-metal structure at one end that serves as a shelter. Both shelter and chain-link enclosure are covered with corrugated-metal roofing. There are hundreds of these kennels of varying sizes.
Kennels, Style 2	1970s-2000s	Long corrugated-metal shed with chain-link enclosures extending from the open side of the shed, covered with a corrugated metal roofing. There are 7 of this style in use and another 5 that appear inactive.

Building/Area Name	Year	Description
Cat Kennels	1970s-2000s	Corrugated metal building on a concrete foundation with small external pens on both sides. There are approximately 9.
Inactive Kennels	1970-2000s	Many of these appear similar to the Style 1 kennels but some are different. The vegetation coverage makes it difficult to determine their exact construction.

2.4 Descriptions of Structures, Roads, Other Improvements on the Site

The current Animal Quarantine Station Site consists of an extensive complex of kennels for dogs and cats. There are two types of kennels for dogs. Individual kennels consist of a chain-link enclosure with a corrugated metal structure at one end to provide shelter, both of which are topped with corrugated sheet metal. This type of kennel is present in a variety of sizes, likely to accommodate dogs of differing sizes. The second type consists of a long, corrugated-metal shed with multiple chain-link enclosures extending from one side. The shed is covered with corrugated-metal roofing and the chain-link enclosure is secured on the top by additional chain link. Both kennel types are erected on a concrete slab. The cat kennels are corrugated metal buildings constructed on a taller concrete foundation, with smaller pens on the outside for the animals.

Two buildings are located in the east half of the Site, the Animal Quarantine Office and the HDOA Maintenance Building. The Maintenance Building is a combination of sheds and bays. The Animal Industry Division building (a laboratory office building), Environmental Health Division Buildings (additional laboratory and testing facilities), a necropsy building, and large animal handling/holding facilities (i.e., livestock pens) and pasture are located west of the H-3 Freeway. A large paved visitor parking lot is located under and east of the elevated H-3.

2.5 Current Use of the Adjoining Properties

The Animal Quarantine Station Site is accessed via Halawa Valley Street, which also forms its western and northern borders. The Site lies just north of Moanalua Freeway (aka H-201) with an elevated portion of the H-3 Freeway bisecting the Site from the southwest to the northeast. There is a nearby transit stop servicing bus routes and, when completed, the Honolulu Authority for Rapid Transportation’s Aloha Stadium Transit Station will be located approximately two miles from the Site. The surrounding neighborhood is largely industrial in nature with the Hawaiian Cement Company located to the north, industrial warehouses to the east, HDOA livestock and research facilities to the west, and U.S. Navy property and the Red Hill Naval Supply Center to the south (see Figures 1 and 2).

3.0 USER-PROVIDED INFORMATION

The "User" of the Site, in accordance with ASTM Standard Practice E1527-13, is the State of Hawaii, Department of Public Safety. Mr. Clayton H. Shimazu, Chief Planner for PSD, was Louis Berger's contact on behalf of this entity. As part of the Phase I ESA process, Louis Berger provided a User Questionnaire to Mr. Shimazu for completion; a copy of the completed questionnaire is included in Appendix K.

3.1 Title Records

Louis Berger obtained ownership information of the Site from EDR via a chain of title search (EDR, 2018h). Appendix H contains the chain of title report, and Table 3-1 summarizes ownership information provided by EDR.

Table 3-1: Property Ownership Information—Animal Quarantine Station Site

Grantor	Grantee	Instrument Number	Recorded
PARCEL (TMK) 1-9-9-010-057-0000			
State of Hawaii, Board of Land and Natural Resources	State of Hawaii, Department of Agriculture via Executive Order No. 4396. Land is set aside for Animal Quarantine, Animal Welfare, and General Commercial Purposes and shall revert to the Department of Land and Natural Resources in the event of non-use or abandonment for a period of 1 year.	T-8079287	02/14/2012
PARCEL (TMK) 1-9-9-010-054-0000			
State of Hawaii, Board of Land and Natural Resources	State of Hawaii, Department of Agriculture via Executive Order No. 4396. Land is set aside for Animal Quarantine, Animal Welfare, and General Commercial Purposes and shall revert to the Department of Land and Natural Resources in the event of non-use or abandonment for a period of 1 year	T-8079287	02/14/2012
PARCEL (TMK) 1-9-9-010-058-0000			
State of Hawaii, Board of Land and Natural Resources (acquired title prior to 1940)	State of Hawaii, Department of Agriculture via Executive Order No. 4396. Land is set aside for Animal Quarantine, Animal Welfare, and General Commercial Purposes and shall revert to the Department of Land and Natural Resources in the event of non-use or abandonment for a period of 1 year	T-8079287	02/14/2012
PARCEL (TMK) 1-9-9-010-006-0000			
N/A	United States of America (acquired title prior to 1940)	N/A	N/A

3.2 Environmental Liens or Activity and Use Limitations

Louis Berger was contracted by the User to obtain an environmental lien and activity and use limitations (AULs) report for the Site. The lien and AUL search report was prepared by EDR (EDR, 2018g) and is included as Appendix I. No environmental liens or AULs were found in connection with the Site. The User is not aware of any environmental liens or AULs associated with the Site.

3.3 Specialized Knowledge

The User has no specialized knowledge related to the Site.

3.4 Commonly Known or Reasonably Ascertainable Information

3.4.1 Previous Studies—1970–1980

Research concerning conditions at the Animal Quarantine Station Site revealed that pesticides were disposed of at the property in the 1970s. The pesticides needed disposing due to the deteriorating condition of the containers holding the pesticides with contents leaking or spilling; workers being exposed to the pesticides; the lack of any acceptable incinerators available in Hawaii; and no approved sanitary landfill for pesticide disposal available locally. The amount of chemicals requiring disposal was sufficient to fill three 55-gallon steel drums containing Rtu 10 percent DDT and six 5-gallon drums of 10 percent DDT. Other pesticides, including malathion and tomato dust, appear to have been buried. The containers comprised approximately 4.5 cubic feet in volume within an underground oubliette and were covered with soil and aggregate and a solid lid. According to records dating to the 1970s and 1980s, the decision to dispose of pesticides at the Animal Quarantine Station (bury) was made following consultations with various state and federal agencies.

The actions taken by the HDOA to bury pesticides appear to be in accordance with USEPA regulations for the disposal and storage of pesticides in effect in 1976. More recent correspondence from the HDOH reported that the stored 10 percent DDT originally thought to have been buried with other pesticides was in fact shipped to Oregon for disposal by a contractor (UNITEK Environmental Services). A copy of the manifest for the DDT waste from the Animal Quarantine Station was later obtained from UNITEK and is included in Appendix K.

The HDOH, Hazard Evaluation and Emergency Response (HEER) Office, in correspondence dated May 24, 2005, required that no excavation or construction work be performed near, around or in the disposal site itself. The HEER Office has been notified about the proposed development of the OCCC facility at the Animal Quarantine Station Site and discussions initiated about the potential for contamination and the possible need to properly remove, treat and dispose of such materials prior to development. However, it was recently learned that the pesticides were excavated and removed during the construction of the Animal Industry Division building and the building was constructed on the former location of the pesticide burial area.

3.4.2 2003 Sampling

During the 1940s and 1950s, the Site was occupied by the U.S. Navy. Historical aerial photos taken in 1944 and 1952 show various structures situated on the property. However, it is unclear from the photos if some of the buildings were actually situated on the Animal Industry Division parking lot area. By 1965, many of the Navy buildings had been removed. In 1968, the State of Hawaii acquired the property to develop the Animal Quarantine Station and no structures were located in the parking lot area. Prior to construction of the Animal Quarantine Station in 1968, the elevation of the Animal Industry Division parking lot was approximately 70 feet above mean sea level (amsl). The topography changed in 1969 with the ground surface raised to between 85 and 90 feel amsl. During the 1970s, the HDOA Disease Education Building, U.S. Department of Agriculture building and two corrals were built in the area of parking lot and were later demolished in 1999 to build the current Animal Industry Division parking lot.

In the early 2000s, a black, viscous, tar-like substance was observed on a small area of the surface of the Animal Industry Division parking lot. The source of the substance was uncertain. In June 2003, Muranaka Environmental Consultants, Inc. collected two composite samples of the tar-like substance found in the parking lot. One sample was collected from parking lot stalls while the second sample was collected from the tar material located on the west side of the parking lot.

The samples were analyzed for PCBs, TPH in diesel, TPH in gasoline, volatile compounds, semi-volatile compounds and eight RCRA metals. Laboratory results indicated that the sample taken from the parking lot stalls contained detectable levels of acetone, barium, cadmium, and chromium while the sample taken from the west side of the parking lot was found to contain barium, cadmium, chromium, and lead at detectable concentrations. Two samples were analyzed for TCLP for the eight RCRA metals, volatile compounds, and semi-volatile compounds. Only barium and chromium were detected above the method detection limits for TCLP and the laboratory results indicated TCLP levels did not exceed USEPA's regulatory limits.

3.4.3 Limited Phase I Environmental Site Assessment—2004

In 2004, Kimura International, Inc. was contracted to conduct a limited Phase I ESA for the Animal Quarantine Station. According to the limited Phase I ESA, a black, viscous, tar-like substance was observed on the Animal Industry Division parking lot surface. The source of the substance was uncertain, however, the substance was previously analyzed in 2003 for PCBs, TPH in diesel, TPH in gasoline, volatile compounds, semi-volatile compounds and eight RCRA metals. Based on the laboratory results, the material was not considered a hazardous substance.

Due to the material's physical characteristics, the source is believed to be a release from a low-refined petroleum product such as commercial fuel oil, waste oil, or asphalt. Since the material at the Site is known and suspected to have originated from a nearby source, the scope of the 2004 investigation was limited to on-site and geologically (i.e., hydraulically) up-gradient sources and not the recommended ASTM search distances for a typical Phase I ESA investigation.

As noted earlier, the State of Hawaii acquired the property in 1968 from the United States of America. Property records show that the U.S. Navy owned the property from 1941 and the earliest owner was the Emma Kaleleonalani Estate. Historical aerial photos taken in 1944 and 1952 show various structures on the property, including in the vicinity of the present-day Animal Industry Division parking lot. The buildings were subsequently demolished and the Animal Quarantine Station was constructed in 1968. The U.S. Navy's Regional Engineers did not have any knowledge of the operations that were performed by the Navy at the Animal Quarantine Station property.

A limited database search was conducted in 2004 for the Site and the facilities on the property. The databases consulted included the NPL, CERCLIS, and the HDOH UST, LUST and Releases databases. The database search identified several possible sources of petroleum material, including releases or fuel tanks associated with commercial fuel oil, asphalt, or any black viscous petroleum product. Other petroleum products such as gasoline, kerosene, or jet fuel were not considered a concern.

One 8,000-gallon bunker oil underground storage tank (UST) was registered on the HDOH UST database to the company Prestressed Concrete located on Halawa Valley Road (the file did not indicate the status of the tank). A release from the tank could potentially travel onto the Animal Quarantine Station Site but is not likely based on the distance from the parking lot where the material is found.

A release associated with commercial fuel oil and asphalt cement USTs removed at the Grace Pacific facility at 1300 Halawa Valley Road was reported to the HDOH HEER Office. Several investigations regarding the release were conducted. The investigations included contaminant delineation, soil remediation, and groundwater monitoring. Findings from the most recent investigation suggested that the contamination was restricted to the Grace Pacific facility.

Kimura visited the Animal Quarantine Station to inspect the surface contamination and surrounding areas. The tar-like material was inspected and it appeared to be emanating from the ground and was not poured onto the surface.

Interviews with HDOA personnel revealed that the material surfaced in approximately 1999. The asphalt paving company was contacted but there was no resolution. HDOA personnel reported that roofing materials were spilled onto the ground surface during construction of the HDOA Laboratory Building (i.e., HDOA Animal Industry Division Building) and was never cleaned up.

Kimura concluded that the tar-like material was not illegally dumped onto the Animal Industry Division parking lot and is coming from below the surface. Several potential sources located up-gradient were identified in the databases. Kimura recommended a subsurface investigation be conducted to determine the horizontal and vertical limits of the material. If the material originated from an up-gradient source, then the material would be found along the north and/or east ends of the property and a pathway should be traced. The subsurface investigation would also indicate whether the material is limited to the subject property and whether the material was on the property by the time the Animal Quarantine Station was constructed.

The property was owned by the U.S. Navy until 1968 and Formerly Used Defense Sites (FUDS) are supposed to be assessed by the military for environmental issues. The U.S. Army Corps of Engineers did not list any FUDS in the Halawa area.

3.5 Valuation Reduction for Environmental Issues

The User indicated that the purchase price for the property is not applicable. All lands comprising the Site are in public ownership and are expected to remain so for purposes of developing the proposed OCCC.

3.6 Owner, Property Manager, and Occupant Information

Information provided by the property owner is presented in Section 6.0 of this report.

3.7 Reason for Performing Phase I ESA

The purpose of this Phase I ESA is to identify, to the extent feasible, the presence of RECs at the Site in support of development of a new OCCC and Animal Quarantine Station.

4.0 RECORDS REVIEW

Federal and State record sources were reviewed to identify potential sites of environmental concern located within established search distances of up to 1.0 mile from the Site. The review of the standard environmental record sources was accomplished utilizing a computer database search report provided by Environmental Data Resources, Inc. (EDR) of Shelton, Connecticut. A copy of the EDR database report (EDR, 2018a) is included as Appendix C. A description of the various databases reviewed and the summaries of the reviews are provided below.

Louis Berger also reviewed unmapped (also referred to as "orphan") listings within the database report, cross-referencing available address information and facility names. Unmapped sites are listings that cannot be plotted with confidence, but are identified as being located within the general area of the Site based on the partial street address, city name, or zip code. In general, a listing cannot be mapped due to inaccurate or incomplete address information in the database that was supplied by the corresponding regulatory agency. Any listings from the unmapped summary, which were identified by Louis Berger as a result of the area reconnaissance and/or cross-referencing to mapped listings, are included in the corresponding database discussion within this section.

4.1 Standard Environmental Record Sources

The databases discussed in this section were reviewed for information regarding documented and/or suspected releases of regulated hazardous substances and/or petroleum products on or near the Site. Louis Berger also reviewed the "unmappable" (also referred to as "orphan site") listings within the database report, cross-referencing available address information with facility names. Ten orphan listings were identified within applicable search radii of the Site. A summary of the sites identified through the Federal and State regulatory agency databases review is presented in Table 4-1. Only sites which were found to be located within the applicable search radii are included in the table.

The following subsections provide a discussion of the databases reviewed, as well as sites identified within the search radius and listed in Table 4-1.

Table 4-1: Federal and State Listed Sites

Federal and State List	Site Appears on List	Search Radius* (miles)	No. of Sites within Search Radius	Last Updated
National Priorities List for Federal Superfund Cleanup (NPL) / Delisted NPL / Proposed NPL	No	1.0	1 / 0 / 0	12/11/17
Superfund Enterprise Management System (SEMS) / SEMS-Archive	No	0.5	1 / 0	12/11/17
Record of Decision (ROD)	No	1.0	1	12/11/17

Federal and State List	Site Appears on List	Search Radius* (miles)	No. of Sites within Search Radius	Last Updated
Resource Conservation and Recovery Information System – Treatment, Storage, or Disposal Facilities (RCRAInfo-TSDF)/RCRIS Corrective Action Activity (CORRACTS)	No	0.5 / 1.0	1 / 1	12/11/17
Resource Conservation and Recovery Information System Generators (LQG/SQG/CESQG) / RCRA NonGenerators (NonGen / NLR)	No	0.25	0 / 3 / 1 / 5	12/11/17
Facility Index System/Facility Identification Initiative Program Summary Report (FINDS)	Yes	Site	NA	02/21/18
Emergency Response Notification System (ERNS)	No	Site	NA	01/16/18
State Hazardous Waste Sites (SHWS)	Yes	1.0	8	01/23/18
Solid Waste Facilities/Landfill Sites (SWF/LF)	No	0.5	0	09/17/12
Leaking Underground Storage Tanks (LUST)	No	0.5	4	08/01/17
Underground Storage Tanks (USTs)	Yes	0.25	12	08/01/17
Environmental Liens (LIENS)	No	Site	NA	NA
Engineering Controls (ENG CONTROLS)	No	0.5	1	01/23/18
Institutional Controls (INST CONTROL)	No	0.5	1	01/23/18
US Engineering Controls (ENG CONTROLS)	Yes	0.5	1	11/13/17
US Institutional Controls (INST CONTROL)	Yes	0.5	1	11/13/17
Voluntary Cleanup Program (VCP)	No	0.5	0	01/23/18
HI Brownfields	No	0.5	0	01/23/18
US Brownfields	No	0.5	0	01/19/18
HI SPILLS	Yes	Site	NA	02/16/18
HI Financial Assurance	Yes	Site	NA	12/18/17
Enforcement and Compliance History (ECHO)	Yes	Site	NA	01/13/18
Department of Defense (DOD)	No	1.0	3	12/31/05
Toxic Chemical Release Inventory System (TRIS)	No	Site	NA	12/31/16
ICIS	No	0.25	0	11/18/16
US MINES	No	0.25	5	10/29/17
Abandoned Mines	No	0.25	2	12/20/17

* The surrounding area search radius indicates the radial area (measured from the Site) for which the database review was performed.

4.1.1 National Priorities List

The USEPA National Priorities Listing (NPL), or Superfund List, is a Federal listing of uncontrolled or abandoned hazardous waste sites. The list is created from the CERCLIS database (see next subsection) and is primarily based upon a score that each site or facility receives from the USEPA's Hazard Ranking System. After a site or facility has been identified as a CERCLIS site, the USEPA conducts an assessment of the property. The ranking score associated with the degree of contamination found is one of the determinations made as to whether the site is placed on the NPL. These sites are then prioritized for possible long-term remedial action and referred to the state for further action under state programs. Delisted sites are those sites that have been deleted from the NPL when no further response is appropriate. Neither the Site nor any other facilities within a one-mile radius are listed in the Delisted NPL or Proposed NPL databases. Although the Site was not identified in the NPL database, one other facility was listed, as described below in Table 4-2.

Table 4-2: NPL Database Listing

Database Listing	Distance/Direction/ Assumed Hydraulic Gradient	USEPA ID	Comments
Pearl Harbor Naval Complex US Naval Command Pearl Harbor, HI 96860	0–1/8 mile Region	HI4170090076	NPL Status: Currently on the Final NPL. Category Description: Surface Water Adjacent to Site. Exposure Pathways: Surface Water; Soil. Substances: Polychlorinated Biphenyls, Bromodichloromethane, Ethylbenzene, Chromic Acid, Hexavalent Chromium, Mercury, Stoddard Solvent, m-Xylene, Bromacil, Diazinon, Arsenic, Dieldrin, Bis(2-ethylhexyl)phthalate, Chlordane, Chlorobenzene, DDT, trans-1, 2-dichloroethylene, Tetrachloroethene, Toluene, Trichloroethylene.

At the time of proposal for the NPL on July 29, 1991, the Pearl Harbor Naval Complex occupied at least 6,300 acres in Pearl Harbor on the Island of Oahu, Honolulu County, Hawaii. Land around the complex supports agriculture, aquaculture, industry, urban, and commercial uses. The complex consists of these major facilities: Naval Shipyard, Naval Supply Center, Naval Station, Submarine Base, Public Works Center, Inactive Ships, and Navy Magazine Lualualei Westlock Branch and Waipio Peninsula. Lands around the complex support agriculture, aquaculture, industry, urban, and commercial uses.

The Pearl Harbor Naval Complex began operation in 1901 when the Navy received an appropriation to acquire land for a naval station. After the attack by the Japanese on December 7, 1941, industrial activity at the complex skyrocketed, reaching a workforce of approximately 24,000 civilians by mid-1943. After World War II, activity declined and has fluctuated with the Navy's requirements.

In 1983, the Navy identified 30 potential hazardous waste sources within the six facilities. Subsequently, an additional source was identified. The 31 sources include unlined landfills, pesticide disposal pits, chromic acid disposal areas, PCB disposal areas, mercury-contaminated harbor sediments, leaking underground solvent tanks, waste oil facilities, and numerous other types of sources resulting from industrial activities at the complex. Six of the sources were initially evaluated, based primarily on toxicity of contaminants present, availability of waste quantity information, sampling results, affected populations, and a documented release of a hazardous substance. Many investigations have found hazardous substances, including mercury, chromium, PCBs, pesticides, trichloroethene, trans-1,2-dichloroethene, and other volatile organic compounds, in soil in the six areas, thus exposing workers on the site (less than 100) to potential contamination. Many of these chemicals have also been found at the remaining 25 areas identified to date. Tetrachloroethene was found approximately 15.2 feet below ground surface in one area.

Soils beneath the Pearl Harbor Naval Complex NPL site are permeable, facilitating movement of contaminants into ground water. Approximately 110,700 people obtain drinking water from wells within two miles of the six sources. In 1988, the Navy detected bis 2-ethylhexyl)phthalate in sediment samples taken from a National Wildlife Refuge that borders an abandoned Navy landfill. The refuge contains habitat for Federally-endangered species, as well as wetlands. Pearl Harbor and nearby portions of the Pacific Ocean contain recreational and commercial fisheries, habitat for endangered species, wetlands, and water-contact recreation areas. The volatile organic compounds in on-site soil also create a potential for gases to be released to the atmosphere. The database report indicated that in October 1992, USEPA and Navy officials were planning to negotiate a Federal Facilities Agreement under CERCLA Section 120 to cover future activities at the site; however, no further information was provided.

Based on the mapping of the Pearl Harbor Naval Complex NPL site presented in the database report, a portion of the Animal Quarantine Station Site appears to fall within the confines of the NPL site; however, given the extensive size of the NPL site and distance of the Site from the Pearl Harbor Naval Complex, it is unlikely that there are any immediate impacts to the Site.

4.1.2 SEMS/SEMS-ARCHIVE

The Superfund Enterprise Management System (SEMS) tracks hazardous waste sites, potentially hazardous waste sites, and remedial activities performed in support of USEPA's Superfund Program across the United States. The list was formerly known as Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), renamed to SEMS by the USEPA in 2015. The list contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This dataset also contains sites which are either proposed to or on the National Priorities List (NPL) and the sites which are in the screening and assessment phase for possible inclusion on the NPL. The SEMS-ARCHIVE list tracks sites that have no further interest under the Federal Superfund Program based on available information. The list was formerly known as the CERCLIS-NFRAP, renamed to SEMS-ARCHIVE by the USEPA in 2015.

Although the Site was not listed in the SEMS database, one other site within a 0.5-mile radius was identified. Pearl Harbor Naval Complex, described in Section 4.2.1, was identified with a discovery date of October 1, 1980 and is currently on the final NPL. Neither the Site nor any other facilities within a 0.5-mile radius appeared on the SEMS-ARCHIVE database.

4.1.3 ROD

Record of Decision (ROD) documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup. Although the Site was not identified in the ROD database, one other facility within a one-mile radius was listed. Pearl Harbor Naval Complex, which appears to encompass a portion of the subject Site, appeared in the database. EDR provided a copy of the ROD, which had been prepared for the 4th Street Coral Pit, Joint Base Pearl Harbor-Hickam West Loch Annex, Oahu, Hawaii, in October 2014. The Coral Pit was reportedly used as a historical waste disposal site for solvent cans, paint sludges, paint cans, empty transformers, acid-filled automotive batteries, and dunnage (e.g., materials such as wood used to segregate cargo and prevent shifting during transport) during World War II; remedial investigations uncovered only scrap metal, construction debris, wood waste and other inert or non-hazardous waste. In addition, groundwater contains elevated levels of metals and surficial soil contains elevated levels of arsenic, both of which are attributed to background conditions. The selected remedy was intended to prevent disturbance of the solid waste and surface soil containing arsenic, ensuring acceptable risks to human and ecological receptors. Land Use Controls (LUCs) are to be implemented as part of the remedy to limit disturbance and exposure to contaminated soil.

Based on the description of the facility in the ROD and the proposed implementation of the LUCs, it is unlikely that the subject Site will be adversely impacted by this facility.

4.1.4 RCRAInfo TSD/CORRACTS

The Resource Conservation and Recovery Act (RCRA) program identifies and tracks hazardous wastes from the point of generation to the point of disposal. The Resource Conservation and Recovery Information System (RCRAInfo) database tracks those facilities that treat, store and/or dispose of hazardous materials as defined by RCRA (referred to as TSD facilities). The RCRAInfo Corrective Action Activity (CORRACTS) database identifies TSD facilities that have conducted, or are currently conducting, corrective action(s) as regulated under RCRA.

The Site was not listed in either the TSDF or CORRACTS databases. However, one other facility within a 0.5-mile radius of the Site is listed in the TSDF database and the same facility is the only one within a one-mile radius listed in the CORRACTS database. Oahu Transit Services Inc. Hal, located at 99-999 Iwaena Street in Aiea, is located approximately 0.1 miles to the north-northwest of the Site. The database report indicates that a remedy has been constructed, and both human exposures and the migration of contaminated groundwater from this facility are controlled. Corrective action performance standards have been attained, therefore, it is unlikely that this off-site facility would have an adverse impact on the Site.

4.1.5 RCRAInfo Gen (LQG/SQG/CESQG)

RCRAInfo is the USEPA's comprehensive information system, providing access to data supporting RCRA (the Resource Conservation and Recovery Act of 1976) and the Hazardous and Solid Waste Amendments of 1984. Inclusion on the list is not necessarily indicative of contamination; rather, it indicates the presence of potential sources of contamination. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by RCRA. Conditionally exempt small quantity generators (CESQG) generate less than 100 kilograms (kg) of hazardous waste, or less than 1 kg of acutely hazardous waste per month. Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month. Large quantity generators (LQGs) generate over 1,000 kg of hazardous waste, or over 1 kg of acutely hazardous waste per month. Non-Generators (NonGen/NLR) do not presently generate hazardous waste.

Although the Site was not identified on the RCRA databases, three SQG, one CESQG and five NonGen facilities were identified within a 0.25-mile search radius of the Site. Based on the assumed hydraulic gradient, absence of reported releases or violations, and/or case status, listings for the off-site facilities are not expected to impact the Site.

4.1.6 FINDS

The Facility Index System/Facility Identification Initiative Program Summary Report (FINDS) contains facility information from several databases including the Federal Permit Compliance System Wastewater Discharges database, the USEPA Civil Enforcement Docket.

The Site was identified in the FINDS database as DOA – Animal Quarantine Station, located at 99-951 Halawa Valley Street, Aiea, with Registry ID 110069606590. The FINDS listing is simply a pointer which indicates that the Site is in the US National Pollutant Discharge Elimination System (NPDES) module of the Compliance Information System (ICIS), which tracks surface water permits issued under the Clean Water Act. Under NPDES, all facilities that discharge pollutants from any point source into waters of the United States are required to obtain a permit. The permit will likely contain limits on what can be discharged, impose monitoring and reporting requirements, and include other provisions to ensure that the discharge does not adversely affect water quality.

4.1.7 ERNS

The Emergency Response Notification System (ERNS) is a national database used to collect information on reported releases of oil and hazardous substances. The Site was not listed in the ERNS database.

4.1.8 SHWS

The State Hazardous Waste Sites (SHWS) database is a list of facilities, sites or areas in which the HEER Office has an interest, has investigated or may investigate under HRS 128D (includes CERCLIS sites). The Site was listed in the SHWS database as Halawa Animal Quarantine Station, with HID Number HID980736263 and Facility Registry Identifier 110013790424. A No Further Action Letter – Restricted Use (Document Number 2006-418-DE) was issued on July 18, 2006 for a tar-like material beneath the Vector Control Facility parking lot. Detected contaminant concentrations were all below HDOH Environmental Action Levels (EALs) and were found at a depth of 6 to 10 feet below ground surface (bgs). Maintenance staff are to conduct surface removal of the tar-like product in areas where it reaches the surface. Controls are required to manage the contamination and consist of an institutional control (i.e., Government – Hawaii Department of Health Letter issued) and engineering controls. The restrictions include: periodic removal of surface exposures of the tar-like material; no disturbance to malathion and tomato dust pit and notification and consultation with HEER Office if the tar-like material is to be excavated of if the burial pit is to be disturbed.

Eight other facilities within a one-mile radius also appeared on the SWHS database. Based on distance from the Site, case status, topographic and/or hydraulic gradient, it is unlikely that contamination from seven of these off-site facilities would have an adverse impact on the Site. Based on case status and proximity to the Site, there is a potential for contamination from one off-site facility to migrate to the Site. A release was reported at the Grace Pacific - Hawaiian Cement Parking Lot at 99-1300 Halawa Valley Street on an unspecified date. TPH-d, TPH-o, and benzo[a]pyrene were detected in soil at concentrations above the 2012 HDOH EALs for unrestricted land use in effect at the time. An assessment of the contamination is ongoing; however, the case was assigned a low priority, therefore, there appears to be no immediate concern with respect to the subject Site.

4.1.9 SWF/LF

The Solid Waste Facility/Landfill Facilities (SWF/LF) database typically contains an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites. Neither the Site nor any other facilities within a 0.5-mile radius appeared on the SWF/LF database.

4.1.10 LUST

The Leaking Underground Storage Tank (LUST) database contains an inventory of regulated USTs that have a cleanup underway. Although the Site did not appear on the LUST database, four other facilities within a 0.5-mile radius were identified. Based on the assumed hydraulic gradient, presence of a hydrologic barrier and/or closed file status, it is unlikely that any of these facilities would potentially have an adverse impact on the Site.

4.1.11 USTs

The Registered Underground Storage Tank (UST) database is a list of facilities that have USTs that are regulated under Subtitle I of RCRA. The Site appeared on the UST database as Animal Quarantine Station, Facility ID 9-101927, with a 600-gallon kerosene UST that was installed on January 22, 1971 and permanently out of use as of November 5, 1990.

In addition, 11 other facilities located within a 0.25-mile radius of the Site were identified in the UST database. Based on the assumed hydraulic gradient, presence of a hydrologic barrier, absence of documented releases, and/or closed case status, none of these facilities are expected to impact the Site.

4.1.12 LIENS

The Environmental Liens (LIENS) database is a listing of properties with environmental liens. The listing includes sites from the Site Remediation & Waste Management Program Sites. A First Priority Type Lien is placed against the property where the discharged occurred, providing that the owners of the property have some responsibility towards the discharge. The First Priority Lien is superior to other types of liens. A Non-Priority (Regular) Type Lien is placed against the Responsible Party and their revenues and all real and personal property, other than the real property comprising the location of the discharge. The Site was not listed in the LIENS database.

4.1.13 ENG CONTROLS

The ENG CONTROLS database is a listing of sites where engineering and/or institutional controls remain in place as part of a remedial action to address soil and/or groundwater contamination. These restrictions ensure protection of human health and the environment as long as they are maintained.

The Site appeared on the ENG CONTROLS database as Halawa Animal Quarantine Station and is noted to have a hazard managed with controls, with an engineering control required. As previously noted, the Site also appears in the SHWS database due to the presence of a tar-like product to a depth of 6-10 feet bgs beneath the northwest section of the Vector Control Facility (i.e., Animal Industry Division Building) parking lot. Detected contaminant concentrations were all below HDOH EALs; however, controls were required to manage the contamination. Specifically, the following engineering controls are required: maintenance staff will conduct surface removal of the tar-like product in areas where it reaches the surface. In addition, there will be no disturbance to the malathion and tomato dust burial pit; and the HEER Office will be notified and consulted if the tar-like material is to be excavated or if the burial pit is disturbed [Note: it was discovered during the course of this Phase I ESA that the pesticide burial pit was encountered and removed during construction of the Animal Industry Division Building in 1978; refer to Section 6.3]. A No Further Action Letter - Restricted Use (Document Number 2006-418-DE) was issued on July 18, 2006 for the tar-like material beneath the Vector Control Facility parking lot at the Site.

4.1.14 INST CONTROL

The INST CONTROL database is a listing of sites where engineering and/or institutional controls remain in place as part of a remedial action to address soil and/or groundwater contamination. These restrictions ensure protection of human health and the environment as long as they are maintained.

The Site appeared on the INST CONTROL database as Halawa Animal Quarantine Station and is noted to have a hazard managed with controls, with an engineering control required. As previously noted, the Site also appears in the SHWS database due to the presence of a tar-like product to a depth of 6-10 feet bgs beneath the northwest section of the Vector Control Facility (i.e., Animal Industry Division Building) parking lot. The following institutional control is required to manage contamination: Government - Hawaii Dept. of Health Letter Issued. A No Further Action Letter - Restricted Use (Document Number 2006-418-DE) was issued on July 18, 2006 for the tar-like material beneath the Vector Control Facility parking lot at the Site.

4.1.15 US ENG CONTROLS

This database is listing of sites with engineering controls in place and is maintained by the USEPA. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Although the Site did not appear in the US ENG CONTROLS database, one other facility located within a 0.5-mile radius of the Site was identified. The Pearl Harbor Naval Complex has implemented the following engineering controls for the on-site operable units (OUs):

- OUs 08 and 10 – Soil and Groundwater – No Further Action
- OU 06 – Soil – Cap, Impermeable Barrier, Operations & Maintenance

- OU 12 – Groundwater – Monitoring
- OU 12 – Soil - Impermeable Barrier, Operations & Maintenance
- OU 03 – Soil – Disposal, Excavation
- OU 01 - Debris – No Further Action
- OU 01 – Soil - No Further Action
- OU 16 – Soil and Groundwater - No Further Action
- OU 05 – Groundwater – Monitoring
- OU 05 – Soil - Impermeable Barrier, Monitoring, Operations & Maintenance, Soil Gas
- OU 05 – Surface Water – Monitoring
- OU 12 – Liquid Waste – No Further Action
- OU 17 – Soil - Cap

Based on assumed hydraulic gradient and establishment of institutional controls, this listing is not expected to have an adverse impact on the Site.

4.1.16 US INST CONTROL

This database is a listing of sites with institutional controls in place and is maintained by USEPA. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Although the Site did not appear in the US INST CONTROL database, one other facility located within a 0.5-mile radius of the Site was identified. The Pearl Harbor Naval Complex was listed with the following institutional controls:

- Land use restriction
- Groundwater use/well drilling regulation
- Access Restriction
- Building, demolition, or excavation regulation
- Deed Restriction
- Institutional Controls (Not Otherwise Specified)
- Access Restriction, Fencing
- Access Restriction, Guards
- Covenant (for Groundwater)
- Deed Notices

Based on assumed hydraulic gradient and establishment of institutional controls, this off-site listing is not expected to have an adverse impact on the Site.

4.1.17 VCP

Through the Voluntary Cleanup Program (VCP), responsible parties, developers, local officials, or individuals may work to remediate non-priority contaminated sites that pose no immediate threat to human health or the environment. The Site did not appear on the VCP database; no other facilities within a 0.5-mile radius were identified.

4.1.18 HI BROWNFIELDS

Brownfields are identified as former or current commercial or industrial use sites that are presently vacant or underutilized, on which there is suspected to have been a discharge of a contamination to the soil or groundwater at concentrations greater than applicable cleanup criteria. The Site is not listed in the HI Brownfields database. No other facilities within a 0.5-mile radius of the Site are listed in the HI Brownfields database.

4.1.19 US BROWNFIELDS

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. The Assessment, Cleanup and Redevelopment Exchange System (ACRES) stores information reported by USEPA Brownfields grant recipients on brownfields properties assessed or cleaned up with grant funding, as well as information on Targeted Brownfields Assessments performed by USEPA Regions. Neither the Site nor any other facilities within a 0.5-mile radius were identified in the US BROWNFIELDS database.

4.1.20 HI SPILLS

The SPILLS database includes releases of hazardous substances to the environment reported to the HDOH, HEER Office since 1988. The Site was listed in the SPILLS database as an orphan site, Livestock Quarantine Station, with Case Number 19951012 for a release of 30 gallons of non-PCB transformer oil. The final result was reported as an SOSC [State On-Scene Coordinator] NFA.

4.1.21 HI Financial Assurance

This is a listing of financial assurance information for underground storage tank facilities that is maintained by the HDOH. Financial assurance is intended to ensure that resources are available to pay for the cost of closure, post-closure care, and corrective measures if the owner or operator of a regulated facility is unable or unwilling to pay. The Site was listed in the Hawaii Financial Assurance database as Animal Quarantine Station, with Facility ID 9-101929 and Tank ID R-1. The tank status is listed as permanently closed and a letter of credit is reported as the type of financial assurance.

4.1.22 ECHO

The USEPA Enforcement and Compliance History Online (ECHO) database provides integrated compliance and enforcement information for regulated facilities nationwide. The Site was listed in the ECHO database as DOA – Animal Quarantine Station (FRS ID 110069606590); however, this database is just a summary of enforcement and compliance action. The database indicated a violation of the Clean Water Act, Case number HI-IU0104870001, which was assessed a state/local penalty of $465,000 for an Administrative Compliance Order dated March 9, 2017. It was reported that this violation is associated with an overflow of the on-site wastewater treatment facility.

4.1.23 DOD

This list consists of federally owned or administered lands, administered by the Department of Defense (DOD), that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands. Although the Site was not listed in the DOD database, three other facilities within a one-mile radius were identified. These include the Aliamanu Military Reservation; Pearl Harbor Naval Station; and Red Hill Naval Supply Center.

The Red Hill Naval Supply Center is located immediately south of the Site and a 3.47-acre portion of that facility is used by the HDOA for the Animal Quarantine Station operations and is considered part of the Site. According to the Department of the Navy, its property is currently part of an environmental investigation for potential contamination from a former oily waste disposal site on Navy property. This investigation will be conducted by the Navy under its Environmental Restoration Program. The Navy ordinarily completes any required investigation and remediation prior to conveyance, unless a deferral is approved by the Navy and processed. If a deferral is required by the State and approved by the Navy, proposed use of the property for new OCCC development would require DAGS and PSD to acknowledge that there is potential subsurface contamination, rights for access shall be reserved to the Navy to conduct the future investigation/monitoring/environmental remediation and maintenance, and the State shall agree to adhere to the potential future "Land Use Control" requirements (Navy's) at the site. Development by the State on the Navy portion of land may be delayed while the environmental activities are ongoing. Layout of the proposed new OCCC facilities on the Animal Quarantine Station site will consider these environmental requirements.

4.1.24 TRIS

The State Toxic Release Inventory System (TRIS) identifies facilities that release toxic chemicals to the air, water and land in reportable quantities. The Site was not listed in the TRIS database.

4.1.25 ICIS

The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program. The Site is not listed in the ICIS database; no other facilities within 0.25 miles are listed.

4.1.26 US MINES

The database contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information. Although the Site did not appear in the US MINES database, five other facilities within 0.25 miles were listed. These listings are not underground mines in the typical sense of the word but, rather, are stone quarries, stone and cement plants, and construction companies with permits for portable crushers. Based on location and/or status, it is unlikely that these off-site listings would have an adverse impact on the Site.

4.1.27 Abandoned Mines

This database is an inventory of land and water impacted by past mining (primarily coal mining) and is maintained by U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement (OSMRE) to provide information needed to implement the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The inventory contains information on the location, type, and extent of abandoned mine lands impacts, as well as information on the cost associated with the reclamation of those problems. The inventory is based upon field surveys by State, Tribal, and OSMRE program officials. It is dynamic to the extent that it is modified as new problems are identified and existing problems are reclaimed. Although the Site did not appear in the US MINES database, two other facilities within 0.25 mile were listed. Based on the descriptions as portable surface facilities operated by construction companies, these listings are unlikely to impact the Site.

4.2 Proprietary Database Reviews

EDR maintains databases that contain sites of potential environmental concern that are not necessarily included in standard government records. A summary of the sites identified through the EDR proprietary databases review is presented in Table 4-3.

Table 4-3: EDR Proprietary Records

EDR Proprietary Record Source	Site Appears on List	Search Radius*	No. of Sites within Search Radius	Last Updated
EDR Manufactured Gas Plants	No	1.0 mile	0	NA
EDR Historical Auto Stations	No	0.125 mile	0	NA
EDR Historical Cleaners	No	0.125 mile	0	NA

* The surrounding area search radius indicates the radial area (measured from the Site) for which the database review was performed.

The following subsections provide a discussion of the databases reviewed, as well as sites identified within the search radius and listed in Table 4-3.

4.2.1 EDR Manufactured Gas Plants

The Manufactured Gas Plant Database, a proprietary EDR database, includes records of coal gas plants. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination. The Site was not listed in this database, and no other sites within a one-mile radius were identified.

4.2.2 EDR Historical Auto Stations

The EDR Historical Auto Stations Database includes selected national collections of business directories and listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include gas station/ filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station and service station. The Site was not listed in this database, and no other sites within a 0.125-mile radius were identified.

4.2.3 EDR Historical Cleaners

The EDR Historical Cleaners Database includes selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry, etc. The Site was not listed in this database, and no other facilities within a 0.125-mile radius were identified.

4.3 Additional Environmental Record Sources

Additional state and local records sources were investigated in an attempt to supplement information obtained through review of standard environmental record sources. The additional records and sources consulted in conjunction with the Phase I ESA and updates are listed below. Copies of correspondence to and received from any of these record sources are included in Appendix K.

4.3.1 U.S. Environmental Protection Agency

On May 11, 2018, an online search of USEPA records was conducted in an effort to ascertain if any records were available for the Site. The following two listings for the Site were found:

- State of Hawaii Department of Agriculture - Site is identified in the Hawaii Environmental Health Warehouse (HI-EHW) as USTRAC-9-101927 in the Underground Storage Tank Program and NPDES-G-A723 with a NPDES Permit.
- DOA – Animal Quarantine Station - Site is identified in the National Pollutant Discharge Elimination System (ICIS-NPDES) with ID HIU010487 and is a Minor Unpermitted Facility. There was one formal enforcement action against the facility on March 9, 2017 (Case Number HI-IU0104870001) in violation of the Clean Water Act.

4.3.2 City and County of Honolulu

On May 11, 2018, a request for access to government records was submitted to the City and County of Honolulu in an effort to ascertain if any records were available for the Site. The City Clerk's Office has notified Louis Berger that no records are available and advised that the Department of Environmental Services may hold pertinent records. Therefore, a request was subsequently submitted to the City and County of Honolulu, Department of Environmental Services on June 15, 2018. The Department responded on the same day indicating that they do not maintain records for the Site, but the State of Hawaii Department of Health may have pertinent records. However, Louis Berger had already obtained available records from that agency.

4.4 Physical Setting

The Site occupies approximately 35 acres in the Halawa Ahupuaa, Ewa District, of Honolulu, Hawaii. The approximate coordinates of the Site are 21° 22' 17.34" North Latitude and 157° 54' 51.22" West Longitude. As previously indicated, Figure 1 is an annotated U.S. Geological Survey (USGS) 7.5-minute quadrangle map showing the Site location, local topography, drainage and cultural features.

The following subsections provide a description of the natural and physical setting of the Site and immediate vicinity. Included is information regarding topography and site drainage, the nature of the underlying geology and hydrogeology, and nearby surface waters and wetlands.

4.4.1 Topography

According to the USGS *7.5-Minute Quadrangle Series, Pearl Harbor Quadrangle, Hawaii* (USGS, 1999), the Site generally slopes toward the west-southwest with elevations ranging from 135 feet to 70 feet amsl. Storm water runoff within the Site sheet flows to on-site drain inlets which discharge to South Halawa Stream. The Site has been mostly built on fill land to support the previous urban development of the area.

4.4.2 Geology and Soils

The Island of Oahu was formed by two shield volcanoes; Koolau to the east and the older Waianae, to the west. The volcanoes are believed to have formed during the late Tertiary to early Pleistocene periods (MacDonald, Abbott, & Peterson, 1983). When the older Waianae volcano became inactive, the lava flows from the Koolau volcano covered the area between the two volcanoes, producing the broad Schofield plateau. The long expanse of the Koolau mountain range separates the windward side of Oahu to the northeast from the leeward side to the southwest. The windward side faces the prevailing tradewinds, which causes a higher degree of erosion on the northeast side of the mountain range and steeper slopes than the leeward side of the Koolau Mountain Range.

Unconsolidated noncalcareous deposits consisting of brown to reddish brown conglomerates and black to brown dense mud and alluvium can be found directly underlying the Site. These deposits are found along either side of the historic North Halawa Stream and are estimated to be up to 200 feet thick. Underlying these unconsolidated deposits is the Koolau volcanic series, which is comprised of gray blue to red and black, very dense and highly vesicular basalts. These basalts contain large phenocrysts of olivine and feldspar and were laid down in flows ranging between 10 and 80 feet thick. The total thickness of the Koolau basalts underlying the Site is estimated to be greater than 2,000 feet.

According to the U.S. Department of Agriculture (USDA) Island of Oahu, Hawaii Soil Survey Map (USDA, NRCS, 2016), soils present within the Site are suggestive of heavily disturbed contexts, with approximately 90 percent of the site consisting of Fill land, mixed (FL). FL refers to areas filled with imported material dredged from the ocean, hauled from nearby areas, and general material from other sources. The remainder of the Site, bordering the Hawaiian Cement Co. and Halawa Quarry, consist of Quarry series (QU) soils consisting of variable redistributed soils associated with modern landforms constructed by the active quarry.

4.4.3 Hydrogeology

The Site is located within the Waimalu Aquifer System (30201) in the Pearl Harbor Aquifer Sector (302). The most recent studies published in the CWRM WRPP indicate that sustainable yield for the Waimalu Aquifer System ranges from 47-77 million gallons per day. The Waimalu Aquifer System is a basal aquifer and estimates for sustainable yield represent the maximum aquifer pumping rate. The Site is also located above (farther inland) of the Underground Injection Control Line, and groundwater underlying the Site may be considered a source for drinking water. The Site lies within the boundaries of the Oahu Sole Source Aquifer. The depth to groundwater based on the Site elevation and the elevation of North Halawa Stream is estimated to be approximately 30 feet bgs, at the center of the Site and approximately 5 to 10 feet at the outer edges of the Site. The flow is assumed to be northwest towards North Halawa Stream.

4.4.4 Surface Water and Wetlands

The Site is located in the Halawa watershed, which extends from the peak of the Koolau Mountains into Pearl Harbor. There are no surface water resources within the Site. North Halawa Stream runs adjacent to the west boundary of the Site and is a freshwater, perennial stream that discharges to the East Loch of Pearl Harbor located over two miles from the Site. The perennial South Halawa Stream flows farther northeast of the Site and terminates to the southeast of the Site. The channelized portion of South Halawa Stream appears to function as an outlet for storm water drainage from adjacent residential properties located north of the stream and to the east of the Site. Halawa Stream is classified by the HDOH as an impaired waterbody, based on visual surveys conducted in 2001-2004, and Total Maximum Daily Loads (TMDLs) are being developed for this watershed.

Wetlands are defined according to hydrophytic vegetation, hydric soils, hydrology and other characteristics. The environmental database report (EDR, 2018a) indicates that no state or federally-regulated wetlands are located on the Site. According to the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (USFWS 2016), there are no mapped wetlands within the Animal Quarantine Station. The nearest mapped wetlands are seasonally flooded palustrine forested broad-leaved evergreen and intermittent riverine streambed wetlands, both associated with Halawa Stream, northwest of the Site boundary. A field survey of the Site was conducted on June 5, 2017 at which time no wetlands or waters of the U.S. were identified within the Site boundaries.

4.4.5 Flood Hazard Area

According to the National Flood Insurance Program (NFIP) Flood Insurance Rate Map (FIRM), the Site is designated as Zone X, which is defined as outside of the 0.2-percent annual chance (500-year) flood zone.

Zone X is a designation where there is no perceived flood impact. Therefore, the NFIP does not regulate any development with a Zone X designation.

4.5 Historical Use Information on the Site

The examination of the Site history was completed through the review of historical aerial photographs, historical Sanborn Fire Insurance Maps and historical topographic maps. A description of the Site history is presented in the following sections.

4.5.1 Aerial Photographs

Louis Berger obtained historical aerial photographs from EDR (EDR, 2018c) for the years 1952, 1968, 1975, 1978, 1985, 1992, 2000, and 2006 (refer to Appendix D). Louis Berger also reviewed online historical aerials for the years 1965, 2001, and 2005 at www.historicaerials.com.

- 1952: Northeastern end of Site and surrounding area to the northeast and south are disturbed. Land to the east and west are undeveloped. Construction appears to be ongoing on Halawa Valley Street on the northeastern side of the Site, as well as on the Site buildings. Although there are structures visible in the location of the current corrals, they are different in configuration than the present structures. There is one building and three building foundations in the vicinity of the current visitor/employee parking lot and the H-3 highway has not yet been constructed. The Animal Industry Division building is not present and its location is undeveloped. Although the current Environmental Health Division buildings have not been constructed, there are other structures in the vicinity. There is a cleared area in the southwestern portion of the Site, which appears to be used for parking. There is an access road from a road to the southwest of the Site, as well as two internal access roads within the Site. A stream can be seen along the southern and northern/northwestern Site boundaries.
- 1965: The completed building previously noted in the location of the current parking lot is still present but now has an adjoining parking lot to the immediate north along Halawa Valley Street. The northeastern end of the Site is disturbed and the pattern of disturbance appears similar to the quarry activities occurring to the northeast across Halawa Valley Street. Elsewhere, the majority of the property is undeveloped, although a few building footprints appear to remain in the northwestern side of the Site.
- 1968: A central portion of the Site has been improved with kennels. The main site access road has been constructed in an east-west direction across the southern one-third of the Site and to the south of the kennels. An elevated water tank is located in the northeastern section of the Site. A small building with an adjoining parking lot is present in the southwestern corner of the Site.
- 1975: There has been additional development at the Site, with an increased number of kennels at the eastern side of the Site, and the maintenance shop and buildings constructed to the west and south. The area to the east of the maintenance shop is an asphalt-paved parking lot. The extreme eastern and northwestern ends of the Site remain vacant.
- 1978: No significant changes observed except that a roadway appears to the present to the south of the maintenance shop.

- **1985**: The Animal Industry Division building and adjoining parking lot to the south have been constructed in the northwestern section of the Site.
- **1992**: The elevated H-3 highway has been constructed and bisects the Site is a northeast-southwest direction. Kennels and buildings, as well as the water tower, have been removed from the central portion of the Site in an apparent attempt to accommodate the construction of the highway. Kennels are now present in the southeastern end of the Site and have been extended to the east and south of the maintenance area, where the previous roadway is no longer present. The Animal Quarantine Station building has been built to the east of the maintenance area in the former parking lot. The structures to the immediate west of maintenance area have been removed, as have all the buildings on the western end of the Site, with the exception of the Animal Industry Division building. However, the corrals are now present in the northwestern corner of the Site, and the visitor/employee parking lot is in its current location beneath the elevated H-3 highway.
- **2000:** No significant changes observed.
- **2005:** No significant changes to Site; however, the five Environmental Health Division buildings have been constructed to the immediate northwest.
- **2006:** No significant changes observed.

4.5.2 Fire Insurance Maps

Louis Berger obtained a Sanborn Fire Insurance Map Report for the Site from EDR (EDR, 2018d); however, the Animal Quarantine Station is an unmapped property (refer to Appendix E).

4.5.3 Historical Topographic Maps

Louis Berger obtained historical topographic maps of the Site from EDR (EDR, 2018b) for the years 1928, 1953, 1954, 1959, 1968, 1970, 1983, 1998, and 2013. The historical topographic maps are included in Appendix F and summarized below.

- The Site appears to be vacant and undeveloped in the 1928 map and is located in the Ewa District. A perimeter roadway is present and an unimproved roadway traverses the Site from southwest to northeast. Two streams are located at the Site, and the Honolulu Plantation Company railroad borders the property to the north. There is only partial coverage of the southern portion of the Site in 1953. No significant changes can be discerned at the Site; however, there is now a Naval Reservation to the immediate south, as well as two additional, large Naval Reservations, Allamanu and Tripler Hospital, further south.
- By 1954, the Site is identified as a Naval Reservation. Although there is still an unimproved roadway present, it is now oriented in a different alignment. Two structures are depicted on the western side of the Site and one structure on the north. One of the streams is no longer shown on the map; however, the waterbody on the southern portion of the Site, South Halawa Stream, is still present. In addition, the North Halawa Stream flows along the northwestern property boundary. In the surrounding area, a quarry is depicted to the northeast, and a residential development, Halawa Heights, appears to the northwest.

- In 1959, there is additional development shown at the Site, with approximately 11 buildings present. The buildings are generally clustered in the northwestern portion of the Site. The southeastern, southwestern and southern sections of the parcel are depicted as wooded on the map. No other significant changes are shown at the Site or surrounding area.
- By 1968, there are only four structures, including a water tower, at the Site. An improved roadway bisects the Site in an east-west direction, with an additional perpendicular road providing access to the northwestern portion of the Site. In the surrounding area, Foster Village has expanded and is located to the southwest of the Site. Sewage disposal facilities are identified to the west and east of the Site. Building configurations change over the review period; however, there are no significant changes until the 1983 map, when the South Halawa Stream is no longer depicted on-site and the 1998 map, when the H-3 is observed to bisect the Site in a northwest-southeast direction. Except for a water tank, all buildings and structures are situated on the west side of H-3.
- In the surrounding area, the Oahu Maximum Security Prison is present to the east of the Site in the 1983 map and undergoes further development, as shown in the 1998 map. That map also shows expanded quarry operations to the northeast of the Site.
- The 2013 map shows only roadways and surficial features, but does not show individual structures. H-3 bisects the Site, as previously described, while Halawa Valley Street borders the northern half of the Site. The North Halawa Stream flows near the northern and northeastern Site boundaries, while South Halawa Stream is now to the southeast of the Site. The quarries are no longer identified to the northeast.

4.5.4 Recorded Land Title and Lien Records

Land title records and lien records are discussed in Sections 3.1 and 3.2. There were no environmental liens or other activity and use limitations found for the Site. The Chain of Title report and the Environmental Lien Search Report are provided in Appendices H and I, respectively.

4.5.5 Local Street Directories

City Directories identify historical land uses at the Site and adjacent area, as well as potential areas of environmental concern by listing the tenants at each address. Louis Berger requested a search of city directories for the Site and surrounding area from EDR in order to identify historical land uses that may have involved hazardous substances and petroleum products (EDR, 2018e). The sources of the information provided in the city directory report are as follows: EDR Digital Archive (1992, 1995, 2000, 2005, 2010, and 2014). The Site (99-941 and 99-951 Halawa Valley Street) appeared in the City Directory Report as shown in Table 4-4 while the City Directory Report is included in Appendix G.

4.5.6 Local Building Permit Records

EDR performed a search of building permit records available from the Honolulu City/County Department of Planning and Permitting for the period 1971 to 2018 in an effort to provide additional information on the environmental condition of the Site (EDR, 2018f). EDR was able to locate only electrical permits for the Site; there were no records of environmental concern for the Site or adjacent properties (Appendix J).

Table 4-4: City Directory Report

Listing(s)	Source	Year
Agriculture Hawaii Department	EDR Digital Archive	2010, 2014
Agriculture Hawaii Department, Henry Sandoval, Less Snack Shop, Naki Lespaul Kauka	EDR Digital Archive	2005
Agriculture Hawaii Department	EDR Digital Archive	2000
Animal Quarantine Station, Sandoval, Henry, Vanarsdel, K	EDR Digital Archive	1995
Animal Quarantine Station	EDR Digital Archive	1992

4.6 Historical Use Information on Adjoining Properties

Information on history of adjoining properties was obtained through a review of historical sources. The area surrounding the Site is urban in nature. Surrounding properties appear to have historically consisted of quarry, industrial or warehouse operations, along with major transportation arteries. No filling stations, auto repair facilities, or dry cleaners were identified in the vicinity of the Site.

4.7 Previous Reports

Louis Berger reviewed previous reports that had been prepared in an attempt to determine the environmental condition of the Site. Many of the reports were provided by the HDOH HEER Office subsequent to a meeting in December 2017. A brief summary is presented below.

Memorandum, Charles K. Yasuda, Head Division of Plant Industry from Stanley M. Tanaka, Supervisor, Weed-Pesticides Branch, re Pesticide Disposed at Animal Quarantine Station, dated July 26, 1976

Summary of the memorandum:

- 1975 – Department approved request to dispose, by deep burial, old and degradable pesticides at Site
- Buried in 8-foot trench [Note: this was later described as a cube] in isolated area at Mauka [inland] end of the Animal Quarantine Station property–malathion, rotenone, captan, diuron, dalapon, atrazine, Sulphur, naled, diazinon.
- Pesticides were decomposing; containers were corroding and contents were spilling or leaking
- No acceptable incinerator in Hawaii or approved local sanitary landfill for pesticides.
- Pesticides had been stored at the Animal Quarantine Station for several years.
- Deep burial in soil of degradable pesticides in isolated area away from underground water source deemed acceptable disposal method.

Letter from USEPA to Governor Ariyoshi, dated September 8, 1976

In response to the letter of August 6, 1976 regarding disposal of chemicals at the Animal Quarantine Station, USEPA noted that the action taken by HDOA appears to be in accordance with the agency's Regulations for Acceptance and Recommended Procedures for Disposal and Storage of May 1, 1974, and Proposed Pesticide Disposal and Storage Regulations of October 15, 1974.

An enclosed map depicted the burial pit area at the terminus of a road, with a parking lot to the right and kennels and an office to the left along the road prior to the burial pit area. The road was marked as coming off the Halawa Crusher Road. There were no other markings to identify which specific parking lot or office were in the vicinity of the burial area.

Memorandum from Hector Matsuda and Dean Yoshizu, Pesticides Inspectors, to Dr. Po-Yung Lai, Acting Chief, Pesticides Branch, dated March 18, 1980

The memorandum was prepared to document the findings of a site inspection of the HDOA Animal Quarantine Station at Halawa as a follow-up to a referral list by Keith Tanaka, dated January 14, 1980. The inspectors were met by Mr. Robert Gould, assistant superintendent. A summary of the site inspection follows:

- Location of the pesticide burial area was made in consultation with Stanley Tanaka, former Pesticides Supervisor and USEPA Inspector.
- Quantity of pesticides disposed of was approximately 2.5 feet in height; disposed into 7-foot underground cube which was refilled with soil aggregate that was subsequently compacted.
- No river or water well was located in the vicinity of the burial area; however, a 75,000-gallon water tower was noted to be approximately 150 yards to the southwest.
- The actual pesticides that were disposed of could not be recalled; however, storage of pesticides included three 55-gallon steel drums of Rtu 10% DDT and six 55-gallon drums of 10% DDT.

Memorandum from Hector Matsuda, Pesticides Inspector, to Dr. Lyle Wong, Chief, Pesticides Branch, re Summary of Disposal Site Inspections, dated May 1, 1980

The memorandum notes that the HDOH-Vector Control Branch [i.e., Animal Industry Division building] has an adequate storage and disposal facility; however, any spills may result in a hazardous situation due to the presence of a stream that runs about 25 feet along the back of the building. The HDOA Animal Quarantine Branch was identified as having no pesticide issues because unwanted pesticides had been disposed of by burying them in a 7-foot cubic hole on their grounds in accordance with USEPA Regulations.

U.S. Environmental Protection Agency Region 9, Toxics & Waste Management Division, Superfund Programs Branch, Preliminary Assessment, November 25, 1983

Summary of this document is as follows:

- Site is identified as Halawa Animal Quarantine Station located at 99-770 Moanalua Road.
- Owner is identified as State of Hawaii DLNR and operator is State of Hawaii DOA.
- Disposal site is inactive; quarantine station is still in use.

- Unknown quantities of pesticides (malathion and tomato dust) are buried in pit below ground.
- Three 55-gallon steel drums of Rtu 10% DDT and six 55-gallon drums of 10% DD are stored above ground.
- Inspection conducted on March 6, 1980 found that pesticide burial does not pose a hazard to the environment at that time. Burial was in accordance with USEPA regulations for acceptance and recommended procedures for disposal of pesticides. No further action recommended.
- Drums of 10% DDT were disposed of via UNITEK Environmental Services; therefore, waste DDT is no longer stored at the Site.

Contact Report between Daniel Chang, Department of Health and Charles Middleton, Department of Agriculture, Animal Quarantine Manager, December 28, 1983

This report documents a telephone conversation between Mr. Chang and Mr. Middleton in which Mr. Chang contacted Mr. Middleton to request information regarding the Site since the HDOH was conducting a Preliminary Assessment under the RCRA 3012 program. Of note, Mr. Chang was seeking information regarding the buried pesticides at the Site. Mr. Middleton indicated that a 7' x 7' x 2' hole was made using a backhoe, the pesticides were placed into the pit and then covered. The pesticides, of an unknown quantity, were reportedly biodegradable. Mr. Middleton also stated that the 10% DDT had been shipped to Oregon for disposal by a contractor.

Contact Report between Daniel Chang, Department of Health and Charles Middleton, Department of Agriculture, Animal Quarantine Manager, December 29, 1983

This report documents a site visit to the Halawa Animal Quarantine Station made by Mr. Chang. He was met by Mr. Middleton and escorted to the pesticide burial area. Mr. Middleton indicated that the pesticides had belonged to the HDOA – Pesticides Branch and they had also supervised the burial. The buried pesticides primarily consisted of malathion and tomato dust. At the time of the site visit, the burial area was being used for cattle rearing and Mr. Middleton stated that it may be used for kennels in the future if the proposed H-3 highway were constructed since it would bisect the property. The pit area would not be dug up except for the installation of sewers for the future kennel facility.

Contact Report between Daniel Chang, Department of Health and J.R. Herold, UNITEK Environmental Services, December 29, 1983

Mr. Chang contacted Mr. Herold to inquire as to whether UNITEK had ever collected waste from the Animal Quarantine Station. Mr. Herold subsequently provided a copy of a manifest for 4 drums of waste DDT from the facility, which confirmed that the waste was shipped to a facility in Oregon for disposal.

Letter Report from Muranaka Environmental Consultants, Inc. to S & M Sakamoto, Inc. re New Vector Control Facility, dated September 3, 2003

This letter report was prepared to document the results of sampling of a tar-like substance that was conducted at the New Vector Control Facility, Oahu, Hawaii (i.e., Animal Industry Division building), on June 20, 2003. The substance was present on asphalt paving on the west side of the parking lot and adjacent fenced-off soil area at the facility.

Two composite samples of the substance were collected, one from the asphalt pavement in stalls number 4 and 10, and one from multiple locations in the adjacent soil to the west of the parking lot. The samples were analyzed for PCBs, TPH in gasoline, TPH in diesel, VOCs, SVOCs, and 8 RCRA metals. The sample collected from the asphalt pavement contained acetone, barium, cadmium and chromium, while the sample collected in the soil area contained barium, cadmium, chromium and lead. TCLP analysis for metals, VOCs and SVOCs was then performed on the samples and no exceedances of the USEPA's regulatory limits were detected. As a result, no special handling procedures are required for disposal of the tar-like substance.

Limited Phase I Environmental Site Assessment, Department of Agriculture, Animal Quarantine Station, 99-941 Halawa Valley Road, Aiea, Hawaii 96701, Prepared for Alpha Engineers, Inc. by Kimura International, Inc., March 25, 2004

A limited Phase I ESA was conducted at the Site (TMK No 9-9-10:46) in order to identify the source of a tar-like material that had been found at the HDOA property (i.e., at the Animal Industry Division parking lot). The substance was observed emanating up through several locations in the parking lot. The Phase I ESA was limited to identifying on-site and off-site sources located Mauka to the Site that could have released the substance.

The report indicates that the Site is owned by the State of Hawaii and occupied by the HDOA Animal Quarantine Station and the HDOH Vector Control Facility (i.e., Animal Industry Division building). The property was owned by the U.S. Navy from 1941 to 1968. The land was occupied by the US Navy in the 1940s and 1950s and historical aerial photographs from this time period show several structures on the HDOA property. However, it is not clear whether the buildings are located on the Animal Industry Division parking lot area. By 1965, the Navy had removed many of the structures and, by 1968, the State of Hawaii had acquired the land to build the HDOA facility. No structures were located in the parking lot area at this time. Prior to the construction of the HDOA facility, the elevation of the Site was approximately 70 feet amsl, but was raised to between 85 to 90 feet amsl upon construction in 1979. In the 1970s, a HDOA Disease Eradication building, USDA building and two corrals were constructed on the parking lot area, and subsequently demolished in 1999 for construction of the current Animal Industry Division parking lot.

The Kimura report states that the Site was located above an underground injection control line which suggests that groundwater beneath the Site is suitable for drinking. The nearest surface water body is the Halawa Stream, located approximately 200 feet to the west. Soil at the Site is Fill Land, mixed, which consists of dredge material from the ocean or material hauled from nearby areas or garbage and general material. Basal groundwater is a result of precipitation percolating through residual soil and permeable volcanic rock. The presence of impermeable layers such as dense lava flows, clay layers or volcanic ash may impede the downward percolation of rainwater, which then forms a perched groundwater aquifer that is not in contact with ocean salt water that saturates the soil below sea level. Recharge of the perched aquifer occurs in areas of high precipitation such as the interior mountainous regions, and groundwater then flows to the areas of discharge along the shoreline. A perched aquifer was identified to the north of the Site in the Halawa Industrial area on Iwaena Street. Hence, Kimura's focus on Mauka sources that could have released the tar-like material.

A previous investigation consisting of composite sampling of the tar-like material in June 2003 was discussed in the Phase I ESA report. The samples were analyzed for PCBs, TPH in diesel, TPH in gasoline, volatiles, semi-volatiles, and eight RCRA metals. Both samples were found to contain detectable levels of barium, cadmium and chromium. One sample had a detection of acetone while the other had a detection of lead. TCLP analyses were also conducted for RCRA metals, volatiles and semivolatiles. Barium and chromium were detected but at concentrations below the USEPA's regulatory limits.

Kimura conducted a review of public records related to the Site and surrounding properties related Mauka to the Site. The following were the findings:

- One 550-gallon fuel oil AST was formerly located at the northwest corner of the Necropsy Building. The tank was removed in 1994 upon upgrade of the incinerator and replaced with a propane tank. No known releases are associated with the fuel oil tank.
- One 600-gallon kerosene tank was identified in the UST records at the Animal Quarantine Station (99-770 Moanalua Road), Facility No. 9-101927. The tank was closed on November 5, 1990. It should be noted that this tank was reported by current facility personnel to have been a gasoline UST.
- Sixteen upgradient (Mauka) facilities with USTs were identified and Kimura noted that, although unlikely, it was possible that a release from one on those facilities (Prestressed Concrete) could have migrated to the Site.
- Six of the 16 UST facilities were identified with leaking UST cases. None of these were determined to have any potential to impact the Site.
- Three facilities, including the Site, were listed on the State of Hawaii's SITELIST database. The Site was listed due to the burial of malathion and tomato dust on the premises, which have characteristics inconsistent with the tar-like material and were, therefore, eliminated as the source. Based on distance from the Site and/or results of investigative activities, the other two facilities were also ruled out as sources.
- Several spills were identified at the Site and surrounding properties, but are unlikely to be a source due to the volume and/or type of material spilled.

A Site reconnaissance revealed that the tar-like substance was oozing from the ground at the Animal Industry Division parking lot and did not appear to be dumped on the surface. Interviews with HDOA personnel indicated that the area was previously occupied by a Quonset hut used by the federal government, as well as a cattle corral; the oozing started soon after the parking lot was paved; the area was formerly used as a dumping ground; and that during construction of the current building, the boilers used to heat up the roofing tar were located in the vicinity of the contamination and tar from the boilers spilled onto the ground and was never cleaned up.

Kimura recommended a subsurface investigation to delineate the limits of the tar-like material and to determine its source.

Subsurface Investigation, Department of Agriculture, Animal Quarantine Station, 99-941 Halawa Valley Road, Aiea, Hawaii 96701, Prepared for Alpha Engineers, Inc. by Kimura International, Inc., April 2004

This reports the subsurface investigation that was conducted to delineate the horizontal and vertical limits of the tar-like material coming out of the ground in the Vector Control (i.e., Animal Industry Division) parking lot and landscaped area west of the lot. Delineation was necessary to determine the source of the material and remediation requirements.

A total of 15 soil borings were installed around the surface release in parking stalls No. 4 and 10 to a minimum depth of 11.5 feet bgs. The product was observed in eight of 15 borings, typically at a depth of 8 feet bgs, and at a thickness of 2 feet, except in boring SB-3 where it was observed at 5.5 feet bgs and SB-11 where it extended to a depth of 11.5 feet bgs. The extent of the product was approximately 100 feet in a north-south direction, and a minimum of 30 feet in an east-west direction as delineation to the west was impeded by the limited access of the drill rig.

Four soil samples were collected at a depth of 9 feet bgs for total petroleum hydrocarbons as diesel (TPH-D) and total petroleum hydrocarbons as oil (TPH-O) analyses. Although TPH-O was present in three samples, there were no exceedances of the applicable regulatory standards. There were no detections of TPH-D in any of the samples. One product sample was submitted for TPH-D, TPH-O and semi-volatile organic laboratory analyses. TPH was detected in the heavy oil range at a concentration of 35,000 parts per million (ppm), exceeding the HDOH Tier 1 SAL of 5,000 ppm. Several SVOCs were detected but there are no applicable State or USEPA standards.

Kimura concluded that the material must have originated from an on-site source since the material did not extend off the HDOA property to the north, south or east. Based on the depth of the material, Kimura also concluded that the material must have been released between 1968 and 1969 during construction of the HDOA Animal Quarantine Station.

Based on the laboratory results, Kimura stated that there are no adverse health effects associated with exposure to the tar product; however, they provided several remediation options for addressing the material, including: 1) do nothing; 2) surface removal; 3) pressure removal, i.e., well installation with sump; and 4) excavation.

Letter from State of Hawaii Department of Health to Department of Agriculture, dated May 24, 2005, re Halawa Animal Quarantine Station, EPA Site ID: HID980736268, 99-941 Halawa Valley St, Aiea, HI, 96701, Land Use Control for On-site Pesticide Burial Pit

The letter stated that HEER reviewed the low priority status given to the Site and was providing comments. Specifically, although the pesticides (malathion and tomato dust) were disposed of in accordance with USEPA regulations in effect at the time, HEER requires that no excavation or construction work be performed near, around or in the pit. If the cover over the Site is disturbed such that contaminated soil is brought to the surface, HEER should be immediately notified.

Also attached to the letter were a number of historical records already discussed, as well as the following:

- Site Summary Report – burial of unknown quantities of malathion, tomato dust and possibly other pesticides. Exact date of burial unknown but was prior to 1977. Buried in 7x7x2 hole and covered, Conducted in accordance with USEPA Regulations in effect at the time.
- Site Screening Sheet – Site is identified as potential release to Class A groundwater or release to Class B groundwater; potential for release to surface water that provides for contact activities.

- Site Recommendation – Site determined to be Low Priority category based on malathion and tomato dust disposed in accordance with federal regulations and DDT waste taken by UNITEK.

Letter from State of Hawaii Department of Health to Mr. Ernest Y.W. Lau, State of Hawaii Department of Accounting and General Services, dated August 7, 2006, re Halawa Animal Quarantine Station, 99-941 & 99-951 Halawa Valley Street, Aiea, Hawaii, No Further Action Determination for Tar-Like Material Beneath Vector Control Facility Parking Lot

This letter indicated that the Hawaii Department of Health (HDOH) Hazard Evaluation and Emergency Response (HEER) Office had reviewed the 2004 Limited Phase I Environmental Site Assessment, the 2004 Subsurface Site Investigation, and the 2003 sampling report for the tar-like material beneath the Vector Control (i.e., Animal Industry Division) parking lot, and did not believe that the material posed a risk to human health or the environment and, therefore, the material may be left in place at the Site. DAGS' request to leave the material in place and conduct surface removal and disposal as necessary was deemed acceptable to the HEER Office. No additional investigative or remedial work was required. However, it was noted that HEER may require additional work if new information becomes available regarding the risks of the material. Also, DAGS is required to notify HEER should they decide to excavate and remove the material.

Archaeological and Architectural Surveys of Potential Sites for the New Oahu Community Correctional Center, Oahu, Hawaii, October 18, 2017

Louis Berger completed archaeological and architectural surveys of four sites on the island of Oahu which were identified as potential locations for the proposed OCCC facility, including the Animal Quarantine Station in Halawa. In accordance with the Historic Preservation Review as outlined in HAR 13-275, the study was intended to identify any significant or previously recorded archaeological or architectural resources (properties) in the project area.

The report indicates that Halawa was primarily used for cattle ranching and plantation agriculture in the mid-1800s. In 1899, the Oahu Railway and Land Company (OR&L) was introduced along the coast of Halawa. As a result, sugar cane cultivation now began in the Halawa Valley since there was a means of transporting the cane to the mills. The area near the Animal Quarantine Station was reportedly undeveloped sugar cane fields. In the first half of the 20th century, Halawa Valley underwent extensive changes as Pearl Harbor became a focus for military and urban development. A new transportation network, consisting of both roads and railroads, was constructed, improving access to the Site and its environs. The property associated with the Red Hill facility was acquired and operated by the U.S. military for training purposes in the early 1900s. By the early 1950s, the Red Hill Military Reservation and the quarry were significant features in the vicinity.

An archaeological desktop survey indicated that the landscape at the Animal Quarantine Station Site appeared to be significantly disturbed by historic agricultural activities and by H-3 construction activities. Previous archaeological surveys in the vicinity had identified a number of sites within one mile of the subject Site, including family shrines, walls, terraces and terrace complexes, house platforms, cave shelters, burial caves, etc. No new sites were identified at the Animal Quarantine Station during an inspection of the ground surface. The report also notes that a concrete pillar stored in the maintenance area of the facility was reportedly moved from the site of a Shinto shrine on King Street in Honolulu; however, the original purpose and location of the pillar have not been determined.

Recommendations included no further archaeological survey, but monitoring during OCCC construction.

5.0 SITE RECONNAISSANCE

Ms. Fameeda Ali and Mr. Robert Nardi of Louis Berger conducted a reconnaissance of the Site on May 7, 8 and 10, 2018. The Site reconnaissance focused on evidence of spills, staining, ASTs, USTs, hazardous waste storage and illegal waste disposal practices, and previous environmental investigations such as monitoring wells and boreholes. The weather was clear skies with a temperature of approximately 75°F. Photographs of the Site are included in Appendix A.

5.1 Methodology and Limiting Conditions

Observations by Louis Berger were limited to surficial conditions and what could be readily seen during the Site inspection. Except for the eastern portion of the Maintenance Building which was locked, the entire Site was accessible for inspection.

5.2 General Site Setting

The Animal Quarantine Station Site has been developed with over 1,600 dog animal kennels (most are not in use), nine cat buildings, administrative and support structures, maintenance and storage buildings, a livestock corral, and vehicle parking areas. The few undeveloped areas within the overall property consist of a large pasture devoted to horse and cattle grazing, grassed areas for small animal use, and vacant areas located on the periphery of the property. An elevated portion of the H-3 Freeway bisects the Site from southwest to northeast.

The surrounding neighborhood is largely industrial in nature with the Hawaiian Cement Company located to the north, industrial warehouses to the east, HDOA livestock and research facilities to the west, and U.S. Navy property and facilities comprising the Red Hill storage facility to the south.

5.3 Observations

Observations of the site reconnaissance are summarized below.

5.3.1 Animal Quarantine Station Office and Kennels

The Animal Quarantine Station is situated to the east of the elevated H-3 Freeway and occupies the majority of the Site that is proposed for redevelopment with the new OCCC. It contains a 1-story concrete building with a public service desk, offices, dispensary, break room, locker rooms, restrooms, janitor's closet, kitchen with coolers, washer and dishwasher, hot water heater room, store room, and garage, with an adjoining asphalt-paved parking lot to the north. The store room is located on the eastern end of the building and is used for paper records, as well as the storage of Tide laundry detergent, Dawn dishwashing liquid, and small quantities of pump oil and Testrox chemical removator (for lime, rust and scale). All items were neatly stored and there was no evidence of spills or stains. The hot water heater room is located off the kitchen on the western end of the building and was used by the janitor for the storage of cleaning supplies and chemicals such as bleach. Once again, all chemicals were neatly stored and there was no evidence of releases. The garage on the east end of the building was observed to contain a number of electric charging station for the carts used throughout the Animal Quarantine Station. Also present were four 5-gallon containers of disinfectant stored directly on the concrete floor. No spills were observed in the vicinity. A small area adjacent to the main garage also held two containers and a spray bottle of disinfectant. Two empty poly drums were observed to the rear of the garage and are used to store water for emergency use, according to Ms. Mary Tashiro, Quarantine Station Operations Supervisor. A propane tank is present on the northwestern exterior of the Animal Quarantine Station office and is utilized for the hot water heater. It was reported by Ms. Tashiro that the facility formerly had small hot water heaters at the grooming stations but those have since been removed. An animal waste grinder is located at the southwestern exterior of the building.

The Animal Quarantine office building is generally surrounded by kennels of varying sizes for animals which did not meet the quarantine requirements for animals entering the State of Hawaii. The animals are kept on-site for up to 120 days. Similar to the MWR area, the kennels are arranged in rows with concrete walkways and separated by grass areas, and there are grooming areas in select locations. There are four different sizes of dog kennels, while cats are housed in a cattery. The majority of kennels are currently unused, and some of the kennels on the northern side of the property are in a state of disrepair and surrounded by overgrown vegetation. Several kennels near the approximate center of the southern half of the Animal Quarantine Station area were used to store a lawn mower, tires, tools and supplies, spray bottles, gasoline containers, and recycling containers for metal cans. Other kennels in each row were used for storage of food supplies and bleach, and in some instances, consumer-size spray cans of wasp and hornet killers. There was no evidence of spills or staining in the Animal Quarantine Station area.

5.3.2 U.S. Army Morale, Welfare and Recreation (MWR)

The MWR area is located on the eastern end of the Site and provides boarding services for U.S. Army personnel pets. The MWR area contains 200 kennels, of which approximately 100 to 125 are occupied with dogs and/or cats at a given time. In addition to the kennels, there are offices and a break room, as well as grooming areas. Five-gallon buckets of bleach and small quantities of cleaning supplies and petroleum products (e.g., lubricants) were observed in the MWR area. Concrete walkways and grass strips are present between the rows of kennels.

A gravel parking lot is located outside of the fenced kennel area in the extreme east. An asphalt-paved walkway leads from the parking lot to the office and breakroom. Just south of the parking lot, and near the property fence, is a wooded area containing the remains of bee hives which were formerly kept in this location, as well as a pile of vegetative waste.

The northern half of the area is occupied by a fenced-in, abandoned caretaker’s cottage. The grounds of the residence were observed to contain several piles of miscellaneous waste, including tires, metal debris, and corroded, compressed gas cylinders. Immediately west of the residence, beyond the fence, kennels are present; however, a number of discarded appliances and other waste was observed in this area. This includes approximately ten refrigerators, vegetative waste, plastic and metallic waste, other home appliances, and an abandoned automotive seat. To the immediate south of the residence is an unused grooming station, as well as two abandoned washers and office equipment.

5.3.3 HDOA Maintenance Building

The HDOA Maintenance Building is a U-shaped 1-story building located in the southern portion of the Site and east of H-3. Mr. George DeMesillo, a long-time member of the HDOA maintenance staff, provided information related to the Maintenance Building. The structure contains covered, fenced-in bays; covered, open bays; and completely enclosed rooms. The western side of the building is utilized by the Animal Quarantine Station, while the eastern side is utilized by the Plant Quarantine Dog Detection Branch. At the time of the Site inspection, the rooms on the eastern side of the building were locked and inaccessible for inspection.

The two northernmost bays (one fenced and one not) on the western side were used for vehicle parking, as well as for storage of a variety of miscellaneous items, including the following:

- Tire piles (stored until there is large enough quantity to recycle)
- Three 55-gallon drums (one of which was labelled "waste oil") on a spill containment pallet, in addition to used filters and apparent oil change-related equipment
- Two 55-gallon drums on a wood pallet
- Approximately six small compressed gas cylinders
- Approximately one dozen chargers
- Cabinet containing small quantities of antifreeze, silicone spray, cleaners, lubricants, air compressor oil, and tools
- Recirculating Zep parts cleaner and 30-gallon drum of Zep Dyna 143 cleaner. Mr. DeMesillo noted that he has not yet had to change the solvent in the parts cleaner.
- Household appliances such as a washer and mini refrigerators; compressor and other miscellaneous equipment, some of it appearing old and discarded.
- A gasoline underground storage tank and pump with dispenser were formerly located just outside the fenced bay. The tank and other equipment were removed and an asphalt patch is clearly visible.

The western interior of the "U" was used for storage of tires, spray cans, metal, and small quantities of chemicals. The southern portion of the Maintenance Building contained two parked vehicles, a forklift, and an ATV with a charging station. A number of paints, adhesives and roof coatings were stored on a wooden pallet in the southeastern corner of this area. Also present in this area were wooden pallets containing miscellaneous metal parts, grease cans, etc. A number of discarded appliances and pieces of mechanical and other equipment were observed in the eastern interior of the "U". These included refrigerators, washers, hot water heaters, an air compressor, and scaffolding. The interior of the U was asphalt-paved and no spills or releases were observed. Booms were noted around a catch basin; however, it was reported that these were placed to prevent trash from entering, rather than to address a spill.

The northernmost bays on the eastern side of the structure contained several trailers, plumbing equipment, tires, paints, wire fencing, lumber, PVC piping, a forklift, and other miscellaneous equipment, as well as a parked car. Minor staining of the asphalt pavement was noted in the open area adjacent to the parked car and is likely attributable to automotive fluids.

The western interior of the Maintenance Building was also inspected. The western side of the Maintenance Building is used by Mr. DeMesillo for carpentry, plumbing and electrical operations. He performs maintenance activities (e.g., oil changes) on small equipment such as saws, lawn mowers and weed trimmers. Used oil is stored in drums in the exterior bay (as observed by Louis Berger) until there is sufficient volume to request a pick-up by an outside contractor. Mr. DeMesillo noted that automotive oil changes were formerly done on-site but that practice was discontinued and those oil changes are now done off-site. He also indicated that he is not aware of any spills at the Site in the 10 years that he has been employed there.

Small quantities of petroleum products and other chemicals were stored inside the Maintenance Building, including grease, thinner, cleaners, silicone spray, wood finish, paints, oils, bleach. Various tools and other equipment relevant to maintenance operations were also stored in the building. In general, all items were neatly stored and there was no evidence of spills or releases.

5.3.4 Hawaii Department of Land and Natural Resources

The Hawaii Department of Land and Natural Resources (DLNR) occupies a small area on the Site that is partially located under the elevated H-3 Freeway. The area is concrete-paved and is utilized for vehicle and other equipment parking. A trailer is present on the northeastern side of this area and appears to be used for office purposes. Piles of miscellaneous waste were observed on the eastern side of the DLNR space, and consisted of construction materials, household appliances, tires, and a number of filled garbage bags. No evidence of spills or staining was observed.

5.3.5 Large Animal Handling/Holding Facilities and Pasture

There is an asphalt-paved driveway leading to nine corrals used for handling and holding cattle and other large animals in the northwestern corner of the Site. Immediately to the south and southwest is a large pasture for the animals. The majority of the pasture lies to the west of the elevated H-3 Freeway; however, a small portion extends beneath the highway. The area beneath the highway appears to have been recently reworked as bare soil was exposed. The pasture is bounded to the west by an access road, beyond which is the Animal Industry Division building.

5.3.6 Hawaii Department of Agriculture, Animal Industry Division

The HDOA Animal Industry Division is located on the extreme western end of the Site and is housed within the 1-story Kanahoahoa Building at 99-941 Halawa Valley Street. It consists of the following: Administration; Veterinary Laboratory; Animal Disease Control Branch; and Aquaculture and Livestock Support Services. This building has also been identified as the Vector Control Facility in some of the project records. This building will not be affected by the proposed project; therefore, it was not entered and the interior was not inspected. A loading dock is present on the western side of the building and a pad-mounted electrical transformer is located along the northern exterior wall. An asphalt-paved parking lot is situated to the south of the building and a viscous, tar-like material (described earlier) was observed in several locations along the western edge of the lot.

5.3.7 Other Areas

Parking for Animal Quarantine Station: A large asphalt-paved parking lot is located under the elevated H-3 Freeway and provides visitor and employee parking for the Animal Quarantine Station. The lot was in good condition and no evidence of releases or staining was observed. The area to the north of the lot is undeveloped and grassy.

North-central Area: An undeveloped area near the north-central border of the Site is used for disposing of vegetative waste associated with grounds maintenance. No environmental concerns were observed.

Eastern Area: A shallow concrete-lined drain is present along the eastern Site boundary, which discharges to an approximately 15-foot deep concrete channel on the adjoining U.S. Navy property to the south. There was minor dumping observed in the drain, which was primarily dry, but no signs of releases or staining were evident.

A water tank, likely associated with the nearby Menehune Water Company at 99-1205 Halawa Valley Street, is located adjacent to the eastern end of the Site. A pump house for the associated tank and pump controls is situated within the Site, but was locked and could not be inspected. Both features would not be affected by OCCC development.

Necropsy Facility: A necropsy facility/incinerator is situated in the southwestern corner of the Site. It is located west of the elevated H-3 Freeway and will not be affected by the proposed OCCC redevelopment; therefore, the interior was not inspected.

Wastewater Treatment Facility: A wastewater treatment facility is situated in the southwestern corner of the Site. It is located west of the elevated H-3 Freeway and will not be affected by the proposed OCCC redevelopment; therefore, the interior was not inspected.

Department of Public Safety, Sheriff's Division Canine Training Center: The PSD Sheriff's Canine Training Center is located within the northern half of the Animal Quarantine facility, just east of the elevated H-3 Freeway and immediately north of the main site access road. Based on the Site observations, it was evident that the kennels in this area had not been used for an extended period, and there was an overgrowth of vegetation.

Under Elevated H-3 Freeway: The north-central border of the Site under the H-3 Freeway was inspected and found to contained several piles of waste, including two severely corroded and leaking drums containing a white powder, tires, glass and plastic bottles, and wood and metal debris.

Hawaii Department of Transportation (HDOT) Right-of-Way (ROW): The HDOT ROW is located along the southern Site boundary, just south of the maintenance area, and contains two structures. One is a caretaker's cottage and the other appeared to be an abandoned building. The kennels to the immediate east of these buildings are used by the U.S. Department of Agriculture (USDA) Plant Protection and Quarantine (PPQ) Dog Detection and Customs and Border Patrol (CBP) Dog Detection units.

HDOH Environmental Health Services Division: There are five buildings in the Environmental Health Services Division located to the immediate northwest of the Site. These buildings are situated within the Animal Quarantine Station site, but are outside the scope of this Phase I ESA. The Environmental Health Services Division consists of the following:

- Building A – Administration

- Building B – Food Safety and Vector Control Branch
- Building C – Indoor and RAD Health Branch
- Building D – Maintenance
- Building E – Warehouse

These buildings were of relatively new construction and, apart from the presence of a pad-mounted electrical transformer outside of Building C, there was no evidence of potential concerns that could impact the subject Site.

5.4 Surrounding Properties

The Site is situated in an area characterized by industrial land uses. Surrounding properties to the north and northeast include Hawaiian Cement Oahu Concrete and Aggregate Division (99-1300 Halawa Valley Street); Grace Pacific Halawa Hot Mix Asphalt Plant (99-1300 Halawa Valley Street); and B and C Trucking Co., Ltd. (99-1200 Halawa Valley Street, AST and drums of grease observed, all in secondary containment). To the immediate east is Nordic PCL Construction (99-1285 Halawa Valley Street, a general contractor) and industrial warehouses with occupants including Menehune Water (99-1205 Halawa Valley Street); Pacific Rim Packaging, Inc. (99-1267A Waiua Place); Bubbie Ice Cream (99-1267 Waiua Place); Blue Hawaii Drafting Services, Inc. and Quality Design/Build, Inc. (99-1255C Waiua Place); T-shirts Hawaii.com (99-1275 Waiua Place); Pint Size Hawaii (99-1287 Waiua Place); Industrial Building for lease (99-1295 Waiua Place); Stan's Contracting Inc. (99-1280 Waiua Place); Pacific Building Envelop, Inc., Beta Construction LLC, Aquariums Hawaii and Moana Technologies LLC (99-1255 Waiua Place); Hawaii Judo Academy and Transpac Group (99-1245 Waiua Place, fuel dispenser observed); General Wax & Candle Company (99-1225 Waiua Place); and Propulsion Controls Engineering (99-1221 Halawa Valley Street). To the southwest of the Site is a HDOT facility. The Red Hill Naval Supply Center is located to the immediate south. The land to the northwest of the Site, across Halawa Valley Street, is wooded and undeveloped.

6.0 INTERVIEWS

Louis Berger inquired as to the availability, for interviews, of past owners, operators, and occupants of the Site who were likely to have material information regarding the potential for contamination at the Site. Louis Berger also provided Owner Questionnaires to representatives of HDOA, HDOT, DLNR and U.S. Navy for completion with copies of the completed questionnaires included in Appendix K. A response from the HDOT is pending.

Before and during the site reconnaissance, Louis Berger team members discussed the property, logistics of the site inspection, and asked questions regarding the Animal Quarantine Station facility and grounds.

6.1 Interviews with Owner

Hawaii Department of Land and Natural Resources

Information provided by Ms. Patti Miyashiro of the DLNR for TMK 9-9-010:054; 9-9-010:057; and 9-9-010:058 is summarized below.

- Site is currently used for animal quarantine, animal welfare and general commercial purposes (parcels 54, 57 and 58) and has been used for this purpose since June 26, 1965. Prior use is unknown.
- DLNR assumed ownership of the Site on October 16, 1964 from the United States of America.
- It is unknown whether asbestos-containing materials and lead based paint are present on the Site.
- No information on file as to whether the Site has ever been used as a gasoline station, automotive repair, commercial printing, dry cleaning, photo-developing, junk/scrap yard, landfill, waste treatment storage, disposal processing or recycling facility, or for industrial or manufacturing operations.
- No information on file as to chemical, paint, pesticide or damaged/discarded automotive/industrial battery storage on the Site.
- No information on file as to waste generation or disposal activities at the Site.
- No information on file as to fill material placement on-site.
- No information on USTs and ASTs at Site.
- Unknown whether spills or remediation have occurred at the Site.
- Unknown whether there are wells, recharge basins, retention basins or holding basins at the Site.
- Unknown whether there are septic or cesspool systems at the Site.
- Unknown whether the Site is served by municipal water, sanitary and storm water utilities.
- Unknown whether there are wetlands or surface water bodies located on the Site.
- Unknown whether radon testing was ever conducted at the Site.
- No information on file regarding permits, enforcement actions, violations or other conditions/issues of potential environmental concern.

United States Navy

Information provided by Susan Kim, Janice Fukumoto and Janice Fukuwa of NAVFAC HI, Navy Region Hawaii for TMK 9-9-010:006 is summarized below.

- Site is currently used as the Animal Quarantine Station. In 1988, the U.S. Navy granted to State of Hawaii right of entry to construct Animal Quarantine Station. Prior to this, the property was vacant.
- The U.S. Navy assumed ownership of the property in 1941 from the Queen Emma Estates.
- It is unknown whether asbestos-containing materials, lead based paint or fluorescent lights are present on the Site.
- It is unknown whether the Site has ever been used as a gasoline station, automotive repair, commercial printing, dry cleaning, photo-developing, junk/scrap yard, landfill, waste treatment storage, disposal processing or recycling facility, or for industrial or manufacturing operations.
- It is unknown whether chemical, paint, pesticide or damaged/discarded automotive/industrial battery are stored on the Site.
- It is unknown whether waste generation or disposal activities have occurred at the Site.
- It is unknown whether fill material has been placed on-site.
- It is unknown whether USTs and ASTs are formerly or currently present at the Site.
- It is unknown whether spills or remediation have occurred at the Site.
- It is unknown whether there are wells, recharge basins, retention basins or holding basins at the Site.
- It is unknown whether there are septic or cesspool systems at the Site.
- It is unknown whether the Site is served by municipal water, sanitary and storm water utilities.
- No wetlands or surface water bodies are located on the Site.
- It is unknown whether radon testing was ever conducted at the Site.
- It is unknown whether permits, enforcement actions or violations have been issued for the Site.
- With regard to the issues of potential environmental concern, the U.S. Navy property to the south of the Animal Quarantine Station site is currently part of an environmental investigation for potential contamination from a former oily waste disposal site. This investigation will be conducted by the Navy under the Navy's Environmental Restoration Program. Proposed use of the property for OCCC development would require DAGS and/or PSD to acknowledge that there is potential subsurface contamination, grant access to the Navy to conduct future investigation/ monitoring/environmental maintenance and adhere to potential future Land Use Control actions at the site. Layout of future facilities should consider these environmental requirements.

6.2 Interviews with Site Manager

Information provided by Dr. Isaac Maeda of the HDOA Animal Quarantine Station is summarized below.

- Site is currently used as a State animal import operation and facility for dog and cat rabies quarantine. Various areas of the property have been used for this purpose for 27 to over 40 years. Prior use of the property is unknown; it was undeveloped.
- The older structures on the Site are possibly over 45 years old, while the age of the newest is 27 years.
- The current landowner assumed ownership around the 1960s; prior to this, the land was owned by the U.S. Navy.
- It is unknown whether asbestos-containing materials and lead based paint are present on the Site.
- Is aware of fluorescent light fixtures within the on-site buildings.
- A wastewater pre-treatment facility is located at the property entrance from Halawa Valley Street. There are no septic or cesspool systems at the Site.
- Is aware of chemical, paint and pesticide storage on the Site.
- Is aware that organic waste generated from animals in the kennels is generated/disposed at the Site.
- It is unknown whether unidentified waste materials, tires, batteries, etc. have been dumped, buried or burned at the Site, except for the following: possible pesticides disposed by burying in oubliette.
- Is aware of fill material on the Site in the form of clean soil/stone.
- Is not aware of any USTs at the Site; there are three propane ASTs (125 gallons, 500 gallons, and 2,000 gallons) at the Site that were installed between the 1980s and 1992. A water tower tank was previously present at the Site approximately between the 1970s and the 1990s.
- There have been no spills associated with the ASTs at the property and no remediation has ever been conducted at the Site.
- No wells are located at the Site.
- No recharge basins, retention basins or holding basins are present.
- The Site is served by municipal water, sanitary and storm water utilities.
- No wetlands or surface water bodies are located on the Site.
- It is unknown whether radon testing was ever conducted.
- The following permits have been issued for the Site: NPDES Permit S000088, 2012 (no longer required by HDOH); City and County of Honolulu, Industrial Wastewater Discharge Permit 20182247289, May 2018-May 2023.
- The following enforcement actions/violations have been issued for the Site: Yes, City and County of Honolulu, Notice of Order, March 21, 2017, and Notice of Violation, October 5, 2016; HDOH, Notice of Violation and Order, 2/27/2017. Listed Notices and Order relating to incident of wastewater spill

into stream August 2016. HDOA has taken corrective actions and a wastewater facility Capital Improvement Plan (CIP) project is in process.

- No other potential areas of environmental concern were identified apart from the pesticide disposal by burial.

6.3 Interviews with Occupants

During the Site reconnaissance on May 10, 2018, Mr. Harrison Hoe, a maintenance worker at the HDOA Animal Quarantine Station, was interviewed by Louis Berger personnel. Information provided by Mr. Hoe is presented below and an affidavit signed by Mr. Hoe is included in Appendix K.

Mr. Hoe has been an employee of the HDOA for 47 years. During approximately 1975, he was present when pesticides were disposed of at the Animal Quarantine Station in a location in the western-most portion of the property. An excavation was made and a concrete bunker was installed, within which 55-gallon drums of pesticides were placed. The bunker was then filled with concrete and covered with soil. The pesticides were buried in this location because it was not expected that the land would be developed.

In 1978, the bunker containing the pesticides was uncovered during construction activities for the present HDOA Administration Building (i.e., Animal Industry Division Building) on the western side of the Animal Quarantine Station property, west of the present H-3 Freeway. The concrete bunker and pesticides contained within were excavated at that time, disposed of, and the HDOA Administration Building subsequently constructed on the former location of the concrete pesticide bunker.

6.4 Interviews with Local Government Officials

There were no interviews with local government officials performed for this Phase I ESA Report. As noted in Section 4.3.2, a written request for public records was submitted to the City and County of Honolulu and no pertinent records were available.

7.0 FINDINGS

Louis Berger has completed a Phase I ESA for the Animal Quarantine Station site. The Site comprises approximately 35 acres distributed across several TMK parcels in Halawa Valley (TMK: 9-9-010:054, 9-9-010:057, 9-9-010:058, 9-9-010:006, 9-9-010:046). The majority of the site, located at 99-951 Halawa Valley Street in Honolulu (Halawa Ahupuaa, Ewa District), is owned by the State of Hawaii (Hawaii Department of Land and Natural Resources is the fee title owner) and operated by the Hawaii Department of Agriculture (HDOA). An additional 3.47-acre portion is owned by the U.S. Navy which has granted HDOA a right-of-entry to use the parcel as part of the operation of the Animal Quarantine Station.

The entire 35-acre property has been subject to this Phase I ESA (the Site). The Site is situated within a highly developed area of Halawa with surrounding properties occupied by industrial and quarry operations, warehouse facilities, and major transportation arteries. This Phase I ESA was conducted in general conformance with ASTM Standards related to the Phase I ESA process. The Phase I ESA was based on a Site inspection, a review of available files and historical records, and the findings of an environmental database report. Based on the data obtained, RECs, HRECs, CRECs, and other environmental concerns were identified, as presented below, and depicted on Figure 3.

7.1 Recognized Environmental Conditions

Based on the data obtained through the course of this Phase I ESA, the following REC was identified at the Site:

- Two severely corroded and leaking drums containing a white powder were observed on the north-central edge of the Site under the elevated H-3 Freeway.

7.2 Historical Recognized Environmental Conditions

Based on the data obtained through the course of this Phase I ESA, the following Historical Recognized Environmental Conditions (HRECs) were identified at the Site:

- In 1975, the HDOA sought and received permission from the USEPA to dispose of an unknown quantity of old and degradable pesticides (primarily malathion and tomato dust, possibly others) by burial on the Site. The pesticides were disposed of in a 7-foot concrete cube in an undeveloped area of the Site and the USEPA subsequently confirmed that the disposal was performed in accordance with its Regulations for Acceptance and Recommended Procedures for Disposal and Storage of May 1, 1974, and Proposed Pesticide Disposal and Storage Regulations of October 15, 1974. In a letter dated May 24, 2005, the HDOH HEER Office stated that no excavation or construction work must be performed near, around or in the pesticide burial pit and if the cover over the Site is disturbed such that contaminated soil is brought to the surface, HEER should be immediately notified. However, in an interview with a long-time HDOA employee, Mr. Harrison Hoe, in May 2018, it was learned that the pesticides were buried on the western side of the Site in a concrete bunker and the bunker and pesticides were removed and disposed of in 1978 during construction of the HDOA Animal Industry Division building. The building is constructed over the location of the former pesticide bunker.

Animal Quarantine Station Site

Sources:
ESRI BING Imagery Service, obtained 2018.

June 2018

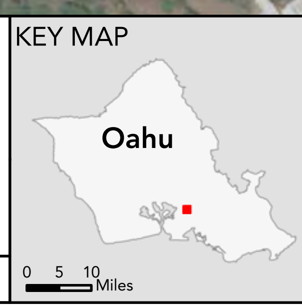


Figure 3
Recognized Environmental Conditions and Other Environmental Concerns
Future Oahu Community Correctional Center

State of Hawaii
Department of Public Safety

N
0 150 300 Feet

- The Site was listed in the SPILLS database with Case Number 19951012 for a release of 30 gallons of non-PCB transformer oil. The final result was reported as an SOSC [State On-Scene Coordinator] No Further Action.
- An enforcement action was filed against the facility on March 9, 2017 (Case Number HI-IU0104870001) in violation of the Clean Water Act. The violation was associated with an overflow of the on-site wastewater treatment facility and a state/local penalty of $465,000 was assessed. According to Dr. Maeda, HDOA has taken corrective actions and a wastewater facility CIP project is in process.

7.3 Controlled Recognized Environmental Conditions

Based on the data obtained through the course of this Phase I ESA, the following Controlled Recognized Environmental Condition (CREC) was identified at the Site:

- A tar-like material has been discovered emanating up from the western edge of the Animal Industry Division parking lot, as well as the nearby soil. Previous investigative activities revealed the presence of the substance to depths of 11.5 feet bgs, with horizontal extents of 100 feet in a north-south direction, and a minimum of 30 feet in an east-west direction. Although TPH was detected in the product, no risks to human health or the environment are anticipated, therefore, the material can be left in place with controls. The HDOH, HEER Office issued a No Further Action Letter – Restricted Use (Document Number 2006-418-DE) on July 18, 2006. Controls are required to manage the contamination and consist of an institutional control (i.e., HDOH Letter issued) and the following engineering controls: maintenance staff will conduct surface removal of the tar-like product in areas where it reaches the surface and the HEER Office will be notified and consulted if the tar-like material is to be excavated.

7.4 Other Environmental Concerns

Based on the data obtained through the course of this Phase I ESA, the following other environmental concerns were identified at the Site:

- The U.S. Navy property to the south of the Animal Quarantine Station site is currently part of an environmental investigation for potential contamination from a former oily waste disposal site. This investigation will be conducted by the Navy under the Navy's Environmental Restoration Program. Proposed use of a portion of TMK 9-9-010-006 for the OCCC relocation would require DAGS and/or PSD to acknowledge that there is potential subsurface contamination, grant access to the Navy to conduct future investigation/monitoring/environmental maintenance and adhere to potential future Land Use Control actions at the site. Layout of future facilities should consider these environmental requirements.
- Drums of waste oil are stored on spill containment and wooden pallets at the maintenance shop.
- Small quantities of disinfectants, bleach, cleaners, lubricants, paints, grease, petroleum products and various other chemicals are stored at the Animal Quarantine Station office building, MWR area and the HDOA Maintenance Building. In general, the materials were neatly stored and there was no evidence of significant spills or staining.

- Waste piles containing tires, compressed gas cylinders, discarded household appliances, wood and metal debris, and construction materials were observed in several locations throughout the Site, including the abandoned caretaker's cottage and northeastern section of the property, north-central edge of Site under elevated H-3 Freeway, and DLNR area in the western-central portion of the Site.

8.0 OPINION

Based on the findings of this ESA, it is Louis Berger's opinion that sampling of the drum contents to facilitate proper removal and disposal of the drums and contents, as well as sampling of the soils in the vicinity of the drums for evaluation of impacts, is warranted at the Site as described in Section 9.0.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Louis Berger has completed a Phase I ESA for the Animal Quarantine Station site comprising approximately 35 acres distributed across several TMK parcels in Halawa Valley (TMK: 9-9-010:054, 9-9-010:057, 9-9-010:058, 9-9-010:006, 9-9-010:046). The majority of the site, located at 99-951 Halawa Valley Street in Honolulu (Halawa Ahupuaa, Ewa District), is owned by the State of Hawaii and operated by HDOA. This Phase I ESA was conducted in general conformance with ASTM Standards related to the Phase I ESA process. The Phase I ESA was based on a Site inspection, a review of available files and historical records, and the findings of an environmental database report.

9.1 Recognized Environmental Conditions

Based on the data obtained during the Site inspection, subsequent regulatory agency records review, and interviews with persons familiar with the Site and its history, the following REC was identified at the Site:

- Two severely corroded and leaking drums containing a white powder were observed on the north-central edge of the Site under the elevated H-3 Freeway. Louis Berger recommends removal and off-site disposal of the drums and their contents, along with waste characterization analysis to facilitate proper disposal. Sampling of the soil beneath and in the vicinity of the drums is recommended to evaluate whether there have been any impacts from the leaking contents.

9.2 Historical Recognized Environmental Conditions

Based on the data obtained through the course of this Phase I ESA, the following HRECs were identified at the Site:

- In 1975, the HDOA sought and received permission from the USEPA to dispose of an unknown quantity of old and degradable pesticides (primarily malathion and tomato dust, possibly others) by burial on the Site. The USEPA has confirmed that the disposal was performed in accordance with its Regulations for Acceptance and Recommended Procedures for Disposal and Storage of May 1, 1974, and Proposed Pesticide Disposal and Storage Regulations of October 15, 1974. In a letter dated May 24, 2005, the HDOH HEER Office stated that no excavation or construction work must be performed near, around or in the pesticide burial pit and if the cover over the Site is disturbed such that contaminated soil is brought to the surface, HEER should be immediately notified. However, in an interview with a long-time HDOA employee, Mr. Harrison Hoe, in May 2018, it was learnt that the pesticides were buried on the western side of the Site in a concrete bunker and the bunker and pesticides were removed and disposed of in 1978 during construction of the HDOA Animal Industry Division building. The building is constructed over the location of the former pesticide bunker. Furthermore, the proposed OCCC development will not occur in this location, therefore, Louis Berger recommends no further action with respect to the formerly buried pesticides.
- The Site was listed in the SPILLS database with Case Number 19951012 for a release of 30 gallons of non-PCB transformer oil. The final result was reported as an SOSC [State On-Scene Coordinator] No Further Action. Therefore, no further action is recommended.

- An enforcement action was filed against the facility on March 9, 2017 (Case Number HI-IU0104870001) in violation of the Clean Water Act. The violation was associated with an overflow of the on-site wastewater treatment facility and a state/local penalty of $465,000 was assessed. According to Dr. Maeda, HDOA has taken corrective actions and a wastewater facility CIP project is in process. Therefore, no further action is recommended.

9.3 Controlled Recognized Environmental Conditions

Based on the data obtained through the course of this Phase I ESA, the following CREC was identified at the Site:

- A tar-like material has been discovered emanating up from the western edge of the Animal Industry Division parking lot, as well as the nearby soil. Previous investigative activities revealed no risks to human health or the environment are anticipated, therefore, the material can be left in place with controls. The HDOH, HEER Office issued a No Further Action Letter – Restricted Use (Document Number 2006-418-DE) on July 18, 2006. Controls are required to manage the contamination and consist of an institutional control (i.e., HDOH Letter issued) and the following engineering controls: maintenance staff will conduct surface removal of the tar-like product in areas where it reaches the surface and the HEER Office will be notified and consulted if the tar-like material is to be excavated. Based on the issuance of a No Further Action Letter, and the fact that the proposed OCCC development will not extend to this area, Louis Berger recommends no further action with respect to the tar-like material in the parking lot.

9.4 Other Environmental Concerns

Based on the data obtained through the course of this Phase I ESA, the following other environmental concerns were identified at the Site:

- The U.S. Navy property to the south of the Animal Quarantine Station Site is currently part of an environmental investigation for potential contamination from a former oily waste disposal site. This investigation will be conducted by the Navy under the Navy's Environmental Restoration Program. Proposed use of a portion of TMK 9-9-010-006 for the OCCC relocation would require DAGS and/or PSD to acknowledge that there is potential subsurface contamination, grant access to the Navy to conduct future investigation/monitoring/environmental maintenance and adhere to potential future Land Use Control actions at the site. Layout of future facilities should consider these environmental requirements. No action is recommended at this time.
- Drums of waste oil are stored on spill containment and wooden pallets at the HDOA Maintenance Building.
- Small quantities of disinfectants, bleach, cleaners, lubricants, paints, grease, petroleum products and various other chemicals are stored at the Animal Quarantine Station office building, MWR area and the HDOA Maintenance Building. In general, the materials were neatly stored and there was no evidence of significant spills or staining.
- Waste piles containing tires, compressed gas cylinders, discarded household appliances, wood and metal debris, and construction materials were observed in several locations throughout the Site,

including the abandoned caretaker's cottage and northeastern section of the property, north-central edge of Site under elevated H-3 Freeway, and DLNR area in the western-central portion of the Site.

Louis Berger recommends that all waste piles be immediately removed for off-site disposal. Drums of used oil, cleaners and other chemicals which are in current use should be properly removed from the Site prior to development activities. Sampling may be warranted if evidence of a release is observed during removal activities.

10.0 DEVIATIONS

There were no deviations from ASTM E1527-13.

11.0 ADDITIONAL SERVICES

The scope of work for this Phase I ESA did not include evaluation of potential asbestos-containing materials, radon gas, or lead-based paint. However, information related to radon gas was provided in the EDR Report (EDR, 2018a), and is therefore conveyed here. According to the USEPA website, the Island of Oahu is located in Radon Zone 3 (indoor average less than 2 picocuries per liter [pCi/L]). The scope of work for this Phase I ESA did not address other non-scope considerations, including, but not limited to:

- Wetlands protection
- Regulatory compliance
- Archaeological, cultural and historic resources
- Industrial hygiene
- Health and safety
- Ecological resources
- Air quality
- Biological agents
- Asbestos
- Lead-based paint
- Mold
- Flood hazards
- Electromagnetic fields
- Seismic hazards
- Stormwater management or drainage
- Structural engineering or integrity
- Geotechnical engineering
- Public safety
- Dam safety

12.0 REFERENCES

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13.0 SIGNATURES OF ENVIRONMENTAL PROFESSIONALS

The environmental professionals whose signatures are provided below performed and reviewed this environmental site assessment.

We declare that, to the best of our knowledge and belief, we meet the definition of Environmental Professional as defined in §312.10 of 40 CFR 312. We have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject property. We have developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in 40 CFR Part 312.

PREPARED BY: ______________________

Fameeda Ali, CHMM, ENV SP

REVIEWED BY: ______________________

Michael J. McCloskey, PG

DATE: July 5, 2018

14.0 QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONALS

Appendix B contains supporting documentation of the qualifications of the environmental professionals identified in Section 13.0.