BENJAMIN J. CAYETANO
GOVERNOR
STATE OF HAWAII

RAYNARD C. SOON
CHAIRMAN
HAWAIIAN HOMES COMMISSION

JOBIE M. K. M. YAMAGUCHI
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P.O. BOX 1879
HONOLULU, HAWAII 96805

December 8, 2000

The Honorable Genevieve Salmonson, Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Ms. Solmonson:

SUBJECT: Finding of No Significant Impact (FONSI) for Nanaikapono Subdivision Upgrade, TMK: 8-9-06 City & County of Honolulu, Island of Oahu

The Department of Hawaiian Home Lands has reviewed the comments received during the 30-day public comment period, which began on September 23, 2000. The Department of Hawaiian Home Lands has determined that this project will not have significant environmental effects and has issued a FONSI. Please publish this notice in the next OEQC Environmental Notice.

We have enclosed a completed OEQC Publication Form and four copies of the final EA. Please contact Mr. Patrick Young at 596-3918 if you have any questions.

Sincerely,

Larry Lum, Administrator
Land Development Division

2000-12-23-OA-FEA—

FINAL

Environmental Assessment for Nanaikapono Subdivision Upgrades In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06

Proposing Agency:

State of Hawaii
Department of Hawaiian Home Lands
Land Development Division
Design and Construction Branch

Accepting Authority:

State of Hawaii
Department of Hawaiian Home Lands

Prepared For:

Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

Prepared By:

Wil Chee – Planning, Inc.
1400 Rycroft Street, Suite 928
Honolulu, Hawaii 96814

December 2000

FINAL

Environmental Assessment
for
Nanaikapono Subdivision Upgrades
In Nanakuli, Oahu, Hawaii
TMK: 8 – 9 – 06

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This document is prepared pursuant to Chapter 343, Hawaii Revised Statutes

December 2000

CONTENTS

CONTENTS (continued)

APPENDICES

LIST OF FIGURES

LIST OF PLATES

ABBREVIATIONS

AC	asphaltic concrete
ATA	Austin, Tsutsumi and Associates, Inc.
BWS	(City and County of Honolulu) Board of Water Supply
DHHL	(State of Hawaii) Department of Hawaiian Home Lands
DLNR	(State of Hawaii) Department of Land and Natural Resources
DOH	(State of Hawaii) Department of Health
DOSH	(State of Hawaii Department of) Occupational Safety and Health
DOT	(State of Hawaii) Department of Transportation
DPP	(City and County of Honolulu) Department of Planning and Permitting
EA	Environmental Assessment
EIS	Environmental Impact Statement
ETI	Earth Tech, Inc.
FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impact
FWS	(U.S.) Fish and Wildlife Service
HAR	Hawaii Administrative Rules
HECO	Honolulu Electric Company
HPS	high pressure sodium
LOS	level-of-service
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
PGE	Pacific Geotechnical Engineers, Inc.
RCP	reinforced concrete pipe
SMA	Special Management Area
SHPD	State Historic Preservation Division
TMK	tax map key
V	volt
W	watt

1.0 INTRODUCTION AND SUMMARY

1.1 Overview.

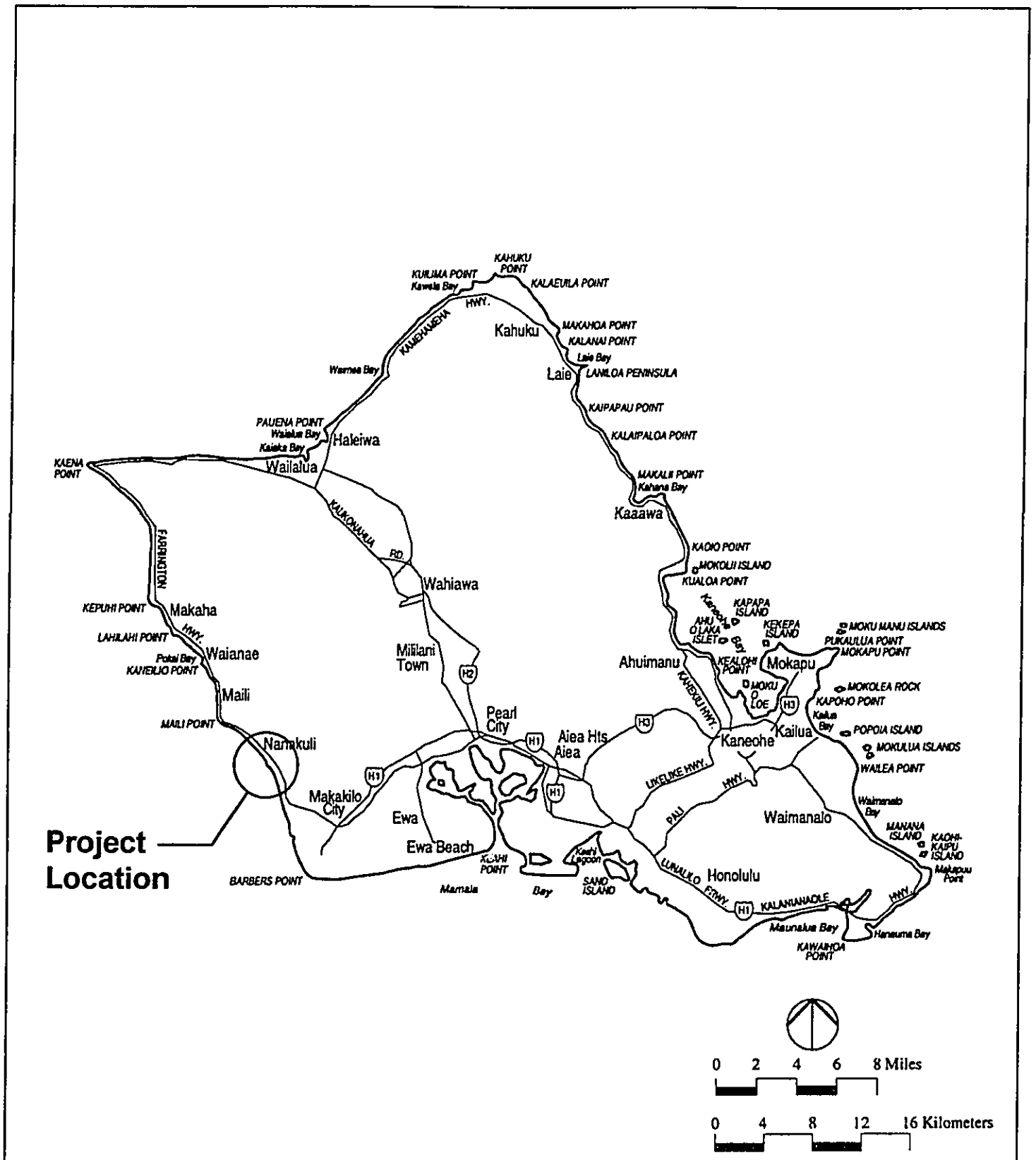
The Department of Hawaiian Home Lands (DHHL) proposes to upgrade the basic infrastructure for the property identified by Tax Map Key (TMK) 8 – 9 – 06 in Nanakuli, Oahu, Hawaii. The project area is makai or seaward of Farrington Highway in a portion of the Nanaikapono Lots (see Figures 1 and 2). Improvements shall include, but not be limited to roadway, drainage, sewer, and water systems; traffic control facilities; and overhead electrical, telephone, and street lighting systems. Completion of the project will result in infrastructure systems that conform to current City and County of Honolulu standards and requirements.

Permits must be acquired for construction-related work. The water system, sewer connection, drainage system and erosion control plan must be County approved and accepted. Acceptance of the road and utilities (particularly for maintenance) must be acquired from State and County agencies. Construction plans prepared by Austin, Tsutsumi and Associates, Inc. (ATA) indicate both State and County approval and re-approval in 1978 and 1980, respectively, of the infrastructure improvements upon which the proposed action is based. Correspondence from the Department of the Army suggests that a Department of the Army permit "will not be required for the project provided all of the drainage outlets remain above the higher high tide line." (Department of the Army, 1998).

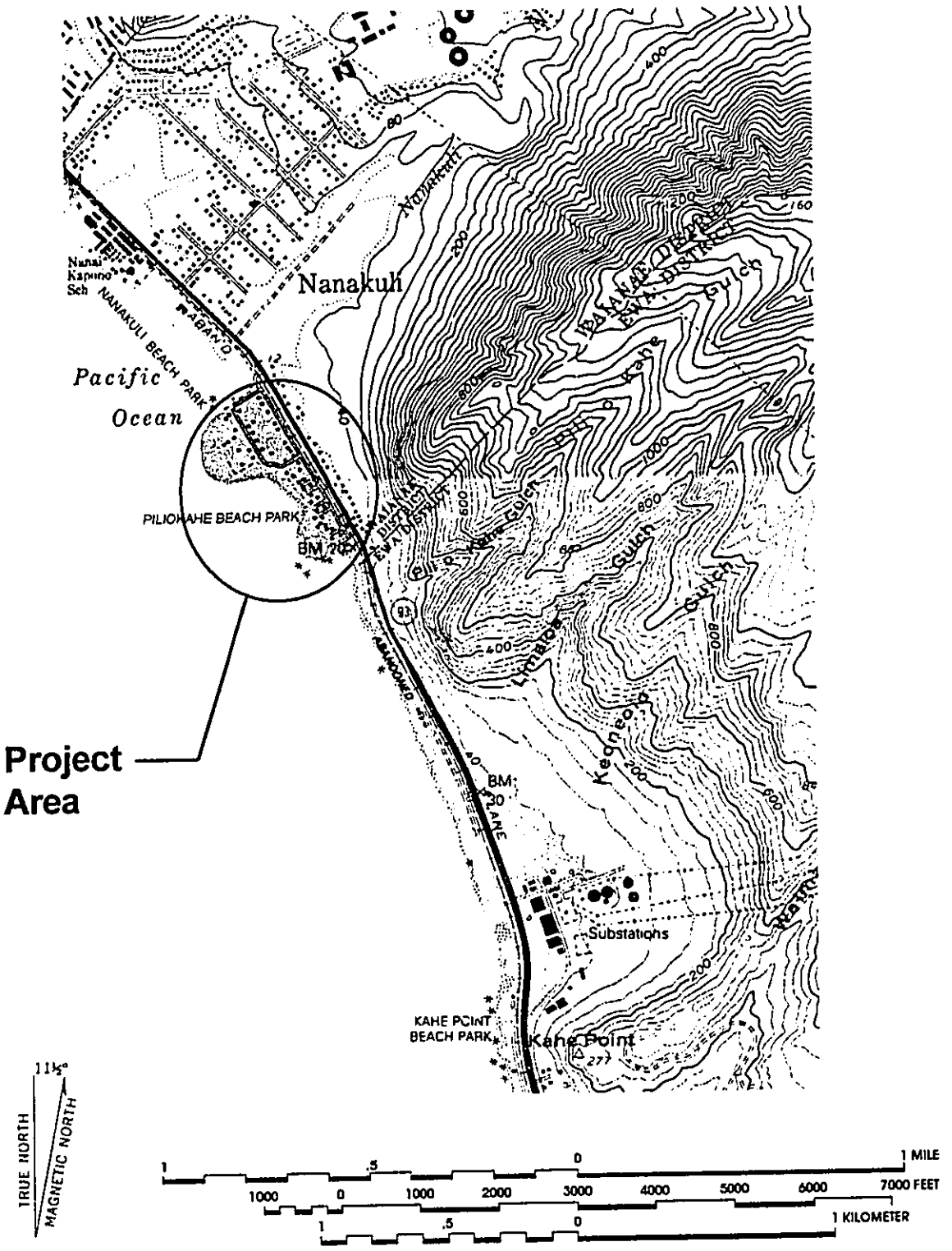
A National Pollutant Discharge Elimination System (NPDES) permit will be acquired if necessary. The type and extent of the permit depends on the Contractor's construction methods which are not known at this time. Notice of Intent (NOI) Form C for Discharges of Storm Water Associated with Construction Activity, NOI Form F for Discharges of Hydrotesting Waters, and NOI Form G for Discharges Associated with Construction Activity Dewatering may apply.

The affected property falls within a Special Management Area (SMA). DHHL may be exempt from being required to process a SMA permit. Uses within a SMA require the preparation of an Environmental Assessment (EA).

There are 52 homestead houselots within the project area. No additional homes or houselots are proposed to be added as part of the proposed action. Laumania, Pohakunui, Piliokahi and Keaulana Avenues will be upgraded to 24-foot-wide, two-lane paved roads with curbs, gutters, turn-arounds and wheelchair ramps. Driveway aprons and lot driveway adjustments and transitions will be provided as required. Traffic improvements at access points are proposed.



ENVIRONMENTAL ASSESSMENT FOR NANAIKAPONO SUBDIVISION UPGRADES In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06 prepared for: Earth Tech, Inc. 700 Bishop Street, Suite 900 Honolulu, Hawaii 96813	**Figure 1** **Location Map**	prepared by: Wil Chee – Planning, Inc.



Source: USGS, 1983.

ENVIRONMENTAL ASSESSMENT FOR NANAIKAPONO SUBDIVISION UPGRADES In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06 prepared for: Earth Tech, Inc. 700 Bishop Street, Suite 900 Honolulu, Hawaii 96813	**Figure 2** **Vicinity Map**	LEGEND AFFECTED PROJECT AREA prepared by: Wil Chee – Planning, Inc.

Completion of the project will result in adjusted and/or relocated water lines with fire hydrants and valves, new sewer lines with manholes and new drain lines with catch basins. For waterline extension, a new water line section will be installed and connected to the existing line at the intersection of Piliokahi and Pohakunui Avenues. The invert depths of the water lines will range from approximately 3 to 6 feet below existing grades.

Drainage system improvements including the box culverts previously indicated on ATA's plans have been dismissed in favor of the realignment of the system. Drain lines along Laumania and Keaulana Avenues will discharge to an outlet located within the adjacent Nanakuli Beach Park at the western end of the subdivision. Drain lines along Pohakunui Avenue (near Piliokahi Avenue) and the northeastern portion of Piliokahi Avenue will discharge to a new outlet located within the immediately adjacent Piliokahe Beach Park at the southeastern end of the subdivision. Drainage improvements will include drain lines of 18-, 24-, 30-, and 54-inch diameter reinforced concrete pipe (RCP) culverts. Invert depths for sewer and drain lines will range from approximately 4.2 to 20 feet below existing grades.

At this time, all new utility lines are proposed to be installed via conventional open-cut trenching methods. Alternately, the construction Contractor may elect to use trenchless methods to further minimize anticipated impacts generally associated with construction activities. Fire hydrants, water meters and meter boxes will be located in the road right-of-way in relation to the final curb, gutter and sidewalk. Sewer laterals with advance riser connections will provide lessees with easy and/or short hook-up routes to their plumbing. Drainage improvements will alleviate ponding in existing roads and lots. Overhead electric, telephone, and cable television equipment will be relocated as necessary.

Project actions include signalization improvements at the Piliokahi Avenue and Farrington Highway intersection. Traffic signalization improvements at the Laumania Avenue and Farrington Highway intersection are not associated with this project; these improvements are expected to be performed by the State of Hawaii Department of Transportation (DOT) under a separate project. DOT's project is expected to precede

Roadway signage and pavement markings will also be installed as part of DHHL's project. Other project features may include tree plantings along improved roadways and the removal of abandoned cars. Extant private improvements such as walls, fences, structures, buried utilities, trees, lawns and plantings that are affected by project actions will be restored to equal or better condition, replaced and/or removed with compensation to the lessee.

1.2 Scope and Authority.

This EA report is prepared pursuant to Chapter 343, HRS and associated Title 11, Chapter 200, Hawaii Administrative Rules. The intent of the EA document is to ensure that systematic consideration is given to the environmental consequences of the proposed action. A Finding of No Significant Impact (FONSI) is anticipated.

1.3 Project Information.

THE AGENCY:	The Department of Hawaiian Home Lands Land Development Division Design and Construction Branch Patrick Young (808) 586-3817
RECORDED FEE OWNER:	Hawaiian Home Lands
AGENCY'S CONSULTANT:	Earth Tech, Inc. 700 Bishop Street, Suite 900 Honolulu, Hawaii 96813 Doug Lee, Project Manager Randy Hamamoto, Project Engineer (808) 523-8874
EA PREPARER:	Wil Chee - Planning, Inc. 1400 Rycroft Street, Suite 928 Honolulu, Hawaii 96814 Claire Tom (808) 955-6088
TMK:	Zone 8, Section 9, Plat 06
PROJECT SITE AREA:	3.5± acres of roadway area within the subdivision
AGENCIES CONSULTED:	City & County of Honolulu Board of Water Supply Department of Design and Construction Department of Environmental Services Department of Parks and Recreation Department of Planning and Permitting State of Hawaii Commission on Persons with Disabilities Department of Hawaiian Home Lands Department of Land and Natural Resources Department of Transportation Office of Environmental Quality Control Office of Hawaiian Affairs

Federal Government
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service

Other Organizations
- AT&T
- GTE Hawaiian Tel
- Hawaiian Electric Company
- Hawaiian Railway Society
- Hui Malama I Na Kupuna (consulting group to DLNR)
- Malama Nanakuli Ahupua'a (consulting group to DLNR)
- Nanakuli Neighborhood Board
- Ocean Cable
- The Gas Company

ACCEPTING AUTHORITY: State of Hawaii
- Department of Hawaiian Home Lands

2.0 DESCRIPTION OF THE ACTION

2.1 Project Location.

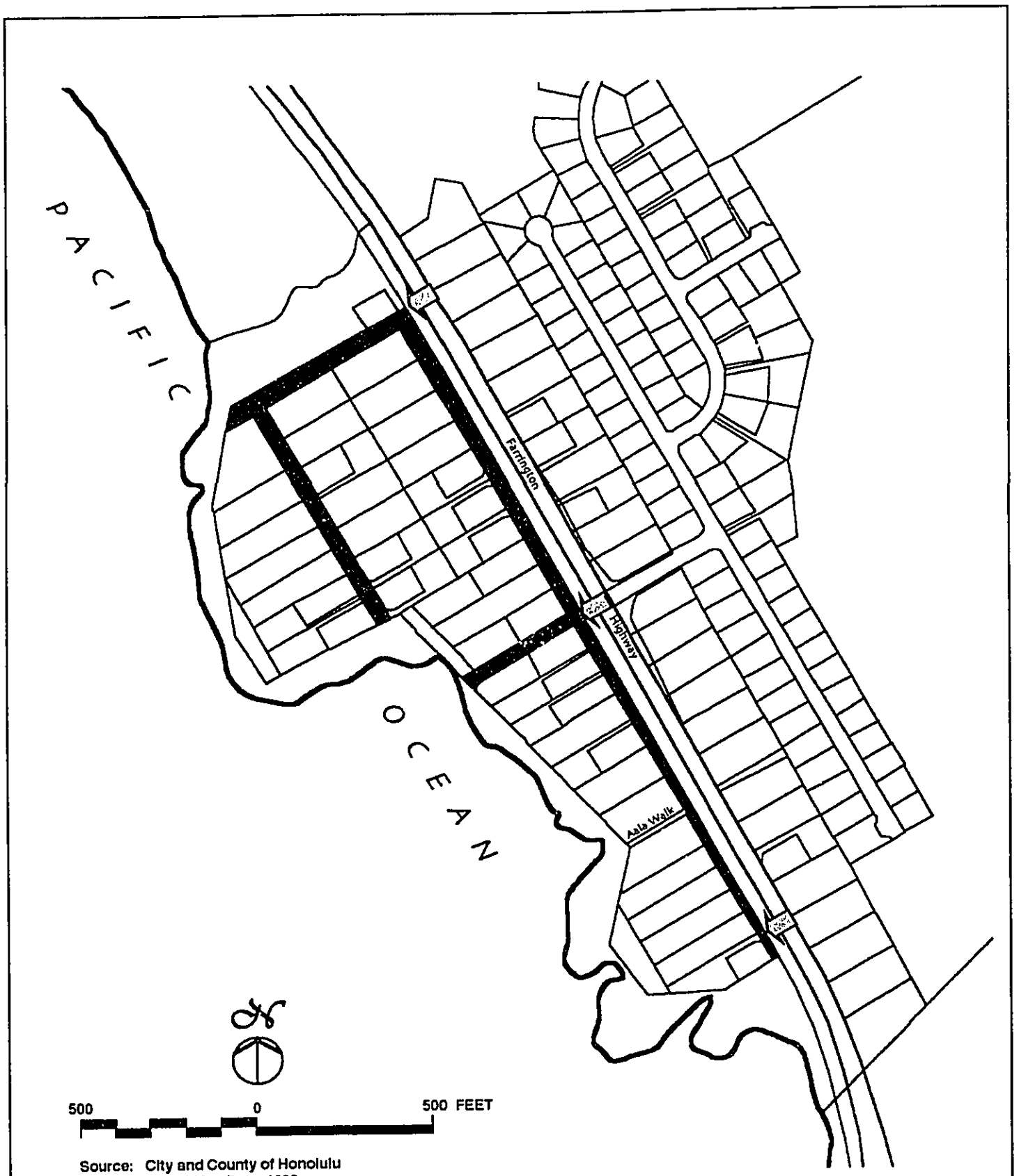
The project area is located in Nanakuli on the island of Oahu, the third largest and most populous island in the Hawaiian Archipelago. The property with government identification TMK: 8 – 9 – 06 is the portion of the Nanaikapono subdivision that lies makai of Farrington Highway and adjacent to Nanakuli Beach Park. Fifty-two (52) existing homestead houselots occupy approximately 21 acres within the project area. Laumania Avenue bounds the subdivision to the northwest. The existing U.S. Navy FORAC III Station and Nanakuli Beach Park parking lot lie adjacent to and northwest of Laumania Avenue. Pohakunui Avenue bounds the subdivision to the northeast. Railroad tracks lie between and parallel to Pohakunui Avenue and Farrington Highway. Parking and public bathrooms for Piliokahe Beach Park are southeast of the site. More than six (6) acres of State-owned Park Reserve area and the Pacific Ocean form the remaining boundaries of the subdivision. Project actions will be mostly constrained to the areas defined by the roadways within the affected subdivision: Laumania, Pohakunui, Piliokahi and Keaulana Avenues.

2.2 Project Site Description.

Laumania, Pohakunui, Piliokahi and Keaulana Avenues occupy a total area of approximately 3.5 acres based upon a 40-foot-wide road right-of-way. Existing roadways are paved, relatively flat and currently in use by area inhabitants. Laumania and Piliokahi Avenues are perpendicular to Farrington Highway; Pohakunui and Keaulana Avenues are parallel to the highway. On-site obstructions include encroaching walls, fences, structures, trees, and lawns or plantings that marginally extend into the roadway right-of-way from individual houselots.

2.3 Project Features.

The proposed action includes improvements to road, drainage, sewer, and water systems; traffic control facilities at the intersection of Piliokahi Avenue and Farrington Highway; and overhead electrical, telephone and street lighting systems (see Figures 3 through 6). Upon completion, the project will provide upgraded basic infrastructure systems within the existing subdivision that conform to current City and County of Honolulu standards and requirements.



Source: City and County of Honolulu
Digital Map Data, 1998

ENVIRONMENTAL ASSESSMENT
FOR
NANAIKAPONO SUBDIVISION UPGRADES
In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06

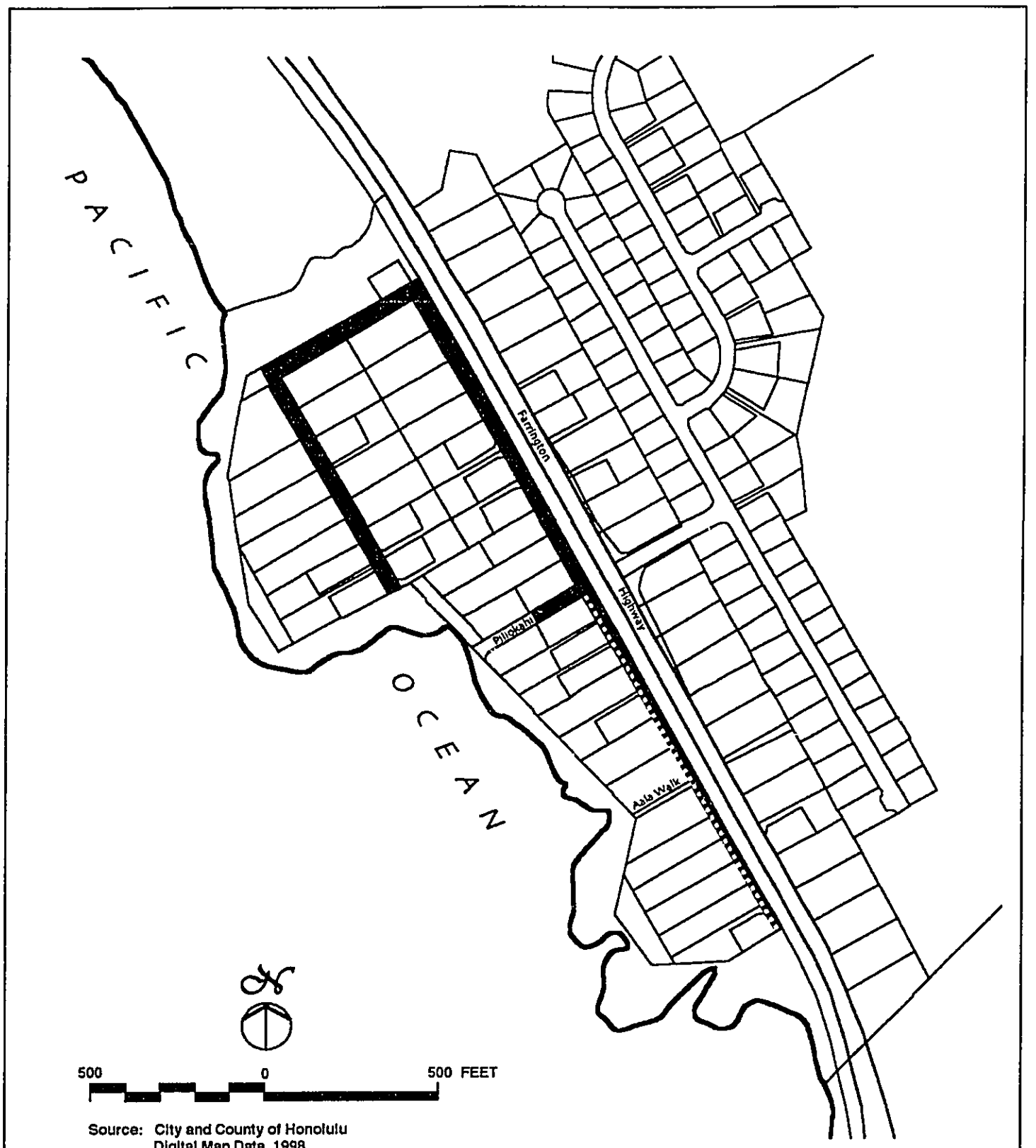
prepared for: Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

Figure 3

Project Site
Roadway Improvements

LEGEND
IMPROVED ROADWAY AREA
IMPROVED ACCESS POINTS

prepared by: Wil Chee – Planning, Inc.



Source: City and County of Honolulu
Digital Map Data, 1998

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Honolulu, Hawaii 96813

Figure 4

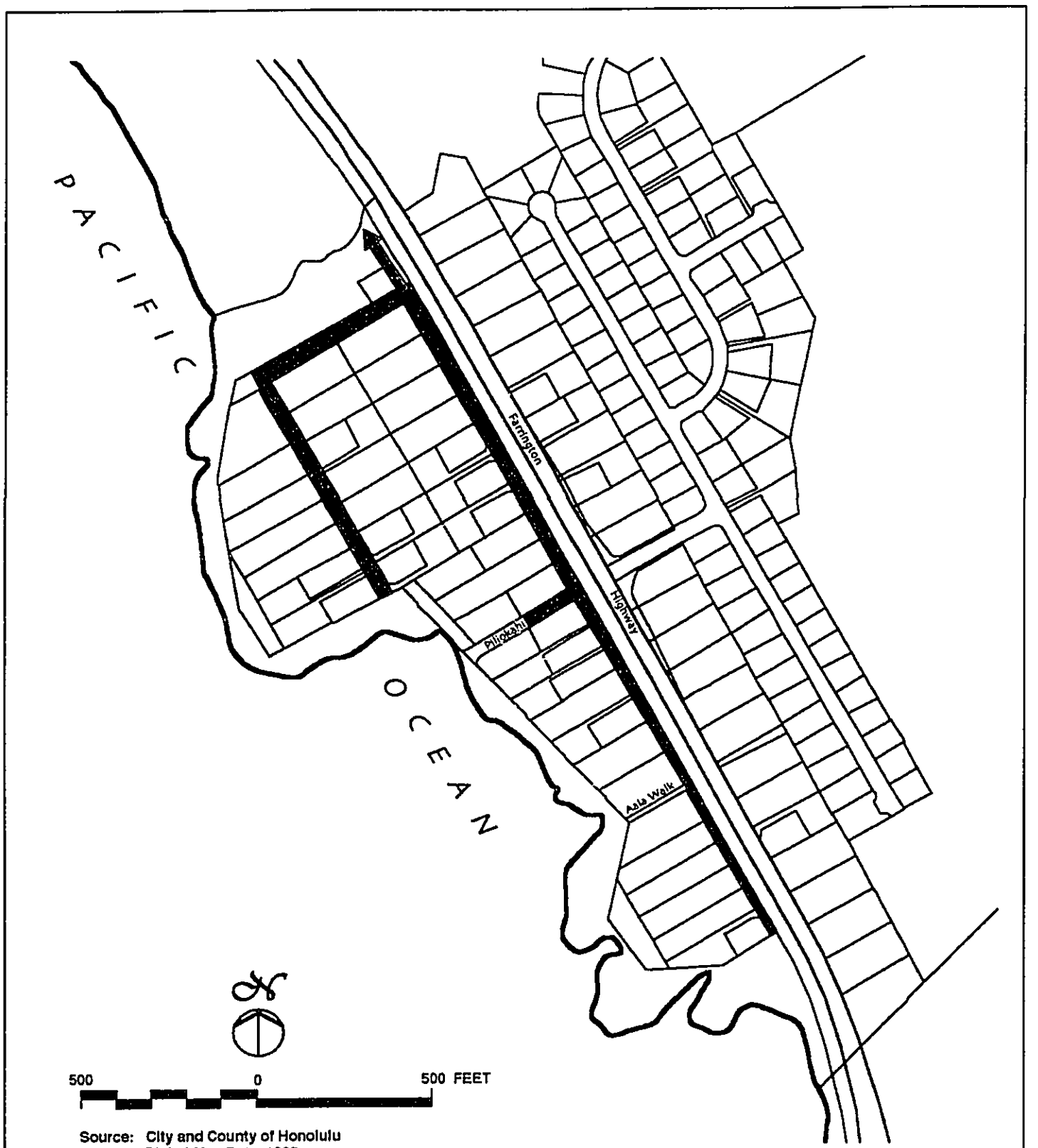
Project Site
Water System Improvements

LEGEND

IMPROVED WATER SYSTEM AREA

NEW WATER LINE SECTION IN THE IMPROVED AREA

prepared by: Wil Chee – Planning, Inc.



Source: City and County of Honolulu
Digital Map Data, 1998

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prepared for: Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

Figure 5

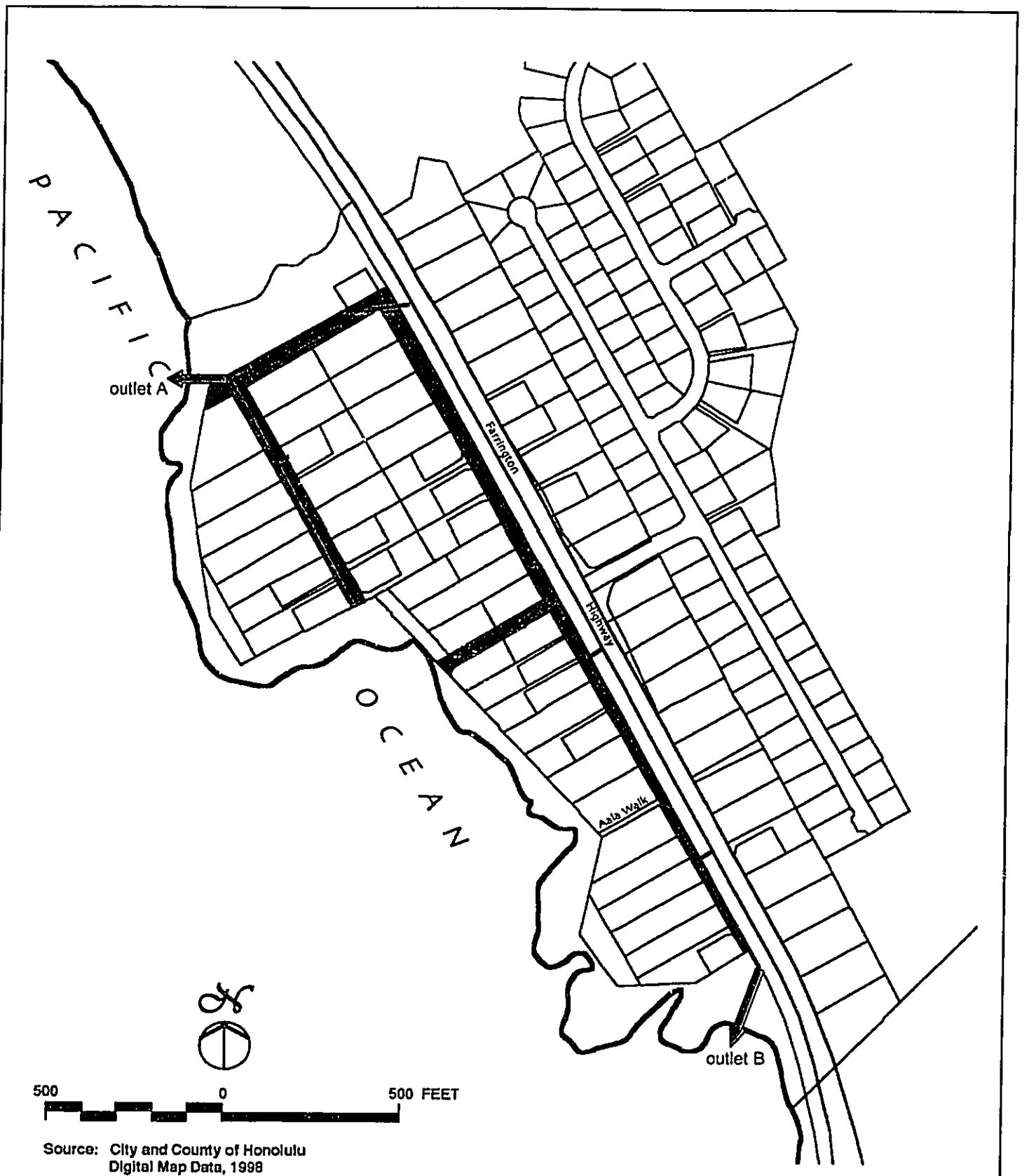
Project Site
Sewer System Improvements

LEGEND

NEW SEWER SYSTEM AREA

NEW SEWER CONNECTION

prepared by: Wil Chee – Planning, Inc.



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prepared for: Earth Tech, Inc.
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Honolulu, Hawaii 96813

Figure 6

Project Site
Drainage System Improvements

LEGEND
- NEW DRAINAGE SYSTEM AREA
- NEW DRAINAGE SYSTEM FEATURES
- TO DISCHARGE POINTS

prepared by: Wil Chee – Planning, Inc.

2.3.1 TECHNICAL CHARACTERISTICS.

Proposed upgrading and redesign of basic infrastructure systems as necessary to comply with current City and County of Honolulu standards and requirements is expected to include the following provisions or actions:

- roadway widening to 24 feet in accordance with City and County of Honolulu standards and improvements such as finished curbs, gutters, turn-arounds, and wheelchair ramps;
- driveway aprons and lot driveway adjustments and transitions, as required;
- traffic improvements including the extension of the makai approach of Piliokahi Avenue to Farrington Highway and signalization at this access point to the subdivision (at the Piliokahi Avenue and Farrington Highway intersection);
- improvement of the existing access point from the south extension of Pohakunui Avenue;
- adjusted and/or relocated water system improvements (including valve boxes, meters and meter boxes, manhole frames and covers to finish grades);
- installation of a new water line section that connects to existing water lines at Pohakunui Avenue for extension of the water system from the vicinity of the Piliokahi Avenue intersection to the southern end of Pohakunui Avenue;
- concrete encasement or realignment of portions of the waterline to meet Board of Water Supply (BWS) standards;
- relocated fire hydrants and water meters and meter boxes, if required, to correct horizontal locations in the right-of-way in relation to the final curb, gutter and sidewalk;
- sewer laterals with advance riser connections that are placed such that lessees are provided with the easiest and/or shortest hook-up routes to their existing lines;
- drainage improvements (such as catch basins, manholes, buried pipe systems, grassed and/or concrete lined swales or ditches, outlet works or connection to an existing drain system and drain inlets with required easements in lots if required) to alleviate ponding in existing roads and lots;
- street signs and pavement markings that shall be reflectorized and shall conform with City and County of Honolulu, Department of Planning and Permitting, Traffic Review Branch (formerly the Department of Transportation Services) standards and requirements, and in accordance with the "Manual on Uniform Traffic Control Devices for Streets and Highways," 1988 edition;
- installation of street lights on wood poles;
- relocated overhead electric, telephone and cable television facilities, as necessary;
- removal of existing abandoned cars;
- grade adjustment walls as required;
- street tree planting with species such as true kou (*Cordia sebestena*), allspice (*Pimenta dioica*) and lignum vitae (*Guaiacum officianale*); and
- treatment of any existing lessee improvements (such as walls, fences, structures, buried utilities, trees, lawns and plantings) including restoration to equal or better condition, replacement and/or compensation for removal.

Proposed work shall comply with State and County erosion control standards and requirements including, but not limited to, preparation of a County approved erosion control plan. Dust control screens and silt fences are expected to be employed by the construction Contractor. Improvements will be accomplished in accordance with the guidelines established in the following references:

- "Standard Details for Public Works Construction dated September 1984 (Department of Public Works, City and County of Honolulu) as amended;
- "Standard Specifications for Public Works Construction" dated September 1986 (Department of Public Works, City and County of Honolulu) as amended;
- "Water System Standards, Volumes 1 & 2, 1985" (Department of Water Supply), as amended;
- "Revised Ordinances of Honolulu, 1990" as amended; and
- the latest standards of the utility companies.

The Nanakuli Road Improvement construction plans prepared by ATA serve as the general basis for the currently proposed utility improvements. A majority of the improvements indicated on ATA's plans have not been executed except for the installation of water lines within the affected subdivision. Project actions described in this EA are depicted on plans prepared by Earth Tech, Inc. (ETI). According to ETI's plans, a new water line section will be installed and connected to the existing lines at Pohakunui Avenue. The alignment and profiles of new sewer and drain lines will be similar to those indicated on ATA's plans with the exception of a new mauka-makai drain line along the northeastern end of Piliokahi Avenue. RCP culverts will be used in lieu of the previously proposed concrete box culverts. Invert depths for new water lines will range from approximately 3 to 6 feet below existing grades; invert depths of sewer and drain lines will range from approximately 4.2 to 20 feet below existing grades. All new lines are proposed to be installed via a conventional open-cut trenching method. Anticipated project actions will involve land-disturbing activities such as grading, grubbing, excavation, general construction and landscaping. Anticipated impacts may be further minimized if the construction Contractor opts to use trenchless construction methods. Proposed on-site excavation and earthwork will be accomplished as necessary to relocate existing utility systems (e.g., water lines and associated features, utility poles and drainage system features) and to extend new utility system features (e.g., sewer lines and laterals) within the subdivision. Adjustments to site grades may be necessary to allow for utility system and roadway improvements. No significant requirement for import or export of fill material is anticipated. Landscaping with trees that are transported to the site is anticipated. Aesthetic treatment will consist of street tree plantings within the roadway right-of-way.

The proposed action will generate no new utility requirements for potable water, solid waste disposal, and communication services such as telephone and cable television. Coordination with the Honolulu Board of Water Supply (BWS), the City and County of Honolulu for waste collection, Hawaiian Electric Company (HECO), GTE, AT&T and cable television providers is required to avoid service disruptions to local customers. Improved wastewater collection and disposal is generally viewed as a benefit of the proposed action. Installation of the new system and the connection to the Nanakuli

Wastewater Pump Station will be coordinated with the Department of Environmental Services (formerly the Department of Wastewater Management) to ensure adequate service for expected demands. The existing street lighting system will be improved. All work must be accomplished in accordance with State of Hawaii Occupational Safety and Health law (DOSH).

Site access and traffic conditions are a concern because the two (2) existing access points into the subdivision from Farrington Avenue "are considered substandard by current standards and are in need of improvements" (Earth Tech, 1998). Minor intersection improvements (i.e., curbing, signage, pavement markings) at the access point at the southern end of Pohakunui Avenue are proposed. The makai approach of Piliokahi Avenue is proposed to be extended and connected to an existing signalized intersection. As noted previously in Section 1.1, signalization of the Laumania Avenue intersection is expected to be performed by DOT as part of a separate project prior to the commencement of DHHL's project. Completed traffic improvements at the mentioned access point are expected "to make traffic access into the Nanaikapono subdivision acceptable with respect to both traffic operations and traffic safety" (Earth Tech, 1998). Coordination with the City and County Department of Planning and Permitting (DPP), Traffic Review Branch has confirmed that that the original 20-foot curb radii is acceptable for use with proposed wheel chair ramps.

Permits from the DPP and DOT will be required before work on any portion of the County street or State highway may begin. During construction, off-duty officers will be provided to control the flow of traffic as required by the DPP and DOT. Traffic control will be provided in accordance with the "Hawaii Administrative Rules Governing the Use of Traffic Control Devices at Work Sites or on Adjacent to Public Streets and Highways" adopted by the Division of Transportation. Current requirements specified in the U.S. Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways, Part VI – Traffic Controls for Street and Highway Maintenance Operations" must also be followed. Construction vehicles traveling on the roadways must meet the vehicle noise level requirements set by the Department of Health (DOH), Title 11, Administrative Rules, Chapter 43, Public Health Regulations, "Community Noise Control for Oahu."

2.3.2 ECONOMIC CHARACTERISTICS.

All necessary development approvals could potentially be in place to allow site work to begin in late 2000. Improvements could be completed in approximately three (3) years after construction funds become available. The initial investigative effort included topographical surveys and geotechnical engineering explorations for design, planning and environmental assessment purposes.

An estimate of the overall construction cost for proposed infrastructure improvements based upon available information is $3.3 million. This estimate includes the relocation or concrete encasement of portions of the existing waterline, extension of the sewer to

the Nanakuli Wastewater Pump Station, archaeological monitoring during construction and various other potential site improvements identified in section 2.3.1.

The surrounding community is expected to experience no direct economic impacts from the proposed action. Construction employment and material expenses are expected to generate general excise tax and income tax revenues to the State of Hawaii.

2.3.3 SOCIAL CHARACTERISTICS.

No additional homestead houselots are expected to result from proposed activities. Project actions are expected to have essentially no effect on residential population or composition. Area residents are expected to benefit from proposed infrastructure and utility system improvements intended for the betterment of public health and safety.

2.3.4 ENVIRONMENTAL CHARACTERISTICS.

Impacts to the environment as a result of the proposed action will be mostly negligible or otherwise insignificant, and potential short- or long-term impacts associated with the proposed action will be mitigable. Essentially no adverse impacts to the geography, geology, hydrology, climate, flora, fauna, land use and aesthetic conditions within the project area are anticipated. Land-disturbing construction activities (e.g., excavation, trenching, earthwork) have the potential to generate impacts that may affect the following areas of environmental concern in the short- or long-term: topography, soils, water quality, air quality, noise quality, historical and archaeological resources, circulation and traffic, and public services and facilities.

Proposed activities could generate potential impacts as discussed in Chapter 4.0:

- minor alterations to the existing topography;
- the removal or relocation of a lessee's lot improvements;
- soil loss;
- geotechnical concerns;
- silt runoff;
- fugitive dust and pollutant emissions;
- construction noise emissions;
- disturbance of historical and cultural resources;
- disruptions to vehicular traffic and circulation; and
- interruptions of public services.

Potential impacts will be avoided, minimized and/or mitigated by the adoption of the measures discussed in Chapter 4.0:

- adherence to City and County of Honolulu grading permit requirements;

- restoration of removed and/or relocated features to equal or better condition or replacement or compensation;
- implementation of temporary and permanent erosion and sedimentation control measures, and compliance with State and County erosion control standards and requirements;
- accomplishment of specific recommendations described in the geotechnical engineering exploration report;
- installation of a site drainage system, implementation of measures to prevent runoff from reaching receiving waters, and adherence to applicable permit requirements;
- employment of adequate dust control measures;
- utilization of properly muffled construction equipment and the incorporation of noise limits and curfew times;
- implementation of archaeological monitoring during construction, proper notification upon any discovery of archaeological or historic resources and coordination with the appropriate agencies to determine the most appropriate actions;
- employment of standard specifications for traffic control; and
- acquirement of the necessary approvals prior to construction, adherence to all permit requirements and coordination with utility providers to avoid service disruptions.

Overall, the environmental impacts of the proposed action are expected to be insignificant due to the mitigation measures that are available. The project is necessary to bring the infrastructure and utility systems into compliance with current City and County of Honolulu standards.

3.0 AFFECTED ENVIRONMENT

3.1 Geography and Topography.

The island of Oahu comprises four main geographically distinct areas: the Waianae Range, Koolau Range, Leilehua (or Schofield) Plateau and coastal plains (U.S. Department of Agriculture, 1972). The project site is located at the foot of the Waianae Range and along the southwestern coast of the island of Oahu.

The project area slopes gently from east to west. Ground surface elevations range from approximately eight (8) feet above mean sea level in shoreline areas to 20 feet above mean sea level in the vicinity of the Pohakunui Avenue access to/from Farrington Highway. Paved roadways within the subdivision are relatively flat, unobstructed and currently in use by area inhabitants (see Plates 1 and 2). There are some topographic obstructions such as walls, fences, structures, trees, lawns and plantings that encroach upon the 40-foot-wide road right-of-way and 20-foot curb radii.

3.2 Geology and Soils.

The geology of the project area "is characterized by basaltic bedrock overlain by alluvium interlayered with ancient coral reefs" (Pacific Geotechnical Engineers, Inc. or PGE, 1998). A relatively thin layer of alluvial silt and clay covers these ancient coral reef. A thicker alluvial layer occurs in former gullies that have generally been covered as a result of site development. Paved public roadways have an asphaltic concrete (AC) surface. In general, the existing roadway is in "fair" condition; however, some localized distressed areas showed "low to moderate severity alligator, edge, longitudinal, and transverse cracking, and low to moderate severity raveling" (PGE, 1998).

Borings were taken to supplement subsurface information shown on the plans prepared by ATA. Near surface conditions from previous borings were deemed to be generally consistent with the conditions revealed by more recent supplemental borings. Geotechnical exploration indicates that the surface fill is "underlain by stiff to very stiff alluvial silt and clay, medium hard to hard coral ledges and locally cemented coralline sand and gravel" (PGE, 1998). The lateral and vertical extent of these deposits in the borings varies across the project area. Findings from the geotechnical engineering exploration report (PGE, 1998) are summarized below:

> Borings 1 through 7 that were taken from existing roadways revealed approximately two (2) to three (3) inches of AC at the surface.
>
> Fill materials of loose to medium dense silty coralline sand and gravel were encountered to depths ranging from a few inches to one (1) foot below existing grades in all borings except Boring 9 on the southern portion of the site within the previously proposed alignment of a box culvert.

Photograph 1A: Laumania Avenue.

View to the southwest along Laumania Avenue. The vehicular entry to the Nanakuli Beach Park parking lot is to the right in the photograph.

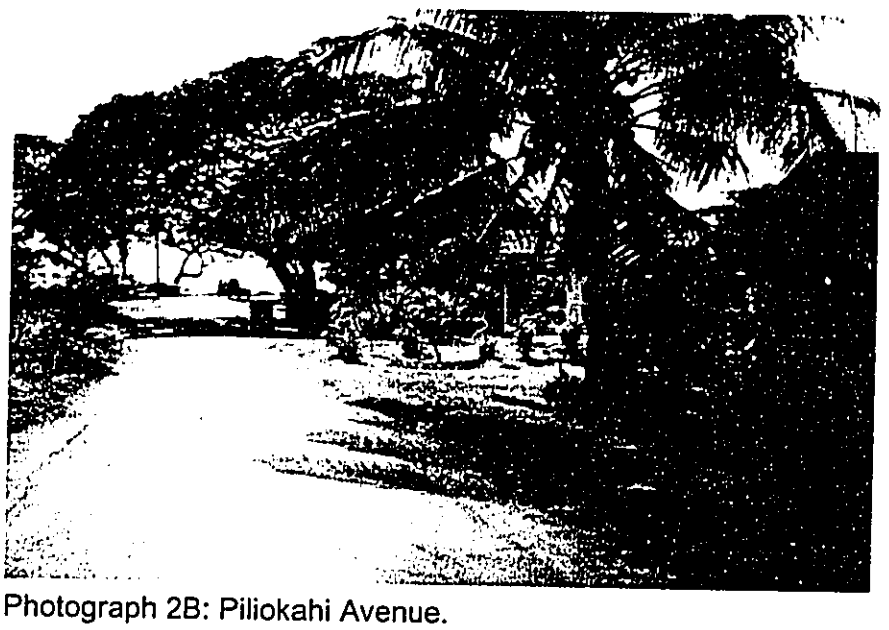
Photograph 1B: Keaulana Avenue.

View to the southeast along Keaulana Avenue. Homestead houselots are located along both sides of this roadway.

ENVIRONMENTAL ASSESSMENT **FOR** **NANAIKAPONO SUBDIVISION UPGRADES** In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06 prepared for: Earth Tech, Inc. 700 Bishop Street, Suite 900 Honolulu, Hawaii 96813	**Plate 1** **Laumania & Keaulana Avenues**	prepared by: Wil Chee – Planning, Inc.

Photograph 2A: *Pohakunui Avenue.*

View to the northwest along the southern extension of Pohakunui Avenue. This portion of the roadway is narrow.



Photograph 2B: Piliokahi Avenue.

View to the southwest along Pohakunui Avenue. Homestead houselots are located along both sides of this roadway.

ENVIRONMENTAL ASSESSMENT FOR **NANAIKAPONO SUBDIVISION UPGRADES** In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06 prepared for: Earth Tech, Inc. 700 Bishop Street, Suite 900 Honolulu, Hawaii 96813	**Plate 2** **Pohakunui & Piliokahi Avenues**	prepared by: Wil Chee – Planning, Inc.

Borings from Pohakunui, Piliokahi and Keaulana Avenues (Numbers 1, 2, 3, 4, 6 and 7) revealed alluvial deposits consisting primarily of fat clay and elastic silts below the surface fill at depths of approximately 0.5 to 3.3 feet below existing grades. In Boring 1, the alluvial deposits were generally underlain by medium hard coral and medium dense to dense and locally cemented silty coralline sand and gravel to the maximum depth explored in this hole at 22.3 feet. In Boring 4, the upper coral ledge was underlain by a layer of basaltic cobbles and boulders between depths of approximately 11 and 12.5 feet below existing grades.

Boring 5 from Laumania Avenue showed recemented coral directly below the fill.

In Boring 8, fat clay alluvial deposits were found from a depth of approximately one foot to the bottom of this boring at 16.5 feet below existing grades. This boring was drilled along the previously proposed alignment of a box culvert south of Piliokahi Avenue. The boring appears to be within a former gully that is in-filled with alluvium. The gully was not observed along the shoreline in the area of the proposed outfall structure for the previously proposed culvert and may instead run to other natural drainage features that previously existed south of Boring 8.

A thin layer of fat clay was encountered at the surface to a depth of approximately 0.8 feet in Boring 9. The clay in this hole was underlain by recemented coral.

Laboratory tests performed on three (3) samples of silt and clay obtained from the borings appear to indicate that the near surface alluvial deposits have high shrink and swell tendencies.

A possible void was encountered in Boring 1 at approximately 12 to 13 feet below the existing ground surface. Based on the geology and available subsurface information, it is possible that other voids or cavities may exist at the site. Voids are common in coral reef formations and typically occur in the form of solution cavities created as fresh water percolates, dissolves and removes part of the coralline material. Near surface voids may be in-filled with soft or loose alluvial sediments and can range in size from less than an inch to over several feet in diameter.

Supplemental geotechnical engineering exploration was conducted to reflect up-dated civil plans that show drain lines along Laumania and Keaulana Avenues discharging to an outlet beyond the Laumania and Keaulana intersection. Drain lines along Pohakunui Avenue (near Piliokahi Avenue) and the northeastern portion of Piliokahi Avenue will discharge to a new outlet located within the adjacent Piliokahe Beach Park at the southeastern end of the subdivision. Findings from the supplemental subsurface exploration (PGE, 1999) are summarized below:

> Subsurface conditions encountered in supplemental borings...are generally consistent with the conditions encountered in PGE's 1998 borings. However, the extent of near surface alluvium near the intersection of Pohakunui and Piliokahi Avenues appears to include a larger area. Alluvial silt and clay deposits were encountered in supplemental Boring 10 drilled in the northeastern portion of Piliokahi Avenue to a depth of approximately 7 feet below the surface pavement. Alluvium was also encountered in Boring 8 previously drilled in an area located just southeast of Boring 10 to the bottom of this hole at 16.5 feet. The clayey surface soil in Boring 10 was underlain by coralline sand and gravel to the bottom of this hole at 16.5 feet.

Subsurface conditions encountered in supplemental Boring 11 drilled along Pohakunui Avenue generally consisted of approximately 3 feet of very stiff elastic silt and fat clay at the surface. A coral ledge was encountered beneath the surface clayey soils to a depth of approximately 15.5 feet. A basaltic cobble and possible boulders were encountered at approximately 15.5 feet in this hole. The basaltic cobble was underlain by coralline sand and gravel to the bottom of this hole at 20 feet.

Subsurface conditions in supplemental Boring 12 also drilled along Pohakunui Avenue generally consisted of approximately 2 feet of sandy silt fill on the surface underlain by silty corraline gravel. A coral ledge was encountered in this boring from a depth of approximately 2 to 11 feet. The coral ledge was underlain by alluvial deposit consisting primarily of very stiff elastic silt to the bottom of this hole at 20.5 feet.

Boring 12 revealed the presence of a deeper alluvial layer below the near surface coral reef formation. This deeper alluvial layer appears to be consistent with the alluvial material encountered below the coralline deposits in Boring 3 and 4 drilled just northwest and southeast, respectively, of Boring 12.

Hard coral was found in supplemental Boring 13 (outlet B) and 14 (outlet A) at the ground surface and extending to depths of approximately 9 to 10 feet. This ledge was underlain by coralline sand and gravel to a depth of approximately 16.5 feet in Boring 13 and to the bottom of Boring 14 at 20.5 feet. Very stiff elastic silt was found below the sand and gravel in Boring 13 to the bottom of this hole at 25.5 feet.

Soils in the project area are of the Mamala and Mokuleia Series. The characteristics of the soils as defined in the *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai* (U.S. Department of Agriculture, 1972) are hereby summarized.

The Mamala Series consists of shallow, well-drained soils along the coastal plains on the islands of Oahu and Kauai. The specific soils type in the northern portion of the affected subdivision is designated as Mamala stony silty clay loam, 0 to 12 percent slopes (MnC). This soils type has a slope range of 0 to 12 percent, but in most places the slope does not exceed six (6) percent. Stones, mostly coral rock fragments, are common in the surface layer and in the profile. Permeability is moderate. Runoff is very slow to medium, and the erosion hazard is slight to moderate. This soils type is used for sugarcane, truck crops and pasture.

The Mokuleia Series consists of well-drained soils along the coastal plains on the islands of Oahu and Kauai. Mokuleia clay (Mtb) occurs in the southernmost portion of the affected subdivision. Permeability is slow in the surface layer. Workability is difficult because of the sticky, plastic clay. This soils type is used for sugarcane and pasture.

3.3 Hydrology and Water Quality.

Groundwater within the general project area exists primarily as basal water floating on salt water; sediments on the coastal plains may also be saturated with groundwater (Armstrong, 1983). Rainfall is a primary source of groundwater recharge.

Groundwater levels measured in "Borings 2, 5 and 9 at depths ranging from 10.8 to 13.2 feet below the existing ground surface...correspond to elevations ranging from

approximately sea level to 0.5 feet above and below sea level" (PGE, 1998). No stabilized water level readings were obtained from Borings 1, 3, 6, 7 and 8. Boring 4 was not drilled deep enough to encounter ground water. "Groundwater was encountered in suppiemental Borings 11 and 14 near sea level, except in Borings 10, 12 and 13...Stabilized water measurements could not be obtained in these holes due to the drilling process" (PGE, 1999). Groundwater levels in the area are expected to fluctuate with tide and rainfall conditions due to the proximity of the project area to the ocean (PGE, 1998).

The quality of fresh water from basaltic aquifers in Hawaii is "excellent: the water is soft, low in mineral content, and potable without disinfection" (Armstrong, 1983). A major threat to the basal freshwater lens is the underlying seawater. Coastal waters in Hawaii are "of high quality because the former practice of ocean disposal of municipal, agricultural, and industrial wastes has been much improved or eliminated by land treatment and water-reuse practices" (Armstrong, 1983).

3.4 Climate.

Most of Hawaii is characterized by slight seasonal variations that create a climate of year-round mild and equitable temperatures, moderate humidities, predominantly northeast trade winds, varied rainfall conditions within short distances and infrequent severe storms (Armstrong, 1983). Temperatures at the project site are expected to be similar to those found elsewhere in Hawaii.

The following climatological information is from *The State of Hawaii Data Book 1997: A Statistical Abstract* (Department of Business, Economic Development and Tourism, 1998). According to data recorded at the Waianae station (at a ground elevation of 10 feet), average temperatures range from 72.1°F during the coolest months (February to March) to 79.7°F during the warmest months (August and September). The lowest recorded temperature at Waianae station is 45°F and the highest recorded temperature is 96°F. Annual precipitation is 20 inches.

3.5 Air Quality.

Hawaii, in general, has air that is "relatively clean and low in pollution" (Armstrong, 1983). The closest air sampling station is located approximately seven (7) miles southeast of the project area at Barbers Point. Historical data demonstrates the prevalence of northwesterly trade winds during most of the year that range from 4 to 12 miles per hour winds with brief periods of 24 miles per hour winds (Armstrong, 1983). Southerly and southwesterly winds may prevail between October and April.

The ambient air quality at project area is presumably good due to the absence of major stationary sources of pollutant emissions. Minor impacts to air quality probably occur as a result of motor vehicle traffic.

3.6 Noise Quality.

Sources of existing background ambient noise levels are largely attributed to motor vehicle traffic along the four (4) avenues within the affected subdivision and from Farrington Highway in particular due to its larger traffic capacity and volume. Other noise sources in the project area include birds, waves or wind rustling through foliage.

3.7 Flora.

The project area comprises an existing subdivision that has paved roads. Ornamental trees and other flora are present within and along homestead houselots. The U.S. Fish and Wildlife Service (FWS) reports that is it "not aware of any threatened or endangered species or sensitive habitats in the project area" (FWS, 1999). A similar determination that no observed flora species within the project area are protected under State environmental laws is expected to be confirmed through correspondence with the Hawaii State Department of Land and Natural Resources (DLNR).

3.8 Fauna.

The area of the existing subdivision is expected to contain no suitable permanent habitat for threatened, endangered or candidate fauna species presumed or known to reside on the island of Oahu. These species include the Hawaiian hoary bat (*Lasiurus cinereaus semotus*), the Hawaiian or Oahu tree snail (genus *Achatinella*), the Hawaiian owl (*Asio flammeus sandwichensis*) and the Oahu creeper (*Paroremyza maculata*). With respect to fauna, the U.S. Fish and Wildlife Service (FWS) reports that is it "not aware of any threatened or endangered species or sensitive habitats in the project area" (FWS, 1999). The DLNR, Division of Forestry and Wildlife is similarly expected to confirm that the proposed site is uninhabited by and is of little or no resource value to known endangered fauna on the island of Oahu. Birds, mammals, reptiles and amphibians that may frequent the project site presumed to be introduced or indigenous species that are commonly found in disturbed environments.

3.9 Historical and Archaeological Resources.

The State Historic Preservation Division (SHPD) in a letter dated 16 February 1999 states the following information:

> "No archaeological surveys have been done along the shore in Nanakuli. Historical documents from the early 1800s indicate that a coastal settlement was present. Archaeological survey of the Department of Hawaiian Homelands properties in the back of the valley (done by our office) found extensive field ruins and over 20 house sites in the back of the valley, with use of the back of the valley starting in the A.D. 1200s-1400s. It is further expected that archaeological remnants of coastal settlements likely survive in areas which have not had extensive land alteration, a common pattern along the Wai'anae coast and elsewhere on O'ahu and in the Islands." (SHPD, 1999).

3.10 Land Use.

The affected portion of the Nanaikapono subdivision falls within a SMA that roughly parallels the shoreline. DHHL may be exempt from being required to process a SMA permit. The preparation of this EA is intended to fulfill the environmental documentation requirement for uses within a SMA.

The project area falls within the Urban (U) State land use district. The project site is located in a Rural area according to the "Year 2010 Urbanized Areas" in the General Plan. The objectives for this area are "to maintain those development characteristics in the urban-fringe and rural areas which make them desirable places to live." (Department of General Planning, 1992). The County Development Plan designation for the project area is Residential (R-5). Park areas extend along the shoreline.

The subdivision area is located within Zones X and D of the 100-year flood hazard area on the Flood Insurance Rate Map (FIRM) prepared by the Federal Emergency Management Agency. The northern portion of the affected subdivision that extends from Laumania Avenue and spans the length of Keaulana Avenue is situated within Zone X—a classification for areas determined to outside the 500-year flood plain. The remainder of the project area is located within Zone D—the classification for areas in which flood hazards are undetermined. The project site lies within the tsunami innundation zone.

3.11 Aesthetic Considerations.

Views from the project site are relatively unobstructed except for existing homestead structures and Farrington Highway. Northeastern views from the project area are of existing homestead uses mauka of Farrington Highway and the foot of the Waianae mountain range. Existing views in the remaining directions are of shoreline park lands, beach areas and the Pacific Ocean.

3.12 Circulation and Traffic.

Information in this section is summarized from the *Nanaikapono Subdivision Upgrading Traffic Improvement Needs Study, TMK: 8 – 9 – 06* (Earth Tech, 1998).

Access to the affected portion of the Nanaikapono subdivision from Farrington Highway is via Laumania Avenue and the south extension of Pohakunui Avenue. Laumania Avenue is perpendicular to the highway and serves as the major access to/from the subdivision. Pohakunui Avenue runs parallel to Farrington Highway. The intersection of the south extension of Pohakunui Avenue with Farrington Highway is used for access to the subdivision but serves more as an access to the adjacent Beach Park. Piliokahi and Keaulana Avenues are roadways within the subdivision.

The two (2) existing access points for the subdivision were built several years ago and are considered substandard by current City and County of Honolulu standards. Both

approaches are single lanes such that left and right turns must be made from the same lane. No right turn deceleration or separate right turn lanes on Farrington Highway are provided at either intersection. Neither intersection is signalized.

Farrington Highway is a 4-lane (two lanes in each direction) undivided highway with posted speed limits of 35 miles per hour. Most vehicles were observed travelling over the speed limit in this area. A vertical and horizontal curve on Farrington Highway just south of Pohakunui Avenue restricts sight distance for Waianae-bound traffic.

Methodologies for assessing existing levels-of-service (LOS) for unsignalized intersections was applied. In general, LOS "A" represents the most favorable operating conditions and LOS "F" represents least favorable conditions. The following paragraphs summarize the LOS analysis:

- Outbound traffic movement from Laumania Avenue is currently at LOS "F" during the morning and afternoon peak hours. The left turn movement from Farrington Highway into Laumania Avenue is currently at LOS "D" in the AM peak traffic period and is forecasted to decrease to level E within three (3) years. The left turn movement from the highway during the PM peak hour is at LOS "B" in the summer but at LOS "C" during the school year when opposing through traffic volumes are heavier. This movement is expected to remain at LOS "C" in the near future.
- Traffic movement at the Pohakunui Avenue intersection is at LOS "B" during the AM peak hour when no outbound left turns are made. The left turn movement from Farrington Highway into Pohakunui Avenue extension is currently at LOS "D" and is forecasted to remain the same. Outbound traffic from Pohakunui Avenue in the PM peak period is at LOS "F" due to the presence of left turning traffic. The left turn movement from Farrington Avenue into Pohakunui Avenue is currently at LOS "B". LOS "C" is expected for this movement with school year and forecasted traffic involving higher volumes of opposing traffic.

3.13 Public Services and Facilities.

3.13.1 WATER SYSTEM.

The Honolulu BWS provides potable water service to the project area through its distribution system. A 24-inch distribution main runs along Farrington Highway. Water lines, fire hydrants and valves are generally aligned along existing roadways. The installation of water lines within the affected portion of the Nanaikapono subdivision has been accomplished in accordance with ATA's construction plans that were approved by State and County authorities in 1980. As depicted on ATA's plans, the existing water system includes the following features:

- an 8-inch size water line located along Pohakunui Avenue that terminates with a 4-inch line in the southern portion of this Avenue;
- a 4-inch water line from Pohakunui Avenue that extends along Piliokahi Avenue and terminates near the midpoint of this roadway; and
- an 8-inch line that extends along Laumania Avenue, connects to an 8-inch line along Keaulana Avenue and terminates with a 4-inch line at the end of Keaulana Avenue.

3.13.2 WASTEWATER SYSTEM.

No municipal wastewater collection or disposal service is currently provided to the affected subdivision due to the absence of underground lines, mains and collection systems. The project site currently generates no demand for municipal wastewater collection services. The homestead houselots have cesspools and septic tanks.

3.13.3 SOLID WASTE DISPOSAL.

Solid waste collection for the project area is provided by the City and County of Honolulu. Solid waste collection vehicles service the affected subdivision via existing roadways.

3.13.4 DRAINAGE SYSTEM.

No on-site drainage systems presently exist within the affected subdivision.

3.13.5 ELECTRICAL AND COMMUNICATION SYSTEMS.

Electrical, telephone, and cable television services are provided to the project area via overhead distribution lines on wooden poles. The poles are generally aligned along existing roadways. The existing street lighting system utilizes 175-watt (W) luminaires mounted on the poles.

3.14 Socio-Economic Conditions.

The project area comprises a populated Hawaiian homestead subdivision. All of the homestead houselots fall within the jurisdiction of the DHHL.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Geography and Topography.

The proposed action involves the construction of an improved roadway with new and relocated supporting infrastructure. No impacts to the geography are anticipated.

Excavation, grading and grubbing will occur, but not to the extent that would significantly alter the general topography of the area. The proposed action is expected to require no significant amount of grading or related alterations to the topography since the affected areas are relatively unobstructed and flat. Some walls, fences, structures, trees, lawns and plantings that encroach upon the 40-foot-wide road right-of-way and 20-foot curb radii will be removed and/or relocated.

MITIGATION: The Contractor must adhere to City and County of Honolulu grading permit requirements. Removed and/or relocated features are expected to be restored to equal or better condition or replaced. Alternately, the lessee may be compensated for the removal of the feature.

4.2 Geology and Soils.

Potential concerns described in the geotechnical engineering exploration report (PGE, 1998) are listed below.

- There are near surface silt and clay deposits with high shrink and swell tendencies. Potential volume change of these soils may occur as a result of changes in their moisture contents. These soils tend to swell upon wetting and shrink upon drying. Volume changes could cause distress to underground utilities and pavements.
- There are medium hard to hard coral and locally cemented coralline sand and gravel along most of the road improvements at relatively shallow depths. Utility trenches, sheeting installations, and manhole excavations extending into cemented coralline materials may require a backhoe equipped with a hydraulic hoe ram, rock excavators or rock trenchers, or other suitable rock excavating equipment.
- There are variable subsurface conditions consisting primarily of sand and gravel, silt and clay, medium hard to hard coral, and cobbles and boulders. Potentially excessive differential settlements could occur along the new utility lines, particularly at locations where the pipe subgrade conditions change from loose granular deposits to hard coral ledges.
- There is a need to perform the road construction and utility trenches along existing streets and near existing houses and underground utilities, such as existing water lines. The road excavation for base and subbase installation may affect the existing underground lines within the new travelway. Trenching and dewatering may cause some ground movements in the vicinity of the trenches.

- There is a potential for cavities or voids within the coral reef formations that may require additional over excavation and/or special treatment.
- There is a possible need to import trench backfill materials due to a large amount of oversize particles that are anticipated in the excavated coralline materials.

Potential erosion could occur as a result of construction activities (e.g., clearing, grading, grubbing, excavation and trenching) that disturb the earth and soils. Exposed soils are susceptible to erosion, especially if it rains heavily during site work periods. Wind erosion may cause some unavoidable soil loss, but the greater concern is silt runoff. Potential adverse impacts are expected to be short-term and temporary.

MITIGATION: Below are the recommended measures described in the geotechnical engineering exploration report (PGE, 1998).

- Provide a thicker overall flexible pavement section for the southern roughly two-thirds of Pohakunui Avenue and the eastern half of Piliokahi Avenue due to the expansive clays/soils.
- Over excavate a portion of the materials directly below the pipe bedding along select sections of the various utility lines and replace the material with crushed rock subbedding to provide for more uniform support of the new lines.
- Accomplish specific recommendations pertaining to site preparation, excavation, trench excavation and dewatering, pipe subgrade treatment and bedding, and backfill placement and compaction. Follow the recommendations for manhole and box culvert foundation support, and lateral earth pressures. Apply the flexible pavement guidelines as they pertain to specific sections of the proposed roadway.

The geotechnical engineering exploration report (PGE, 1998) also includes more detailed recommendations pertaining to the following actions or activities: site preparation; excavation; cut and fill slopes; trench excavation and dewatering; pipe subgrade treatment and bedding; backfill materials, placement and compaction; manhole foundation support; lateral earth pressures; and flexible pavement. Pacific Geotechnical Engineers, Inc. further recommended that additional subsurface soil test borings be performed due to the re-siting of the drainage culvert along Aala Walkway. The report is incorporated by reference in ETIs construction plans. The construction Contractor shall abide by the specific recommendations in the report.

Additional recommendations are hereby summarized from the supplemental geotechnical report (PGE, 1999):

- In general, the anticipated subsurface conditions for the proposed water line...are still applicable. However, it appears that subsurface conditions at the water line invert in the vicinity of Station 12+00 should consist primarily of coral and coralline sand and gravel, instead of the previously anticipated elastic silt, clay, and possible cobbles and boulders.
- The extent of the clayey soils anticipated at the pipe line inverts for the sewer line and drain line have changed... The pipe subbedding thickness based on general

subsurface conditions presented in Table 1 of the October 27, 1998 report should be used with revised Table 2 to estimate subbedding thicknesses along particular areas of the pipeline. A Revised Schematic Section of Pipe Bedding & Backfill Requirements based on the presently proposed drain line pipe sizes is presented on Plate 5.

- The cobbles and boulders encountered in PGE's previous Boring 4 at the southeastern end of Pohakunui Avenue appear to be a localized condition. However, a basaltic cobble was encountered in supplemental Boring 11 at a depth of approximately 15.5 feet. This may indicate the possible presence of basaltic cobbles and boulders within the deeper alluvium encountered below the near surface coral reef formation.

  Deeper alluvium was encountered in Boring 3, 4, and 12 drilled in the southeastern portion of Pohakunui Avenue and in Boring 13 at outlet B. As indicated in Table 2, the deeper alluvium may affect the pipe subbedding thickness for the sewer and drain line in this area, and drain outlet B. If cobbles and boulders are encountered at the pipe invert level, the thicker subbedding thickness recommended in Table 1 of PGE's October 27, 1998 report should be provided for the pipe.

- The pavement subgrade treatment and approximate treatment areas as recommended in the October 27, 1998 report are still appropriate.

Both temporary and permanent erosion and sedimentation control measures will be implemented. Proposed work shall comply with State and County erosion control standards and requirements including, but not limited to, preparation of a County approved erosion control plan. Strict erosion control measures are specified in the reports and regulations of the City and County of Honolulu, DOH, U.S. Department of Agriculture–Natural Resources Conservation Service, and U.S. Environmental Protection Agency. The use of dust control screens and silt fences is anticipated.

4.3 Hydrology and Water Quality.

The loss of localized groundwater recharge due to the increase in paved surfaces at the project site is expected to be negligible and ultimately inconsequential to the overall function of the natural hydrological system. Impervious surfaces created as a result of the proposed action will increase localized runoff and decrease total time of concentration; however, this impact is also expected to be negligible in the context of the entire system such that its impact shall be insignificant. No mitigation measures with respect to hydrology are proposed or considered to be warranted.

Runoff within the existing residential subdivision discharges to the Pacific Ocean. Project actions include the installation of a site drainage system that is expected to benefit the affected area since there is currently no drainage system for the subdivision. During construction, localized silt runoff has the potential to impact water quality. Construction activities may require dewatering; however, it is not known at this time what construction methods will be employed by the construction Contractor.

MITIGATION: County approval and acceptance of the drainage system is required. During construction, measures will be taken to prevent silt runoff from the construction areas from reaching the Pacific Ocean. Actions such as construction dewatering will require coverage under the NPDES Permit system. The Contractor must abide by the permit requirements.

4.4 Climate.

The proposed action is expected to generate no measurable adverse impacts to the climate in the short- or long-term. No mitigation measures with respect to the climate are warranted or proposed.

4.5 Air Quality.

Short-term air quality impacts generated by the proposed action are primarily attributed to construction activity. Pollutant concentrations from construction vehicle activity are expected to increase primarily along affected existing roadways. Other short-term and temporary air quality impacts are anticipated from site preparation and earth moving activities that generate fugitive dust or particulate emissions.

Off-site stationary source impacts are attributed to the increased electrical demand resulting from the proposed project which in turn causes more fuel to be burned and more pollutants to be emitted into the air. HECO facilities that provide power must continuously demonstrate compliance with all applicable ambient air quality standards and control regulations.

MITIGATION: Fugitive dust impacts can be effectively mitigated via the employment of adequate dust control measures during the construction period. A recommended method is the frequent watering of unpaved roads and areas of exposed soils.

4.6 Noise Quality.

Sources of existing background ambient noise levels in the project area are expected to continue to be generated by motor vehicle traffic. Unavoidable, short-term and temporary noise impacts are expected to occur during the construction period. Noise from construction activities is predicted to be audible in the area of activity. Actual work is expected to move from one location on the project site to another during the construction period such that the exposure to construction noise at any receptor location will probably be of less duration than the total construction period for the entire project.

MITIGATION: Measures that reduce construction noise to inaudible levels may not be practical in all cases due to the exterior nature of the work (grading, grubbing, earth movement, trenching, etc.). Standard mitigation includes the use of properly muffled

construction equipment and the incorporation of DOH construction noise limits and curfew times (which are applicable on Oahu) during the construction phases of the project. DOH permit procedures do not allow noisy construction activities on holidays. During construction, adherence to the vehicle noise level requirements set by the DOH, Title 11, Administrative Rules, Chapter 43, Public Health Regulations, "Community Noise Control for Oahu" will be required of the construction Contractor.

4.7 Flora.

The vegetation in the project area presumably contains no known threatened, endangered or candidate species. The loss of existing ornamental vegetation is expected to be offset by the project feature of street tree plantings. Species such as true kou (*Cordia sebestena*), allspice (*Pimenta dioica*) and lignum vitae (*Guaiacum officianale*) will be planted within the roadway right-of-way. Street tree plantings will be accomplished in accordance with "Standard City and County of Honolulu, Department of Parks and Recreation Specifications for Street Tree Plantings and Landscaping" such that no mitigation measures are proposed or considered to be warranted.

4.8 Fauna.

No known threatened or endangered faunal species or habitats have been identified at the project site. No short- or long-term adverse impacts to important faunal species are anticipated and no mitigation measures are proposed or considered to be warranted.

4.9 Historical and Archaeological Resources.

As indicated in the letter from the SHPD, "it is possible that subsurface archaeological deposits could be present in the project area. If such deposits are present, they could be extremely important for understanding Nanakuli's settlement history and the settlement history of the entire Wai'anae coast" (SHPD, 1999). Construction activities (i.e., grading, excavation, trenching) by nature have the potential to adversely impact archaeological or historical resources in the short- and long-term if any such resources exist.

MITIGATION: The SHPD in its letter dated 16 February 1999 recommends the following action:

> "...that an archaeological inventory survey of the proposed project area be performed early in the planning phases of the project—to determine if historic sites are present, and, if so, to gather sufficient information to evaluate their significance. This survey should involve scattered excavation units throughout the project area. A report of the finds should be submitted to the State [H]istoric Preservation Division for adequacy review.

> "If significant historic sites are found during the survey, a mitigation plan may need to be developed and executed. This might involve additional salvage excavation in project element alignments."

The Applicant intends to perform an archaeological inventory survey along areas that will be disturbed by construction activities and report the findings to SHPD as recommended. This work is proposed to be accomplished during the site preparation phase of the construction period. Stoppage of work and the notification of the State Historic Preservation Office will be accomplished if any archaeological or historic resources are discovered. Mitigation of any potential adverse impacts to historic and cultural resources will require coordination with the Hawaii State Historic Preservation Officer and the Advisory Council on Historic Preservation to determine the most appropriate actions.

4.10 Land Use.

Proposed infrastructure improvements represent no change in current land uses within the project area. The immediately surrounding and adjacent park areas provide the people of this community with a convenient place for recreation, leisure and informal gatherings. No short- or long-term adverse impacts are expected to result from project actions. Thus, no mitigation is proposed or considered to be warranted.

4.11 Aesthetic Considerations.

The proposed action will result in an improved and more attractive roadway within the existing subdivision. Street tree plantings and the removal of existing abandoned cars are project features that are expected to benefit subdivision inhabitants. No mitigation with respect to aesthetic conditions is proposed or considered to be warranted.

4.12 Circulation and Traffic.

As noted in Section 1.1, a separate project expected to be performed by the DOT includes the signalization of the Laumania Avenue and Farrington Highway intersection. This project is expected to be performed prior to the commencement of the improvements associated with DHHL's project as described in this EA.

Upon project completion, access to and egress from the site for all types of vehicles will be improved with respect to traffic operations and traffic safety. Project actions include minor improvements at the existing access point at the south extension of Pohakunui Avenue. The more significant improvement is the extension of Piliokahi Avenue to Farrington Highway. The existing intersection of Farrington Highway with the mauka extension of Piliokahi Avenue (which serves the homesteads that lie mauka of Farrington Highway) is signalized. The action to connect the makai portion of the Nanaikapono subdivision to this existing signalized intersection "would not adversely

affect traffic operations...and should increase traffic safety" (Earth Tech, Inc., 1998). Proposed improvements are expected to benefit area residents. No direct or measurable increase in traffic volumes is anticipated from the roadway and utility improvements.

With the completion of DHHL's project, the affected subdivision will be served by three access points, with signalization at two of those points (at the Laumania Avenue/Farrington Highway intersection and the Piliokahi Avenue/Farrington Highway intersection). Although "it is not desirable to have both intersections signalized, it was determined that the two intersections could be timed to minimize disruption to traffic flow along Farrington Highway" (Earth Tech, 1999).

Short-term and temporary impacts to circulation and traffic may occur from the operation and movement of slow-moving construction vehicles and equipment. Traffic in the immediate vicinity of proposed actions is expected to consist primarily of residents traveling to and from work during peak hours. Low traffic volumes exist during off-peak hours. Construction activities have the potential to generate minor impacts to traffic circulation within the immediate vicinity of project actions but will have no effect on the long-term future traffic volumes in the project area.

MITIGATION: Permits from the DPP and DOT will be required before work on any portion of the County street or State highway may begin. The Traffic Control Branch, DPP and DOT, must be notified prior to the start of work. Short-term traffic impacts during construction are expected to be controlled and directed as necessary to ensure public safety. Standard specifications for traffic control will be implemented during construction per the regulations and requirements in the following references:

- "Hawaii Administrative Rules Governing the Use of Traffic Control Devices at Work Sites or on Adjacent to Public Streets and Highways" adopted by the Division of Transportation; and
- "Manual on Uniform Traffic Control Devices for Streets and Highways, Part VI Traffic Controls for Street and Highway Maintenance Operations" as specified by the U.S. Federal Highway Administration.

Appropriate signs and barriers will be erected. All lanes must be open during the morning peak traffic period (5:30 AM to 8:30 AM) and afternoon peak period (3:30 PM to 6:30 PM). During the off-peak hours, only one (1) lane of Farrington Highway may be closed. The traffic signal system must be kept operational during construction. Off-duty police are expected to be provided for traffic control as required by the DPP and DOT. All driveways must be kept open unless the owners of the property are otherwise provided satisfactory alternative access and egress. After working hours, trenches will be covered with a non-skid bridging material and all lanes will be open. Provisions for pedestrian traffic will allow safe passage around any closed walkways.

4.13 Public Services and Facilities.

The proposed action is expected to generate no change or new demand for water, solid waste disposal, and electrical and communication services. No adverse short- or long-term impacts to water, wastewater, drainage, electrical and communication systems are anticipated since coordination with the appropriate agency will be accomplished and is required from the City and County of Honolulu in order to implement the proposed action. Approvals pertaining to utility systems are listed below:

- Building Permit for Electrical, Plumbing, Sidewalk/Driveway Work (City/County Department of Design & Construction, formerly the Building Department)
- Grading, Grubbing and Stockpiling Permit (City/County Department of Facility Maintenance, formerly the Department of Public Works)
- Water System (Board of Water Supply)
- Sewer Connection (City/County Department of Environmental Services, formerly the Department of Wastewater Management)

State and County approval and re-approval of infrastructure improvements including those pertaining to the drainage system are noted on the construction plans prepared by ATA. Furthermore, the Department of the Army in a letter dated 16 December 1998 states that "a Department of the Army permit will not be required for the project provided all of the drainage outlets remain above the higher high tide line."

The current proposals are based on ATAs plans. Changes to the previous proposals include the use of RCP culverts versus concrete box culverts, the realignment of the drainage system to an outlet within the adjacent Nanakuli Beach Park, the realignment of the southernmost drainage culvert to an outlet within the adjacent Piliokahe Beach Park, and the installation of a new water line section along the southern portion of Pohakunui Avenue. Other utility improvements are stated below.

- Water System. A new 8-inch water line section will be installed along the southern portion of Pohakunui Avenue and connected to existing water lines. This will extend the water system from the vicinity of the Piliokahi Avenue intersection to the southern end of Pohakunui Avenue. Existing 4- and 8-inch water lines, fire hydrants and water meters within the subdivision will be relocated if necessary due to road widening or other infrastructure improvements.
- Wastewater System. New 8-inch sewer lines and manholes will be installed along the four (4) avenues within the affected subdivision. Sewer laterals with advance riser connections will also be provided. This new sewer system is proposed to be connected to the Nanakuli Wastewater Pump Station. Sewer laterals are expected to be designed to account for site specific conditions such as multiple homes constructed on the lots, the location of existing cesspools, obstructions such as walls or concrete slabs and the addition of future services on the lots.
- Solid Waste Collection and Disposal. No change to the existing system is proposed.
- Drainage System. New 18-inch drain lines with catch basins will be installed along the lengths of Laumania, Keaulana and Pohakunui Avenues and along the northern portion of Piliokahi Avenue within the affected subdivision. A section of new 42-inch RCP culvert along Pohakunui Avenue will connect to an existing double 6-foot by 2-

foot box culvert in the mauka portion of the Nanaikapono subdivision and extend across Pohakunui Avenue to Farrington Highway. Drainage easements to be granted in favor of the City and County of Honolulu will allow storm water discharge at two (2) locations: at outlet A within the adjacent Nanakuli Beach Park and at outlet B within the adjacent Piliokahe Beach Park (refer to Figure 6). Collected storm water on the northern portion of the project site will drain via 18-inch and 30-inch RCP culverts to outlet A; storm water on the southern portion of the site will drain via 54-inch RCP culverts to outlet B.

- Electrical and Communication Systems. Wooden poles that distribute electrical, telecommunication and cable television services will be relocated as necessary due to roadway widening and utility improvements. Existing light fixtures will be removed. New 100W, 120-volt (V) High Pressure Sodium (HPS) luminaires on a 6-foot bracket arm with a 120/240V photocell and identification tag will be installed on the poles.

Completion of project actions will improve the water system and facilitate municipal wastewater collection and disposal service for the subdivision. Installation of a site drainage system and improvement of the lighting system are also considered to be benefits of the project.

MITIGATION: Coordination with the BWS for water system improvements and the Department of Facility Maintenance for acceptance and maintenance of the road and utilities, especially the drainage system, has been initiated. Installation of the new wastewater system and its connection to the Nanakuli Wastewater Pump Station will be coordinated with the Department of Environmental Services to ensure adequate service for expected demands. Approval from the DOH to accept the drainage system and any ocean outfalls or connections to an existing drain system, and for maintenance and coverage under the City and County of Honolulu General Permit will be obtained for the proposed action. During construction, the Contractor will be responsible for any solid waste that is generated by project actions and is expected to make the necessary arrangements for collection and disposal. The Contractor will be responsible for coordinating with HECO, GTE and AT&T for the relocation of any facilities.

4.14 Socio-Economic Conditions.

Proposed infrastructure improvements are expected to benefit the subdivision community and result in no significant adverse impacts to the population and socio-economic character of the area. Project actions include no additional homes or houselots within the populated Hawaiian homestead subdivision. Short-term construction employment and material expenses are expected to generate general excise tax and income tax revenues to the State of Hawaii. Area residents are expected to benefit from project actions aimed at the betterment of public health and safety. No mitigation is proposed or considered to be warranted.

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5.0 ALTERNATIVES TO THE PROPOSED ACTION

Two drainage improvement alternatives, two traffic signalization alternatives and the alternative of no action were considered but eliminated from further consideration. The following paragraphs present the pertinent discussions.

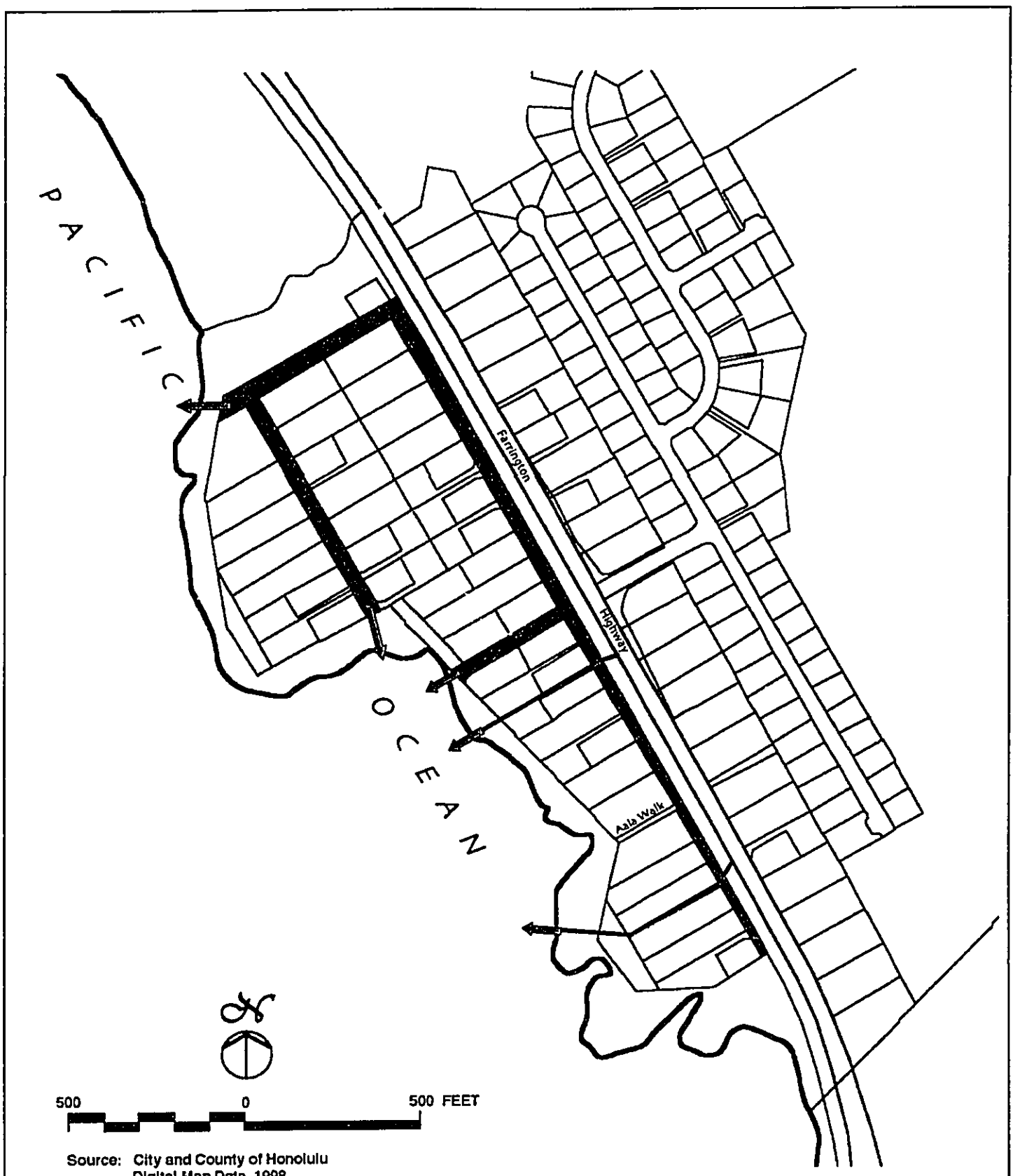
5.1 Drainage Improvement Alternatives.

5.1.1 ALTERNATIVE A.

This alternative would be to more closely follow the improvements indicated on ATA's plans. In particular, two (2) RCP culverts located along alternative alignments would be constructed as part of the site drainage system (see Figure 7). One (1) 42-inch RCP culvert would connect to the existing double 6-foot by 2-foot box culvert in the mauka portion of the Nanaikapono subdivision and extend across Pohakunui Avenue to Farrington Highway. This culvert would be generally parallel to and south of Piliokahi Avenue. The second RCP culvert would be located south of Aala Walkway. A proposed 24-inch RCP culvert would similarly connect to the existing 9-foot by 3.5-foot culvert within the portion of the subdivision that lies mauka of Farrington Highway. A total of five (5) drainage easements would be needed for storm water discharge at the terminations of Laumania Avenue, Keaulana Avenue, Piliokahi Avenue, the RCP culvert south of Piliokahi Avenue, and the RCP culvert south of Aala Walkway. This alternative would directly impact the properties of four (4) lessees in the area south of Piliokahi Avenue and two (2) lessees south of Aala Walkway. Storm water would be discharged from five (5) locations versus the two (-2) locations of the proposed project. The increased concerns associated with this alternative resulted in its elimination.

5.1.2 ALTERNATIVE B.

This alternative included a drainage system design with outlet structures at the ends of Laumania Avenue, Keaulana Avenue, Piliokahi Avenue and Aala Walk (see Figure 8). At an informal meeting held on 4 November 1998, the residents expressed concern regarding the location of the proposed outlet structures fronting the subdivision and their proximity to limu gathering areas and swimming and recreational areas used by the children. The decision was made by DHHL to investigate the feasibility of redesigning the drainage system to provide only two (2) outlets (as indicated in the proposed action discussed in this document). The drainage analysis determined that the system with two (2) outlets would be feasible. Both proposed outlets will be located within beach park shorelines; however, the outlet structures themselves would be located in areas that are inaccessible or rarely utilized by beach park users. Invert elevations of both outlets can be kept above the higher high tide line at approximately 2.5 feet. Despite the cost savings due to the elimination of the two (2) other outlet structures, the total coast of the drainage system would be higher due to the increase in pipe size and depth



Source: City and County of Honolulu
Digital Map Data, 1998

ENVIRONMENTAL ASSESSMENT
FOR
NANAIKAPONO SUBDIVISION UPGRADES
In Nanakuli, Oahu, Hawaii TMK: 8 – 9 – 06

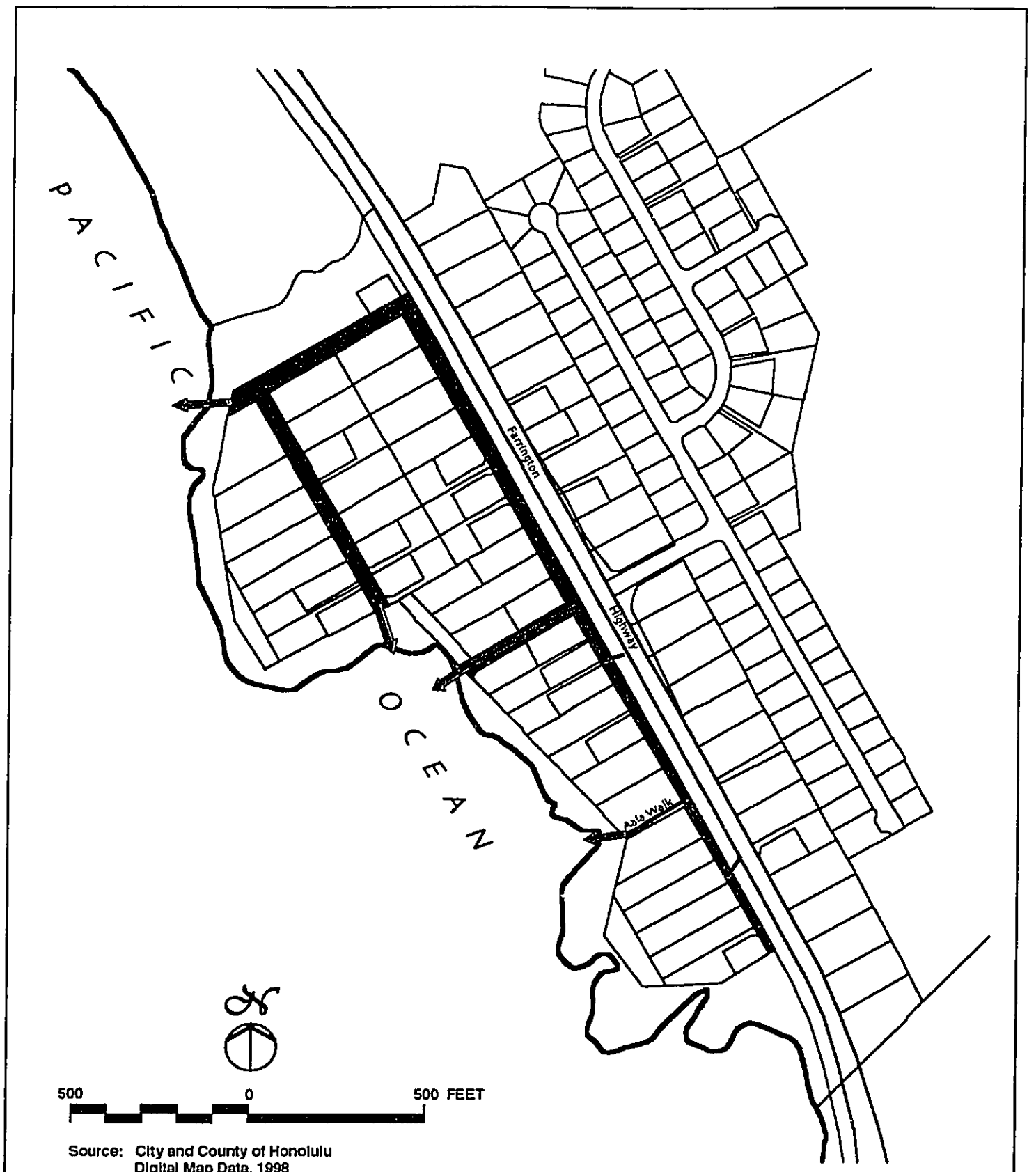
prepared for: Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

Figure 7

Alternative A
Drainage System Improvements

LEGEND
- NEW DRAINAGE SYSTEM AREA
- NEW RCP CULVERT
- TO DISCHARGE POINTS

prepared by: Wil Chee – Planning, Inc.



ENVIRONMENTAL ASSESSMENT
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prepared for: Earth Tech, Inc.
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Honolulu, Hawaii 96813

Figure 8

Alternative B
Drainage System Improvements

LEGEND
NEW DRAINAGE SYSTEM AREA
NEW RCP CULVERT
TO DISCHARGE POINTS

prepared by: Wil Chee – Planning, Inc.

of excavation for the drainline to the southeast. DHHL evaluated the additional cost relative to the efficiency of the design and welfare of the residents and the decision was made to proceed with the drainage system that requires only two (2) outlets.

5.2 Traffic Signalization Alternatives.

5.2.1 ALTERNATIVE A.

This alternative provides no signalized intersection for the affected portion of the Nanaikapono subdivision. Instead, only the two (2) existing access points for the subdivision (Laumania Avenue and the south extension of Pohakunui Avenue) would be improved. Specific improvements at the Laumania Avenue intersection would involve the following actions: the widening of the outbound approach of Laumania Avenue to two (2) lanes to provide separate left- and right-turn lanes; and the provision of a separate left-turn and deceleration lane on Farrington Highway to improve traffic safety. Similar improvements at the intersection of the south extension of Pohakunui Avenue with Farrington Avenue (e.g., widening of the outbound approach and provision of a separate left-turn and deceleration lane on Farrington Highway at this intersection) were considered. As indicated in the traffic improvement needs study (ETI, 1998), a separate left-turn lane on Farrington Highway may be difficult to implement due to highway geometry. Actions proposed for Alternative A would improve traffic safety; however, the provision of a signalized access is required to provide subdivision residents with acceptable levels of service. As a result of this determination, Alternative A was eliminated from consideration.

5.2.2 ALTERNATIVE B.

Under this alternative, the Laumania Avenue intersection would be improved but not signalized whereas the other improvements would be executed. At a meeting held with the DOT on 15 October 1998 it was confirmed that existing design projects included the signalization of the Laumania Avenue intersection. DOT stated that it would support the improvements at the Piliokahi Avenue and Farrington Highway intersection should DHHL decide to proceed with the improvements. The decision was made by DHHL to proceed with the intersection improvements at Piliokahi Avenue and Farrington Highway as recommended in the traffic analysis. Alternative B was subsequently eliminated because DOT decided to proceed with its project to signalize the existing Laumania Avenue intersection. It was determined that the two intersections could be timed to minimize disruptions to traffic flow along Farrington Highway.

5.3 No Action.

No action would result in no basic infrastructure improvements within the affected subdivision. Short- and long-term impacts, both beneficial and adverse, would not be generated if the project is not implemented. Under the no action alternative, the stated need for infrastructure improvements would not be met despite the apparent approval and acceptance of actions that would allow existing road and utility systems to conform to current City and County of Honolulu standards. Substandard road and utility systems would continue to serve the affected Hawaiian homestead subdivision. The threat to area residents from potentially hazardous traffic conditions at both access points to/from the subdivision would persist.

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6.0 FINDINGS AND DETERMINATIONS

The results of this assessment are that the negative impacts that have been identified in this document and discussed in Chapter 4.0 shall be adequately minimized by the suggested mitigation measures. The project as proposed is expected to result in no significant impact on the environment. It has been determined that an Environmental Impact Statement (EIS) is not required for the proposed project. A FONSI is anticipated, and a Negative Declaration is determined to be in order.

A review of the "Significance Criteria" used as a basis for the above determination is presented below. An action is determined to have a significant impact on the environment if it meets any one of the thirteen (13) criteria.

(1) *Involves an irrevocable commitment to loss or destruction of any natural or* cultural resources.

The proposed infrastructure improvements are expected to result in no loss or destruction of natural or cultural resources identified in Chapters 3.0 and 4.0 of this document because such resources at the site are limited. Mitigation measures that will be implemented to control erosion and runoff in the short- and long-term will also prevent, control or minimize potential impacts from the project. Measures to prevent, control and/or minimize impacts to historical and archaeological resources, if these are found to exist at the site, will also be implemented.

(2) Curtails the range of beneficial uses of the environment.

Completion of the proposed project will improve the basic infrastructure at the project site. This is considered to be a beneficial use on the project site and will result in the construction of permanent drainage and wastewater collection systems.

(3) Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 343, HRS; and any revisions thereof and amendments thereto, court decisions, or executive orders;

The proposed project is consistent with the environmental policies established in Chapter 344, HRS.

(4) Substantially affects the economic or social welfare of the community or state;

Completion of the proposed project is intended to improve the quality of life within the existing DHHL subdivision. Tax revenues at both the local and state levels will be generated. Development of the project will provide construction jobs. These impacts are all viewed as benefits of the proposed action.

(5) Substantially affects public health;

Anticipated water quality, air quality, noise quality and traffic impacts that may affect public health will be short-term and temporary. These impacts are generally unavoidable and necessary for construction. Mitigation measures will be employed to control and reduce unavoidable impacts. The overall long-term water quality, air quality, noise quality impacts resulting from the proposed project are expected to be minimal. Traffic improvements such as signalization are expected to improve traffic safety in the affected area.

(6) Involves substantial secondary impacts, such as population changes or effects on public facilities;

The proposed project itself will result in no population changes or effects on public facilities because no new homestead houselots will be created as a result of proposed infrastructure improvements.

(7) Involves a substantial degradation of environmental quality;

Implementation of the proposed infrastructure improvements will result in the installation of drainage and wastewater collection systems that will contribute to the improvement of the environmental quality within the affected area. With proposed street tree planting and the removal of abandoned cars, the visual character of the project will also be improved.

(8) Is individually limited but cumulatively has considerable effect on the environment, or involves a commitment for larger actions;

The proposed project helps to address the deficiencies of the existing infrastructure systems within the affected subdivision. The proposed project in the Rural District in an area zoned R-5 is consistent with State and local planning objectives and policies that presumably consider the effects on the environment. This project is not tied to a larger action.

(9) Substantially affects a rare, threatened or endangered species or its habitat;

No threatened or endangered or candidate threatened or endangered species or habitats exist within the project site.

(10) Detrimentally affects air or water quality or ambient noise levels;

Short-term and temporary impacts to water quality, air quality and noise quality are anticipated. These impacts are generally unavoidable and necessary for construction. Mitigation measures will be employed to control and reduce unavoidable impacts. The overall long-term water quality, air quality, and noise quality impacts resulting from the proposed project are expected to be minimal.

(11) Affects or is likely to suffer damage by being located in an environmentally sensitive area, such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, freshwater, or coastal waters;

Criteria for locations within the tsunami inundation zone and within flood zone X and D where the base flood elevations are undetermined apply; however, proposed infrastructure improvements are essentially related to the already existing DHHL subdivision.

(12) Substantially affects scenic vistas and view planes identified in county or state plans or studies;

Proposed infrastructure improvements that are primarily subsurface features will not affect significant aesthetic resources such as scenic vistas or view planes.

(13) Requires substantial energy consumption.

Proposed infrastructure improvements are not expected to require substantial energy consumption relative to other similar projects.

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7.0 REFERENCES CITED

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8.0 LIST OF PREPARERS

PREPARER	RESPONSIBILITIES	AFFILIATION
Lee, Doug	Project Manger	Earth Tech, Inc.
Hamamoto, Randy	Project Engineer	Earth Tech, Inc.
Chee, Wilbert C.F.	Principal, Senior Planner	Wil Chee - Planning, Inc.
Tom, Claire-Anne	Planner / Document Writer	Wil Chee - Planning, Inc.

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9.0 LIST OF INDIVIDUALS AND AGENCIES CONSULTED

Individuals

Casey, Abe, State of Hawaii, Department of Transportation, Highways Division
Gorospe, Ben, Commission on Persons with Disabilities
Hirayama, Mel, Department of Planning and Permitting, Traffic Review Branch
Kimura, Dawn, Department of Planning and Permitting, Civil Engineering Branch
Lennen, William, U.S. Army Corps of Engineers
Nishimura, Dennis, Department of Planning and Permitting, Wastewater Branch
Salmonson, Genevieve, Director, Office of Environmental Quality Control
Schlapak, Ben, Hawaiian Railway Society
Siu-Li, Mario, Department of Planning and Permitting, Subdivision Branch
Shiraishi, David, Department of Public Works, Refuse Collection
Swenson, Chris, U.S. Fish and Wildlife Service, Pacific Islands Office
Takakura, Mel, Department of Planning and Permitting, Civil Engineering Branch
Watanabe, Lance, Department of Planning and Permitting, Traffic Review Branch
Winn, Johnathan, State of Hawaii, Department of Transportation, Highways Division

Agencies

Federal Government
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service, Pacific Islands Office

State of Hawaii
- Commission on Persons with Disabilities
- Department of Hawaiian Home Lands
- Department of Land and Natural Resources
- Department of Transportation
- Office of Environmental Quality Control
- Office of Hawaiian Affairs

City and County of Honolulu
- Board of Water Supply
- Department of Design and Construction
- Department of Parks and Recreation
- Department of Planning and Permitting
- Department of Environmental Services

Organizations

AT&T
GTE Hawaiian Tel
Hawaiian Electric Company
Hawaiian Railway Society
Hui Malama I Na Kupuna (consulting group to DLNR)
Malama Nanakuli Ahupua'a (consulting group to DLNR)
Nanakuli Neighborhood Board
Ocean Cable
The Gas Company

The community meeting was held on November 8, 1998, during which time the project was discussed and attendees were given the opportunity to provide their input.

Appendix A

Comments from Consulted Parties

WIL CHEE - PLANNING, INC.

December 6, 2000

Ms. Genevieve Salmonson, Director
State of Hawaii Office of Environmental Quality Control
235 South King Street, Suite 702
Honolulu, HI 96813

Subject: Draft Environmental Assessment (DEA) for the Nanaikapono Subdivision Upgrades

Ms. Salmonson:

Enclosed, please find the itemized responses to comments from the Office of Environmental Quality (OEQC) excerpted from the letter addressed to Mr. Patrick Young dated October 23, 2000. A Final Environmental Assessment (FEA) that incorporates the responses to comments from OEQC will be submitted. To our knowledge, no other agencies, organizations, or individuals submitted written comments on the DEA.

Comments from OEQC are italicized and the corresponding responses are hereby provided.

Item 1. *SUSTAINABLE BUILDING. Plans for building and campus design should incorporate the provisions contained in the Environmental Council's "Guidelines for Sustainable Building Design Hawai'i" (enclosed) especially with respect to the use of renewable energy resources such as solar power.*

Not Applicable. The proposed project involves road and utility improvements only. No new structures are planned.

Item 2. *BURIED ELECTRICAL LINES. When water and sewer lines are relocated, how feasible is it to put electrical lines underground?*

An additional $600,000 would be required to provide underground electrical lines. This additional item would be cost prohibitive for the project.

Item 3. *CONSULTATION. People living in the subdivision are not listed as being consulted. Please describe any and all consultation efforts which have taken place and discuss the impacts that the project will have on these individuals.*

A community meeting was held on November 8, 1998. At that time attendees were briefed on the proposed improvements and given an opportunity to comment. Proposed improvements are expected to directly benefit the residents of the Nanaikapono subdivision.

Land Use Planners and Environmental Consultants
1MSA Center • 1400 Rycroft Street • Suite # 920 • Honolulu, Hawaii 96814 • Phone 808-955-8008 • Fax 808-942-1651 • E-Mail wcp@aloha.net

Item 4. *USE OF NATIVE XEROPHYTES IN LANDSCAPING. On page 6 of the Draft EA, we note that several non-native species are proposed for tree planting. The region is relatively dry. To conserve on water use, we would like to suggest the use of native Hawaiian xerophytic vegetation in landscaping the campus. Please consult with a botanist with the City Parks Department.*

With regards to the use of native xerophytes landscaping, the materials chosen were based on their ability to tolerate the hot, dry environmental conditions of the site. The selected tree types have proven to grow in even harsher local conditions such as Kahuku and Laie.

The landscape architect for the project supports the use of native Hawaiian trees in the landscape; however, his concern pertains to the availability of suggested native xerophytes in street tree sizes (5 gal. to 25 gal.) and quantities needed, as well as their ability to "survive" in very limited planter space (3 ft. by 3 ft.).

Per consultation with the Department of Planning and Permitting, Urban Design Branch, "haole kou" trees were revised to "true kou" trees that are native to Hawaii and listed as an approved City and County of Honolulu street tree.

Item 5. *RECYCLABLE PRODUCTS. To promote recycling, we suggest the use of recyclable products such as plastic lumber for fences, etc. Also, we would like to suggest that roadways be surfaced with "glasphalt," an aggregate of glass and asphalt.*

The City and County will maintain improved roads under an agreement with the Department of Hawaiian Home Lands. Current City standards do not provide for the use of glasphalt for a finished road surface. Required improvements to existing walls and fences will be performed using like materials to match existing conditions.

The City approves the use of glasphalt for base course material; however, the project does not specify the need for an asphalt treated base course and would incur unnecessary additional cost to use glasphalt as a substitute for untreated basalt base course.

Item 6. *CULTURAL AND HISTORICAL CHARACTERISTICS. Please consult with the Office of Hawaiian Affairs, the Nanakuli Neighborhood Board, Hui Malama I Na Kupuna and Malama Nanakuli Ahupua'a as to cultural uses in and surrounding the property. Pursuant to Act 50, SLH 2000, assess all direct, indirect and cumulative effects the project may have on cultural practices or sites.*

The Nanakuli Neighborhood Board was sent a copy of the Draft EA. No comments have been received to date. The Office of Hawaiian Affairs is a state agency in receipt of state notices and provided no comment to date. Hui Malama and Malama Nankuli are consulting groups to the Department of Land and Natural Resources who have provided their comments on the project.

We hope you concur with our responses. Should you have any additional questions regarding the project or this letter of response, please contact Randy Hamamoto or Doug Lee of Earth Tech, Inc.

Sincerely,

Claire Tom

Claire Tom
Planner

BENJAMIN J. CAYETANO
GOVERNOR

GENEVIEVE SALMONSON
DIRECTOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

October 23, 2000

Mr. Patrick Young
Department of Hawaiian Home Lands
State of Hawai'i
1099 Alakea Street, 12th Floor
Honolulu, Hawai'i 96813

Dear Mr. Young:

We have reviewed your draft environmental assessment for the "Nanaikapono Subdivision Upgrades" and offer the following comments for your response and consideration.

1. **SUSTAINABLE BUILDING.** Plans for building and campus design should incorporate the provisions contained in the Environmental Council's "Guidelines for Sustainable Building Design in Hawai'i" (enclosed) especially with respect to the use of renewable energy resources such as solar power.
2. **BURIED ELECTRICAL LINES.** When water and sewer lines are relocated, how feasible is it to put electrical lines underground?
3. **CONSULTATION.** People living in the subdivision are not listed as being consulted. Please describe any and all consultation efforts which have taken place and discuss the impacts that the project will have on these individuals.
4. **USE OF NATIVE XEROPHYTES IN LANDSCAPING.** On page 6, we note that several non-native species are proposed for tree planting. The region is relatively dry. To conserve on water use, we would like to suggest the use of native Hawaiian xerophytic vegetation in landscaping the campus. Please consult with a botanist with the City Parks Department.
5. **USE OF RECYCLABLE PRODUCTS.** To promote recycling, we suggest the use of recyclable products such as plastic lumber for fences, etc. Also, we would like to suggest that roadways be surfaced with "glasphalt," an aggregate of glass and asphalt.
6. **CULTURAL AND HISTORICAL CHARACTERISTICS.** Please consult with the Office of Hawaiian Affairs, the Nanakuli Neighborhood Board, Hui Malama I Na Kupuna and Malama Nanakuli Ahupua'a as to cultural uses in and surrounding the property. Pursuant to Act 50, SLH 2000, assess all direct, indirect and cumulative effects the project may have on cultural practices or sites.

If you have any questions, please call Leslie Segundo at 586-4185. Thank you for the opportunity to comment.

Sincerely,

GENEVIEVE SALMONSON
Director
Enclosures

c: Douglas Lee, Earth Tech

UNOFFICIAL VERSION

HOUSE OF REPRESENTATIVES
TWENTIETH LEGISLATURE, 2000
STATE OF HAWAII

H.B. NO. 2895 H.D. 1

A BILL FOR AN ACT

RELATING TO ENVIRONMENTAL IMPACT STATEMENTS.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that there is a need to clarify that the preparation of environmental assessments or environmental impact statements should identify and address effects on Hawaii's culture, and traditional and customary rights.

The legislature also finds that native Hawaiian culture plays a vital role in preserving and advancing the unique quality of life and the "aloha spirit" in Hawaii. Articles IX and XII of the state constitution, other state laws, and the courts of the State impose on government agencies a duty to promote and protect cultural beliefs, practices, and resources of native Hawaiians as well as other ethnic groups.

Moreover, the past failure to require native Hawaiian cultural impact assessments has resulted in the loss and destruction of many important cultural resources and has interfered with the exercise of native Hawaiian culture. The legislature further finds that due consideration of the effects of human activities on native Hawaiian culture and the exercise thereof is necessary to ensure the continued existence, development, and exercise of native Hawaiian culture.

The purpose of this Act is to: (1) Require that environmental impact statements include the disclosure of the effects of a proposed action on the cultural practices of the community and State; and (2) Amend the definition of "significant effect" to include adverse effects on cultural practices.

SECTION 2. Section 343-2, Hawaii Revised Statutes, is amended by amending the definitions of "environmental impact statement" or "statement" and "significant effect", to read as follows:

""Environmental impact statement" or "statement" means an informational document prepared in compliance with the rules adopted under section 343-6 and which discloses the environmental effects of a proposed action, effects of a proposed action on the economic [and] welfare, social welfare, and cultural practices of the community and State, effects of the economic activities arising out of the proposed action, measures proposed to minimize adverse effects, and alternatives to the action and their environmental effects.

The initial statement filed for public review shall be referred to as the draft statement and shall be distinguished from the final statement which is the document that has incorporated the public's comments and the responses to those comments. The final statement is the document that shall be evaluated for acceptability by the respective accepting authority.

"Significant effect" means the sum of effects on the quality of the environment, including actions that irrevocably commit a natural resource, curtail the range of beneficial uses of the environment, are contrary to the State's environmental policies or long-term environmental goals as established by law, or adversely affect the economic [or] welfare, social welfare[.], or cultural practices of the community and State."

SECTION 3. Statutory material to be repealed is bracketed. New statutory material is underscored.

SECTION 4. This Act shall take effect upon its approval.

Approved by the Governor as Act 50 on April 26, 2000

GUIDELINES FOR ASSESSING CULTURAL IMPACTS
Adopted by the Environmental Council, State of Hawaii
November 19, 1997

I. INTRODUCTION

It is the policy of the State of Hawaii under Chapter 343, HRS, to alert decision makers, through the environmental assessment process, about significant environmental effects which may result from the implementation of certain actions. An environmental assessment of cultural impacts gathers information about cultural practices and cultural features that may be affected by actions subject to Chapter 343, and promotes responsible decision making. Articles IX and XII of the State Constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices, and resources of native Hawaiians and other ethnic groups. Chapter 343 also requires environmental assessment of cultural resources, in determining the significance of a proposed project.

The Environmental Council encourages preparers of environmental assessments and environmental impact statements to analyze the impact of a proposed action on cultural practices and features associated with the project area. The Council provides the following methodology and content protocol as guidance for any assessment of a project that may significantly affect cultural resources.

II. CULTURAL IMPACT ASSESSMENT METHODOLOGY

Cultural impacts differ from other types of impacts assessed in environmental assessments or environmental impact statements. A cultural impact assessment includes information relating to the practices and beliefs of a particular cultural or ethnic group or groups.

Such information may be obtained through scoping, community meetings, ethnographic interviews and oral histories. Information provided by knowledgeable informants, including traditional cultural practitioners, can be applied to the analysis of cultural impacts in conjunction with information concerning cultural practices and features obtained through consultation and from documentary research.

In scoping the cultural portion of an environmental assessment, the geographical extent of the inquiry should, in most instances, be greater than the area over which the proposed action will take place. This is to ensure that cultural practices which may not occur within the boundaries of the project area, but which may nonetheless be affected, are included in the assessment. Thus, for example, a proposed action that may not physically alter gathering practices, but may affect access to gathering areas would be included in the assessment. An ahupua'a is usually the appropriate geographical unit to begin an assessment of cultural impacts of a proposed action, particularly if it includes all of the types of cultural practices associated with the project area. In some cases, cultural practices are likely to extend beyond the ahupua'a and the geographical extent of the study area should take into account those cultural practices.

The historical period studied in a cultural impact assessment should commence with the initial presence in the area of the particular group whose cultural practices and features are being assessed. The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs.

The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man made and natural, including submerged cultural resources, which support such cultural practices and beliefs.

The Environmental Council recommends that preparers of assessments analyzing cultural impacts adopt the following protocol:

(1) identify and consult with individuals and organizations with expertise concerning the types of cultural resources, practices and beliefs found within the broad geographical area, e.g., district or ahupua'a;

(2) identify and consult with individuals and organizations with knowledge of the area potentially affected by the proposed action;

(3) receive information from or conduct ethnographic interviews and oral histories with persons having knowledge of the potentially affected area;

(4) conduct ethnographic, historical, anthropological, sociological, and other culturally related documentary research;

(5) identify and describe the cultural resources, practices and beliefs located within the potentially affected area; and

(6) assess the impact of the proposed action, alternatives to the proposed action, and mitigation measures, on the cultural resources, practices and beliefs identified.

Interviews and oral histories with knowledgeable individuals may be recorded, if consent is given, and field visits by preparers accompanied by informants are encouraged. Persons interviewed should be afforded an opportunity to review the record of the interview, and consent to publish the record should be obtained whenever possible. For example, the precise location of human burials are likely to be withheld from a cultural impact assessment, but it is important that the document identify the impact a project would have on the burials. At times an informant may provide information only on the condition that it remain in confidence. The wishes of the informant should be respected.

Primary source materials reviewed and analyzed may include, as appropriate: Mahele, land court, census and tax records, including testimonies; vital statistics records; family histories and genealogies; previously published or recorded ethnographic interviews and oral histories; community studies, old maps and photographs; and other archival documents, including correspondence, newspaper or almanac articles, and visitor journals. Secondary source materials such as historical, sociological, and anthropological texts, manuscripts, and similar materials, published and unpublished, should also be consulted. Other materials which should be examined include prior land use proposals, decisions, and rulings which pertain to the study area.

III. CULTURAL IMPACT ASSESSMENT CONTENTS

In addition to the content requirements for environmental assessments and environmental impact statements, which are set out in HAR §§ 11-200-10 and 16 through 18, the portion of the assessment concerning cultural impacts should address, but not necessarily be limited to, the following matters:

1. A discussion of the methods applied and results of consultation with individuals and organizations identified by the preparer as being familiar with cultural practices and features associated with the project area, including any constraints or limitations which might have affected the quality of the information obtained.

2. A description of methods adopted by the preparer to identify, locate, and select the persons interviewed, including a discussion of the level of effort undertaken.

3. Ethnographic and oral history interview procedures, including the circumstances under which the interviews were conducted, and any constraints or limitations which might have affected the quality of the information obtained.

4. Biographical information concerning the individuals and organizations consulted, their particular expertise, and their historical and genealogical relationship to the project area, as well as information concerning the persons submitting information or interviewed, their particular knowledge and cultural expertise, if any, and their historical and genealogical relationship to the project area.

5. A discussion concerning historical and cultural source materials consulted, the institutions and repositories searched, and the level of effort undertaken. This discussion should include, if appropriate, the particular perspective of the authors, any opposing views, and any other relevant constraints, limitations or biases.

6. A discussion concerning the cultural resources, practices and beliefs identified, and, for resources and practices, their location within the broad geographical area in which the proposed action is located, as well as their direct or indirect significance or connection to the project site.

7. A discussion concerning the nature of the cultural practices and beliefs, and the significance of the cultural resources within the project area, affected directly or indirectly by the proposed project.

8. An explanation of confidential information that has been withheld from public disclosure in the assessment.

9. A discussion concerning any conflicting information in regard to identified cultural resources, practices and beliefs.

10. An analysis of the potential effect of any proposed physical alteration on cultural resources, practices or beliefs; the potential of the proposed action to isolate cultural resources, practices or beliefs from their setting; and the potential of the proposed action to introduce elements which may alter the setting in which cultural practices take place.

11. A bibliography of references, and attached records of interviews which were allowed to be disclosed.

The inclusion of this information will help make environmental assessments and environmental impact statements complete and meet the requirements of Chapter 343, HRS. If you have any questions, please call us at 586-4185.

Guidelines for Sustainable Building Design in Hawai`i

A planner's checklist

(Adopted by the Environmental Council on October 13, 1999)

Introduction

Hawai`i law calls for efforts to conserve natural resources, promote efficient use of water and energy and encourage recycling of waste products. Planning a project from the very beginning to include sustainable design concepts can be a critical step toward meeting these goals.

The purpose of the state's environmental review law (HRS Ch. 343) is to encourage a full, accurate and complete analysis of proposed actions, promote public participation and support enlightened decision making by public officials. The Office of Environmental Quality Control offers the following guidelines for preparers of environmental reviews under the authority of HRS 343 to assist agencies and applicants in meeting these goals.

These guidelines do not constitute rules or law. They have been refined by staff and peer review to provide a checklist of items that will help the design team create projects that will have a minimal impact on Hawai`i's environment and make wise use of our natural resources. In a word, projects that are *sustainable*.

A sustainable building is built to minimize energy use, expense, waste, and impact on the environment. It seeks to improve the region's sustainability by meeting the needs of Hawai`i's residents and visitors today without compromising the needs of future generations. Compared to conventional projects, a resource-efficient building project will:

I. Use less energy for operation and maintenance
II. Contain less *embodied* energy (e.g. locally produced building products often contain less *embodied* energy than imported products because they require less energy-consuming transportation.)
III. Protect the environment by preserving/conserving water and other natural resources and by minimizing impact on the site and ecosystems
IV. Minimize health risks to those who construct, maintain, and occupy the building
V. Minimize construction waste
VI. Recycle and reuse generated construction wastes
VII. Use resource-efficient building materials (e.g. materials with recycled content and low embodied energy, and materials that are recyclable, renewable, environmentally benign, non-toxic, low VOC (Volatile Organic Compound) emitting, durable, and that give high life cycle value for the cost.)
VIII. Provide the highest quality product practical at competitive (affordable) first and life cycle costs.

In order to avoid excessive overlapping of items, the checklist is designed to be read in totality, not just as individual sections. This checklist tries to address a range of project types, large scale as well as small scale. Please use items that are appropriate to the type and scale of the project.

Although this list will help promote careful and sensitive planning, mere compliance with this checklist does not confirm sustainability. Compliance with and knowledge of current building codes by users of this checklist is also required.

TABLE OF CONTENTS

I. Pre Design

___1. Hold programming team meeting with client representative, Project Manager, planning consultant, architectural consultant, civil engineer, mechanical, electrical, plumbing (MEP) engineer, structural engineer, landscape architect, interior designer, sustainability consultant and other consultants as required by the project. Identify project and sustainability goals. Client representatives and consultants need to work together to ensure that project and environmental goals are met.

___2. Develop sustainable guideline goals to insert into outline specifications as part of the Schematic Design documents. Select goals from the following sections that are appropriate for the project.

___3. Use Cost-Benefit Method for economic analysis of the sustainability measures chosen. (Cost-Benefit Method is a method of evaluating project choices and investments by comparing the present and life cycle value of expected benefits to the present and life cycle value of expected costs.)

___4. Include "Commissioning" in the project budget and schedule. (Building "Commissioning" is the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained in accordance with specifications that meet the owner's needs, and recognize the owner's financial and operational capacity. It improves the performance of the building systems, resulting in energy efficiency and conservation, improved air quality and lower operation costs. *Refer to Section IX.*)

II. Site Selection & Site Design

A. Site Selection

___1. Analyze and assess site characteristics such as vegetation, topography, geology, climate, natural access, solar orientation patterns, water and drainage, and existing utility and transportation infrastructure to determine the appropriate use of the site.

___2. Whenever possible, select a site in a neighborhood where the project can have a positive social, economic and/or environmental impact.

___3. Select a site with short connections to existing municipal infrastructure (sewer lines, water, waste water treatment plant, roads, gas, electricity, telephone, data communication lines and services). Select a site close to mass transportation, bicycle routes and pedestrian access.

B. Site Preparation and Design

___1. Prepare a thorough existing conditions topographic site plan depicting topography, natural and built features, vegetation, location of site utilities and include solar information,

rainfall data and direction of prevailing winds. Preserve existing resources and natural features to enhance the design and add aesthetic, economic and practical value. Design to minimize the environmental impact of the development on vegetation and topography.

___2. Site building(s) to take advantage of natural features and maximize their beneficial effects. Provide for solar access, daylighting and natural cooling. Design ways to integrate the building(s) with the site that maximizes and preserves positive site characteristics, enhances human comfort, safety and health, and achieves operational efficiencies.

___3. Locate building(s) to encourage bicycle and pedestrian access and pedestrian oriented uses. Provide bicycle and pedestrian paths, bicycle racks, etc. Racks should be visible and accessible to promote and encourage bicycle commuting.

___4. Retain existing topsoil and maintain soil health by clearing only the areas reserved for the construction of streets, driveways, parking areas, and building foundations. Replant exposed soil areas as soon as possible. Reuse excavated soils for fill and cut vegetation for mulch.

___5. Grade slopes to a ratio of less than 2 : 1 (run to rise). Balance cut and fill to eliminate hauling. Check grading frequently to prevent accidental over excavation.

___6. Minimize the disruption of site drainage patterns. Provide erosion and dust controls, positive site drainage, and siltation basins as required to protect the site during and after construction, especially, in the event of a major storm.

___7. Minimize the area required for the building footprint. Consolidate utility and infrastructure in common corridors to minimize site degradation, and cost, improve efficiency, and reduce impermeable surfaces.

___8. For termite protection, use non toxic alternatives to pesticides and herbicides, such as Borate treated lumber, Basaltic Termite Barrier, stainless steel termite barrier mesh, and termite resistant materials.

III. Building Design

___1. Consider adaptive re-use of existing structures instead of demolishing and/or constructing a new building. Consult the State Historic Preservation Officer for possible existing historic sites that may meet the project needs.

___2. Plan for high flexibility while designing building shell and interior spaces to accommodate changing needs of the occupants, and thereby extend the life span of the building.

___3. Design for re-use and/or disassembly. (For recyclable and reusable building products, see Section VII).

___4. Design space for recycling and waste diversion opportunities during occupancy.

___5. Provide facilities for bicycle and pedestrian commuters (showers, lockers, bike racks, etc.) in commercial areas and other suitable locations.

___6. Plan for a comfortable and healthy work environment. Include inviting outdoor spaces, wherever possible. *(Refer to Section VIII.)*

___7. Provide an Integrated Pest Management approach. The use of products such as Termi-mesh, Basaltic Termite Barrier and the Sentricon "bait" system can provide long term protection from termite damage and reduce environmental pollution.
___8. Design a building that is energy efficient and resource efficient. *(See Sections IV, V, VII.)* Determine building operation by-products such as heat gain and build up, waste/gray-water and energy consumption, and plan to minimize them or find alternate uses for them.
___9. For natural cooling, use
   a. Reflective or light colored roofing, radiant barrier and/or insulation, roof vents
   b. Light colored paving (concrete) and building surfaces
   c. Tree Planting to shade buildings and paved areas
   d. Building orientation and design that captures trade winds and/or provides for convective cooling of interior spaces when there is no wind.

IV. Energy Use

___1. Obtain a copy of the State of Hawai'i Model Energy Code (available through the Hawai'i State Energy Division, at Tel. 587-3811). Exceed its requirements. (Contact local utility companies for information on tax credits and utility-sponsored programs offering rebates and incentives to businesses for installing qualifying energy efficient technologies.)
___2. Use site sensitive orientation to :
   a. Minimize cooling loads through site shading and carefully planned east-west orientation.
   b. Incorporate natural ventilation by channeling trade winds.
   c. Maximize daylighting.
___3. Design south, east and west shading devices to minimize solar heat gain.
___4. Use spectrally selective tints or spectrally selective low-e glazing with a Solar Heat Gain Coefficient (SHGC) of 0.4 or less.
___5. Minimize effects of thermal bridging in walls, roofs and window systems.
___6. Maximize efficiencies for lighting, Heating, Ventilation, Air Conditioning (HVAC) systems and other equipment. Use insulation and/or radiant barriers, natural ventilation, ceiling fans and shading to avoid the use of air conditioning whenever appropriate.
___7. Eliminate hot water in restrooms when possible.
___8. Provide tenant sub-metering to encourage utility use accountability.
___9. Use renewable energy. Use solar water heaters and consider the use of photovoltaics and Building Integrated Photovoltaics (BIPV).
__10. Use available energy resources such as waste heat recovery, when feasible.

A. Lighting

___1. Design for at least 15% lower interior lighting power allowance than the Energy Code.
___2. Select lamps and ballasts with the highest efficiency, compatible with the desired level of illumination and color rendering specifications. Examples that combine improved color rendering with efficient energy use include compact flourescents and T8 flourescents that use tri-phosphor gases.
___3. Select lighting fixtures which maximize system efficacy and which have heat removal capabilities
___4. Reduce light absorption on surfaces by selecting colors and finishes that provide high reflectance values without glare.
___5. Use task lighting with low ambient light levels.
___6. Maximize daylighting through the use of vertical fenestration, light shelves, skylights, clerestories, building form and orientation as well as through translucent or transparent interior partitions. Coordinate daylighting with electrical lighting for maximum electrical efficiency.
___7. Incorporate daylighting controls and/or motion activated light controls in low or intermittent use areas.
___8. Avoid light spillage in exterior lighting by using directional fixtures.
___9. Minimize light overlap in exterior lighting schemes.
__10. Use lumen maintenance procedures and controls.

B. Mechanical Systems

___1. Design to comply with the Energy Code and to exceed its efficiency requirements.
___2. Use "Smart Building" monitor/control systems when appropriate.
___3. Utilize thermal storage for reduction of peak energy usage.
___4. Use Variable air volume systems to save fan power.
___5. Use variable speed drives on pumping systems and fans for cooling towers and air handlers.
___6. Use air-cooled refrigeration equipment or use cooling towers designed to reduce drift.
___7. Specify premium efficiency motors.
___8. Reduce the need for mechanical ventilation by reducing sources of indoor air pollution. Use high efficiency air filters and ultraviolet lamps in air handling units. Provide for regular maintenance of filtration systems. Use ASHRAE standards as minimum.
___9. Locate fresh air intakes away from polluted or overheated areas. Locate on roof where possible. Separate air intake from air exhausts by at least 40 ft.
__10. Use separate HVAC systems to serve areas that operate on widely differing schedules and/or design conditions.
__11. Use shut off or set back controls on HVAC system when areas are not occupied.
__12. Use condenser heat, waste heat or solar energy. (Contact local utility companies for information on the utility-sponsored Commercial and Industrial Energy Efficiency

Programs which offer incentives to businesses for installing qualifying energy efficient technologies.)

__13. Evaluate plug-in loads for energy efficiency and power saving features.
__14. Improve comfort and save energy by reducing the relative humidity by waste reheat, heat pipes or solar heat.
__15. Minimize heat gain from equipment and appliances by using:
  a. Environmental Protection Agency (EPA) Energy Star rated appliances.
  b. Hoods and exhaust fans to remove heat from concentrated sources.
  c. High performance water heating that exceeds the Energy Code requirements.
__16. Specify HVAC system "commissioning" period to reduce occupant exposure to Indoor Air Quality (IAQ) contaminants and to maximize system efficiency.

V. Water Use

A. Building Water

___1. Install water conserving, low flow fixtures as required by the Uniform Plumbing Code.
___2. If practical, eliminate hot water in restrooms.
___3. Use self closing faucets (infrared sensors or spring loaded faucets) for lavatories and sinks.

B. Landscaping and Irrigation

(See Section VI.)

VI. Landscape and Irrigation

___1. Incorporate water efficient landscaping (xeriscaping) using the following principles:
  a. Planning, Efficient irrigation: Create watering zones for different conditions. Separate vegetation types by watering requirements. Install moisture sensors to prevent operation of the irrigation system in the rain or if the soil has adequate moisture. Use appropriate sprinkler heads.
  b. Soil analysis/improvement: Use (locally made) soil amendments and compost for plant nourishment, improved water absorption and holding capacity.
  c. Appropriate plant selection: Use drought tolerant and/or slow growing hardy grasses, native and indigenous plants, shrubs, ground covers, trees, appropriate for local conditions, to minimize the need for irrigation.
  d. Practical turf areas: Turf only in areas where it provides functional benefits.

  e. Mulches: Use mulches to minimize evaporation, reduce weed growth and retard erosion.

Contact the local Board of Water Supply for additional information on xeriscaping such as efficient irrigation, soil improvements, mulching, lists of low water-demand plants, tours of xeriscaped facilities, and xeriscape classes.

___2. Protect existing beneficial site features and save trees to prevent erosion. Establish and carefully mark tree protection areas well before construction.
___3. Limit staging areas and prevent unnecessary grading of the site to protect existing, especially native, vegetation.
___4. Use top soil from the graded areas, stockpiled on the site and protected with a silt fence to reduce the need for imported top soil.
___5. Irrigate with non-potable water or reclaimed water when feasible. Collect rainwater from the roof for irrigation.
___6. Sub-meter the irrigation system to reduce water consumption and consequently water and sewer fees. Contact the local county agency to obtain irrigation sub-metering requirements and procedures. Locate irrigation controls within sight of the irrigated areas to verify that the system is operating properly.
___7. Use pervious paving instead of concrete or asphalt paving. Use natural and man-made berms, hills and swales to control water runoff.
___8. Avoid the use of solvents that contain or leach out pollutants that can contaminate the water resources and runoff. Contact the State of Hawai'i Clean Water Branch at 586-4309 to determine whether a NPDES (National Pollutant Discharge Elimination System) permit is required.
___9. Use Integrated Pest Management (IPM) techniques. IPM involves a carefully managed use of biological and chemical pest control tactics. It emphasizes minimizing the use of pesticides and maximizing the use of natural process
__10. Use trees and bushes that are felled at the building site (i.e. mulch, fence posts). Leave grass trimmings on the lawn to reduce green waste and enhance the natural health of lawns.
__11. Use recycled content, decay and weather resistant landscape materials such as plastic lumber for planters, benches and decks.

VII. Building Materials & Solid Waste Management

A. Material Selection and Design

___1. Use durable products.
___2. Specify and use natural products or products with low embodied energy and/or high recycled content. Products with recycled content include steel, concrete with glass,

drywall, carpet, etc. Use ground recycled concrete, graded glass cullet or asphalt as base or fill material.

___3. Specify low toxic or non-toxic materials whenever possible, such as low VOC (Volatile Organic Compounds) paints, sealers and adhesives and low or formaldehyde-free materials. Do not use products with CFCs (Chloro-fluoro-carbons).

___4. Use locally produced products such as plastic lumber, insulation, hydro-mulch, glass tiles, compost.

___5. Use advanced framing systems that reduce waste, two stud corners, engineered structural products and prefabricated panel systems.

___6. Use materials which require limited or no application of finishing or surface preparation. (i.e. finished concrete floor surface, glass block and glazing materials, concrete block masonry, etc.).

___7. Use re-milled salvaged lumber where appropriate and as available. Avoid the use of old growth timber.

___8. Use sustainably harvested timber.

___9. Commit to a material selection program that emphasizes efficient and environmentally sensitive use of building materials, and that uses locally available building materials. (A list of Earth friendly products and materials is available through the Green House Hawai`i Project. Call Clean Hawai`i Center, Tel. 587-3802 for the list.)

B. Solid Waste Management, Recycling and Diversion Plan

___1. Prepare a job-site recycling plan and post it at the job-site office.

___2. Conduct pre-construction waste minimization and recycling training for employees and sub-contractors.

___3. Use a central area for all cutting.

___4. Establish a dedicated waste separation/diversion area. Include Waste/Compost/Recycling collection areas and systems for use during construction process and during the operational life cycle of the building.

___5. Separate and divert all unused or waste cardboard, ferrous scrap, construction materials and fixtures for recycling and/or forwarding to a salvage exchange facility. Information on "Minimizing C&D (construction and demolition) waste in Hawai`i" is available through Department of Health, Office of Solid Waste Management, Tel. 586-4240.

___6. Use all green waste, untreated wood and clean drywall on site as soil amendments or divert to offsite recycling facilities.

___7. Use concrete and asphalt rubble on-site or forward the material for offsite recycling.

___8. Carefully manage and control waste solvents, paints, sealants, and their used containers. Separate these materials from C&D (construction and demolition) waste and store and dispose them of them carefully.

___9. Donate unused paint, solvents, sealants to non-profit organizations or list on HIMEX (Hawai`i Materials Exchange). HIMEX is a free service operated by Maui Recycling

Group, that offers an alternative to landfill disposal of usable materials, and facilitates no-cost trades. See web site, www.himex.org.

__10. Use suppliers that re-use or recycle packaging material whenever possible.

VIII. Indoor Air Quality

___1. Design an HVAC system with adequate supply of outdoor air, good ventilation rates, even air distribution, sufficient exhaust ventilation and appropriate air cleaners.

___2. Develop and specify Indoor Air Quality (IAQ) requirements during design and contract document phases of the project. Monitor compliance in order to minimize or contain IAQ contaminant sources during construction, renovation and remodeling.

___3. Notify occupants of any type of construction, renovation and remodeling and the effects on IAQ.

___4. Inspect existing buildings to determine if asbestos and lead paint are present and arrange for removal or abatement as needed.

___5. Supply workers with, and ensure the use of VOC (Volatile Organic Compounds)-safe masks where required.

___6. Ensure that HVAC systems are installed, operated and maintained in a manner consistent with their design. Use UV lamps in Air Handling Units to eliminate mold and mildew growth. An improperly functioning HVAC system can harbor biological contaminants such as viruses, bacteria, molds, fungi and pollen, and can cause Sick Building Syndrome (SBS).

___7. Install separate exhaust fans in rooms where air polluting office equipment is used, and exhaust directly to the exterior of the building, at sufficient distance from the air intake vents.

___8. Place bird guards over air intakes to prevent pollution of shafts and HVAC ducts.

___9. Control indoor air pollution by selecting products and finishes that are low or non-toxic and low VOC emitting. Common sources of indoor chemical contaminants are adhesives, carpeting, upholstery, manufactured wood products, copy machines, pesticides and cleaning agents.

__10. Schedule finish application work to minimize absorption of VOCs into surrounding materials e.g. allow sufficient time for paint and clear finishes to dry before installing carpet and upholstered furniture. Increase ventilation rates during periods of increased pollution.

__11. Allow a flush-out period after construction, renovation, remodeling or pesticide application to minimize occupant exposure to chemicals and contaminants.

IX. Commissioning & Construction Project Closeout

___1. Appoint a Commissioning Authority to develop and implement a commissioning plan and a preventative maintenance plan. Project Manager's responsibilities must include coordination of commissioning activities during project closeout.
___2. Commissioning team should successfully demonstrate all systems and perform operator training before final acceptance.
___3. Provide flush-out period to remove air borne contaminants from the building and systems.
___4. Provide as-built drawings and documentation for all systems. Provide data on equipment maintenance and their control strategies as well as maintenance and cleaning instructions for finish materials.

X. Occupancy and Operation

A. General Objectives

___1. Develop a User's Manual for building occupants that emphasizes the need for Owner/Management commitment to efficient sustainable operations.
___2. Management's responsibilities must include ensuring that sustainability policies are carried out.

B. Energy

___1. Purchase EPA rated, Energy Star, energy-efficient office equipment, appliances, computers, and copiers. (Energy Star is a program sponsored by U.S. Dep. Of Energy. Use of these products will contribute to reduced energy costs for buildings and reduce air pollution.)
___2. Institute an employee education program about the efficient use of building systems and appliances, occupants impact on and responsibility for water use, energy use, waste generation, waste recycling programs, etc.
___3. Re-commission systems and update performance documentation periodically per recommendations of the Commissioning Authority, or whenever modifications are made to the systems.

C. Water

___1. Start the watering cycle in the early morning in order to minimize evaporation.
___2. Manage the chemical treatment of cooling tower water to reduce water consumption.

D. Air

___1. Provide incentives which encourage building occupants to use alternatives to and to reduce the use of single occupancy vehicles.

___2. Provide a location map of services within walking distance of the place of employment (child care, restaurants, gyms, shopping).
___3. Periodically monitor or check for indoor pollutants in building.
___4. Provide an IAQ plan for tenants, staff and management that establishes policies and documentation procedures for controlling and reporting indoor air pollution. This helps tenants and staff understand their responsibility to protect the air quality of the facility.

E. Materials and Products

___1. Purchase business products with recycled content such as paper, toners, etc.
___2. Purchase Furniture made with sustainably harvested wood, or with recycled and recycled content materials, which will not off gas VOC's.
___3. Remodeling and painting should comply with or improve on original sustainable design intent.
___4. Use low VOC, non-toxic, phosphate and chlorine free, biodegradable cleaning products.

F. Solid Waste

___1. Collect recyclable business waste such as paper, cardboard boxes, and soda cans.
___2. Avoid single use items such as paper or Styrofoam cups and plates, and plastic utensils.

XI. Resources

Financing: Energy Efficiency in Buildings. U.S. Department of Energy, DOE/EE-0152, May, 1998 (Call Tel.1-800-DOE-EREC or visit local office)

Building Commissioning: The Key to Quality Assurance. U.S. Department of Energy, DOE/EE-0153, May, 1998 (Call Tel.1-800-DOE-EREC or visit local office)

Guide to Resource-Efficient Building in Hawaii. University of Hawai'i at Manoa, School of Architecture and Energy, Resources and Technology Division, Department of Business, Economic Development and Tourism, October 1998. (Call Tel. 587-3804 for publication)

Hawaii Model Energy Code. Energy, Resources and Technology Division, Department of Business, Economic Development and Tourism, November 1997 (Call Tel. 587-3810 for publication)

Photovoltaics in the Built Environment: A Design Guide for Architects and Engineers. NREL Publications, DOE/GO #10097-436, September 1997 (Call Tel.1-800-DOE-EREC or visit local office)

Building Integrated Photovoltaics: A Case Study. NREL Publications #TP-472-7574, March 1995 (Call Tel.1-800-DOE-EREC or visit local office)

Solar Electric Applications: An overview of Today's Applications. NREL Publications, DOE/GO #10097-357, Revised February, 1997 (Call Tel.1-800-DOE-EREC or visit local office)

Green Lights: An Enlightened Approach to Energy Efficiency and Pollution Prevention. U.S. Environmental Protection Agency, Pacific Island Contact Office (Call Tel. 541-2710 for publication.)

Healthy Lawn, Healthy Environment. U.S. Environmental Protection Agency, Pacific Island Contact Office. (Call Tel. 541-2710 for this and related publications)

How to Plant a Native Hawaiian Garden. Office of Environmental Quality Control (OEQC), Department of Health, State of Hawai'i (Call Tel. 586-4185 for publication)

Buy Recycled in Hawai'i. Clean Hawai'i Center, Energy, Resources and Technology Division, Department of Business, Economic Development and Tourism, November 1997. (Call Tel. 587-3802 for publication)

Hawai'i Recycling Industry Guide and other recycling and reuse related fact sheets. Clean Hawai'i Center, Energy, Resources and Technology Division, Department of Business, Economic Development and Tourism, July 1999. (Call Tel. 587-3802 for publication)

Minimizing Construction and Demolition Waste. Office of Solid Waste Management, Department of Health and Clean Hawai'i Center, Energy, Resources and Technology Division, Department of Business, Economic Development and Tourism, February 1998. (Call Tel. 586-4240 for publication)

Contractor's Waste Management Guide and Construction and demolition Waste Management Facilities Directory. Clean Hawai'i Center, Energy, Resources and Technology Division, Department of Business, Economic Development and Tourism, 1999. (Call Tel. 587-3802 for publication)

Waste Management and Action: Construction Industry. Department of Health, Solid and Hazardous Waste Branch (Call Tel. 586-7496 for publication)

Business Guide For reducing Solid Waste. U.S. Environmental Protection Agency, Pacific Island Contact Office, Tel. 541-2710 (Call for publication.)

The Inside Story: A Guide to Indoor Air Quality. U.S. Environmental Protection Agency, Pacific Island Contact Office, Tel. 541-2710 (Call for this and related publications.) Additional information is available from the American Lung Association, Hawai'i, Tel. 537-5966

Selecting Healthier Flooring Materials. American Lung Association and Clean Hawai'i Center, February 1999. (Call Tel. 537-5966 x307)

Office Paper Recycling: An Implementation Manual. U.S. Environmental Protection Agency, Pacific Island Contact Office, Tel. 541-2710 (Call for publication.)

Acknowledgments

OEQC and the Environmental Council would like to thank Allison Beale, Gary Gill, Nick H. Huddleston, Gail Suzuki-Jones, Purnima McCutcheon, Virginia B. MacDonald, Steve Meder, Ramona Mullahey, Thomas P. Papandrew, Victor Olgay, Howard Tanaka, and Howard Wiig for their assistance with this project.

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

MICHAEL D. WILSON, CHAIRPERSON
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HISTORIC PRESERVATION
LAND
STATE PARKS
WATER RESOURCE MANAGEMENT

February 16, 1999

Clair Tom
Wil Chee Planning, Inc.
1400 Rycroft Street, Suite 928
Honolulu, Hawaii 96814

LOG NO: 23026
DOC NO: 9902EJ10

Dear Ms. Tom:

SUBJECT: Chapter 6E-8 Historic Preservation Review -- Pre-Assessment Consultation for the Department of Hawaiian Homelands, Environmental Assessment for Nanaikapono Subdivision Upgrades in Nanakuli
Nanakuli, Wai'anae, O'ahu
TMK: 8-9-6 various

Thank you for the opportunity to provide comments during preparation of the EA for the Nanaikapono Subdivision upgrades. Proposed improvements include roadway, drainage, sewer and water systems, traffic control facilities, overhead electrical telephone and street lighting systems within the existing 21-acre, 52 homestead residential subdivision. Our review is based on historic reports, maps, and aerial photographs maintained at the State Historic Preservation Division. In addition, Elaine Jourdane and Ross Cordy of our staff made a brief field inspection of portions of the project area in January 1999.

No archaeological surveys have been done along the shore in Nanakuli. Historical documents from the early 1800s indicate that a coastal settlement was present. Archaeological survey of the Department of Hawaiian Homelands properties in the back of the valley (done by our office) found extensive field ruins and over 20 house sites in the back of the valley, with use of the back of the valley starting in the A.D. 1200s-1400s. It is expected that coastal Nanakuli settlements would have been present earlier, by the A.D. 1000s-1100s. It is further expected that archaeological remnants of coastal settlement likely survive in areas which have not had extensive land alteration, a common pattern along the Wai'anae coast and elsewhere on O'ahu and in the Islands.

Given the above and the fact that the project area does not seem to have undergone extensive, modern land alteration, it is possible that subsurface archaeological deposits could be present in the project area. If such deposits are present, they could

be extremely important for understanding Nanakuli's settlement history and the settlement history of the entire Wai'anae coast.

Given this situation, we recommend that an archaeological inventory survey of the proposed project area be performed early in the planning phases of the project -- to determine if historic sites are present, and, if so, to gather sufficient information to evaluate their significance. This survey should involve scattered excavation units throughout the project area. A report of the finds should be submitted to the State historic Preservation Division for adequacy review.

If significant historic sites are found during the survey, a mitigation plan may need to be developed and executed. This might involve additional salvage excavation in project element alignments.

If you have any questions please call Sara Collins at 692-8026 or Elaine Jourdane at 692-8027.

Aloha,

Don Hibbard, Administrator
State Historic Preservation Division

EJ:jk

c: Planning Office, DHHL

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Aloha,

Don Hibbard, Administrator
State Historic Preservation Division

EJ:jk

c: Planning Office, DHHL

Appendix B

Geotechnical Engineering Exploration Report

FINAL REPORT

GEOTECHNICAL ENGINEERING INVESTIGATION

PGE Job No. 8950-001

for

DEPARTMENT OF HAWAIIAN HOME LANDS
NANAIKAPONO UPGRADE DESIGN
NANAKULI, OAHU, HAWAII

October 27, 1998

Submitted by:

Pacific Geotechnical Engineers, Inc.
429-B Waiakamilo Road
Honolulu, Hawaii 96817

Pacific Geotechnical Engineers, Inc.
Soils and Foundations & Engineering Geology

429-B Waiakamilo Road
Honolulu, Hawaii 96817
Telephone (808) 841-8024
Facsimile (808) 848-5102
Email: pgeinc@gte.net

October 27, 1998
8950-001

Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

Attention: Mr. Douglas Lee

Gentlemen:

Submitted herewith are six (6) copies of our final report entitled, "Geotechnical Exploration, Nanaikapono Upgrading Design, Nanakuli, Oahu, Hawaii." Our work was performed in general accordance with our February 19, 1998 proposal.

A September 10, 1998 draft and October 7, 1998 revised draft of this report were previously submitted. This final report has addressed your September 22, 1998 and October 9, 1998 comments regarding our draft report.

Subsurface conditions in our soil test borings drilled along the existing roads and proposed utility alignments consist primarily of fill on the surface underlain by stiff fat clay and elastic silt, medium hard to hard coral ledges, and locally cemented to uncemented coralline sand and gravel.

Based on our review of available subsurface information, our understanding of the proposed construction, and the results of our field exploration, laboratory testing, and engineering analyses, it is our opinion that the site is suitable for construction of the proposed infrastructure improvements from a geotechnical engineering standpoint after proper subgrade treatment and preparation. A more detailed discussion of our findings and recommendations are presented in the main text of our report.

Soil samples recovered during our field exploration will be stored for a period of two months after the date of this report. They will be discarded after that time, unless a longer storage period is requested. Please inform us of your storage requirements.

It has been a pleasure performing this assignment for you. Please do not hesitate to contact us if you have any questions regarding this report.

Yours very truly,

PACIFIC GEOTECHNICAL ENGINEERS, INC.

Glen Y.F. Lau, P.E.
President

GYL:KKF(8950-001FNLRPT.001)
(Six copies submitted)

TABLE OF CONTENTS

FINAL REPORT
GEOTECHNICAL EXPLORATION
NANAIKAPONO UPGRADING DESIGN
NANAKULI, OAHU, HAWAII
FOR EARTH TECH, INC.
PGE, INC. JOB NO. 8950-001

SUMMARY

To explore site subsurface conditions, nine (9) supplemental exploratory borings were drilled along the roads to be improved and near possible underground utilities to depths ranging from 11.5 to 22.3 feet. Subsurface conditions in our borings generally consisted of fill on the surface underlain by stiff fat clay and elastic silt, medium hard to hard coral ledges, and locally cemented to uncemented coralline sand and gravel. Ground water was encountered in our borings at approximately sea level.

Potential main geotechnical concerns include:

- Presence of clayey subgrade soils below portions of the proposed roads and utilities with high shrink and swell tendencies;
- Presence of variable subsurface conditions consisting of loose sand and gravel, cobbles and boulders, silt and clay, and medium hard to hard coral. Potentially excessive differential settlements could occur in the new utility lines, particularly where the lines transition between soil and hard coral;
- Presence of medium hard to hard coral at relatively shallow depths;
- A need to excavate/dewater trenches along narrow existing streets near houses and structures;
- Possible presence of cavities or voids within the coral formations that may require special treatment; and
- Possible need to import trench backfill materials due to a large amount of oversize particles that are anticipated in the excavated coralline materials.

Based on Earth Tech, Inc.'s preliminary plans, it is anticipated that pavement subgrade conditions along the roughly southern two-thirds of Pohakunui Avenue and roughly eastern half of Piliokahi Avenue may consist of expansive clays. A thicker overall flexible pavement section is recommended in these areas.

Because of variable site subsurface conditions, over excavation of a portion of the materials directly below the pipe bedding along select sections of the various utility lines and replacement with crushed rock subbedding are recommended to provide for more uniform support of the new lines.

More detailed discussions and recommendations are presented in the text of this report.

1.0 INTRODUCTION

This report presents the result of the geotechnical exploration we performed for the proposed improvements to be constructed at a portion of the Nanaikapono Lots located at Nanakuli, Oahu, Hawaii. The approximate location of the site is shown on the Map of Area, Plate 1.

2.0 PROJECT CONSIDERATIONS

It is our understanding that this project includes upgrade and redesign, as necessary, of the roads at the Nanaikapono Lots to comply with current City and County of Honolulu standards and requirements. It is our understanding that the work may include improvements to the roads, drainage, sewer and water systems, traffic control facilities, overhead electrical, telephone, and street lighting systems.

Construction plans dated 1980 for the road improvements were previously prepared by Austin, Tsutsumi and Associates, Inc. (ATA). The proposed improvements shown on these plans consisted of a 24-foot-wide two-lane paved road with curbs and gutters. ATA's construction plans also included new sewer, water, and drain lines with invert depths ranging from approximately 4 to 17 feet below existing grades. Two (2) concrete box culverts, oriented in a east to west direction, were planned to cross under Pohakunui Avenue. It is our understanding that the majority of ATA's improvement plans have not been implemented at this site.

Earth Tech, Inc.'s (ETI's) preliminary plans indicate that the new utility lines at this subdivision will consist of sewer and drain lines, two (2) reinforced concrete pipe (RCP) culverts, and a waterline extension. It is our understanding that a new section of water line will be installed and connected to the existing water lines at Pohakunui Avenue from Stations 10+11 to 21+20. The invert depths of the sewer and drain lines will range from approximately 4.2 to 17.3 feet below existing grades. The invert depths of the water lines will range from approximately 3 to 6 feet below existing grades. It is our understanding that the new utility lines are to be installed by conventional open-cut trenching methods.

After the completion of our field work and according to ETI's preliminary plan and profile drawings, the box culverts previously proposed by ATA have been replaced with 42- and 24-inch RCP culverts to be constructed along Piliokahi Avenue and Aala Walkway,

respectively. ETI's preliminary drawings indicate that the box culverts previously planned near our Borings 8 and 9 have been re-sited to Piliokahi Avenue and Aala Walkway, respectively. Subsurface conditions along Aala Walkway have not been explored at this time. Additional subsurface exploration is recommended at this location and other select portions of Pohakunui and Piliokahi Avenues where clayey soils with high shrink and swell tendencies were found.

Subsurface conditions at the site were previously explored for the ATA project by Ernest K. Hirata, Inc. (EKH). EKH drilled a total of seven (7) soil test borings to depths ranging from approximately 4.5 to 5 feet below existing grades. The scope of the our work included drilling additional deeper borings at select locations to supplement the previous subsurface information.

3.0 SCOPE OF WORK

The scope of this geotechnical exploration was specified in your February 10, 1998 Request for Proposal and in the Department of Hawaiian Home Land's (DHHL's) scope of work. It was specified that our scope of work should consist of the following:

- Preliminary investigations and research of the site with regard to ordinances, statutes, encumbrances, restrictions, etc. which may affect this project from a geotechnical engineering standpoint.
- A soils investigation and report.
- Gathering available plans, including Nanakuli Road Improvement plans prepared by ATA dated 1980.
- Preparing construction contract specifications including:

  a. Grading specifications;
  b. Review the construction plans, grading specifications, proposal, and special provisions; and
  c. Provide a letter indicating that items a and b have been reviewed.

The construction grading specifications and contract document review will be presented in separate submittals. Based on the above considerations, the following scope of services was performed:

1. Review of Available Data - Available data on general subsurface and geologic conditions in the vicinity of the project area were reviewed. Our sources included information in our files, previous borings by others, Soil Conservation Service, and other readily available published information.

2. Coordination of Field Work - Prior to the start of our field exploration, our work was coordinated with various utility companies to check for possible underground utilities at the proposed boring locations. Each boring location was toned using a metal detector as a check for possible underground utilities. Excavation and street usage permits were obtained from the City and County of Honolulu prior to the start of the drilling.

3. Field Exploration - Subsurface conditions at the site were explored by drilling nine (9) supplemental soil test borings to depths ranging from approximately 11.5 to 22.3 feet below the existing ground surface. These borings were drilled at select locations in the area of the proposed road improvements to supplement the previous borings drilled for the ATA project. The drilling was performed using a truck mounted drill rig using continuous flight augers and rotary wash drilling methods. A water truck was also mobilized to provide water for the drilling operations.

   The approximate locations of the our supplemental borings along with the previous borings by others are shown on the Plot Plan, Plate 2. The locations and elevations of the supplemental borings were surveyed by Control Point Surveying, Inc. (CPS). The logs of our borings and a more detailed description of our field exploration program are presented in Appendix A of this report.

4. Laboratory Testing - At the completion of the field work, the soil samples and rock cores from our borings were transported to our laboratory in Honolulu for further examination and laboratory testing. Our laboratory testing program included index and classification tests, strength tests, swell tests, unconfined compression tests on intact rock cores, moisture-density relations tests, and California Bearing Ratio (CBR) tests.

   A more detailed description of the laboratory tests and the test results are presented in Appendix B of this report.

5. Engineering Analysis and Report Preparation - Based on the results of our data review, field exploration and laboratory testing, engineering analyses were performed and comments and recommendations developed regarding:

   a. Site preparation and grading,
   b. Anticipated excavation conditions,
   c. Trench excavation and backfilling,
   d. Pipe bedding and trench backfill materials, placement, and compaction, and
   e. Guidelines for flexible pavements.

The results of our data review, field exploration, laboratory testing, engineering analyses, and our findings and recommendations were discussed with you during the course of the work and have been summarized in this report.

4.0 SITE CONDITIONS

4.1 GENERAL

The project site is located along the southwestern coast of the island of Oahu at the foot of the Waianae volcano. The geology of this coastal region is characterized by basaltic bedrock overlain by alluvium interlayered with ancient coral reefs. The existing coast is comprised of an ancient coral reef that formed during a higher stand of the sea. In the vicinity of the site, this ancient coral reef is covered by a relatively thin layer of alluvial silt and clay. The alluvial layer is thicker in former gullies that appear to cross the southeastern part of the site. In general, these gullies have been covered as a result of site development and are not readily apparent at the ground surface.

4.2 SURFACE CONDITIONS

The site is bounded by Laumania Avenue on the north, Pohakunui Avenue on the east, and the Pacific Ocean on the west and south. Existing public roads within this subdivision include Pohakunui and Keaulana Avenues running in a generally north to south direction and Laumania and Piliokahi Avenues running in a generally east to west direction. Adjacent existing structures include the U.S. Navy FORAC III Station and Nanakuli Beach Park parking lot on the north, railroads tracks and Farrington Highway on the east, and the Piliokahi Beach Park parking lot and public restrooms on the south.

Topographically, the site slopes gently from the east to west with ground surface elevations ranging from approximately +8 feet in the north to +20 feet in the south. All elevations in this report are reference to Mean Sea Level.

The site is currently occupied by house lots with single story houses. Most of the lots are fenced with either dirt and gravel, asphaltic, or concrete driveways. Vegetation within the lots generally consist of trees, hedges, and lawns.

The existing roads are paved with asphaltic concrete (AC) with overhead electric lines and fire hydrants. The pavement along these roads was in generally fair condition at the time of our field work, except for some localized distressed areas. The localized pavement distress

observed at the site included low to moderate severity alligator, edge, longitudinal, and transverse cracking, and low to moderate severity raveling. Traffic along the roads was very light at the time of our field exploration and consisted mainly of passenger vehicles and garbage trucks.

4.3 SUBSURFACE CONDITIONS

Subsurface conditions encountered at the site are illustrated on the Log of Borings presented in Appendix A. The approximate locations of our borings along with previous borings by others are shown on Plate 2. Because the borings are widely spaced, subsurface and groundwater conditions between the borings may vary locally. Based on our review of the subsurface information shown on ATA's 1980 plans, it is our opinion that the near surface conditions from the previous borings are generally consistent with those conditions encountered in our supplemental borings.

Subsurface conditions encountered in our borings generally consisted of fill on the surface underlain by stiff to very stiff alluvial silt and clay, medium hard to hard coral ledges and locally cemented coralline sand and gravel. The lateral and vertical extent of these deposits in our borings varied across the site.

Approximately 2 to 3 inches of AC was encountered at the surface in our borings, except in Borings 8 and 9, which were drilled from a gravel driveway and a grassed area, respectively.

Fill materials, generally consisting of loose to medium dense silty coralline sand and gravel, were encountered to depths ranging from a few inches to one foot below existing grades. No fill was found in Boring 9.

In Borings 1, 2, 3, 4, 6 and 7 below the surface fill, alluvial deposits consisting primarily of fat clay and elastic silt, were encountered at depths ranging from approximately 0.5 to 3.3 feet below existing grades. Recemented coral was found directly below the fill in Boring 5. A thin layer of fat clay was encountered at the surface in Boring 9 to a depth of approximately 0.8 feet. The clay in this hole was underlain by recemented coral.

In Boring 8, alluvial deposits consisting of fat clay were found from a depth of approximately one foot to the bottom of this boring at 16.5 feet below existing grades. This boring appears to be located in a former gully that has become in-filled with alluvium. The

gully was not observed along the shoreline in the area formerly proposed for a box culvert outfall structure. Based on available topographic plans and the present shoreline configuration, it appears that this in-filled gully may run to other natural drainage features that may have existed in the area south of Boring 8.

In Boring 1, the alluvial deposits directly below the surface fill were generally underlain by medium hard coral, and medium dense to dense and locally cemented silty coralline sand and gravel to the maximum depth explored in this hole at 22.3 feet. The coral ledges in the remaining holes, except for Boring 8, were generally encountered at relatively shallow depths ranging from 0.5 to 3.3 feet below existing grades.

In Boring 4, the upper coral ledge was underlain by a layer of basaltic cobbles and boulders between depths of approximately 11 and 12.5 feet below existing grades. The cobbles and boulders were underlain by elastic silt to the bottom of this hole at 14.7 feet.

Laboratory swell/consolidation tests performed on three (3) samples of silt and clay obtained from our borings indicated total swell values ranging from 1.5 to 7.2 percent for the test samples. As shown on Plates B-4.1 and B-4.2 in Appendix B, laboratory CBR tests performed on bulk samples indicated total swells ranging from 1.7 to 17.7 percent. The results of Atterberg Limits tests performed on samples of the near surface alluvial deposits indicated plasticity indices ranging from 18 to 102 percent. The high plasticity indices of these soils are consistent with the swelling behavior observed in our swell and CBR tests. Based on these test results, it appears that the near surface alluvial deposits have high shrink and swell tendencies.

Unconfined compression tests performed on relatively intact coral cores from select borings indicated unconfined rock strengths ranging from 180 to 2,690 pounds per square inch (psi). Based on available subsurface information and our laboratory test results, it is anticipated that the strength and hardness of the coral ledges at the site may vary from the unconfined compressive strength test results presented herein because of the geological features of the formation such as the degree of cementation, fracture spacing and orientation, and fracture in-filling of the coral.

A possible void was encountered in Boring 1 at a depth of approximately 12 to 13 feet below the existing ground surface. Based on the geology of the area and available subsurface information, it is possible that other voids or cavities may exist at the site. Voids are common in coral reef formations and typically occur in the form of solution cavities created as fresh

water percolates through the coralline material, dissolving and removing part of the coral. Near surface voids are often in-filled with soft or loose alluvial sediments. These voids can range in size from less than an inch to over several feet in diameter.

The groundwater level was measured in our Borings 2, 5, and 9 at depths ranging from 10.8 to 13.2 feet below the existing ground surface. These water levels correspond to elevations ranging from approximately sea level to 0.5 feet above and below sea level. Because of the drilling process, it was not possible to obtain stabilized water level readings in Borings 1, 3, and 6 through 8. Boring 4 was not drilled deep enough to encounter ground water. Because of the proximity of the site to the ocean, it is anticipated that the groundwater levels will fluctuate with the tide and rainfall landward of the site.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 GENERAL

Based on available subsurface information obtained from our field exploration and previous study by others, the results of our laboratory tests, and our engineering analyses, it is our opinion that the site is suitable for construction of the proposed road and utility improvements from a geotechnical engineering standpoint. Potential main geotechnical concerns at this site include:

- Presence of near surface silt and clay deposits with high shrink and swell tendencies. Potential volume change of these soils may occur as a result of changes in their moisture contents. These soils will tend to swell upon wetting and shrink upon drying. The volume changes could cause distress to underground utilities and pavements;

- Presence of medium hard to hard coral and locally cemented coralline sand and gravel along most of the road improvements at relatively shallow depths. Utility trenches, sheeting installations, and manhole excavations extending into cemented coralline materials may require a backhoe equipped with a hydraulic hoe ram, rock excavators or rock trenchers, or other suitable rock excavating equipment;

- Presence of variable subsurface conditions consisting primarily of sand and gravel, silt and clay, medium hard to hard coral, and cobbles and boulders. Potentially excessive differential settlements could occur along the new utility lines, particularly at locations where the pipe subgrade conditions change from loose granular deposits to hard coral ledges;

- The need to perform the road and utility construction along existing streets and near existing houses and underground utilities, such as existing water lines. The road excavations for base and subbase installation may affect the existing underground lines within the new travelway. Trenching and dewatering may cause some ground movements in the vicinity of the trenches;

- Possible presence of cavities or voids within the coral reef formations which may require additional over excavation and/or special treatment; and

- Possible need to import trench backfill materials due to a large amount of oversize particles that are anticipated in the excavated coralline materials.

Based on ETI's preliminary plans, it is anticipated that the pavement subgrade conditions along the roughly southern two-thirds of Pohakunui Avenue and roughly eastern half of Piliokahi Avenue may consist of expansive silt and clay. A thicker overall flexible pavement section is recommended in these areas because of the expansive soils.

Because of variable site subsurface conditions, over excavation of a portion of the materials directly below the pipe bedding along select sections of the various utility lines and replacement with crushed rock subbedding are recommended to provide for more uniform support of the new lines.

More detailed discussions and recommendations are presented in the following report sections.

5.2 SITE PREPARATION

1. Prior to the start of construction, it is recommended that a photographic and/or video survey be made of existing nearby houses, fence walls, slabs-on-grade, pavements and other structures near the proposed construction to document the existing conditions. Any existing damage should be noted. The preconstruction survey should include establishing settlement points on existing structures, slabs, and pavements near the pipeline alignments, particularly where the lines and manholes will be installed near settlement sensitive buildings and structures. The settlement points should be periodically surveyed during the construction. The photographs, videos, and settlement data would provide valuable records in the event movements and damages arise during the construction. The settlement information would also be useful to alert the Contractor of potential movements, and the possible need to modify their excavation and dewatering operations.

2. Prior to grading, the areas of the proposed improvements should be prepared by stripping off all pavements, vegetation, and the top six (6) inches of soil containing roots, organic matter, and debris. Grubbing to deeper depths may be needed

where large roots extend to deeper depths in unpaved areas. All stripped-off material and old pavements should be hauled to a suitable disposal site.

3. It is our understanding that the existing cesspools at the subdivision may need to be backfilled. The treatment and backfilling of the cesspools are dependent on their sizes, depths, construction, and present conditions. General guidelines for backfilling the cesspool are described below. These guidelines may need to be modified depending on the present condition of the cesspools and site conditions, such as proximity to existing structures.

   a. The portions of the existing sewer laterals that may interfere with the new laterals should be removed. The remaining portions of the existing laterals should be cut and plugged.

   b. After the existing cesspools are located and their covers have been removed, any soft materials that may be present at the bottom of the cesspools should be removed to firm soils. The excavated material should be disposed of at a suitable disposal site.

   c. After cleaning-out the cesspools, they may be backfilled with select borrow structural fill placed and compacted to at least 90 percent of ASTM D1557-91 maximum dry unit weight as outlined in subsection 5.6 of this report.

      If water is present in the bottom of the cesspools, locally available No. 2B gravel may be used as backfill. The No. 2B gravel may be placed in the wet until at least one foot above the water table. The top of the gravel above the water table should be compacted with vibratory equipment to a dense consistency as evident by little to no settlement of the gravel surface under repeated passes with the compaction equipment. If No. 2B gravel is used to backfill the remainder of the cesspool, it should be placed in not more than 12 inch thick loose lifts and compacted to a dense consistency.

      To minimize potential infiltration of fines into the gravel, a non-woven geotextile fabric should be placed on top of the gravel. The remainder of the excavation may then be backfilled with select borrow structural fill.

      Alternatively, lean concrete, sand cement grout, or flowable fill may be used in lieu of No. 2B gravel and/or structural fill. The concrete, grout, or flowable fill should be placed by tremie methods if ground water is present in the cesspools.

   d. If it is not possible to remove any soft materials that may be present in the cesspools before backfilling, a woven geotextile, such as Mirafi 500X or equal, should be placed over the bottom before backfilling. The backfill over the woven geotextile should consist of No. 2B gravel. The remainder of the cesspool may be backfilled as described in this subsection. Because the soft materials at the bottom of the cesspools would not be removed, some amount of ground movements and settlement should be anticipated.

5.3 EXCAVATION CONDITIONS

1. Temporary excavations, shoring, and dewatering that are required for construction of the proposed improvements are the Contractor's responsibility. All construction excavations should be performed and supported in accordance with applicable Federal, State and local safety regulations, including current OSHA trench excavation safety standards.

2. Excavations to the depths required for road, utility and manhole installations are expected to generally encounter fill material on the surface, underlain by stiff to very stiff alluvial silt and clay, medium hard to hard coral ledges, loose to medium dense sand and gravel, and possible cobbles and boulders.

   It is anticipated that the stiff alluvial silt and clay and uncemented to weakly cemented sand and gravel materials can generally be excavated with conventional earthwork equipment. Excavation and removal of medium hard to hard coral, and cobbles and boulders are likely to require a hydraulic hoe ram, or other suitable rock excavation equipment. Blasting as a means of excavating the coralline materials and boulders may not be feasible at this site because of the proximity to existing houses and structures.

5.4 PERMANENT CUT AND FILL SLOPES

1. Permanent cut and fill slopes should not be steeper than 2 horizontal to 1 vertical (2H:1V). All fills placed on slopes steeper than 5H:1V should be continuously keyed and benched into the existing hillside. All fill slopes should be overbuilt and trimmed back to expose firm compacted material. All permanent cut and fill slopes should be vegetated as soon as practical to reduce overall erosion rates.

5.5 TRENCH EXCAVATION AND DEWATERING CONSIDERATIONS

1. All phases of the trenching, shoring, and dewatering required for the proposed construction are the Contractor's responsibility. The Contractor should retain qualified structural and geotechnical engineers experienced in this type of work and licensed in the State of Hawaii to design the trench excavation support and dewatering systems.

   The Contractor's excavation support and dewatering systems should protect against instability of the trenches, boiling and/or blow out of the trench bottoms, and settlement of existing structures and pavements near the proposed lines during construction.

2. Based on the ETI's plans, invert elevations of the new sewer lines and sewer manholes may range from approximately -4.8 to +6.2 feet. This will require trench depths of roughly 9 to 20 feet below existing grades. Portions of the sewer lines and select manholes will also extend below the groundwater table.

   Invert elevations of the new drain lines per the ETI's plans may range from approximately +3.5 to +11.4 feet. This corresponds to trench depths of roughly 3 to 9.5 feet below the existing ground surface.

3. Trenches excavated into the stiff silt and clay, and hard, moderately to highly cemented coral ledges can probably be made with near vertical sides. It is expected that these trenches may remain relatively stable for short periods of time, provided they are not subjected to traffic and construction equipment surcharges, vibrations, and/or drying. This, however, should not relieve the Contractor from satisfying all applicable safety codes relating to open-cut excavations and the use of shoring and bracing, and/or trench shields to protect their workmen.

4. To reduce the potential for sloughing and/or caving of the trenches if unshored, it is recommended that the trenches be backfilled as soon as practical after the utility lines have been installed and tested.

5. Other excavation measures, such as benching or sloping the sidewalls of the excavation, can also be used in conjunction with excavation shoring and bracing. If the sides of the excavations are sloped or benched, the pipes should be installed in a shallow sub-ditch at the bottom of the excavations. It is anticipated that benching and sloping of the sidewalls of the excavation along most of the existing streets within the project area may not be feasible because of the relatively narrow streets and proximity to existing houses and structures.

6. It is anticipated that shoring and sheeting or other suitable excavation support systems will likely be required along the deeper utility alignments and at manhole locations because of the proximity of the lines to existing structures and the presence of weakly cemented to uncemented loose sand and gravel layers above and below the groundwater table.

   The Contractor's excavation shoring and sheeting should be designed to protect against excavation instability and settlements in existing houses and structures near the proposed lines during construction. Underpinning may be needed for structures located near the proposed lines. The requirements for underpinning should be determined by the Contractor's structural and geotechnical engineers. The excavation sheeting should be installed to sufficient depths below the excavations to reduce the potential for boiling and/or bottom heave. Temporary sheeting may encounter dense or hard coral at some locations. Pre-excavation may be needed to allow the sheets to be installed to sufficient depths.

7. Dewatering flows are expected to vary depending on such factors as, subsurface conditions, depth of excavation below the water table, length and width of open trench, and excavation sheeting and dewatering methods employed by the Contractor. Based on our past experience with similar subsurface and groundwater conditions, it is anticipated that the coralline deposits at this site may be moderately to highly permeable and have a potential for large volumes of groundwater inflow. The Contractor should be prepared to utilize several methods to dewater the trenches, depending on the conditions encountered during the progress of the work. The dewatering systems should include properly designed filters and/or geotextile filter fabrics to minimize the pumping of fines.

8. Prior to discharge, all pumped water from the construction dewatering operations and any water used in hydrostatic pressure testing should conform to applicable Federal, State and local regulations, including but not limited to Chapter 54, Water Quality Standards, and Chapter 55, Water Pollution Control, of Title 11, Administrative Rules of the State Department of Health. If un-backfilled trenches are used for water disposal, the pumped water should be properly filtered before discharge to reduce possible contamination of the bedding and gravel cradle for the new pipe lines and manholes.

5.6 PIPE SUBGRADE TREATMENT AND BEDDING

Based on the subsurface conditions encountered in our borings, it is anticipated that the drainage and sewer line inverts may be in loose sand and gravel, hard coral, expansive clays or cobbles and boulders. To provide for more uniform pipeline support and to reduce the potential for distress due to loose or expansive site soils, it is recommended that a portion of the loose soils and expansive silt and clay below the pipe bedding material be over excavated and replaced with crushed rock subbedding material and geotextile filter fabric. Pipe subgrade treatment, bedding and subbedding recommendations are outlined in the following paragraphs. A schematic section of a recommended trench backfill is shown on Plate 3. Recommended subbedding thicknesses for various subsurface conditions is presented in Table 1. Anticipated pipe subsurface conditions at the bottom of the pipe bedding is presented in Table 2.

1. Prior to the placement of any bedding materials, the bottom of the trenches and manhole excavations should be compacted to provide a firm bottom and to check for yielding or soft areas. Any yielding or soft areas that do not readily compact should be excavated to firm soils and replaced with bedding material. The compaction of the portions of the trenches and excavation bottoms below the groundwater table should be performed after the installation of the geotextile filter fabric and placement of the first lift of subbedding material.

2. The pipe bedding material should consist of a clean, granular basaltic gravel conforming to ASTM D448, No. 67 size. It should be placed in not more than 12

inch thick loose lifts and compacted to a dense consistency with vibratory equipment as indicated by little to no settlement of the gravel under repeated passes with the compaction equipment.

3. To provide for a more uniform support of the proposed pipelines, it is recommended that a portion of the existing subsurface materials *directly below the pipe bedding* be excavated and replaced with subbedding material and a geotextile filter fabric as indicated in Table 1. The ASTM No. 67 size basaltic gravel used for the bedding may also be used for the subbedding. The subbedding material should be placed and compacted as indicated in item 2 above.

4. Cobbles, boulders and elastic silts, may be encountered near the sewer line inverts in the vicinity of Boring 4 at the south end of Pohakunui Avenue. To provide for more uniform support of the sewer line at this location, at least 18 inches of any cobbly and bouldery material and elastic silt found directly below the pipe bedding in this area should be over excavated and replaced with a geotextile filter fabric and subbedding material installed as described in Item 3. above. Similarly, expansive soils may be encountered near the sewer line inverts along the roughly eastern half of Piliokahi Avenue and along Pohakunui Avenue in the general area near Boring 8. At least 12 inches of subbedding material should be provided at these location as indicated in Table 1.

5. Subsurface and groundwater conditions may vary locally between borings. Additional over excavation below the pipe bedding should be performed in localized areas of clayey, soft or loose soils are encountered directly below the pipe bedding.

6. The bedding for pipes 8 to 18 inches in diameter should extend from at least 6 inches below the pipe inverts to at least 12 inches above the crown of the pipes. The bedding for pipes with diameters of 24 inches and larger should extend from at least 12 inches below the pipe inverts to at least 12 inches above the crown of the pipes. The bedding and subbedding materials should be completely wrapped in a geotextile filter fabric to minimize migration of fines into these materials. The fabric should overlap at least 12 inches along all joints.

7. Care should be taken to protect the pipes from damage during the backfilling operations. The bedding material should be placed and tamped, supplemented by hand shoveling, to provide full contact with the entire periphery of the pipes.

8. A sufficient amount of bedding material should be provided along the sides of the new pipes to provide lateral support for the pipes in various subsurface conditions and to allow for a sufficient amount of working room to properly place and compact the bedding material along the sides of the pipes. Guidelines for trench widths are shown on Plate 3.

   The trench widths at the top of the pipes, however, should be kept as narrow as possible to minimize the potential of overloading the pipes. If PVC pipes are

used, the trench width at the top of the pipe should not exceed the outside diameter of the pipe by more than 8 to 9 inches on either side for 8-inch diameter pipes. The trench widths may be increased by the thickness of any sheeting provided by the Contractor.

9. For the portions of the trenches where the excavation exceeds the widths recommended herein because of cave-ins or over excavation by the Contractor, a stronger pipe may be needed to resist potentially higher trench overburden loads or a higher quality bedding than the crushed rock recommended herein, such as a Class A concrete bedding in accordance with City's Standard Detail S-47 of the Standard Details for Public Works Construction of September 1984, may be needed. The need for a stronger pipe or higher quality bedding should be reviewed by the project's designers on a case by case basis.

5.7 BACKFILL MATERIALS, PLACEMENT, AND COMPACTION

1. The excavated on-site granular fills and coralline sand and gravel materials, well graded from fine to coarse and free of vegetation, organics, debris, concrete, old pavements, and particles larger than three (3) inches in maximum dimension may be reused as trench and excavation fill in the intermediate backfill zone above the pipe bedding (see Plate 3). This material should have a CBR swell value of less than 3 percent, and a CBR value of at least 10. It should not be used in the top 24 inches of the backfill under pavements. All imported borrow materials should conform to the requirements of this paragraph.

2. Trenches and manhole excavations made into hard coral ledges, and cemented sand and gravel deposits may result in a large amount of oversize particles. This material should not be used in the trench and excavation backfills unless it can be crushed and screened to provide a well graded, fine to coarse granular mixture conforming to the trench backfill requirements stated herein.

3. The on-site elastic silt and fat clay classified as MH and CH, respectively have high shrink and swell tendencies and low CBR values after wetting. These materials should not be used in structural fills and trench backfills, but may be stockpiled for possible reuse in landscape or yard areas as top soil provided it conforms to the project landscaping requirements. Otherwise, these materials should be hauled to a suitable disposal site.

4. At least the top two (2) feet of the trench backfill below the finish AC pavement surfaces should consist of base course, subbase course, and granular structural backfill. At least the top two (2) feet of the trench backfill below the finish slab should consist of structural fill. Granular structural backfill material should conform to Select Borrow for Subbase Course, Section 30, of the Standard Specifications for Public Works Construction of September 1986, hereafter referred to as the Standard Specifications. The structural backfill should have a liquid limit of 25 percent or less, and a plasticity index of 10 or less.

5. Nesting of cobbles and boulders in the trench and manhole excavations should not be allowed.

6. All bedding and backfill materials should be reviewed, and if appropriate, tested by a qualified geotechnical engineer prior to their use in backfills at the site.

7. Wet and saturated soils and clayey soils from the trenches are expected to have relatively high moisture contents. Spreading and drying of these materials may be necessary to obtain moisture contents suitable for compaction.

8. The trench intermediate backfill material should be placed in not more than 10-inch thick horizontal loose lifts, moisture conditioned to between optimum and 3 percent wet of optimum moisture content for the material being placed, and compacted to at least 85 percent relative compaction in grassed and unpaved areas, and to at least 90 percent relative compaction up to a level that is not higher than two (2) feet below the finish pavement surface or to the bottom of the pavement subbase, whichever is deeper.

   At least the top two (2) feet of the backfill below pavements should be compacted to at least 95 percent relative compaction.

   Relative compaction in this report is defined as the dry unit weight of the compacted material expressed as a percentage of the maximum dry unit weight of the same material based on ASTM D1557-91 test procedures.

9. The compaction of the backfill materials should be checked and periodically tested by a qualified testing laboratory.

5.8 MANHOLE FOUNDATION SUPPORT

1. To provide for more uniform support of the new manholes, at least 12 inches of the soils below the manholes should be over excavated and replaced with bedding material and a geotextile filter fabric. For manholes underlain by expansive silt or clay, or soft or loose submerged materials, the over excavation depths should be increased to at least 24 inches below the bottom of the manhole slabs. The over excavation should extend beyond the foundation limits by the same amount as the over excavation depths. Our recommended schematic sections of manhole over excavations are presented on Plate 4.

2. The bedding material, placement, and compaction should conform to the requirements of subsection 5.5 of this report.

3. The foundations of the manholes constructed as described above can be designed for an allowable bearing pressure of 2,000 pounds per square foot (psf) for total dead plus long term live loads. A one-third increase in allowable bearing pressure can be used when considering the total of all loads, including wind or seismic forces.

5.9 LATERAL EARTH PRESSURES

1. The new manholes will need to be designed to resist lateral earth pressures from the backfill. Backfill materials placed against these structures should consist of select borrow structural backfill material as described in subsection 5.6 (item 4) of this report and should be compacted to at least 90 percent relative compaction.

   At least the top two (2) feet of the backfill below paved areas should be compacted to at least 95 percent relative compaction.

2. For wall design and assuming that granular backfill materials are used, it is recommended that an equivalent at-rest fluid pressure of 60 pounds per square foot per foot of depth (psf/ft) above and 90 psf/ft below a long term high water level at Elevation +3 feet be used. Traffic or other surcharges, if present, should be added to the above lateral earth pressures.

5.10 GUIDELINES FOR FLEXIBLE PAVEMENT

1. It is our understanding that the vehicular traffic mix anticipated at this subdivision may consist mainly of passenger vehicles, light trucks, vans, and occasional garbage trucks. The traffic volume is anticipated to be low.

2. Based on available subsurface conditions, and road profiles presented on ETI's preliminary plans, it is anticipated that the pavement subgrade conditions along Pohakunui, Laumania, and Keaulana Avenues located north of Piliokahi Avenue and the roughly western half of Piliokahi Avenue may generally consist of coralline sand and gravel, and hard coral. The pavement subgrade along the roughly eastern half of Piliokahi Avenue and Pohakunui Avenue south of Piliokahi Avenue are anticipated to generally consist of silt and clay.

   Based on a subgrade CBR value of 2 and 15 for clay and coralline sand, respectively, and a traffic design index of 2, the following flexible pavement sections are recommended:

   Roads Located North of Piliokahi Avenue (Coralline Subgrade):
   - 2 inches of AC;
   - 6 inches of untreated basaltic base course; and
   - 6 inches of subbase course.

Roads Located South of Piliokahi Avenue and Roughly Eastern Half of Piliokahi Avenue (Silt and Clay Subgrade):

- 2 inches of AC;
- 6 inches of untreated basaltic base course; and
- 22 inches of subbase course.

The AC thickness should be increased to 3 inches at entrance areas or where heavy traffic is anticipated.

3. As indicated on ETI's preliminary plans, the existing 8-inch diameter waterline is located approximately 2.5 to 3.5 feet below existing grades.

   Due to a thicker pavement section required in areas of silt or clayey subgrade, the roadway excavation for the new pavements may disturb the existing water line. In these areas, the total depth of roadway excavation for the new pavements may be reduced to not closer than 12 inches above the crown of the water line and not closer than 3 feet horizontally from the centerline of the waterline to reduce the potential disturbance and damage to these lines. This will result in a thinner subbase layer over the water lines.

   Based on available subsurface information and ETI's preliminary plans, it appears that the roadway excavation depth to install the new pavements over the existing waterline may need to be reduced along Pohakunui Avenue from roughly Stations 9+00 to 10+11 and along Piliokahi Avenue from roughly Stations 0+07 to 3+00.

   A thinner pavement section is anticipated along the remaining roadway areas. Because of a thinner overall pavement section, roadway excavation depths should be reduced. At these locations, the full thickness of subbase should be provided for the new pavements.

4. The on-site near surface silt and clay material have high shrink and swell tendencies. Care should be exercised to minimize drying of the clayey subgrade during pavement construction. The clayey portions of the pavement subgrade should be scarified to a depth of at least six (6) inches, thoroughly moisture conditioned to between optimum and 3 percent wet of optimum moisture content and compacted to at least 95 percent relative compaction prior to placement of the subbase material. The top at least six (6) inches of coralline sand and gravel subgrades should be moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 95 percent relative compaction.

5. The subbase and base course materials should conform to Sections 30 and 31, respectively, of the Standard Specifications. It should extend at least 12 inches beyond the AC pavement edges.

The subbase course materials should be placed over the compacted subgrade as soon as possible to minimize drying and loosening of the compacted subgrade. The subbase and base materials should be placed in not more than 8-inch thick loose lifts, moisture conditioned to within 2 percent of the optimum moisture contents for these materials, and compacted to at least 95 percent relative compaction.

5.11 ADDITIONAL SUBSURFACE EXPLORATION

Because of variable site subsurface conditions and the re-siting of a drainage culvert to Aala Walkway, it is recommended that additional subsurface soil test borings be performed at this site. Because of the relatively wide spacing of the borings drilled to-date, the approximate extent and thickness of the alluvium near the intersection of Pohakunui and Piliokahi Avenues near our Borings 7 and 8, and in the vicinity of our Borings 3 and 4 are not known. Based on the available subsurface information, it appears that the general alignment of possible buried alluvial channels at the site may not run completely in the east to west direction, but may also meander across the site. The approximate extent of the basaltic cobbles and boulders encountered in our Boring 4 at the south end of Pohakunui Avenue are also not known. Although previous borings by others in these areas provide some information regarding near surface conditions, they do not provide any information below a depth of approximately 5 feet which was the maximum depth explored in these previous holes. Subsurface conditions along the Aala Walkway are also not known.

To reduce the uncertainty in the subsurface conditions and to better plan the proposed construction, it is recommended that at least four (4) supplemental soil test borings, each approximately 15 feet in depth, be drilled at the site. Two (2) of the borings would be drilled near the intersection of Pohakunui and Piliokahi Avenues to provide supplemental information on the approximate extent of the alluvium that was found in our Boring 8 and previous borings 5 and 6. One of the borings would be drilled along Aala Walkway. The remaining boring would be drilled between our Borings 3 and 4 to provide supplemental information on the approximate extent of the cobbles and boulders, and alluvium found in our Boring 4.

6.0 PLANS/SPECS REVIEW AND SERVICES DURING CONSTRUCTION

During the design, we plan to review the geotechnical related sections of the project plans and specifications to check that the intent of our design recommendations have been properly reflected in the draft report design.

During construction, we recommend that we be retained to assist Earth Tech, Inc. to observe site preparation, road construction, and utility trench excavation and backfilling operations. We would periodically check on the suitability of bearing materials encountered, road and trench subgrade preparation, and backfill placement and compaction.

We believe that as the Geotechnical Engineer of Record (GER), we are the best qualified to recognize and deal with situations and conditions that would require the GER's professional judgement and interpretation. Modifications to our recommendations could be developed and implemented on a timely basis, if necessary, should subsurface conditions differ from those presented in this report.

7.0 LIMITATIONS

This geotechnical exploration report has been prepared for the use of Earth Tech, Inc., the Department of Hawaii Home Lands (DHHL), and their designated engineering consultants in accordance with generally accepted soils and foundation engineering practices. No other warranty, expressed or implied, is made as to the professional advice included in this report.

This report has been developed for the use of Earth Tech, Inc., the DHHL, and their designated designers and engineers for the proposed road improvements to be constructed at Nanakuli, Waianae, Hawaii. It does not contain sufficient information for the purposes of other parties or for other uses.

This report does not reflect variations which may occur in the subsurface and groundwater conditions between borings. The nature and extent of variations in the subsurface and groundwater conditions may not become evident until construction.

Groundwater was encountered in most of the borings drilled at the time of our field exploration. Fluctuations in the groundwater level may occur due to variations in rainfall, tides, stream levels, temperature and other factors that may be different from the conditions that existed at the time of our measurements.

The comments and recommendations presented in this report are based on the anticipated construction described herein. Should the actual construction differ from that described in this report, we should be notified and retained to check if any modifications to the recommendations presented in this report are needed. The comments and recommendations presented in this report shall not be considered valid unless the changes are reviewed by us and the preliminary recommendations of this report verified or modified in writing.

The field exploration portion of this study may not have disclosed the presence of underground structures and formations, such as drywells, storage tanks, landfills, cavities, voids, etc., that may be present at the site. Should these items be encountered during construction, we should be notified to provide appropriate recommendations for their disposal and/or treatment. Assessment of the presence or absence of these structures was not included in the scope of this study.

The scope of our services for this project was limited to conventional geotechnical engineering services and did not include any environmental assessment or evaluations. Silence in this report regarding any environmental aspects of the site does not indicate the absence of potential environmental problems.

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The following plates and appendices are attached and complete this report.

Plate 1	-	Map of Area
Plate 2	-	Plot Plan
Plate 3	-	Schematic Section of Trench Bedding and Backfill Requirements
Plate 4	-	Manhole Overexcavation Detail
Table 1	-	Pipe Bedding Thickness By General Subsurface Conditions
Table 2	-	Anticipated Pipe Subsurface Conditions At Bottom of Pipe Bedding
Appendix A	-	Field Exploration
Appendix B	-	Laboratory Testing

Yours very truly,

PACIFIC GEOTECHNICAL ENGINEERS, INC.

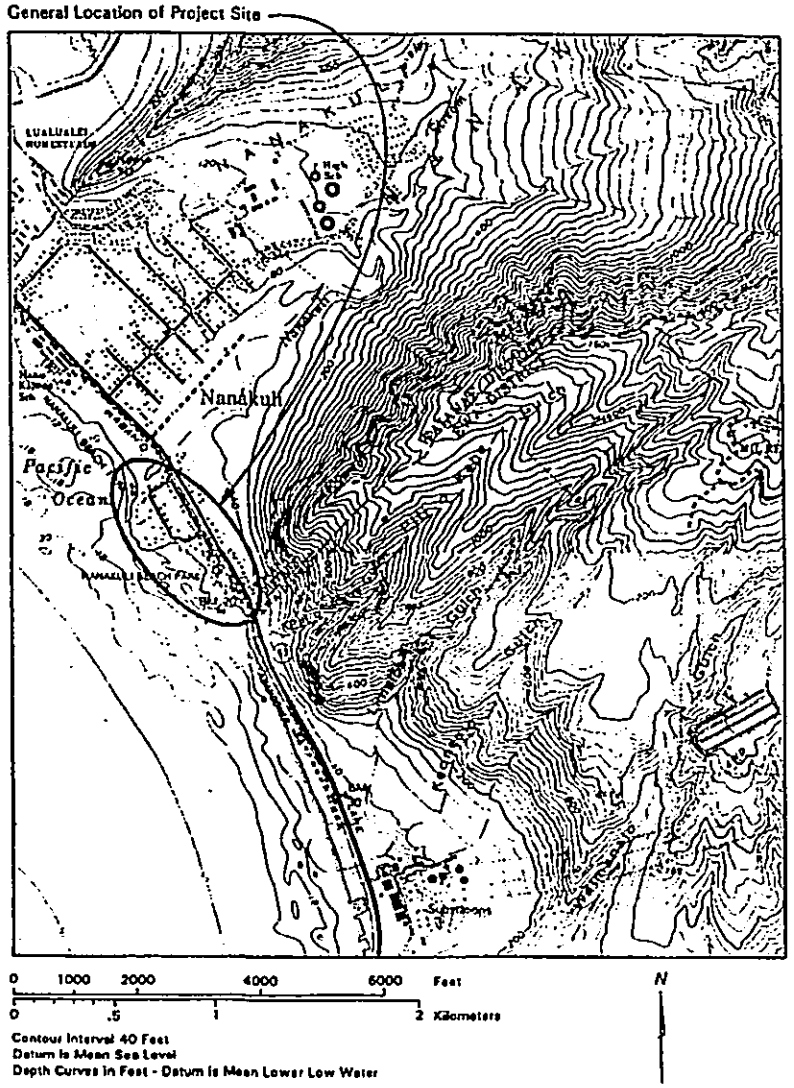
Glen Y.F. Lau, P.E.
President

Sharen H. Cho
Staff Engineer

GLEN Y.F. LAU
LICENSED PROFESSIONAL ENGINEER

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

GYL(8950-001FNLRPT.001)
(Six copies submitted)

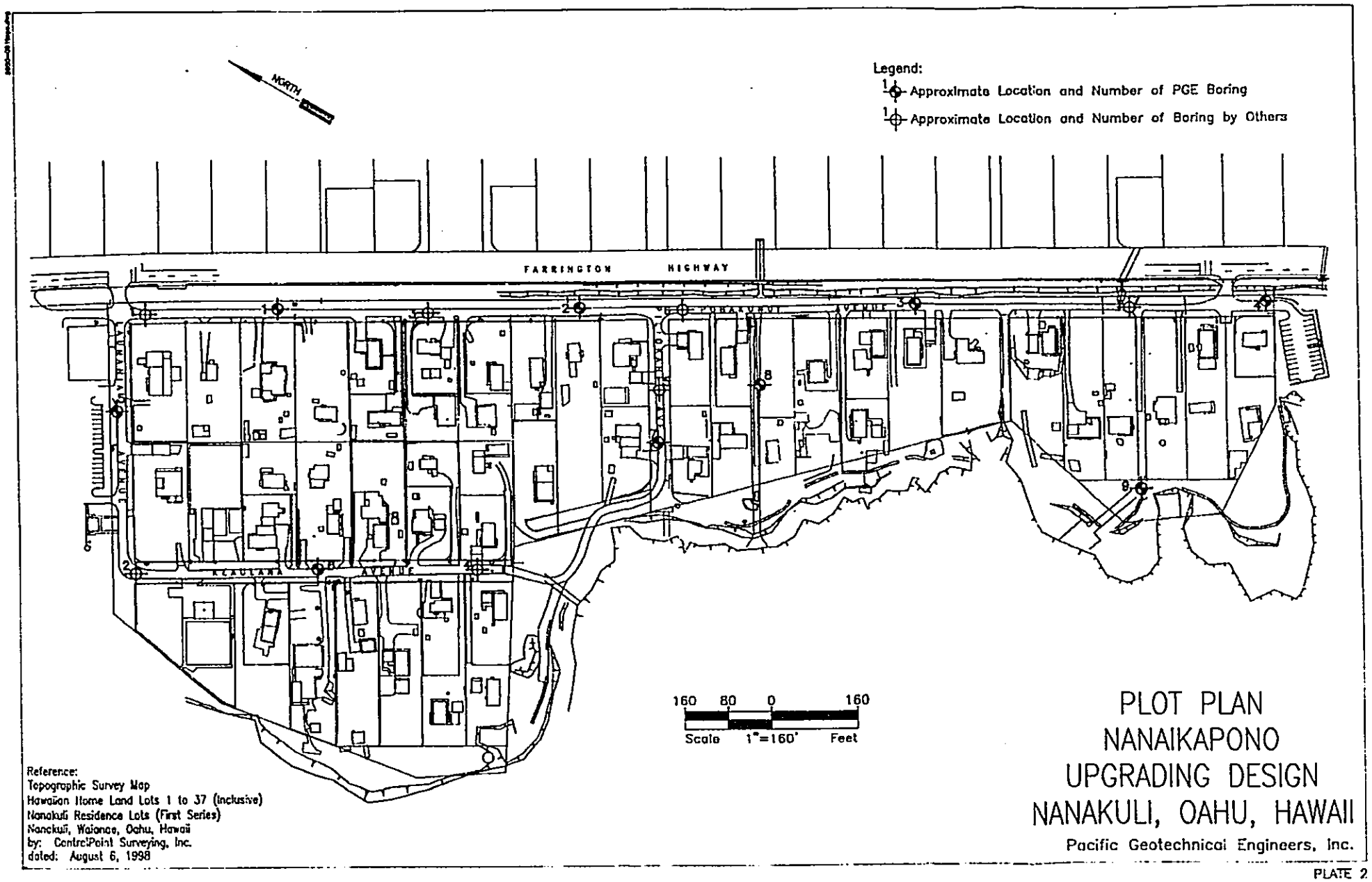


MAP OF AREA

Reference:
USGS Topographic Maps
Schofield Barracks & Eva, Hawaii
Dated: 1983

Pacific Geotechnical Engineers, Inc.

PLATE 1

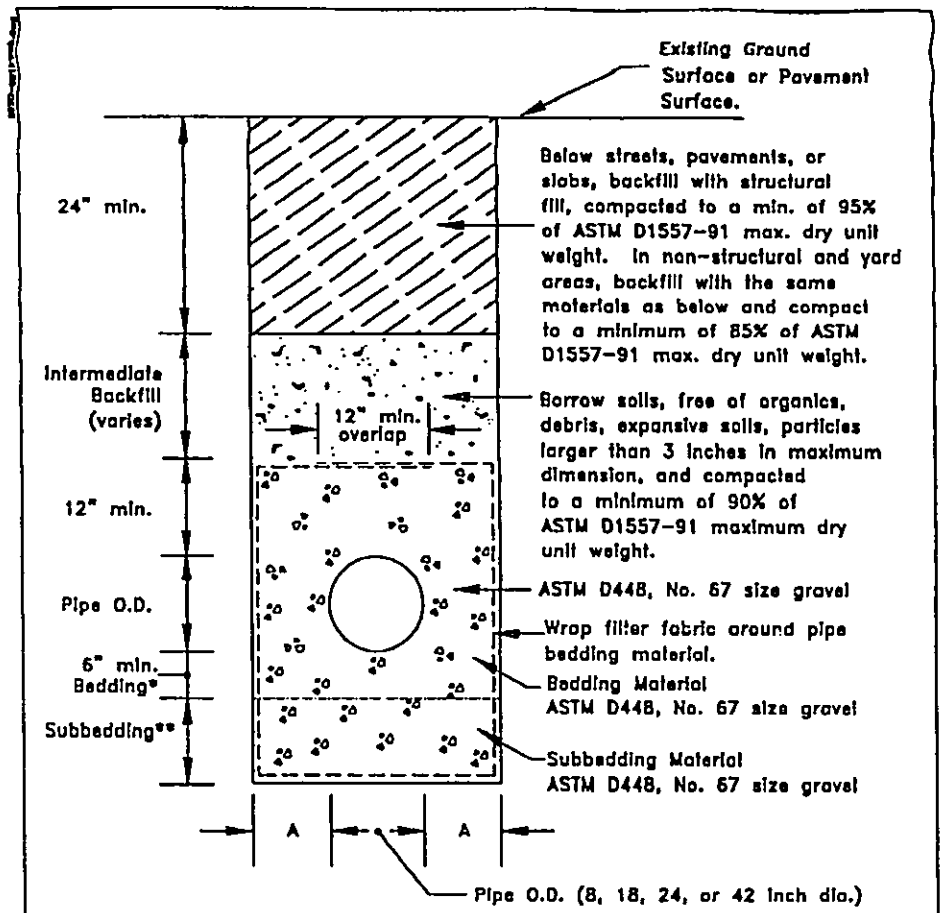


Reference:
Topographic Survey Map
Hawaiian Home Land Lots 1 to 37 (inclusive)
Nanakuli Residence Lots (First Series)
Nanakuli, Waianae, Oahu, Hawaii
by: CentrePoint Surveying, Inc.
dated: August 6, 1998

PLOT PLAN
NANAIKAPONO
UPGRADING DESIGN
NANAKULI, OAHU, HAWAII

Pacific Geotechnical Engineers, Inc.

PLATE 2



NOTES:

1) A=8" for 8" dia. pipe for sewerline
   A=9" for 18" dia. pipe for drainline
   A=12" for 24" dia. pipe for RCP culvert
   A=15" for 42" dia. pipe for RCP culvert

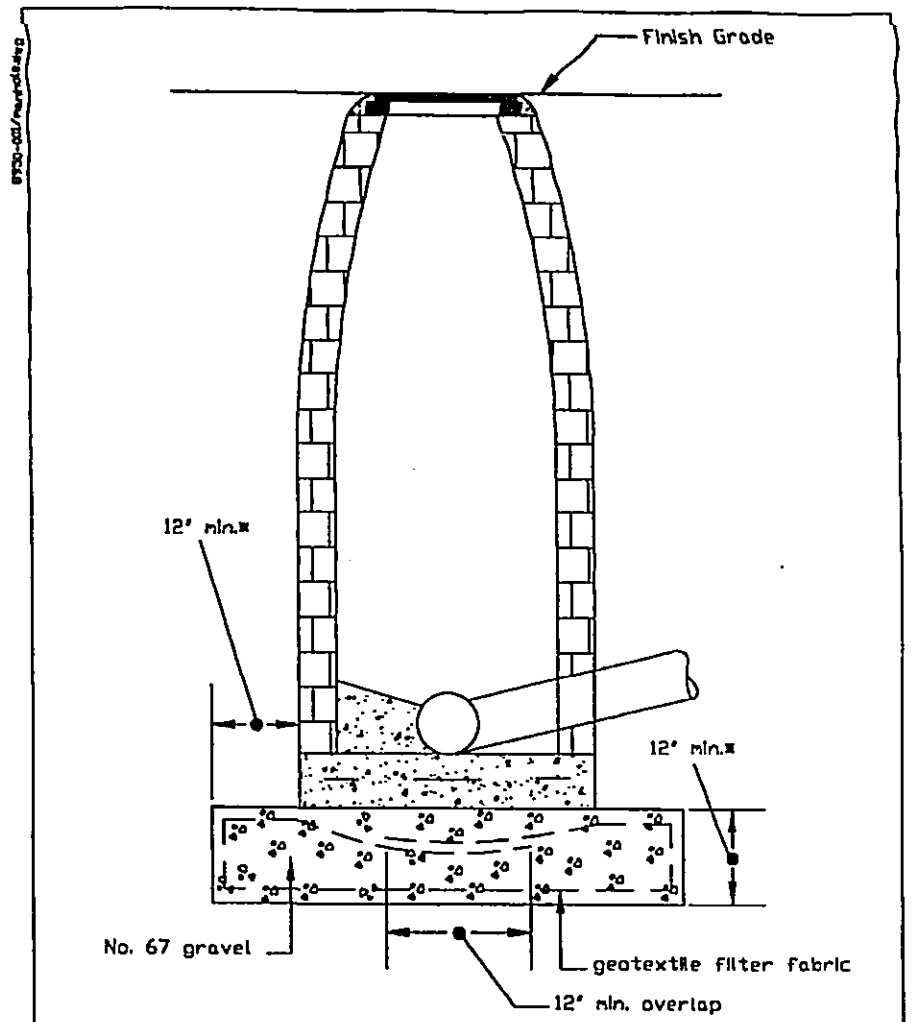
* Increase bedding thickness to 12 inches for pipes 24" dia. and larger.

** Provide subbedding as specified in the text.

Schematic Section of
Pipe Bedding & Backfill Requirements
(not to scale)

Pacific Geotechnical Engineers, Inc.

PLATE 3



NOTE:

* Increase to at least 24 inches below the bottom of the slab for manholes underlain by expansive clays, soft or loose submerged materials.

Manhole Overexcavation Detail
(not to scale)

Pacific Geotechnical Engineers, Inc.

PLATE 4

TABLE 1

PIPE SUBBEDDING THICKNESS BY GENERAL SUBSURFACE CONDITIONS

General Subsurface Conditions at Bottom of Pipe Bedding	Recommended Minimum Subbedding Thickness Below Pipe Bedding (inches)	
	Above Ground Water	Below Ground Water
Coral and coralline sand and gravel	6	12
Elastic silt and fat clay	12	12
Basaltic cobbles and boulders	18	18

NOTES:
1. Provide the following minimum bedding thicknesses below the pipe inverts:
   - 6 inches of bedding for pipes 8 to 18 inches in diameter
   - 12 inches of bedding for pipes 24 to 42 inches in diameter
2. A design high groundwater level at Elevation +3 feet is recommended.

TABLE 2

ANTICIPATED PIPE SUBSURFACE CONDITIONS AT BOTTOM OF PIPE BEDDING

Location	Approximate Stations[1]	Assumed Pipeline Invert Elevations (Feet)[1]	Anticipated Subsurface Conditions at Bottom of Pipe Bedding
Pohakunui Avenue	0+00 to 21+29	-3.2 to +6.2 (sewer) +5.2 to+11.4 (drain line)	Coral and coralline sand and gravel
	10+11 to 21+20	+6.0 to +15.1 (water line)	
	Vicinity of 12+00 ±	+2.5 to +2.0 (sewer) +6.5 to+7.2 (drain line) +8.0 to +9.2 (water line)	Elastic silt and fat clay and poss. basaltic cobbles/boulders
	Vicinity of 18+00 ±	+9.5 to+10.5 (drain line) +10.1 to +12.9 (water line)	Elastic silt and fat clay
	Vicinity of 21+20±	+6.2 (sewer)	Elastic silt and fat clay and possible basaltic cobbles and boulders
Laumania Avenue	0+00 to 5+12	-3.2 to -1.1 (sewer) +4.2 to +9.8 (drain line)	Coral and coralline sand and gravel
Piliokahi Avenue	0+00 to 2+50±	+1.1 to +2.1 (sewer) +4.8 to +5.0 (drain line)	Elastic silt and fat clay
	2+50± to 3+66	+2.1 to +2.4 (sewer) +3.5 to +4.8 (drain line)	Coral and coralline sand and gravel
Keaulana Avenue	0+00 to 8+40	-1.1 to +2.1 (sewer) +3.9 to +6.6 (drain line)	Coral and coralline sand and gravel
Aala Walkway	0+00 to 2+56	+7.2 to +5.0 (drain line "D", 24-inch diam. RCP)	Possible elastic silt and fat clay and coralline sand and gravel

NOTE: 1. Approximate Station Numbers and Approximate Pipeline Invert Elevations are based on Earth Tech, Inc.'s preliminary plans received on October 21, 1998.

2. The borings drilled for this project were widely spaced. The transitions between the various anticipated subsurface and groundwater conditions indicated herein may vary locally between borings. The anticipated subsurface conditions at bottom of pipe bedding may differ locally from those presented in this table. Additional over excavation below the pipe bedding should be performed if localized areas of soft or loose soils, or cavities are encountered.

APPENDIX A

FIELD EXPLORATION

Our field exploration consisted of drilling nine (9) soil test borings in the period of time from June 23 through 25, 1998 to depths ranging from 11.5 to 22.3 feet below the existing ground surface. The approximate locations of the borings are shown on the Plot Plan, Plate 2 in the main text. The locations and their corresponding elevations were estimated based on information provided on the project topographic plans and our field personnel's measurement.

The borings were drilled by our subcontracted driller, Hawaii Test Borings, Inc. (HTB), using a B-53 truck-mounted drill rigs with 4-inch diameter continuous flight augers and rotary wash drilling equipment. The drilling was conducted under the observation of our engineering personnel, who prepared a log of the materials encountered in each boring and obtained relatively undisturbed and disturbed soil samples for further examination and laboratory testing.

Relatively undisturbed and disturbed soil samples were obtained in the borings using a stainless steel split barrel sampler with an outside diameter (O.D.) of 3.3-inch and an inside diameter (I.D.) of 2.4-inch and a Standard Penetration Test (SPT) split spoon sampler with an O.D. and I.D. of 2-inch and 1.4-inch, respectively. The sampler was driven with blows from a 140 pound hammer falling 30 inches. Each sampling attempt consisted of driving the sampler for a total distance of approximately 18 inches and recording the blow counts for each 6 inches of penetration. The blow counts for the last 12 inches of penetration were recorded. At the completion of each day of drilling, the soil samples and rock cores recovered during the operations were transported to our laboratory in Honolulu for further examination and testing.

Coralline rock was continuously cored in select borings with a double tube, NX-size core barrel that recovers cores of approximately 2-inch in diameter. The rock quality designation (RQD) for the NX cores, along with the percentages of core recovery, are indicated on the boring logs. RQD is defined as the total length of intact recovered pieces of cores, 4 inches or longer, expressed as a percentage of the overall core length.

Graphical representations of the soils encountered in the borings are presented on the Log of Borings, Plates A-1.1 through A-1.9. The soils encountered in the borings and test pits were initially classified in the field according to American Society of Testing and Material (ASTM) D2488 procedure and the Unified Soil Classification System presented on Plates A-2.1 and A-2.2. Additional field data from our observation of the drilling process, soil cuttings,

wash water, color, drilling rate, and soil sampling were used to supplement our field classifications of the soils. Our field classifications were later refined according to the ASTM D2487 based on laboratory test results performed on selected soil samples. Coralline rock was classified according to the Calcareous Rock Classification System for Hawaii described on Plate A-3. The rocks encountered were described according to the Rock Description System presented on Plate A-4.

At the completion of the drilling, the borings were backfilled to the ground surface with soil cuttings and on-site materials.

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The following plates are attached and complete this appendix.

Plates A-1.1 through A-1.9	-	Log of Boring, Borings 1 through 9
Plates A-2.1 and A-2.2	-	Unified Soil Classification System
Plate A-3	-	Calcareous Rock Classification System for Hawaii
Plate A-4	-	Rock Description System

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY mt

BORING 1 (Page 1 of 1)

SURFACE ELEVATION 15.1 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
						0			AC	2 inches of asphaltic concrete
		NX	78	18	50/3"				SP	Light brown poorly graded coralline sand, with coralline gravel, damp (fill)
									CH	Dark grayish brown fat clay, with some coralline sand, moist (alluvium)
						5			MH	Tan coral, medium hard to hard, highly fractured (Type I Coral)
		NX	48	0						Seam of brown elastic silt with coralline gravel
									GP	Tan poorly graded coralline gravel and cobbles, medium dense, locally cemented, with sand and some silt, moist
						10				possible void
					1				GP	
		NX	48	16	43/3"	15				Brown recemented coral, medium hard, highly fractured, weakly to moderately cemented (Type II Coral)
										grades light grayish brown
									SP	Tan poorly graded coralline sand, medium dense to dense, locally cemented, with some silt and coralline gravel, moist
36					31	20				

Boring completed at 22.3 feet on 08-24-98.

Unable to measure stabilized groundwater level due to drilling process.

NOTES
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
☑ - Standard penetration test sample (SPT-split spoon sampler)
I - Core run
DRIVING ENERGY 140-lb dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE A-1.1

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY mt

BORING 2 (Page 1 of 1)

SURFACE ELEVATION 12.8 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
						0			AC	2 inches of asphaltic concrete
32	82	NX	20	0	68/4"				SP	Light brownish white gravelly coralline sand, medium dense, damp to moist (fill)
									CH	Dark grayish brown fat clay, very stiff, with some coralline sand, moist (alluvium)
						5			SP	Tan coral, medium hard, highly fractured (Type I Coral)
										Tan gravelly coralline sand, dense, locally cemented, with some silt, saturated
19					46					Tan cemented coralline sand, medium hard, highly fractured, weakly to moderately cemented (Type II Coral)
		NX	90	16		10				
										(Water level at 1134 hours on 06-25-98)
		NX	88	56						dark gray basaltic boulder
						15				grades with some basaltic sand and gravel
										grades without basaltic sand and gravel

Boring completed at 17.5 feet on 06-24-98.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
☑ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE A-1.2

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lc/bl

BORING 3 (Page 1 of 1)

SURFACE ELEVATION 13.3 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
									AC	2 inches of asphaltic concrete
33	78				41				GM	Light grayish brown silty coralline gravel, medium dense, with sand, damp (fill)
					40/1"				MH	
		NX	37	10	43/1"					Dark grayish brown elastic silt, very stiff, with some basaltic gravel, moist (alluvium)
						5			SH	Tan recemented coral, medium hard, highly fractured, weakly to moderately cemented (Type II Coral)
										Tan silty coralline sand, loose, locally weakly cemented, moist
31					4	10				grades brown, very loose, and with some brown elastic silt
									ML	Light grayish brown sandy silt, very stiff, wet
25					32	15				grades light brown and with some basaltic and coralline gravel

Boring completed at 15.5 feet on 06-23-98.

Unable to measure stabilized groundwater level due to drilling process.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
◪ - Standard penetration test sample (SPT-split spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE A-L3

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lml

BORING 4 (Page 1 of 1)

SURFACE ELEVATION 19.8 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
					12/6"				AC	3 inches of asphaltic concrete
					31				GP	Light brown sandy poorly graded coralline gravel, medium dense, with silt, moist (fill)
29	92				93				CH	Dark grayish brown fat clay, very stiff, with some coralline sand, moist (alluvium)
		NX	54	30		5				Tan coral, medium hard, moderately fractured (Type I Coral)
									SP	Tan poorly graded coralline sand, locally cemented, with coralline gravel and some silt
		NX	56	30						
						10				Tan coral, medium hard, moderately fractured (Type I Coral)
										Dark gray basaltic cobbles and boulders, with some coralline sand and gravel
31					50/8"				MH	Light grayish brown elastic silt, hard, with some basaltic sand and gravel, saturated
										grades with basaltic cobbles

Boring completed at 14.7 feet on 06-24-98.

Groundwater not encountered

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
◪ - Standard penetration test sample (SPT-split spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE A-L4

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lml

BORING 5 (Page 1 of 1)

SURFACE ELEVATION 13.0 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: ROD % or (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
						0			AC	2 inches of asphaltic concrete
		NX	92	60					GM	Light brown silty coralline gravel, dense, with coralline sand, moist (fill)
										Tan recemented coral, medium hard, moderately fractured, moderately cemented (Type II Coral)
						5				grades with seams of Type I Coral
		NX	92	56						Light grayish white coral, medium hard, moderately fractured (Type I Coral)
						10				
		NX	76	48						Tan recemented coral, medium hard, moderately fractured, weakly to moderately cemented (Type II Coral)
		NX	60	8		15				(Water level at 1144 hours on 08-25-98)
										grades highly fractured
						20				
					13				SM	Light brownish gray silty coralline sand, loose to medium dense, saturated
										Boring completed at 22.0 feet on 08-25-98.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
◪ - Standard penetration test sample (split-spoon sampler)
T - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE A-1.5

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lml

BORING 6 (Page 1 of 1)

SURFACE ELEVATION 10.5 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: ROD % or (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
						0			AC	2 inches of asphaltic concrete
20	87				27				SM	Brown silty coralline sand, loose to medium dense, with some coralline gravel, moist (fill)
30	78				64/4"				ML	Light brownish gray sandy coralline silt, stiff, moist
									MH	Brown elastic silt, very stiff to hard, moist (alluvium)
		NX	32	24		5				White coral, medium hard, slightly fractured (Type I Coral)
									GM	Light brown silty coralline gravel, medium dense to dense, with sand, locally cemented, moist
28					30					
		NX	88	62		10				Light grayish white coral, medium hard, highly fractured (Type I Coral)
										grades slightly fractured
						15				
										Boring completed at 15.0 feet on 08-25-98.
										Unable to measure stabilized groundwater level due to drilling process.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
◪ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE A-1.6

PROJECT Nanakapono Upgrading Design JOB No. 8950-001

LOCATION Nanakuli, Oahu, Hawaii DRAWN BY tc/pd

BORING 7 (Page 1 of 1)

SURFACE ELEVATION 10.7 ± Feet

DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (INCH) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
25		NX	50	0	20/11" 79/6"	5			AC	2 inches of asphaltic concrete
									SP ML	Light brownish gray gravelly, poorly graded, coralline sand, loose to medium dense, with silt, moist (fill)
										Brown sandy silt, hard, with some coralline gravel, moist (alluvium)
									SP SM	Tan coral, medium hard, highly fractured (Type I Coral)
										grades with recemented and seams of uncemented coralline sand
					83					Tan poorly graded coralline sand, very dense, with silt and coralline gravel, locally weakly cemented, moist
					22	10				grades medium dense

Boring completed at 11.5 feet on 06-23-98.

Unable to measure stabilized groundwater level due to drilling process.

NOTES:
■ - Relatively undisturbed sample
⊙ - Disturbed sample
□ - Sample lost during extraction
☑ - Standard penetration test sample (SPT-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc.

PLATE A-L7

PROJECT Nanakapono Upgrading Design JOB No. 8950-001

LOCATION Nanakuli, Oahu, Hawaii DRAWN BY tc/pd

BORING 8 (Page 1 of 1)

SURFACE ELEVATION 11.6 ± Feet

DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (INCH) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
					15				SM	Light brown silty coralline sand, loose, damp (fill)
									CH	Dark grayish brown fat clay, stiff, with decomposed wood, moist (alluvium)
33					16					
					23	5				grades very stiff and without decomposed wood
54	70				15					grades stiff
51	71				21					
51	73				21	10				grades with trace of basaltic gravel
54	89				24	15				grades very stiff

Boring completed at 16.5 feet on 06-23-98.

Unable to measure stabilized groundwater level due to drilling process.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
□ - Sample lost during extraction
☑ - Standard penetration test sample (SPT-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc.

PLATE A-L8

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY bd

BORING 9 (Page 1 of 1)

SURFACE ELEVATION 10.3 ± Feet
DATUM Mean Sea Level

LAB DATA		CORE INFO							
MOISTURE CONTENT %	DRY UNIT WEIGHT (pcf)	CORE TYPE	RECOVERY %	RQD % (REC) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS
19		NX	80	54	47/4"	0			CH
						5			SP
		NX	10	0					SM
						10			
					27				
						15			
					30				

DESCRIPTION

Dark grayish brown fat clay, stiff, with some coraline sand and roots, damp to moist (alluvium)

Tan recemented coral, medium hard, slightly fractured, moderately cemented (Type II Coral)

Tan poorly graded coraline sand, medium dense, with silt and coraline gravel, locally cemented, moist

(Water level at 1334 hours on 06-25-98)

Boring completed at 16.5 feet on 06-24-98.

NOTES:
■ - Relatively undisturbed sample
☑ - Disturbed sample
☐ - Sample lost during extraction
◪ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING

Pacific Geotechnical Engineers, Inc.

PLATE A-1.9

CHECKED BY/DATE

UNIFIED SOIL CLASSIFICATION SYSTEM – (ASTM D2487-93)

MAJOR DIVISIONS			LETTER SYMBOL	GRAPHIC SYMBOL	GROUP NAMES
COARSE-GRAINED SOILS (MORE THAN 50% RETAINED ON NO. 200 SIEVE)	GRAVELS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVELS (LESS THAN 5% FINES)	GW		WELL-GRADED GRAVEL, WELL-GRADED GRAVEL WITH SAND
			GP		POORLY-GRADED GRAVEL, POORLY-GRADED GRAVEL WITH SAND
		GRAVELS WITH (MORE THAN 12% FINES)	GM		SILTY GRAVEL, SILTY GRAVEL WITH SAND
			GC		CLAYEY GRAVEL, CLAYEY GRAVEL WITH SAND
	SANDS (50% OR MORE OF COARSE FRACTION PASSES NO. 4 SIEVE)	CLEAN SAND (LESS THAN 5% FINES)	SW		WELL-GRADED SAND, WELL-GRADED SAND WITH GRAVEL
			SP		POORLY-GRADED SAND, POORLY-GRADED SAND WITH GRAVEL
		SANDS WITH (MORE THAN 12% FINES)	SM		SILTY SAND, SILTY SAND WITH GRAVEL
			SC		CLAYEY SAND, CLAYEY SAND WITH GRAVEL
FINE-GRAINED SOILS (50% OR MORE PASSES NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML		SILT, SILT WITH SAND OR GRAVEL, SANDY OR GRAVELLY SILT
			CL		LEAN CLAY, LEAN CLAY WITH SAND OR GRAVEL, SANDY OR GRAVELLY SILT
			OL		ORGANIC SILT OR CLAY, ORGANIC SILT OR CLAY WITH SAND OR GRAVEL, SANDY OR GRAVELLY ORGANIC SILT OR CLAY
	SILTS AND CLAYS (LIQUID LIMIT 50 OR MORE)		MH		ELASTIC SILT, ELASTIC SILT WITH SAND OR GRAVEL, SANDY OR GRAVELLY ELASTIC SILT
			CH		FAT CLAY, FAT CLAY WITH SAND OR GRAVEL, SANDY OR GRAVELLY FAT CLAY
			OH		ORGANIC SILT OR CLAY, ORGANIC SILT OR CLAY WITH SAND OR GRAVEL, SANDY OR GRAVELLY ORGANIC SILT OR CLAY
HIGHLY ORGANIC SOILS			PT		PEAT

NOTE:
DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE CLASSIFICATIONS. REFER TO ASTM D2487 FOR BORDERLINE CLASSIFICATIONS GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, AND SP-SC.

UNIFIED SOIL CLASSIFICATION SYSTEM
(SHEET 1 OF 2)

Pacific Geotechnical Engineers, Inc.

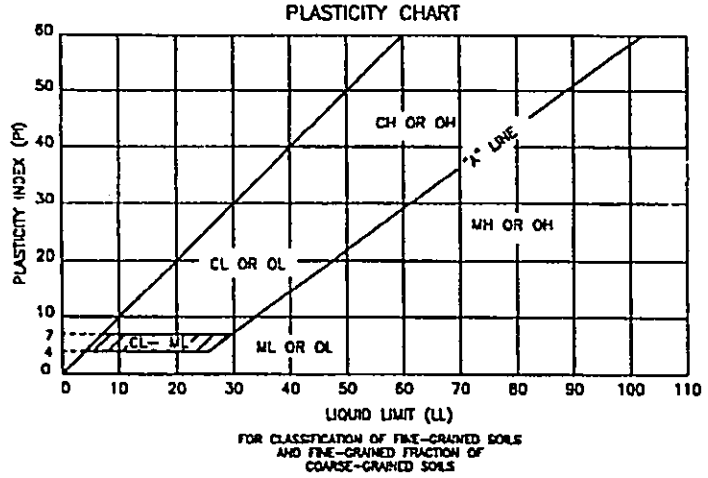
PLATE A-2.1

GRADATION CHART

MATERIAL SIZE	PARTICLE SIZE			
	LOWER LIMIT		UPPER LIMIT	
	MILLIMETERS	SIEVE SIZE **	MILLIMETERS	SIEVE SIZE **
SAND				
FINE	0.075	#200 **	0.425	#40 **
MEDIUM	0.425	#40 **	2.00	#10 **
COARSE	2.00	#10 **	4.75	#4 **
GRAVEL				
FINE	4.75	#4 **	19.0	3/4" *
COARSE	19.0	3/4" *	75.0	3" *
COBBLES	75.0	3" *	300	12" *
BOULDERS	300	12" *	---	---

** U.S. STANDARD SIEVE * SQUARE OPENINGS

PLASTICITY CHART



FOR CLASSIFICATION OF FINE-GRAINED SOILS AND FINE-GRAINED FRACTION OF COARSE-GRAINED SOILS

NOTE:
WHEN SHOWN ON THE BORING LOGS, THE FOLLOWING TERMS ARE USED TO DESCRIBE THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE COMPACTNESS OF COHESIONLESS SOILS.

COHESIVE SOILS (APPROXIMATE SHEAR STRENGTH IN KSF)		COHESIONLESS SOILS	
VERY SOFT	LESS THAN 0.25	VERY LOOSE	THESE ARE USUALLY
SOFT	0.25 TO 0.5	LOOSE	BASED ON AN EXAMINATION
MEDIUM STIFF	0.5 TO 1.0	MEDIUM DENSE	OF SOIL SAMPLES,
STIFF	1.0 TO 2.0	DENSE	PENETRATION RESISTANCE,
VERY STIFF	2.0 TO 4.0	VERY DENSE	AND SOIL DENSITY DATA.
HARD	GREATER THAN 4.0		

UNIFIED SOIL CLASSIFICATION SYSTEM

(SHEET 2 OF 2)

Pacific Geotechnical Engineers, Inc.

PLATE A-2.2

CALCAREOUS ROCK CLASSIFICATION SYSTEM FOR HAWAII

BASIC TYPES OF CALCAREOUS ROCK

TYPE I

IN SITU REEF ROCK
Composed largely of undisturbed coralline skeletons. The skeletons are cemented together during accretion. The cementing agents are calcium compounds secreted by the marine organisms. The joined skeletons form a structural framework. Coralline and other calcareous debris commonly fill the framework interstices.

TYPE II

SECONDARY ROCK
Composed essentially of cemented fragments of coralline skeletons and/or calcareous shells. Cementation is believed to occur primarily after accretion is completed and the marine deposit begins to emerge above sea level. The common types of secondary rock are listed below.

1. Conglomerate - Cemented, non-uniform sand-and gravel size particles of cemented coralline skeletons and/or calcareous shell. The skeletons and shells are originally deposited in near-shore waters. The cementing agent is calcium carbonate precipitated primarily from percolating ground water.

2. Shell Rock - Cemented shells and shell fragments that have accumulated in protected shallow sea water. The shells are often cemented in a clay-and silt-size matrix. Cementation develops from calcium carbonate deposited by ground water.

3. Dune Rock - Cemented dune sand. The cementing agent is generally calcium carbonate precipitated from percolating ground water. Dune rock generally has a relatively low density because the constituent sand grains are loosely packed and often poorly cemented.

TYPE III

CHALK
Poorly cemented mass of calcareous clay-and silt-size particles, believed to be precipitated fro shallow sea water and associated with near-shore environments.

*The term coralline is used to indicate coral and/or other calcium compound secreting organisms.

Pacific Geotechnical Engineers, Inc.

PLATE A-3

ROCK DESCRIPTION SYSTEM

A. DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Fresh: No visible sign of decomposition or discoloration. Rings under hammer impact.

Slightly Weathered: Slight discoloration inwards from open fractures, otherwise similar to Fresh.

Moderately Weathered: Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock but cores cannot be broken by hand or scraped by knife. Texture preserved.

Highly Weathered: Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.

Completely Weathered: Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.

Residual Soil: Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change relative to fresh rock.

B. HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Soft: Can be peeled with a knife, material crumbles under firm blows with the sharp end of a geologic pick.

Soft: Can just be scraped with a knife, indentations of 2 to 4 mm with firm blows of the pick point.

Medium Hard: Cannot be scraped or peeled with a knife but can be scratched with knife point. Hand held specimen breaks with firm blows of the pick.

Hard: Difficult to scratch with knife point, cannot break hand held specimen.

Very Hard: Cannot be scratched with pocket knife.

C. ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Crushed: Less than 5 microns (mechanical clay) to 0.1 foot.

Intensely Fractured: 0.05 to 0.1 foot (contains no clay).

Highly Fractured: *0.1 to 0.5 feet.

Moderately Fractured: 0.5 to 1.0 feet

Occasionally Fractured: 1.0 to 3.0 foot

Slightly Fractured: Greater than 3.0 feet.

APPENDIX B

LABORATORY TESTING

GENERAL - To evaluate their engineering properties, selected soil samples obtained during the field exploration were subjected to laboratory moisture content and dry density determinations, Atterberg Limits tests, gradation tests, strength tests, swell tests, moisture-density relation tests, and CBR tests. The tests and their results are described in the following paragraphs.

MOISTURE CONTENT AND DRY DENSITY - Relatively undisturbed selected soil samples were tested to determine their in situ moisture contents and dry densities. The tests were performed in accordance with ASTM D2216 test method. Results of the moisture content and dry density determinations are presented on the Log of Borings, Plates A-1.1 through A-1.9, at the respective sample depths.

ATTERBERG LIMITS - Five (5) Atterberg Limits tests were performed on samples of silts and clays in accordance with ASTM D4318 test method. The test results are presented on Plates B-1.1 and B-1.2.

GRADATION ANALYSIS - Three (3) gradation tests were performed by sieve method in accordance with ASTM D422 to evaluate grain size distribution. The test results are presented on Plate B-2.

SHEAR STRENGTH - Two (2) triaxial shear tests were performed on relatively undisturbed soil samples to evaluate their shear strength properties. The triaxial tests were performed under unconsolidated, undrained triaxial (TX/UU) conditions in accordance with ASTM D2850 test method. The tests were performed on the soils samples at their field moisture contents. Total stress properties were measured in these tests. The results of the strength tests are summarized in Table B-1.

UNCONFINED COMPRESSIVE STRENGTH - Five (5) samples of intact rock cores were tested under unconfined compression conditions in accordance with ASTM D2938 test method

to evaluate their unconfined compressive strengths. The test results are summarized in Table B-2.

MOISTURE-DENSITY RELATION - Two (2) moisture-density relation tests were performed on bulk samples of the near surface soils to determine their moisture-density relations. The tests were performed according to ASTM D1557 test method. The test results are presented on Plates B-3.1 and B-3.2.

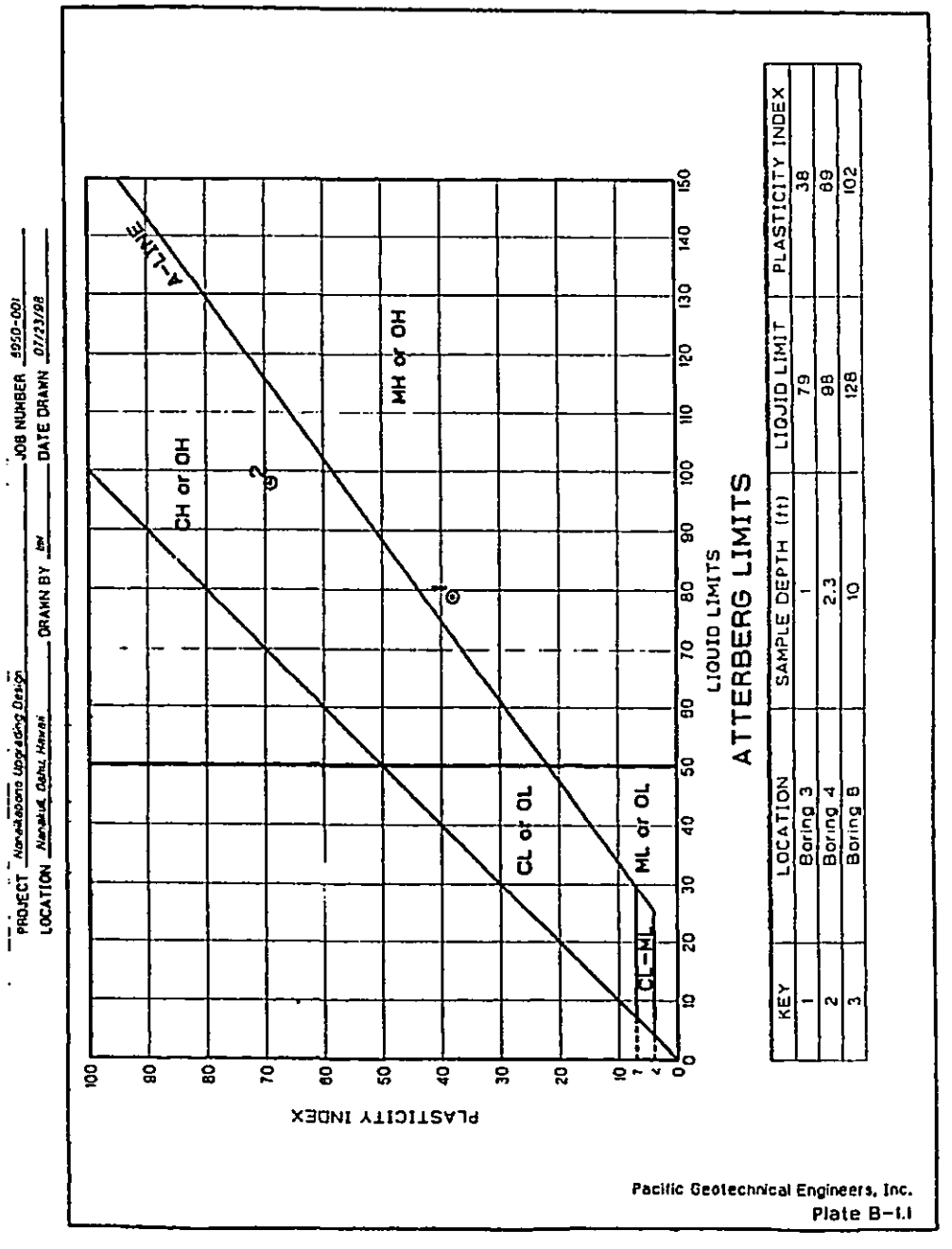
CALIFORNIA BEARING RATIO (CBR) - Two (2) laboratory CBR tests were performed in accordance with ASTM D1883 test method on the bulk samples used in the moisture-density relation tests. The results of the CBR tests are shown on Plates B-4.1 and B-4.2.

SWELL/CONSOLIDATION - Three (3) samples of the silts and clays were tested in general accordance with ASTM D4546 (Method B) test method to determine their swell/consolidation characteristics. The test results are summarized on Table B-3.

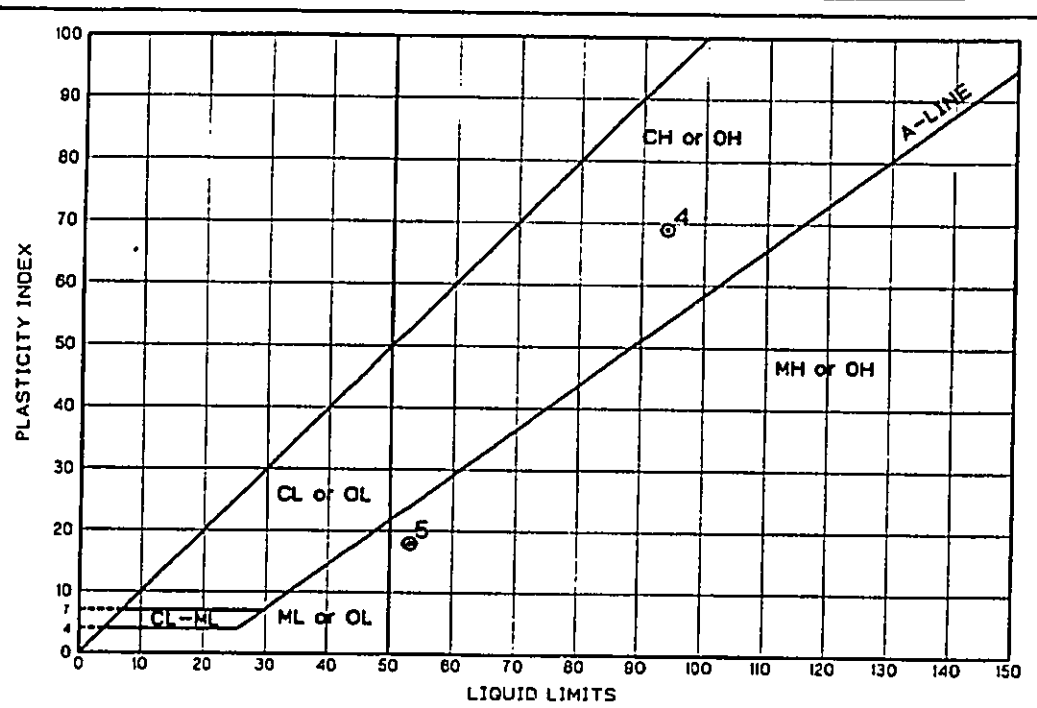
- o0o -

The following plates and tables are attached and complete this appendix.

Plates B-1.1 and B-1.2	-	Atterberg Limits
Plate B-2	-	Gradation Curves
Plates B-3.1 and B-3.2	-	Compaction Test Results
Plates B-4.1 and B-4.2	-	California Bearing Ratio (CBR) Test
Table B-1	-	Summary of Shear Strength Tests (Soil)
Table B-2	-	Summary of Unconfined Compression Tests (Coral)
Table B-3	-	Summary of Swell Tests



PROJECT Nanakuli Upgrading Design JOB NUMBER 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lei DATE DRAWN 07/23/98

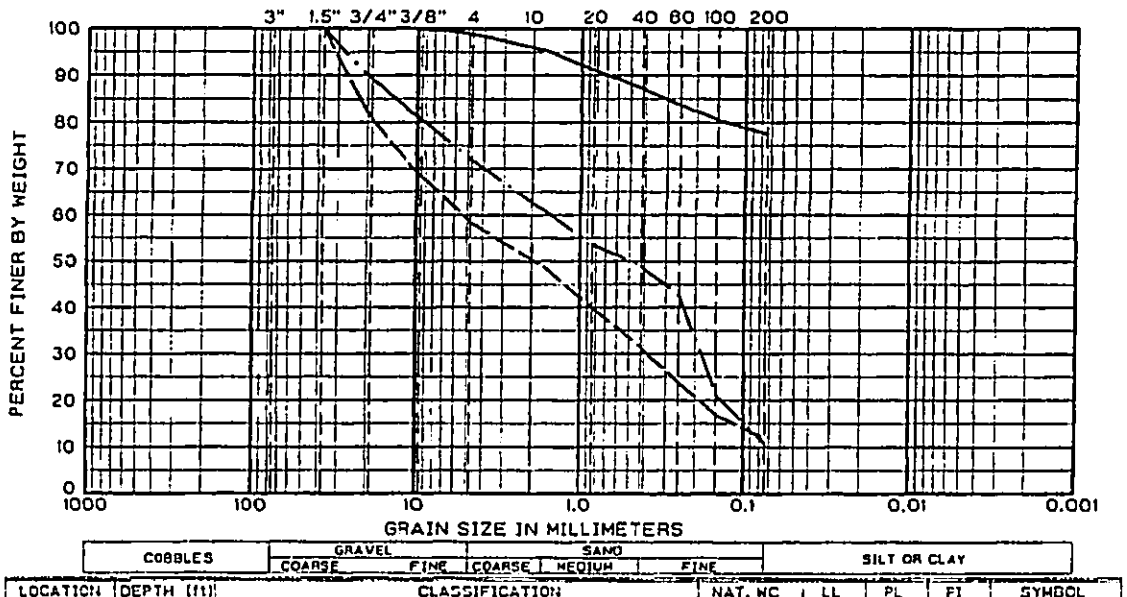


ATTERBERG LIMITS

KEY	LOCATION	SAMPLE DEPTH (ft)	LIQUID LIMIT	PLASTICITY INDEX
4	Bulk 1	1.0 - 2.5	84	69
5	Bulk 2	1.5 - 3.0	53	18

Pacific Geotechnical Engineers, Inc.
Plate B-1.2

PROJECT Nanakuli Upgrading Design JOB NUMBER 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lei DATE DRAWN 07/23/98



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LOCATION	DEPTH (ft)		CLASSIFICATION	NAT. MC	LL	PL	PI	SYMBOL
Boring 3	14.0	ML	Light grayish brown sandy silt					
Boring 7	7 - 10.5	SP-SM	Tan sand with silt and gravel					
Boring 9	11.5 - 15.5	SP-SM	Tan sand with silt and gravel					

GRADATION CURVE

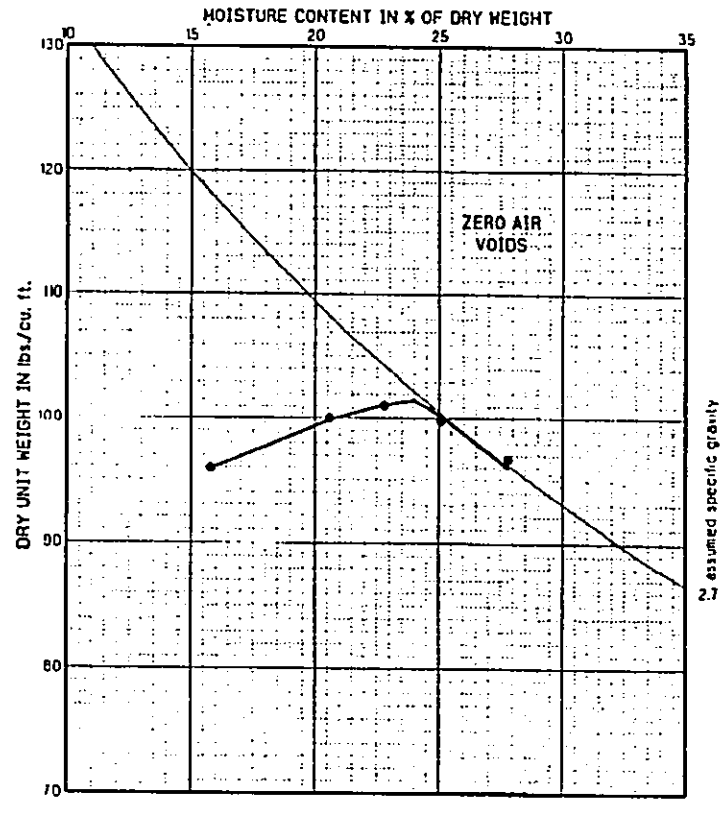
Pacific Geotechnical Engineer, Inc.
Plate B-2

SAMPLE DEPTH 1 - 2.5 feet
ELEVATION 19.8 ft.±
SOIL Dark grayish brown fat clay
COMPACTION METHOD ASTM D1557-91
OPTIMUM MOISTURE CONTENT 23.5 %
MAXIMUM DRY UNIT WEIGHT 101.5 pcf

JOB NUMBER: 8950-001
PROJECT: Nanakapono Upgrading Design
Nanakuli, Oahu, Hawaii
DRAWN BY: lal (10/14/1998)

BULK 1

SAMPLE LOCATION: Near Boring 4



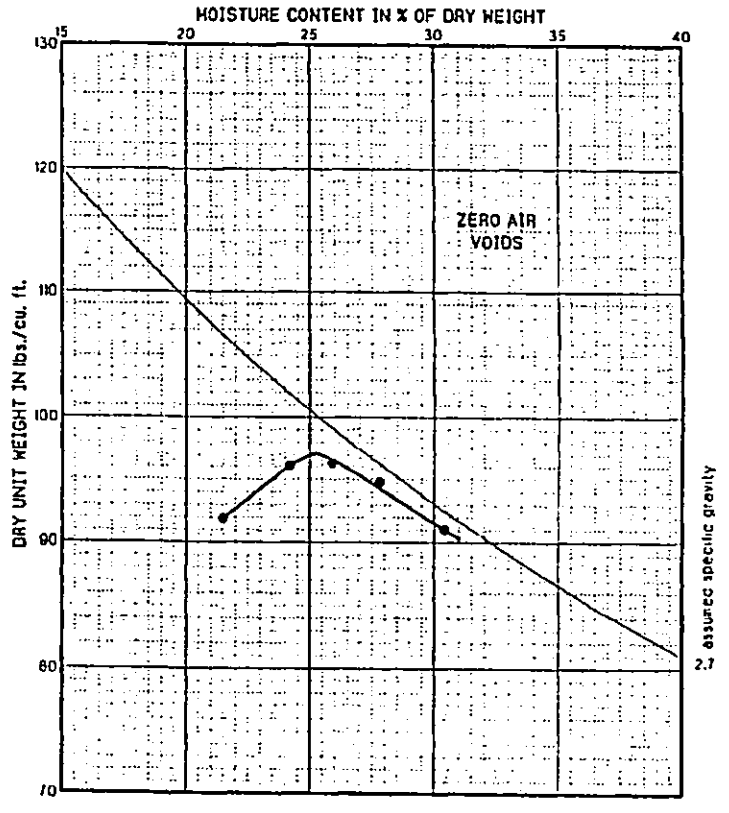
COMPACTION TEST DATA

SAMPLE DEPTH 1.5- 3.0 feet
ELEVATION 10.5 ft.±
SOIL Reddish brown elastic silt
COMPACTION METHOD ASTM D1557-91
OPTIMUM MOISTURE CONTENT 25.5 %
MAXIMUM DRY UNIT WEIGHT 97.0 pcf

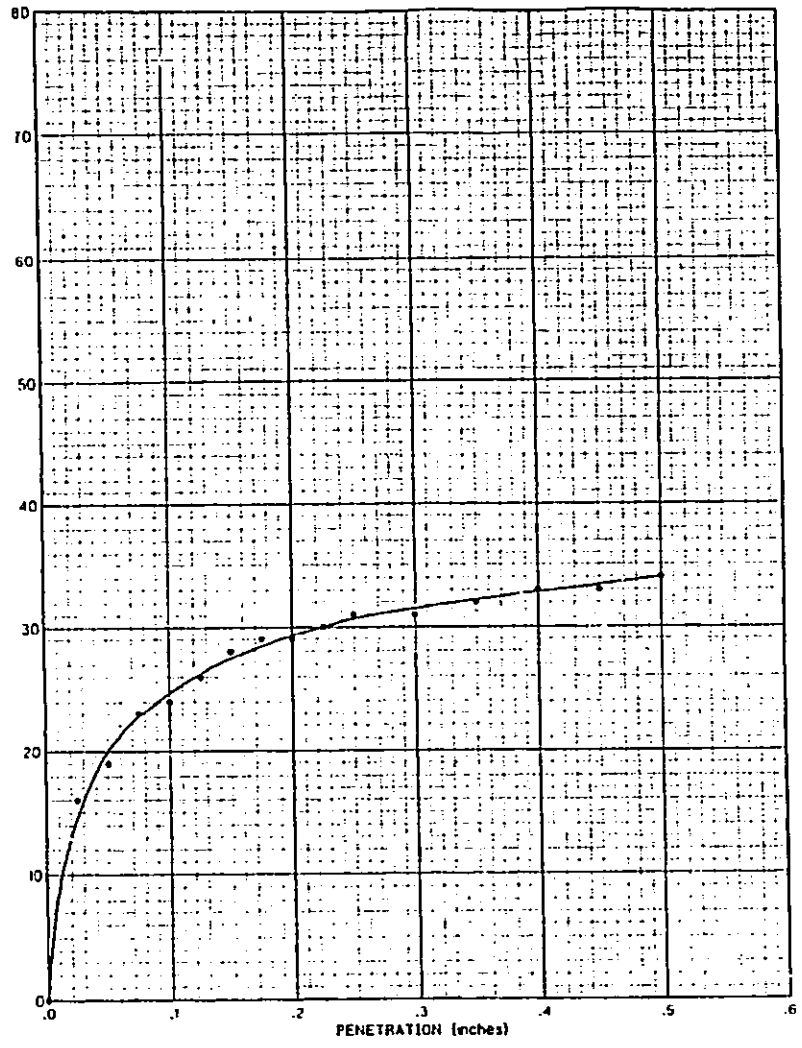
JOB NUMBER: 8950-001
PROJECT: Nanakapono Upgrading Design
Nanakuli, Oahu, Hawaii
DRAWN BY: lal (10/14/1998)

BULK 2

SAMPLE LOCATION: Near Boring 6



COMPACTION TEST DATA



CALIFORNIA BEARING RATIO (CBR) TEST RESULTS

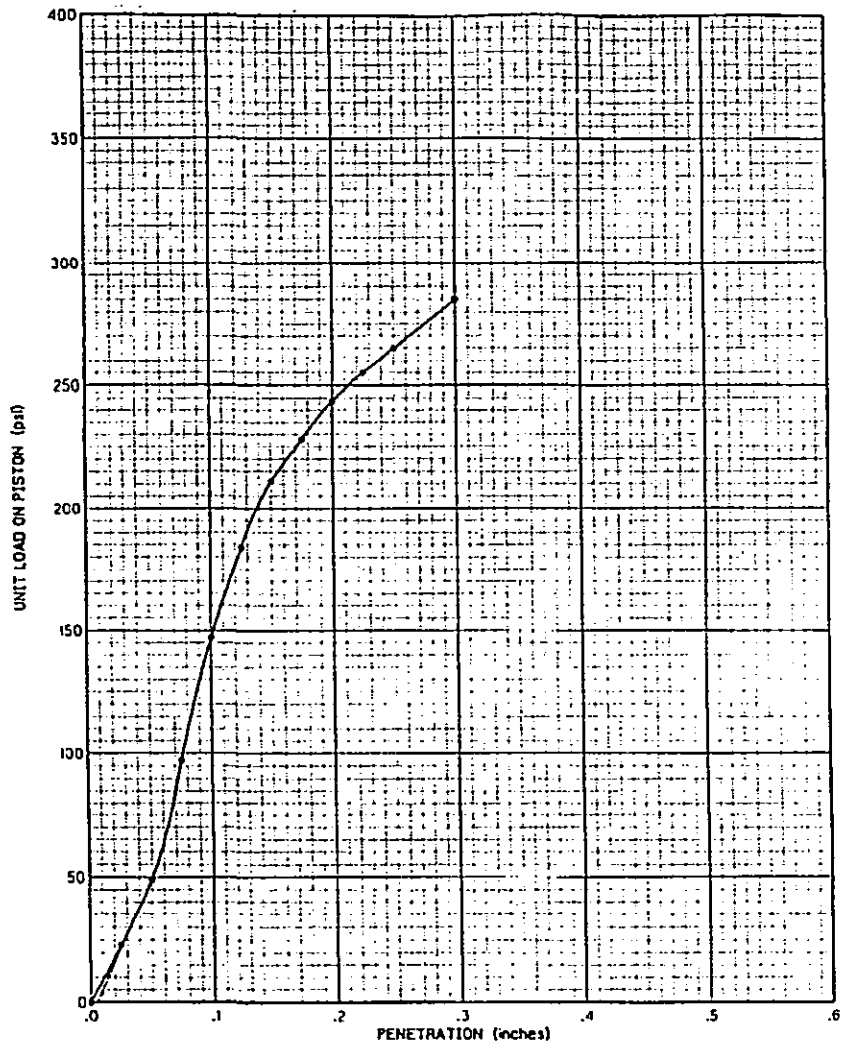
Bulk No.	Depth (ft)	Before Soaking		After Soaking			Laboratory CBR Value	
		Moisture Content (%)	Dry Unit Weight (PCF)	Moisture Content (%)	Dry Unit Weight (PCF)	% Swell	@ 0.1"	@ 0.2"
1	1-2.5	20.7	98.1	36.6	81.4	17.7	2	2

Soil Description (USCS) Dark grayish brown fat clay (CH)

Test Method ASTM D 1883-94

Pacific Geotechnical Engineers, Inc.

Plate B-4.1



CALIFORNIA BEARING RATIO (CBR) TEST RESULTS

Bulk No.	Depth (ft)	Before Soaking		After Soaking			Laboratory CBR Value	
		Moisture Content (%)	Dry Unit Weight (PCF)	Moisture Content (%)	Dry Unit Weight (PCF)	% Swell	@ 0.1"	@ 0.2"
2	1.5-3.0	28	92.2	31.6	90.7	1.7	16	17

Soil Description (USCS) Reddish brown elastic silt (MH)

Test Method ASTM D 1883-94

Pacific Geotechnical Engineers, Inc.

Plate B-4.2

TABLE B-1

SUMMARY OF SHEAR STRENGTH TESTS (SOIL)

Boring No.	Depth (feet)	Unified Soil Classification	Moisture Content (%)	Dry Density (pcf)	Confining Pressure (psf)	Peak Shear Strength (psf)	Test Type
8	5.5	CH	54.4	69.7	500	1,510	TX/UU
8	10.0	CH	50.5	73.3	1000	1,540	TX/UU

TABLE B-2

UNCONFINED COMPRESSION TEST (CORAL)

Boring No.	Depth (feet)	Unconfined Compressive Strength (psi)
1	1.8 - 2.3	2,690
2	11.0 - 11.5	180
4	3.2 - 3.8	850
5	8.5 - 9.0	690
9	1.2 - 1.8	290

TABLE B-3

SUMMARY OF SWELL /CONSOLIDATION TESTS

Boring No.	Depth (feet)	Unified Soil Classification	Before Test		After Test		Confining Pressure (psf)	Swell (%)
			Moisture Content (%)	Dry Density (pcf)	Moisture Content (%)	Dry Density (pcf)		
3	1.0	MH	33.4	77.6	50.0	72.8	100	7.2
4	2.3	CH	29.0	91.5	34.3	88.7	200	3.7
8	7.0	CH	50.5	71.4	53.6	70.7	800	1.5

ADDENDUM NO. 1
TO REPORT

SUPPLEMENTAL SUBSURFACE EXPLORATION

PGE Job No. 8950-001

for

DEPARTMENT OF HAWAIIAN HOME LANDS

NANAIKAPONO UPGRADE DESIGN
NANAKULI, OAHU, HAWAII

August 9, 1999

Submitted by:
Pacific Geotechnical Engineers, Inc.
429-B Waiakamilo Road
Honolulu, Hawaii 96817

Pacific Geotechnical Engineers, Inc.

Soils and Foundations
& Engineering Geology

429-B WaiaLamilo Road
Honolulu, Hawaii 96817
Telephone (808) 841-8024
Facsimile (808) 848-5102
Email: pge@pacificgeotechnical.com

August 9, 1999
8950-001

Earth Tech, Inc.
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

Attention: Mr. Douglas Lee

Subject: Addendum No. 1 to Report
Supplemental Subsurface Exploration
Nanaikapono Upgrading Design
Nanakuli, Oahu, Hawaii

Gentlemen:

1.0 INTRODUCTION

This Addendum No. 1 to Report includes the results of a supplement subsurface exploration that Pacific Geotechnical Engineers, Inc. (PGE) performed for the above subject project. PGE's services were performed in general accordance with its January 26, 1999 addendum proposal. This report addendum should be attached and made a part of PGE's October 27, 1998 geotechnical engineering investigation report.

2.0 PROJECT CONSIDERATIONS

PGE's October 27, 1998 geotechnical report was based on box drainage culverts and outlets originally planned near its Boring 8 and 9 locations. During the design, it was planned to re-site these culverts to Piliokahi Avenue and the Aala Walkway. The drainage system was to include four drainage outlets (designated A, B, C, and D) at various locations along the shoreline.

According to Earth Tech, Inc.'s (ETI's) transmittal dated January 25, 1999 and based on feedback during a neighborhood information meeting, it is PGE's understanding that drain outlets B, C, and D will be deleted by realigning the drainage system toward the western and southeastern ends of the subdivision. Under this revised scheme, the majority of the proposed drain line along Piliokahi Avenue, except at the northeastern end, and the drain line previously planned along the Aala Walkway will be deleted. According to the up-dated civil plans dated June 30, 1999, the revised scheme will include drain lines along Laumania and Keaulana Avenues that will discharge into outlet A. The revised scheme will also include drain lines along Pohakunui Avenue (near Piliokahi Avenue) and the northeastern portion of Piliokahi

Avenue that will discharge into a new outlet designated outlet B located in an existing park at the southeastern end of the subdivision. The drain lines may consist of 18-, 24-, 30- and 54-inch diameter reinforced concrete pipe (RCP) culverts with inverts as deep as approximately 20 feet below existing grades.

As described in PGE's October 27, 1998 report, variable subsurface conditions, consisting primarily of coralline deposits with some areas of alluvium and cobbles and boulders, were encountered in its soil test borings. These variable subsurface conditions could affect subgrade supporting conditions for the new utilities and pavements, and trenching and excavation operations. In addition, no subsurface information was available at proposed drain outlets A and B.

Alluvial silt and clay deposits were found below the surface fill materials in PGE's Borings 1, 2, 3, and 4 drilled along Pohakunui Avenue, in Boring 6 drilled along Keaulana Avenue, in Boring 7 drilled along Piliokahi Avenue, and in Boring 8 drilled along a former drainage box culvert alignment (Plot Plan, Plate 1). Basaltic cobbles and boulders were also found in PGE's Boring 4 drilled at the south end of Pohakunui Avenue.

Because of the relatively wide spacing of our borings, the approximate extent and thickness of the alluvium near the intersection of Pohakunui and Piliokahi Avenues near Borings 7 and 8, and in the vicinity of PGE's Borings 3 and 4 are not known. Based on available subsurface information, it appears that the general alignments of possible buried alluvial channels at the site may not run completely in the mauka-makai direction, but may also meander across the site. The approximate extent of the basaltic cobbles and boulders encountered in Boring 4 at the southern end of Pohakunui Avenue are also not known.

Although previous borings drilled by others in these areas provide some information regarding near surface conditions, they do not provide any information below a depth of approximately 5 feet which was the maximum depth explored in these previous holes. Previous Boring 2 located at the corner of Laumania and Keaulana Avenues was drilled only to a depth of 4.5 feet.

To reduce the uncertainty in the subsurface conditions, explore subsurface conditions at the current proposed outlet locations, and to better plan the proposed construction, it was recommended that supplemental soil test borings be drilled at the site.

3.0 SCOPE OF WORK

Based on the above considerations, the following supplemental scope of work was performed:

1. Coordination of Field Work - Prior to the start of the supplemental field exploration, PGE coordinated its work with various utility companies to check the boring locations for possible underground utilities. Each boring location was also toned using a metal detector as an additional check for possible underground utilities. Up-dated excavation and street usage permits were obtained from the City and County of Honolulu prior to the start of the drilling.

2. Supplemental Field Exploration - Five (5) supplemental soil test borings, designated Borings 10 through 14, were drilled to depths ranging from approximately 16.5 to 25.5 feet below the existing ground surface.

   Borings 10 through 12 were drilled along the proposed sewer and drain line alignments at the eastern end of Piliokahi Avenue and on Pohakunui Avenue south of Piliokahi Avenue. Borings 13 and 14 were drilled at the locations of proposed RCP drain outlets.

   The drilling was performed using a truck mounted drill rig using continuous flight augers and rotary wash drilling methods. A water truck was also mobilized to provide water for the drilling operations.

   The approximate locations of PGE's supplemental borings along with the previous borings by others are shown on the revised Plot Plan, Plate 1. The boring locations and elevations were estimated based on the project topographic map and PGE's field measurements. The Log of Borings are presented on Plates 2.1 through 2.5.

3. Laboratory Testing - After the completion of the field work, the soil samples and rock cores from the supplemental borings were transported to PGE's laboratory in Honolulu for further examination and laboratory testing. Select soil samples were tested for moisture content and dry density (refer to logs), Atterberg Limits (Plate 3) and gradation (Plate 4).

4. Engineering Analysis and Report Addendum Preparation - Based on the results of the supplemental field exploration and laboratory testing, engineering analysis was performed, and the comments and recommendations presented in PGE's October 27, 1998 report were updated. PGE's preliminary feedback

regarding the results of its supplemental exploration were presented in its June 30, 1999 progress memo.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered in the supplemental borings are illustrated on the boring logs, Plates 2.1 through 2.5. Subsurface conditions encountered in these borings are generally consistent with the conditions encountered in PGE's 1998 borings. However, the extent of the near surface alluvium near the intersection of Pohakunui and Piliokahi Avenues appears to include a larger area. Alluvial silt and clay deposits were encountered in supplemental Boring 10 drilled in the northeastern portion of Piliokahi Avenue to a depth of approximately 7 feet below the surface pavement. Alluvium was also encountered in Boring 8 previously drilled in an area located just southeast of Boring 10 to the bottom of this hole at 16.5 feet. The clayey surface soil in Boring 10 was underlain by coralline sand and gravel to the bottom of this hole at 16.5 feet.

Subsurface conditions encountered in supplemental Boring 11 drilled along Pohakunui Avenue generally consisted of approximately 3 feet of very stiff elastic silt and fat clay at the surface. A coral ledge was encountered beneath the surface clayey soils to a depth of approximately 15.5 feet. A basaltic cobble and possible boulders were encountered at approximately 15.5 feet in this hole. The basaltic cobble was underlain by coralline sand and gravel to the bottom of this hole at 20 feet.

Subsurface conditions in supplemental Boring 12 also drilled along Pohakunui Avenue generally consisted of approximately 2 feet of sandy silt fill on the surface underlain by silty coralline gravel. A coral ledge was encountered in this boring from a depth of approximately 2 to 11 feet. The coral ledge was underlain by alluvial deposit consisting primarily of very stiff elastic silt to the bottom of this hole at 20.5 feet.

Boring 12 revealed the presence of a deeper alluvial layer below the near surface coral reef formation. This deeper alluvial layer appears to be consistent with the alluvial material encountered below the coralline deposits in Borings 3 and 4 drilled just northwest and southeast, respectively, of Boring 12.

Hard coral was found in supplemental Boring 13 (outlet B) and 14 (outlet A) at the ground surface and extending to depths of approximately 9 to 10 feet. This ledge was underlain by coralline sand and gravel to a depth of approximately 16.5 feet in Boring 13 and to the bottom of Boring 14 at 20.5 feet. Very stiff elastic silt was found below the sand and gravel in Boring 13 to the bottom of this hole at 25.5 feet.

Pacific Geotechnical Engineers, Inc.

Ground water was encountered in supplemental Borings 11 and 14 near sea level, except in Borings 10, 12 and 13. Stabilized water measurements could not be obtained in these holes due to the drilling process.

5.0 DISCUSSION AND RECOMMENDATIONS

PGE's main findings and recommendations based on the results of the supplemental borings and testing and June 30, 1999 civil plans are summarized below:

1. In general, the anticipated subsurface conditions for the proposed water line as outlined in Table 2 of PGE's October 27, 1998 report are still applicable. However, it appears that subsurface conditions at the water line invert in the vicinity of Station 12+00 should consist primarily of coral and coralline sand and gravel, instead of the previously anticipated elastic silt, clay, and possible cobbles and boulders.

2. The extent of the clayey soils anticipated at the pipe line inverts for the sewer line and drain line have changed as shown in the attached revised Table 2 - Revised Anticipated Pipe Subsurface Conditions at Bottom of Pipe Bedding. The pipe subbedding thickness based on general subsurface conditions presented in Table 1 of our October 27, 1999 report should be used with revised Table 2 to estimate subbedding thicknesses along particular areas of the pipeline. A Revised Schematic Section of Pipe Bedding & Backfill Requirements based on the presently proposed drain line pipe sizes is presented on Plate 5.

3. The cobbles and boulders encountered in PGE's previous Boring 4 at the southeastern end of Pohakunui Avenue appear to be a localized condition. However, a basaltic cobble was encountered in supplemental Boring 11 at a depth of approximately 15.5 feet. This may indicate the possible presence of basaltic cobbles and boulders within the deeper alluvium encountered below the near surface coral reef formation.

   Deeper alluvium was encountered in Borings 3, 4, and 12 drilled in the southeastern portion of Pohakunui Avenue and in Boring 13 at outlet B. As indicated in Table 2, the deeper alluvium may affect the pipe subbedding thickness for the sewer and drain line in this area, and drain outlet B. If cobbles and boulders are encountered at the pipe invert level, the thicker subbedding thickness recommended in Table 1 of PGE's October 27, 1998 report should be provided for the pipe.

4. The pavement subgrade treatment and approximate treatment areas as recommended in our October 27, 1998 report are still appropriate.

- o0o-

Please do not hesitate to contact the undersigned if you have any questions regarding this report addendum.

Yours very truly,

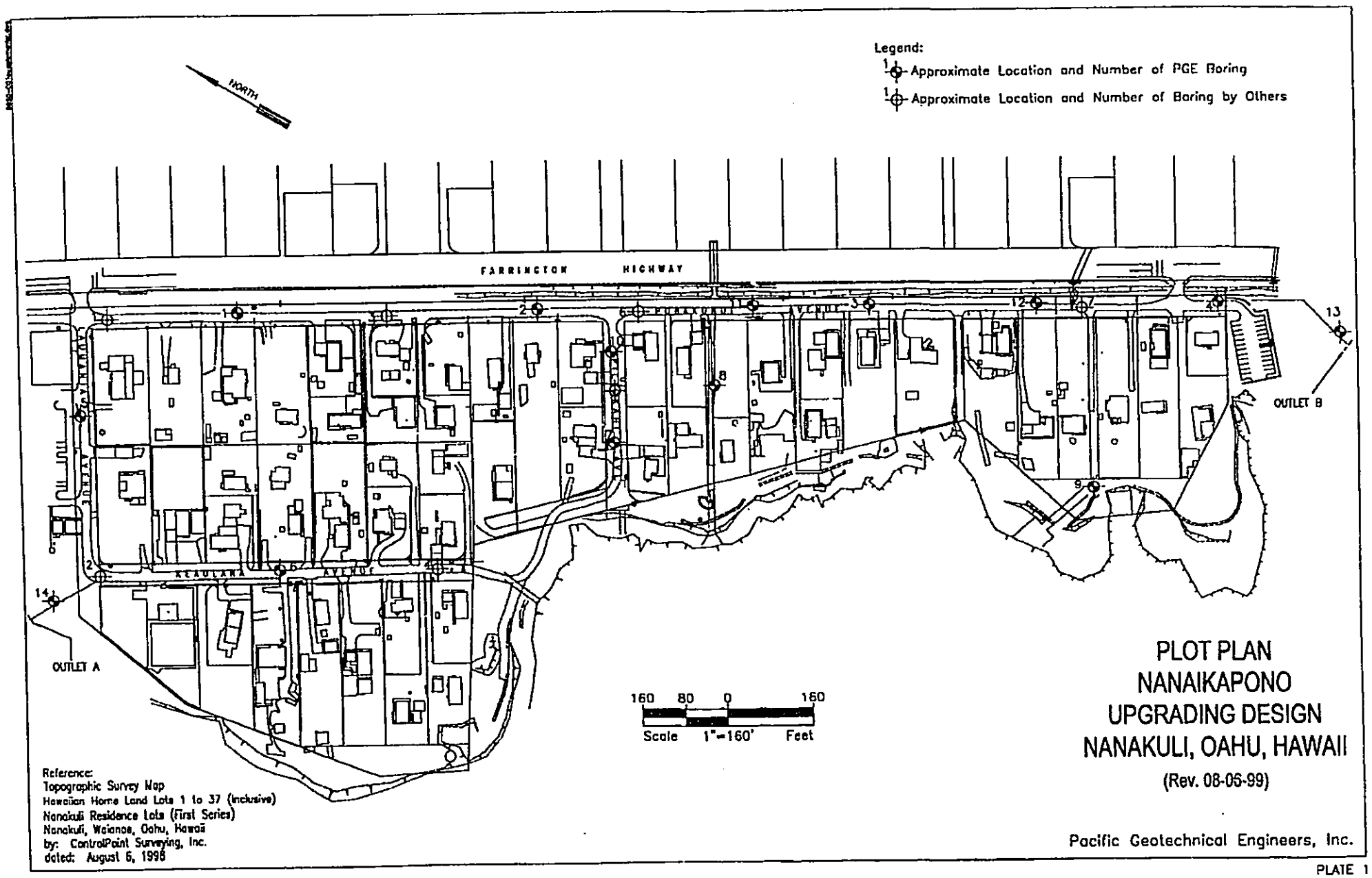
PACIFIC GEOTECHNICAL ENGINEERS, INC.

Glen Y.F. Lau, P.E.
President

(8950-001addendum.ltr)
(Six copies submitted)

Attachments:

Plate 1	-	Plot Plan
Plate 2.1 through 2.5	-	Log of Borings, Boring 10 through 14
Plate 3	-	Atterberg Limits
Plate 4	-	Gradation Curve
Plate 5	-	Revised Schematic Section of Pipe Bedding & Backfill Requirements
Table 2	-	Revised Anticipated Pipe Subsurface Conditions at Bottom of Pipe Bedding



Reference:
Topographic Survey Map
Hawaiian Home Land Lots 1 to 37 (inclusive)
Nanakuli Residence Lots (First Series)
Nanakuli, Waianae, Oahu, Hawaii
by: ControlPoint Surveying, Inc.
dated: August 6, 1998

PLOT PLAN
NANAIKAPONO
UPGRADING DESIGN
NANAKULI, OAHU, HAWAII

(Rev. 08-06-99)

Pacific Geotechnical Engineers, Inc.

PLATE 1

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY mg

BORING 10 (Page 1 of 1)

SURFACE ELEVATION 12 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % OF (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
									AC	3 inches of asphaltic concrete
40	75				26				CH	Grayish brown fat clay, very stiff, moist, with trace of coralline sand and roots (alluvium)
44	74				25					grades with some coralline gravel
30	89				35	5				
									GP	Tan coralline gravel, dense, locally cemented with some silt and sand, moist (highly fractured Type I coral)
20	90				95	10				
									SM	Tan silty coralline sand, loose, locally weakly cemented, with some coralline gravel, wet
45	78				17	15				
					50/0"					Boring completed at 16.5 feet on 06-16-99.

* Note: Unable to obtain stabilized water level reading due to drilling process.

NOTES:
■ - Relatively undisturbed sample
⊗ - Disturbed sample
□ - Sample lost during extraction
◪ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE 2.1

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY mg

BORING 11 (Page 1 of 1)

SURFACE ELEVATION 13 ± Feet
DATUM Mean Sea Level

LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % OF (RQD) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
35	85				32				CH	Dark grayish brown fat clay, very stiff, moist (alluvium)
					60/1"					Tan coral, medium hard, moderately fractured (Type I coral)
		NX	100	60		5				
		NX	88	25		10				grades highly fractured
										(Water level at 1410 hours on 06-18-99)
		NX	45	7		15				
										Basaltic cobble and possible boulders
									GP	Light brownish orange coralline gravel, locally weakly cemented and with coralline sand, saturated
					23				SP	Light grayish tan coralline sand, medium dense, locally weakly cemented and with coralline gravel, saturated
						20				Boring completed at 20.0 feet on 06-17-00.

NOTES:
■ - Relatively undisturbed sample
⊗ - Disturbed sample
□ - Sample lost during extraction
◪ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE 2.2

PROJECT Nanakapono Upgrading Design JOB No. 8950-001

LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lrg

BORING 12 (Page 1 of 1)

SURFACE ELEVATION 16.5 ± Feet

DATUM Mean Sea Level

LAB DATA		CORE INFO							
MOISTURE CONTENT %	DRY UNIT WEIGHT (pcf)	CORE TYPE	RECOVERY %	RQD % or (NQII) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
15	71				125/5"				ML	Dark brown sandy silt, medium stiff, moist (fill)
									GM	Light tan and dark brown silty coralline gravel, medium dense, with some coralline sand, moist
		NX	91	30						White coral, medium hard, moderately fractured (Type I coral)
						5				White to tan coral, medium hard, moderately to highly fractured, moderately cemented (Type II coral)
		NX	33	7						
						10			MH	Grayish brown and light gray elastic silt, very stiff, with some coralline sand, moist (alluvium)
28					30					
28	98				51	15				grades with some basaltic gravel, saturated
35	86				73					grades hard
						20				Boring completed at 20.5 feet on 06-17-99.

* Note: Unable to obtain stabilized water level reading due to drilling process.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
☑ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE 2.3

PROJECT Nanakapono Upgrading Design JOB No. 8950-001

LOCATION Nanakuli, Oahu, Hawaii DRAWN BY lrg

BORING 13 (Page 1 of 1)

SURFACE ELEVATION 20 ± Feet

DATUM Mean Sea Level

LAB DATA		CORE INFO							
MOISTURE CONTENT %	DRY UNIT WEIGHT (pcf)	CORE TYPE	RECOVERY %	RQD % or (NQII) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
					50/0"					Tan recemented coral, medium hard, moderately fractured, moderately cemented (Type II coral)
		NX	77	38						Tan coral, medium hard, moderately fractured (Type I coral)
						5				grades highly fractured
		NX	37	0						
						10			GM	Light brown silty coralline gravel, loose, locally weakly cemented with coralline sand, moist
28	92				19				SM	Light grayish brown silty coralline sand, loose, with some fine coralline and basaltic gravel, moist
25					13	15			MH	Dark brown elastic silt, very stiff, with some basaltic gravel and trace of coralline sand, moist (alluvium)
					38					
40					24	20				grades wet
					31					
						25				Boring completed at 25.5 feet on 06-16-99.

* Note: Unable to obtain stabilized water level reading due to drilling process.

NOTES:
■ - Relatively undisturbed sample
☒ - Disturbed sample
☐ - Sample lost during extraction
☑ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING — Pacific Geotechnical Engineers, Inc. — PLATE 2.4

PROJECT Nanakapono Upgrading Design JOB No. 8950-001
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY MG

BORING 14 (Page 1 of 1)

SURFACE ELEVATION 12.5 ± Feet
DATUM Mean Sea Level

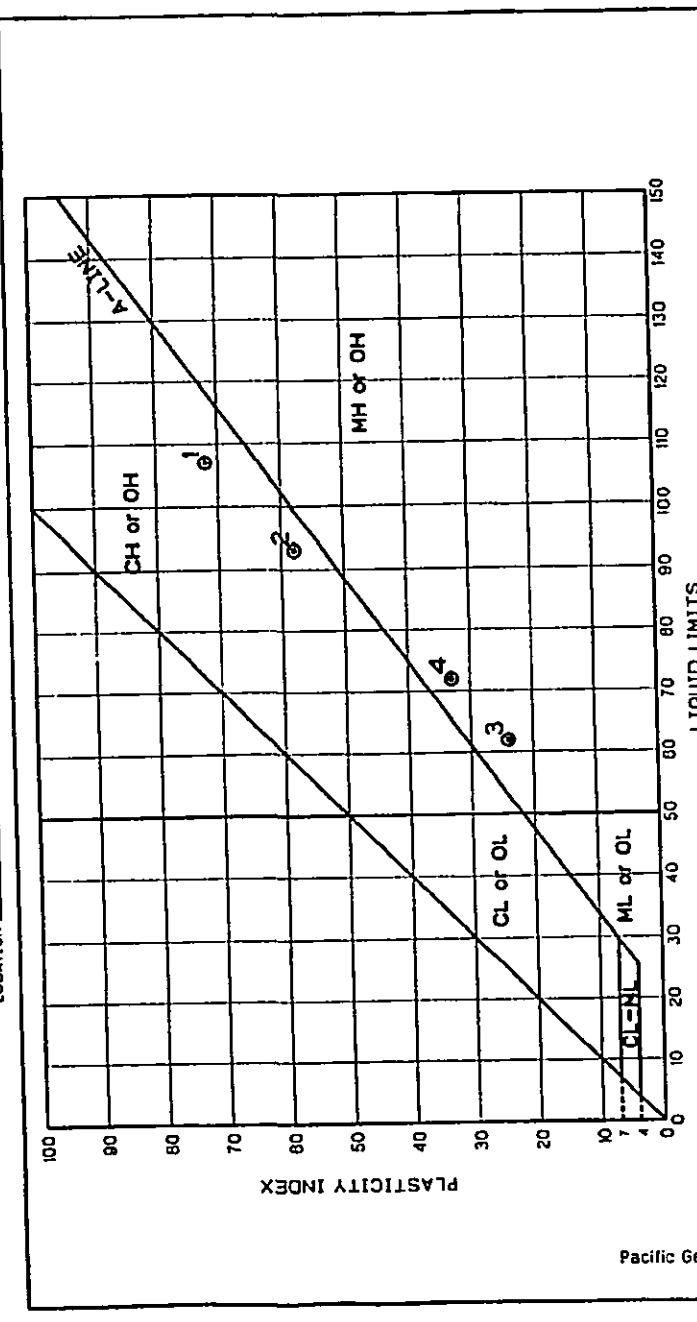
LAB DATA: MOISTURE CONTENT %	LAB DATA: DRY UNIT WEIGHT (pcf)	CORE INFO: CORE TYPE	CORE INFO: RECOVERY %	CORE INFO: RQD % or (NQI) %	BLOWS/FT.	DEPTH (feet)	SAMPLES	GRAPHIC LOG	SOIL CLASS	DESCRIPTION
										Tan coral, medium hard, highly fractured (Type I coral)
		NX	100	37		5				
		NX	61	31						
19					17	10			SP	Tan coralline sand, loose, locally weakly cemented, with coralline gravel, moist
26	87				57	15			GP GM	Tan poorly graded coralline gravel, medium dense, with silt and locally weakly cemented coralline sand, saturated
										(Water level at 1530 hours on 08-16-99)
					23	20				Boring completed at 20.5 feet on 08-18-99.

NOTES:
■ - Relatively undisturbed sample
⊠ - Disturbed sample
□ - Sample lost during extraction
◪ - Standard penetration test sample (split-spoon sampler)
I - Core run
DRIVING ENERGY: 140-lb. dropping 30 inches

LOG OF BORING
Pacific Geotechnical Engineers, Inc.

PLATE 2.5

PROJECT Nanakapono Upgrading Design JOB NUMBER 8950-021
LOCATION Nanakuli, Oahu, Hawaii DRAWN BY JC DATE DRAWN 07/15/09



ATTERBERG LIMITS

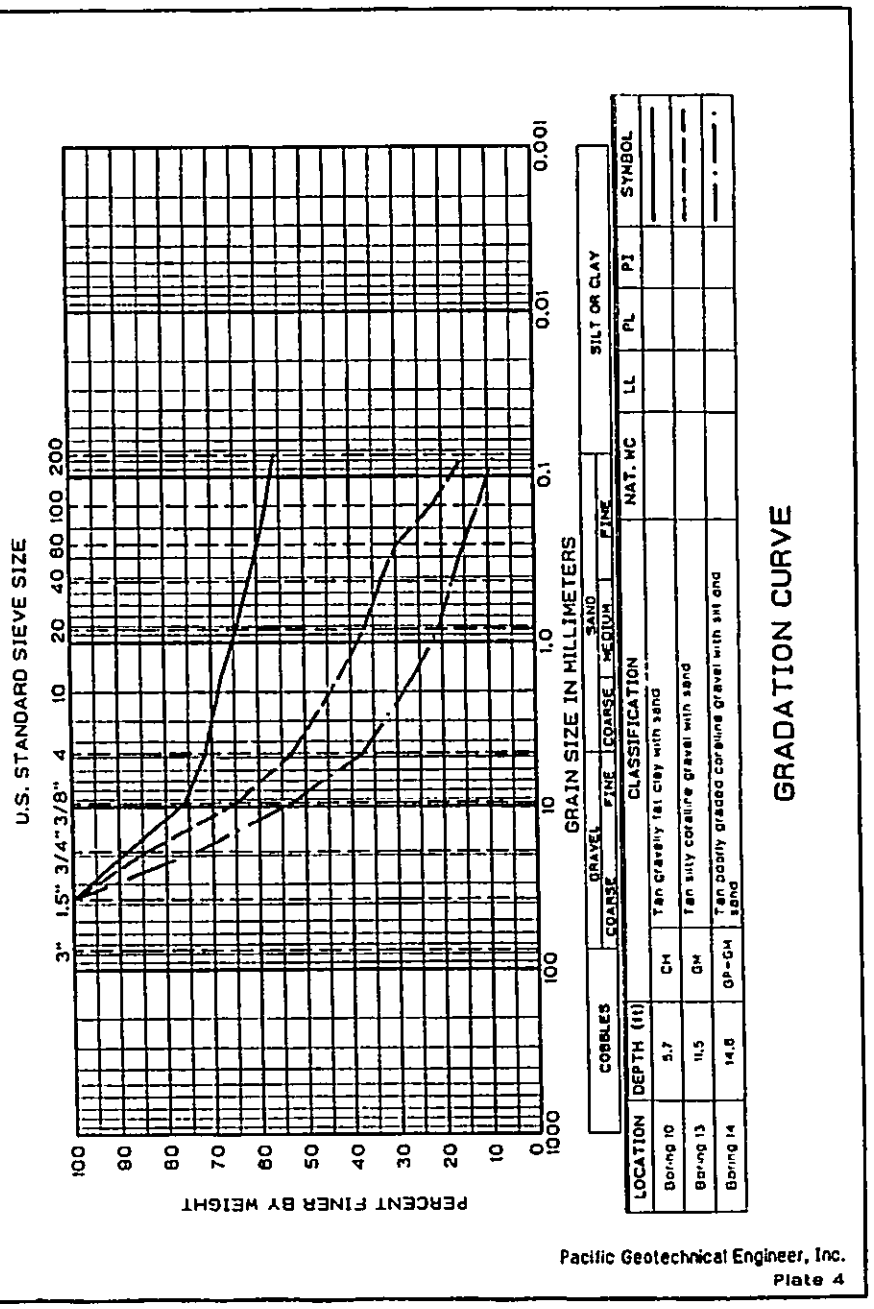
KEY	LOCATION	SAMPLE DEPTH (ft)	LIQUID LIMIT	PLASTICITY INDEX
1	Boring 10	3.5	107	72
2	Boring 11	1.8	93	56
3	Boring 12	16.5	62	24
4	Boring 13	12	72	33

Pacific Geotechnical Engineers, Inc.
Plate 3

PROJECT Nanakuli Loop Road Design — JOB NUMBER 4950-001

LOCATION Nanakuli, Oahu, Hawaii — DATE DRAWN 01/12/89

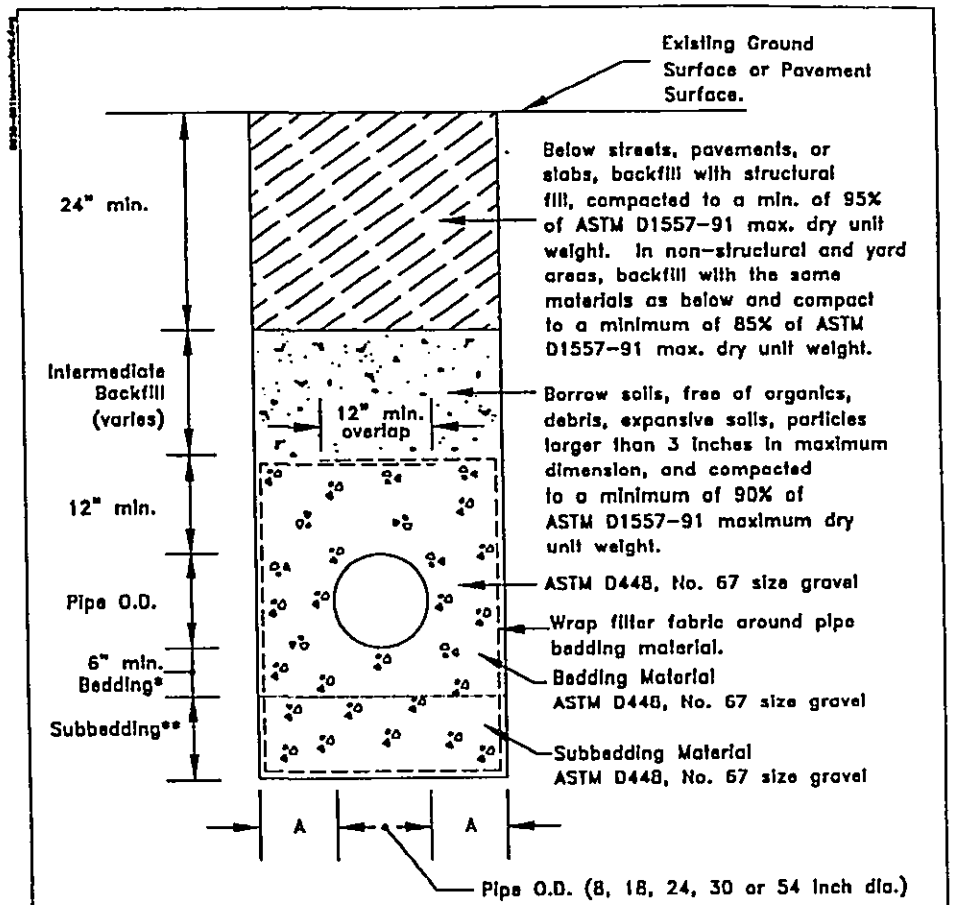
DRAWN BY JG



GRADATION CURVE

Pacific Geotechnical Engineer, Inc.

Plate 4



NOTES:

1) A=8" for 8" dia. pipe for sewerline
   A=9" for 18" dia. pipe for RCP drainline
   A=12" for 24" dia. pipe for RCP drainline
   A=13" for 30" dia. pipe for RCP drainline
   A=17" for 54" dia. pipe for RCP drainline

* Increase bedding thickness to 12 inches for pipes 24" dia. and larger.

** Provide subbedding as specified in the text.

Revised Schematic Section of
Pipe Bedding & Backfill Requirements
(not to scale)

Pacific Geotechnical Engineers, Inc.

PLATE 5

TABLE 2

REVISED ANTICIPATED PIPE SUBSURFACE CONDITIONS AT BOTTOM OF PIPE BEDDING

Location	Approximate Stations[1]	Assumed Pipeline Invert Elevations (Feet)[1]	Anticipated Subsurface Conditions at Bottom of Pipe Bedding
Pohakunui Avenue	0+00 to 16+00±	-3.7 to +4.0 (sewer)	Coral and coralline sand and gravel
	7+80 to 16+00±	+3.7 to+8.5 (drain line)	
	10+10 to 20+95±	+9.7 to +14.9 (water line)	
	16+00 to 21+35±	+4.0 to +6.2 (sewer) +3.7 to+2.5 (drain line)	Elastic silt and fat clay and possible basaltic cobbles/boulders
	21+35 to 24+00±	+2.5 to +3.0 (54-inch RCP and outlet "B")	
Laumania Avenue	0+00 to 5+12±	-3.0 to -1.1 (sewer) +5.0 to +10.0 (drain line)	Coral and coralline sand and gravel
Piliokahi Avenue	0+00 to 2+90± 1+50 to 2+30±	+2.7 to +4.0 (sewer) +7.4 to +7.5 (drain line)	Coral and coralline sand and gravel
	0+00 to 1+50±	+6.7 to +7.4 (drain line)	Elastic silt and fat clay
Keaulana Avenue	0+00 to 7+70±	-1.1 to +2.1 (sewer) +3.6 to +6.9 (drain line)	Coral and coralline sand and gravel
	-0+11 to -1+29±	+3.6 to +3.9 (30-inch RCP and outlet "A")	

NOTE: 1. Approximate Station Numbers and Approximate Pipeline Invert Elevations are based on Earth Tech, Inc.'s pre-final plans dated June 30, 1999.

5. The borings drilled for this project were widely spaced. The transitions between the various anticipated subsurface and groundwater conditions indicated herein may vary locally between borings. The anticipated subsurface conditions at bottom of pipe bedding may differ locally from those presented in this table. Additional over excavation below the pipe bedding should be performed if localized areas of soft or loose soils, or cavities are encountered.

Appendix C

Traffic Improvement Needs Study

NANAIKAPONO SUBDIVISION UPGRADING TRAFFIC IMPROVEMENT NEEDS STUDY

TMK : 8-9-06

Prepared for

State of Hawaii
Department of Hawaiian Home Lands
Land Development Division
Design and Construction Branch

Prepared by

Earth Tech
700 Bishop Street, Suite 900
Honolulu, Hawaii 96813

August 1998

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NANAIKAPONO SUBDIVISION UPGRADING
TRAFFIC IMPROVEMENTS NEEDS STUDY

The Department of Hawaiian Home Lands is planning to upgrade the infrastructure of its Nanaikapono Subdivision in Nanakuli. A study was undertaken to identify the traffic improvements which should be implemented as part of this upgrading project. This report describes the methodology used in the study and its recommendations.

Project Justification and Study Methodology

The Department of Hawaiian Home Lands (hereinafter called the Department) intends to improve the infrastructure of the Nanaikapono Subdivision, over which it has jurisdiction. There are currently 52 homestead houselots in this Nanakuli project located on the makai side of Farrington Highway adjacent to the Nanakuli Beach Park. The subdivision is identified by Tax Map Key 8-9-06. The Department does not intend to add additional homes as part of the infrastructure improvements. The improvementsare scheduled to be completed in about three years if construction funds become available for the improvements.

Two roadways provide access to the subdivision from Farrington Highway including Laumania Avenue and the south extension of Pohakunui Avenue. Laumania Avenue is perpendicular to Farrington Highway and is the major access for the subdivision. Pohakunui Avenue runs parallel to Farrington Highway and turns to intersect the highway at two locations. The north extension is very lightly used. The south extension of Pohakunui Avenue could be used by the subdivision residents but serves more as an access to Nanakuli Beach Park. Both intersection approaches are T-intersections so that only left and right turns can be made from the side street approaches. Piliokahi Avenue is another perpendicular street serving the subdivision but does not intersect Farrington Highway. The mauka approach of Piliokahi Avenue serves the Nanakuli Residence Lots, Series 7, and does intersect Farrington Highway as a signalized intersection. The layout of these roadways within the subdivision is shown on Figure 1.

The two access points were built many years ago and are considered substandard by current standards and are in need for improvements. Both the Laumania Avenue and Pohakunui Avenue approaches are single lanes so that left and right turns must be made from the same lane. There are no separate left turn lanes at both intersections. There are also no right turn deceleration or separate right turn lanes on Farrington Highway at both intersections. Both intersections areunsignalized.

Farrington Highway has been upgraded to a four lane (two lanes in each direction) undivided highway signed for 35 miles per hour. However, most vehicles travel way over the speed limit on this location of the highway. In addition to the speeding problem, there is a vertical and horizontal curve on Farrington Highway just south of Pohakunui Avenue that restricts sight distance for Waianae Bound traffic.

Based on the above considerations, the study analyzed two important considerations: traffic operations and traffic safety. For the first aspect, traffic counts were taken and analyzed to determine how well traffic was operating at the intersection. Traffic accident data and observation of traffic movements at the two intersections were reviewed to determine if there is a safety problem.

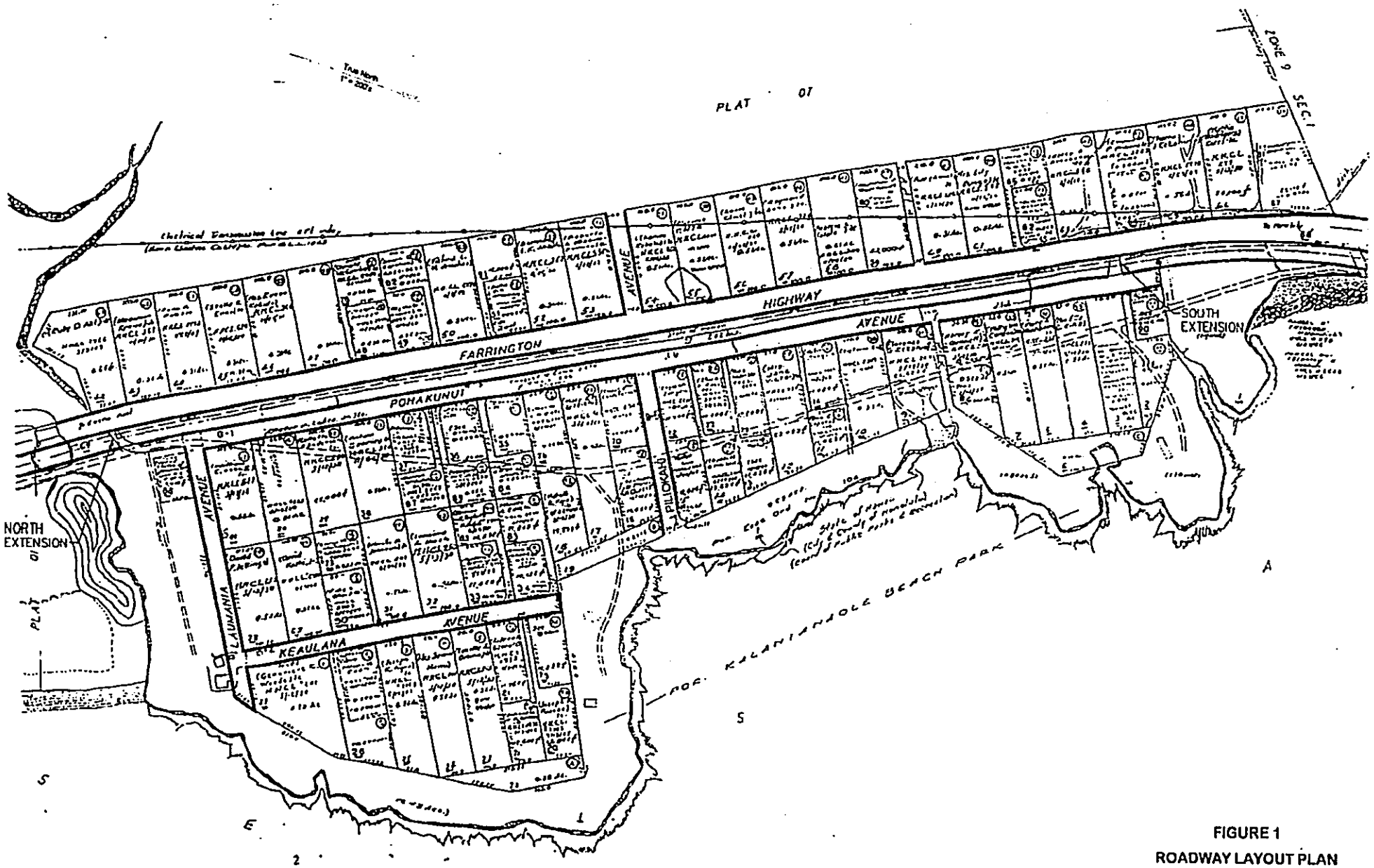


FIGURE 1
ROADWAY LAYOUT PLAN

Traffic Operations Analysis

Level of Service Concept - The concept of level of service is used to determine how well traffic is operating at an intersection. The level of service considers the volume of traffic and the geometry of the intersection to determine how well traffic is operating. The Federal Highway Administration of the U.S. Department of Transportation developed and continuously upgrades the Highway Capacity Manual (Special Report 209) with methodologies for calculating levels of service on freeways, highway, and intersections. The third edition of this manual was released in 1994.

The manual includes a methodology for calculating levels of service at unsignalized intersections. The methodology does not calculate a level of service for the whole intersection. Rather, it calculates a level of service for critical movements at an unsignalized intersection:

1. the left and right turn and through movements from the side (stop-controlled) street; and
2. the left turns from the main street into the side street.

Traffic volumes on both the main street and side street are considered. In general higher traffic volumes on the main street would reduce the level of service for the side street. It is possible for traffic volumes to remain constant on the side street but experience decreases in levels of service due to traffic increases on the main street.

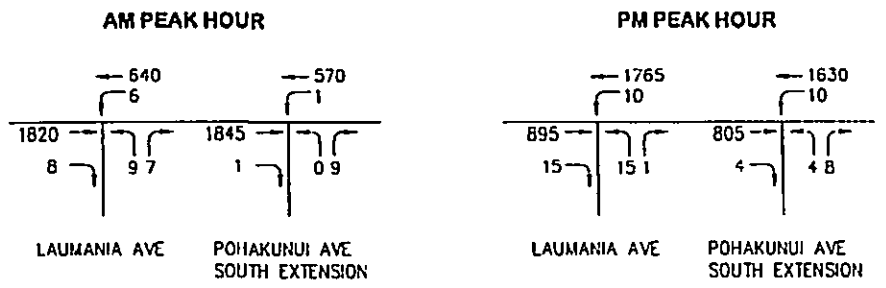
The levels of service are based on the average delay time for each of the movements and range from A (best with very little delay) to F (worst with average delays over one minute). Levels of service better than E are considered acceptable. Traffic improvements should be considered for an unsignalized intersection with level of service F movements.

Traffic Volumes - In order to determine the volume of traffic at both intersections, traffic counts were taken during the morning and afternoon peak hours on June 25, 1998, at the two study intersections. Turning movement traffic counts required workers to station themselves near the intersection and count each passing vehicle as a through or turning movement in 15 minute intervals. The worksheets for the traffic counts are included in the Appendix. The resultant peak hour movements are shown on Figure 2a, with traffic volumes rounded to the nearest 5. Traffic volumes less that 10 vehicles per hour were not rounded. The traffic volumes turning into and from the side streets can be characterized as light.

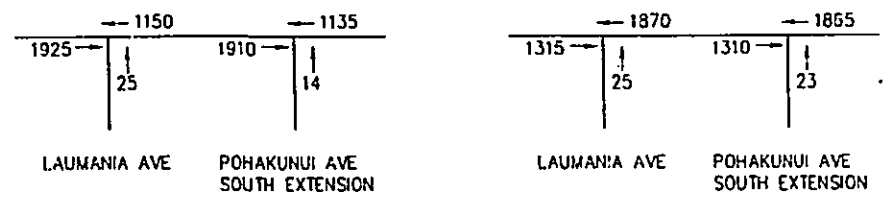
These traffic counts were taken during the summer when peak period traffic volumes are lower and needed to be adjusted. The State of Hawaii Department of Transportation took metered traffic counts at the incoming approaches of both intersections in December 15-16, 1994, while school was still in session. Metered counts cannot differentiate between through and turning movements, they can count only the number of vehicles passing by. The State's peak hour approach counts are summarized on Figure 2b.

The State's counts are higher than the summer counts and were used to adjust the latter. The summer traffic volumes turning from and into the side streets were factored up by the ratio of the State side street outbound volume divided by the corresponding summer volumes. The State's volumes on Farrington Highway were used to replace the summer highway through volumes. The adjusted existing traffic volumes are shown on Figure 2c.

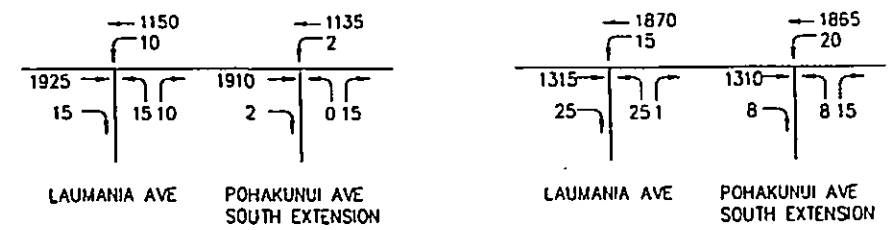
The proposed traffic improvements are expected to take about three years to implement. During this period, through traffic on Farrington Highway can be expected to increase due to regional growth. The State's traffic count taken on Farrington Highway at Keananoio Bridge just south of the project site showed



A) EXISTING SUMMER TRAFFIC VOLUMES
JUNE 25, 1998



B) STATE DOT METERED TRAFFIC VOLUMES
DECEMBER 15-16, 1994



C) ADJUSTED EXISTING TRAFFIC VOLUMES
JUNE 25, 1998

FIGURE 2

EXISTING TRAFFIC VOLUMES

negligible traffic growth between 1992 and 1996. The two-way daily traffic increased from 34,900 to 35,600 vehicles, representing less than 2 percent increase in four years. Based on this information the through traffic volumes from Figure 2c were increased by 3 percent (representing a 1 percent annual growth rate). The traffic volumes turning into and from the side streets were not increased since the Department does not expect to add more housing. The resultant traffic forecast is shown on Figure 3.

Level of Service Analysis - Levels of service were calculated for the existing summer (Figure 2a), adjusted existing (Figure 2c) and forecast (Figure 3) traffic volumes. The results of this analysis are summarized in Table 1.

The outbound traffic movement from Laumania Avenue is already at level of service F in both AM and PM peak hours. This could be attributed to the presence of outbound left turns and the high volume of traffic on Farrington Highway. The left turn movement from Farrington Highway into Laumania Avenue is currently at level of service D in the AM peak and is forecast to decrease to level E within three years.

During the PM peak, the left turn movement from the highway is at level of service B in the summer but at level C in the school year when the opposing through traffic volumes are heavier. This movement is expected to remain at level of service C in the near future.

Levels of service are better at the Pohakunui Avenue extension approach during the morning peak hour (level B) when no outbound left turns are made. The left turn movement from Farrington Highway into Pohakunui Avenue extension is currently at level of service D for both summer and adjusted conditions, and is forecast to remain the same.

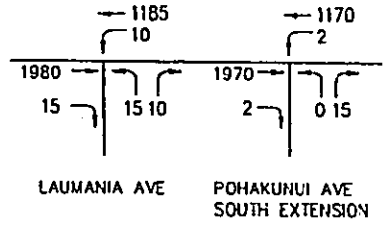
However, the outbound traffic from Pohakunui Avenue extension in the PM peak is at level of service F for all three conditions due to the presence of left turning traffic. The levels of service for the left turn movement from Farrington Highway into Pohakunui Avenue extension is currently at B but would be at C for the other two conditions due to the higher volumes of opposing traffic. This is a similar pattern to the left turn movement at Laumania Avenue.

The above analysis indicates the need for traffic improvements at both side street approaches. The simplest action would be to widen the outbound approaches to two lanes to separate left and right turn movements. This action would reduce delay for the latter movement to level of service B, as shown in Table 1. However, left turning vehicles would still experience level of service F conditions and long delays, which is not acceptable.

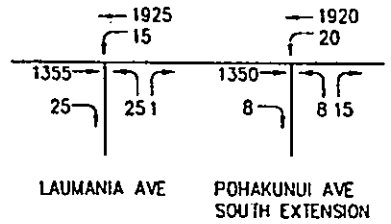
Traffic signals are very often proposed to alleviate long delays on side streets. However, traffic signals would not be practical for several reasons. First, warrants have been established to objectively determine the need for traffic signals. These warrants are included in the Federal Highway Administration's *Manual of Uniform Traffic Control Devices* (1978). These warrants include minimum traffic and pedestrian volume requirements, and accident experience. Based on these warrants, the two intersection side street approaches do no have sufficient volumes or accident experience to justify traffic signals.

A second reason for not installing traffic signals is the two intersections proximity to the existing traffic signals at Piliokahi Avenue and Nanakuli Avenue. Traffic signals in close proximity to one another can have a detrimental effect on traffic operations.

The study did not analyze weekend operations when traffic to the beach park can be an important factor. The Department should not be accountable for providing improvements to beach visitors.



AM PEAK HOUR



PM PEAK HOUR

FIGURE 3

TRAFFIC FORECAST VOLUMES

TABLE 1

LEVEL OF SERVICE ANALYSIS

Intersection Approach	AM Peak Hour			PM Peak Hour		
	Existing Summer	Adjusted Existing	3-Year Forecast	Existing Summer	Adjusted Existing	3-Year Forecast
Laumania Ave, outbound	F	F	F	F	F	F
w/separate left			F			F
w/separate right			B			B
Farrington Hwy, left turn	D	D	E	B	C	C
Pohakunui Ave., outbound	B	B	B	F	F	F
w/separate left			--			F
w/separate right			B			B
Farrington Hwy, left turn	D	D	D	B	C	C

Traffic Safety Analysis

Traffic safety is an important consideration given the high human and property costs associated with traffic accidents. Traffic safety at the two intersections were evaluated by reviewing traffic accident records and driver behavior.

Traffic accident records for the period from January 1995 to April 1998 were obtained from the State Department of Transportation and are summarized in Table 2. All of the recorded accidents involved motor vehicles and did not involve any pedestrians or two-wheeled vehicles.

The Laumania Avenue intersection had a total of 8 recorded accidents in the study period, with 5 of the accidents occurring in 1996. Of these 8 accidents, 6 were classified as rear-end and 2 as others. Only one of these 8 accidents resulted in personal injury.

The Pohakunui Avenue extension intersection had a total of 6 recorded accidents in the study period, with 3 of the accidents occurring in 1995. All were classified as rear-end accidents and 4 of the accidents resulted in personal injury.

The accident numbers in themselves do not indicate a major traffic hazard, and the number of accidents seem to be declining. However, the predominance of rear-end accidents does indicate a possible problem that could be mitigated with separate left and right turn lanes or deceleration lanes on Farrington Highway. The higher number of personal injuries at Pohakunui Avenue indicates a more serious safety problem at this intersection.

TABLE 2

TRAFFIC ACCIDENT RECORD ON FARRINGTON HIGHWAY AT LAUMANIA AVENUE AND POHAKUNUI AVENUE

	Laumania Avenue				Pohakunui Avenue		
	Total	Rear End	Other	Accidents w/ Personal Injury	Total	Rear End	Accidents w/ Personal Injury
1995	2	1	1	0	3	3	2
1996	5	5	0	1	2	2	2
1997	1	0	1	0	0	0	0
1998*	0	0	0	0	1	1	0

* Thru April 1998

All recorded accidents involved motor vehicles and did not include pedestrians, bicycles, motorcycles, or mopeds.

The workers who took the traffic turning movement counts were asked for their comments on traffic operations. They expressed their concern whenever they saw a vehicle trying to enter from the side street. Many of these drivers "took chances" to enter the highway after waiting a long time and becoming impatient. The counters also saw hazardous situations when vehicles tried to make left or right turns into the side street. Both maneuvers caused following cars to swerve or brake suddenly. The left turn from Farrington Highway into Pohakunui Avenue was especially hazardous given the short sight distance as cars approached the intersection. Based on these two analyses, at the minimum a separate left turn lane and a right turn deceleration lane should be provided on Farrington Highway to mitigate a potentially unsafe traffic situation.

Recommendations

Traffic improvements are required to make traffic access into the Nanaikapono subdivision acceptable with respect to both traffic operations and traffic safety. At the minimum, the following improvements should be implemented at the Laumania Avenue intersection to provide at least one improved intersection for the subdivision residents:

1. Widen the outbound approach of Laumania Avenue to two lanes to provide separate left and right turn lanes. This would shorten the wait time for right turn vehicles but would not improve the situation for left turn vehicles.
2. Provide a separate left turn lane and deceleration lane on Farrington Highway to improve traffic safety.

Implementing traffic improvements at the Pohakunui Avenue intersection should be left to the discretion of the Department. The issue is if they would want to be accountable for beach park users as well as subdivision residents. It is also noted that a separate left turn lane on Farrington Highway may be difficult to implement due to the highway geometry.

A traffic signal is required to provide acceptable levels of service to the subdivision residents. As previously noted, it would not be desirable to signalize the existing intersections. Rather, a possible action may be to extend the makai approach of Piliokahi Avenue to Farrington Highway and connect it with an existing signalized intersection. This would not adversely affect traffic operations by not adding additional signals and should also increase traffic safety. If this improvement is implemented, left turns (both inbound and outbound) should be banned at the two existing intersections as a safety measure. Left turns would only be permitted at the signalized intersection.

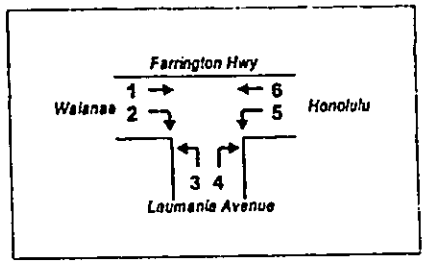
APPENDIX A

TRAFFIC COUNT WORKSHEETS

Nanaikapono Subdivision Upgrading
Traffic Count Movement

Location: Farrington Hwy. / Laumania St.
Date: 25 June 1998

Time: 5:30-8:00 am
3:00-5:30 pm
Weather: Cloudy/Light Drizzle
Recorder: Richard Sellona



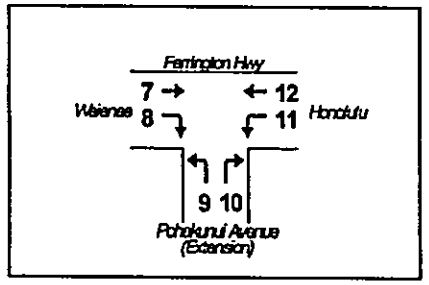
Morning	Movement Number						
Time Period	1	2	3	4	5	6	Total
5:30-5:45	382	1	3	2	1	75	464
5:45-6:00	372	1	3	0	1	78	455
6:00-6:15	493	3	1	1	1	130	629
6:15-6:30	433	0	1	2	3	140	579
6:30-6:45	478	2	3	2	1	184	670
6:45-7:00	418	3	4	2	1	184	610
7:00-7:15	369	1	2	0	4	174	550
7:15-7:30	331	6	5	0	1	177	520
7:30-7:45	408	7	9	2	3	231	660
7:45-8:00	213	4	1	0	0	147	365

Afternoon	Movement Number						
Time Period	1	2	3	4	5	6	Total
3:00-3:15	255	4	8	0	0	342	609
3:15-3:30	243	4	6	5	3	345	606
3:30-3:45	258	5	4	0	2	415	682
3:45-4:00	194	1	4	0	4	445	648
4:00-4:15	221	3	5	0	2	460	691
4:15-4:30	226	5	2	1	2	445	681
4:30-4:45	185	4	5	2	1	363	560
4:45-5:00	209	6	5	2	0	452	674
5:00-5:15	198	5	3	1	3	356	566
5:15-5:30	191	3	6	2	1	349	552

Nanaikapono Subdivision Upgrading
Traffic Count Movement

Location: Farrington/Pohakuni Avenue (Extention)
Date: 25-Jun-98

Time: 5:30-8:00 am
3:00-5:30 pm
Weather: Cloudy/Light Drizzle
Recorder: Nestor A. Beltran



Morning	Movement Number						
Time Period	7	8	9	10	11	12	Total
5:30-5:45	330	1	1	0	1	63	396
5:45-6:00	405	1	0	3	0	76	485
6:00-6:15	425	0	0	3	1	110	539
6:15-6:30	482	0	0	4	0	140	626
6:30-6:45	486	1	0	0	0	167	654
6:45-7:00	421	0	0	2	0	152	575
7:00-7:15	383	0	0	1	1	170	535
7:15-7:30	287	0	2	0	1	108	398
7:30-7:45	367	0	3	3	1	211	585
7:45-8:00	306	1	0	1	4	175	487

Afternoon	Movement Number						
Time Period	7	8	9	10	11	12	Total
3:00-3:15	194	2	1	1	2	300	500
3:15-3:30	212	0	1	3	4	365	585
3:30-3:45	235	1	1	1	3	417	658
3:45-4:00	201	0	1	3	2	422	629
4:00-4:15	178	1	2	2	5	412	600
4:15-4:30	192	2	0	2	2	381	579
4:30-4:45	193	0	2	5	4	392	596
4:45-5:00	176	0	1	1	5	372	555
5:00-5:15	164	0	0	1	2	369	536
5:15-5:30	203	0	0	0	2	345	550

APPENDIX B

LEVELS OF SERVICE FOR UNSIGNALIZED INTERSECTIONS

APPENDIX B
LEVELS OF SERVICE FOR UNSIGNALIZED INTERSECTIONS

This abstract summarizes the procedure for analyzing the capacities of unsignalized intersections. The procedure is described in the *Highway Capacity Manual, Special Report 209* (1994) by the Highway Research Board. This manual "is a collection of techniques for estimating highway capacity that have been judged, through consensus, as the best available at the time of publication." This manual does not set legal standards for highway design but the procedures have been widely accepted and used in the traffic engineering profession.

The methodology for unsignalized intersection calculates the capacities of critical movements which cross or turn through the major traffic streams. The capacity of each movement is based on the gap distribution in conflicting traffic streams and the gap acceptance behavior of drivers. The intersection geometry and traffic volumes are analyzed through a series of charts to determine the capacity of each critical movement. The estimated average delay is then calculated based on the volume of vehicles and the capacity of the movement. The levels of service are based on the following ranges of average delay:

Level of Service	Average Total Delay (seconds/vehicle)
A	≤ 5
B	>5 and ≤ 10
C	>10 and ≤ 20
D	>20 and ≤ 30
E	>30 and ≤ 45
F	>45