DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

FILE COPY

AUG 23 2015

KIRK CALDWELL
MAYOR

ROBERT J. KRONING, P.E.
DIRECTOR

MARK YONAMINE, P.E.
DEPUTY DIRECTOR

WW.CSE 15-092

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OFC. OF ENVIRONMENTAL QUALITY CONTROL

August 6, 2015

Ms. Jessica Wooley
Office of Environmental Quality Control (OEQC)
State Department of Health
235 S. Beretania Street, Room 702
Honolulu, Hawaii 96813

Dear Ms. Wooley:

SUBJECT: Kahanahou Wastewater Pump Station and Sewer Force Main Upgrades

With this letter, the City and County of Honolulu, Department of Design and Construction (DDC), transmits the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) for the proposed, situated in Kaneohe in the Koolaupoko District on the island of Oahu for publication in the next available edition of the Environmental Notice.

Enclosed is a completed OEQC Publication Form, two copies of the DEA-AFONSI, an Adobe Acrobat PDF file of the same, and an electronic copy of the publication form in MS Word. Simultaneous with this letter, we have submitted the summary of the action in a text file by electronic mail to your office.

If there are any questions, please contact Roy Tamashiro of our Wastewater Division at (808) 768-8760 or Tina Speed, Planner at Townscape, Inc. at (808) 536-6999.

Sincerely,

fr. M. Yonamine

Robert J. Kroning, P.E.
Director

Enclosures: One (1) hard copy of OEQC Publication Form
Two (2) hard copies of DEA-AFONSI
One (1) CD with: One (1) electronic copy of DEA-AFONSI (PDF)
One (1) electronic copy of OEQC Publication Form (MS Word)

# AGENCY ACTION
# SECTION 343-5(b), HRS
# PUBLICATION FORM

| | |
|---|---|
| **Project Name:** | Draft Environmental Assessment for the proposed Kahanahou Wastewater Pump Station and Sewer Force Main Upgrades, Kaneohe, Oahu |
| **HRS §343-5 Trigger(s):** | 1. Use of County lands and funds<br>2. Use within the Special Management Area (SMA) |
| **Island:** | Oahu |
| **District:** | Koolaupoko |
| **TMK:** | 4-5-047:095 (Kahanahou WWPS), 4-5-047:093 (Kahanahou Place), 4-5-047:127 (Kahanahou Place), 4-5-057:015 (Miyazaki), 4-5-057:018 (Lilipuna Place), 4-5-002:001 (Makani Kai Marina), 4-5-002:014 (Various Landowners) |
| **Permits:** | City & County DPP: Shoreline Setback Variance, Sewer Connection Application, Trenching Permit, Grading and Grubbing Permit. City & County DTS: Street Usage Permit. State DOH: NPDES permit, Community Noise Permit and Noise Variance. State SHPD: Archaeological Monitoring Plan and possibly Archaeological Inventory Survey (AIS) |
| **Proposing/ Determination Agency:** | City & County of Honolulu, Department of Design and Construction,<br>650 S. King St., Honolulu HI 96813. Contact: Roy Tamashiro, P.E. Telephone: (808) 768-8760, email: rtamashiro2@honolulu.gov |
| **Accepting Authority:** | N/A |
| **Consultant:** | Townscape, Inc., 900 Fort Street Mall, Suite 1160, Honolulu HI 96813. Contact: Tina Speed Telephone: (808) 536-6999, email: tina@townscapeinc.com |

**Status (check one only):**

| | |
|---|---|
| _X_ DEA-AFNSI | Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of DEA, a completed OEQC publication form, along with an electronic word processing summary and a PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day comment period ensues upon publication in the periodic bulletin. |
| __FEA-FONSI | Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and a PDF copy (send both summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin. |
| __FEA-EISPN | Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day consultation period ensues upon publication in the periodic bulletin. |
| __Act 172-12 EISPN | Submit the proposing agency notice of determination on agency letterhead, an OEQC publication form, and an electronic word processing summary (you may send the summary to oeqchawaii@doh.hawaii.gov). NO environmental assessment is required and a 30-day consultation period upon publication in the periodic bulletin. |
| __DEIS | The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin. |
| __FEIS | The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin. |

__ Section 11-200-23 Determination — The accepting authority simultaneously transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the proposing agency. No comment period ensues upon publication in the periodic bulletin.

__Section 11-200-27 Determination — The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is not required. No EA is required and no comment period ensues upon publication in the periodic bulletin.

__Withdrawal (explain)

**Summary** (Provide proposed action and purpose/need in less than 200 words. Please keep the summary brief and on this one page)**:**

The City and County of Honolulu (City), proposes to upgrade the Kahanahou Wastewater Pump Station (WWPS) in Kaneohe, Oahu. Infiltration and inflow of rainfall into the sewer system requires increasing the WWPS capacity. Proposed improvements to the WWPS include upgrades in pump capacity from 0.654 million gallons per day (mgd) to 1.26 mgd, renovations to the existing pump station, construction of a new emergency generator building, and other associated on-site improvements.

The City also proposes to increase the capacity of the force main directly downstream of the Kahanahou WWPS. Four alternative routes were evaluated, along with a delayed action and no action alternative. The preferred alternative runs west along Kahanahou Circle, turning south at Lilipuna Place, through a private residence and the Makani Kai Marina townhouse complex, and ending at the existing sewer manhole on Makahio Street. This route was selected because it meets the project objectives and design criteria, avoids problematic areas, and crosses through fewer private properties than other routes.

The proposed project will have short term impacts on traffic, noise, and air quality during construction. Efforts to minimize these impacts will be implemented to the extent practicable. The City anticipates a Finding of No Significant Impact for this project.

# Kahanahou Wastewater Pump Station and Sewer Force Main Upgrades Kaneohe, Oahu

# DRAFT ENVIRONMENTAL ASSESSMENT

**Prepared for:**
**CITY AND COUNTY OF HONOLULU**
**Department of Design and Construction**
**Wastewater Division**

**August 2015**

**Prepared by:**
**Townscape, Inc.**

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# PROJECT SUMMARY

| | |
|---|---|
| Project Name: | Kahanahou Wastewater Pump Station and Sewer Force Main Upgrades |
| Applicant: | City and County of Honolulu<br>Department of Design and Construction<br>650 South King St<br>Honolulu, HI 96813 |
| Agent: | Townscape, Inc. |
| Contact: | Tina Speed, Environmental Planner |
| Phone: (808) 536-6999 | Fax: (808) 524-4998 |
| Approving Agency: | City and County of Honolulu |
| Tax Map Key Parcels and | |
| Roads Potentially Affected: | 4-5-047:095 (Kahanahou WWPS)<br>4-5-047:093 (Kahanahou Place)<br>4-5-047:127 (Kahanahou Place)<br>4-5-057:015 (Miyazaki)<br>4-5-057:018 (Lilipuna Place)<br>4-5-002:001 (Makani Kai Marina)<br>4-5-002:014 (Various Landowners)<br>Ka Hanahou Circle<br>Lilipuna Road<br>Lilipuna Place<br>Wailele Road<br>Makahio Street |
| State Land Use District: | Urban District |
| Existing County Zoning: | Residential District R-10, R-7.5 and R-5 |
| City Development Plan: | Koolau Poko Sustainable Communities Plan |
| Land Use Designation: | Low Density Residential |
| Special Designation: | Special Management Area (SMA)<br>Shoreline Setback Area |
| Anticipated Determination: | Finding of No Significant Impact (FONSI) |

## PROJECT SUMMARY (continued)

Pre-Consultation Parties:

City and County of Honolulu

- Department of Environmental Services
- Department of Facility Maintenance
- Department of Planning and Permitting
- Department of Transportation Services
- Honolulu Board of Water Supply
- Honolulu Fire Department
- Honolulu Police Department
- Neighborhood Board #30: Kaneohe
- Honolulu City Council, District 3

State of Hawaii

- Department of Business, Economic Development and Tourism, Office of Planning
- Department of Health, Environmental Management Division
- Department of Land and Natural Resources
    - Commission on Water Resource Management
    - Engineering Division
    - Office of Conservation and Coastal Lands
    - State Historic Preservation Division
- Department of Transportation, Highways Division
- Office of Hawaiian Affairs
- University of Hawaii at Manoa
    - Environmental Center
    - Water Resources Research Center
- Hawaii State House of Representatives, District 48
- Hawaii State Senate, District 24

Utility Companies

- Hawaii Gas
- Hawaiian Electric Company
- Hawaiian Telcom

Private Landowners

- Makani Kai Marina townhouse complex
- Other private landowners

# EXECUTIVE SUMMARY

The City and County of Honolulu proposes to upgrade the Kahanahou Wastewater Pump Station (WWPS) and Sewer Force Main in Kaneohe, Oahu. The WWPS, built in 1966, was found to experience high infiltration and inflow of rainwater into the sewer system. This requires that the WWPS increase its capacity from 0.654 millions of gallons per day (mgd) to more than 1.26 mgd. The upgrades in pump capacity will also include renovations and replacement of the existing SCADA system and motor control center, piping, wet well, and ventilation system. A new emergency generator building is proposed to house a new diesel fueled generator to replace the existing propane unit.

Upgrades to the Kahanahou WWPS require upgrades to the existing 8-inch force main that conveys wastewater from the Kahanahou WWPS to a 10-inch gravity main and on to the Waikapoki WWPS. Replacing the existing force man will increase the capacity from 0.47 mgd to handle the WWPS upgrade flow. The proposed force main will be re-routed to bypass the Waikapoki WWPS to flow directly to the Kaneohe Wastewater Preliminary Treatment Facility.

Construction on the Kahanahou WWPS will occur entirely within the existing WWPS site. The new force main will follow the existing force main as it exits the WWPS property, then will follow a more northerly route along City streets until it traverses two private properties, a residential property on Lilipuna Place, and the Makani Kai Marina townhouse complex.

The proposed project is expected to cost $3.0 million for the WWPS upgrades and $1.3 million for the force main replacement.

Most project impacts are expected to be short term and related to construction activities, such as noise, dust, and traffic. Efforts to minimize such impacts will be taken to the extent practicable. Long term impacts are improved environmental conditions related to a reduction in sanitary sewer overflows.

This proposed project is expected to receive a Finding of No Significant Impact (FONSI).

# TABLE OF CONTENTS

# TABLE OF FIGURES



# APPENDICES

A Preliminary Design Alternatives Report for Kahanahou Wastewater Pump Station Upgrade (Okahara and Associates, Inc., January 2011)

B Final Engineering Report - Kahanahou Wastewater Pump Station Force Main Sewer Line Study, Kaneohe, Oahu, Hawaii (Okahara and Associates, Inc., December 2013, Revised June 2015)

C Digital Flood Insurance Map (DFIRM) (Federal Emergency Management Agency, 2013)

D Pre-Environmental Assessment Consultation

E Literature Review and Field Inspection Report (LRFI) (Cultural Surveys Hawaii, Inc., January 2014)

F Special Management Area Determination Letter (City and County of Honolulu Department of Planning and Permitting, March 2010)

# ACRONYMS

| | |
|---|---|
| AIS | Archaeological Inventory Survey |
| BMP | Best Management Practice |
| BWS | Board of Water Supply |
| City | City and County of Honolulu |
| CMU | Concrete Masonry Unit |
| CSH | Cultural Surveys Hawaii |
| CSM | Collection System Maintenance Division (ENV) |
| CWB | Clean Water Branch (DOH) |
| CWRM | Commission on Water Resource Management |
| CZM | Coastal Zone Management |
| DCAB | Disability and Communication Access Board |
| DDC | Department of Design and Construction (City) |
| DFIRM | Digital Flood Insurance Rate Map |
| DLNR | Department of Land and Natural Resources (State) |
| DOFAW | Division of Forestry and Wildlife (DLNR) |
| DOH | Department of Health (State) |
| DPP | Department of Planning and Permitting (City) |
| DTS | Department of Transportation Services (City) |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| ENV | Department of Environmental Services (City) |
| EPA | Environmental Protection Agency (Federal) |
| FEMA | Federal Emergency Management Agency |
| FONSI | Finding of No Significant Impact |
| GIS | Geographic Information System |
| GPM | Gallons Per Minute |

## ACRONYMS (continued)

| | |
|---|---|
| HAR | Hawaii Administrative Rules |
| HDPE | High Density Polyethylene |
| HECO | Hawaiian Electric Company |
| HID | High Intensity Discharge |
| HP | Horsepower |
| HRS | Hawaii Revised Statutes |
| I/I | Inflow and Infiltration |
| INFIX | (City of Honolulu's wastewater flow calculation model) |
| KBMP | Kaneohe Bay Master Plan |
| KBMPTF | Kaneohe Bay Master Plan Task Force |
| KMCAS | Kaneohe Marine Corps Air Station |
| kW | Kilowatt |
| LRFI | Literature Review and Field Inspection |
| LUO | Land Use Ordinance |
| MCC | Motor Control Center |
| MGD | Million Gallons per Day |
| MH | Manhole |
| NFPA | National Fire Protection Association |
| NPDES | National Pollutant Discharge Elimination System |
| OD | Outside Diameter |
| PVC | Polyvinyl Chloride |
| SCADA | Supervisory Control and Data Acquisition |
| SDR | Standard Dimension Radio |
| SHPD | State Historic Preservation Division (DLNR) |
| SMA | Special Management Area |
| SSO | Sanitary Sewer Overflow |
| TMK | Tax Map Key |

## ACRONYMS (continued)

| | |
|---|---|
| USDA | United States Department of Agriculture |
| VFD | Variable Frequency Drive |
| WWPS | Wastewater Pump Station |
| WWTP | Wastewater Treatment Plant |

# 1. INTRODUCTION

## 1.1 PROJECT BACKGROUND AND NEED

The Kahanahou Wastewater Pump Station (WWPS) is owned and operated by the City and County of Honolulu (City) and is located in a residential subdivision in Kaneohe, Oahu (Figure 1). Wastewater from the Kahanahou WWPS tributary area flows to the Kahanahou WWPS and is pumped through an existing force main to the Waikapoki WWPS, where it is pumped through another force main to the Kaneohe Bay East interceptor sewer to the Kaneohe Wastewater Preliminary Treatment Facility (Figure 2).

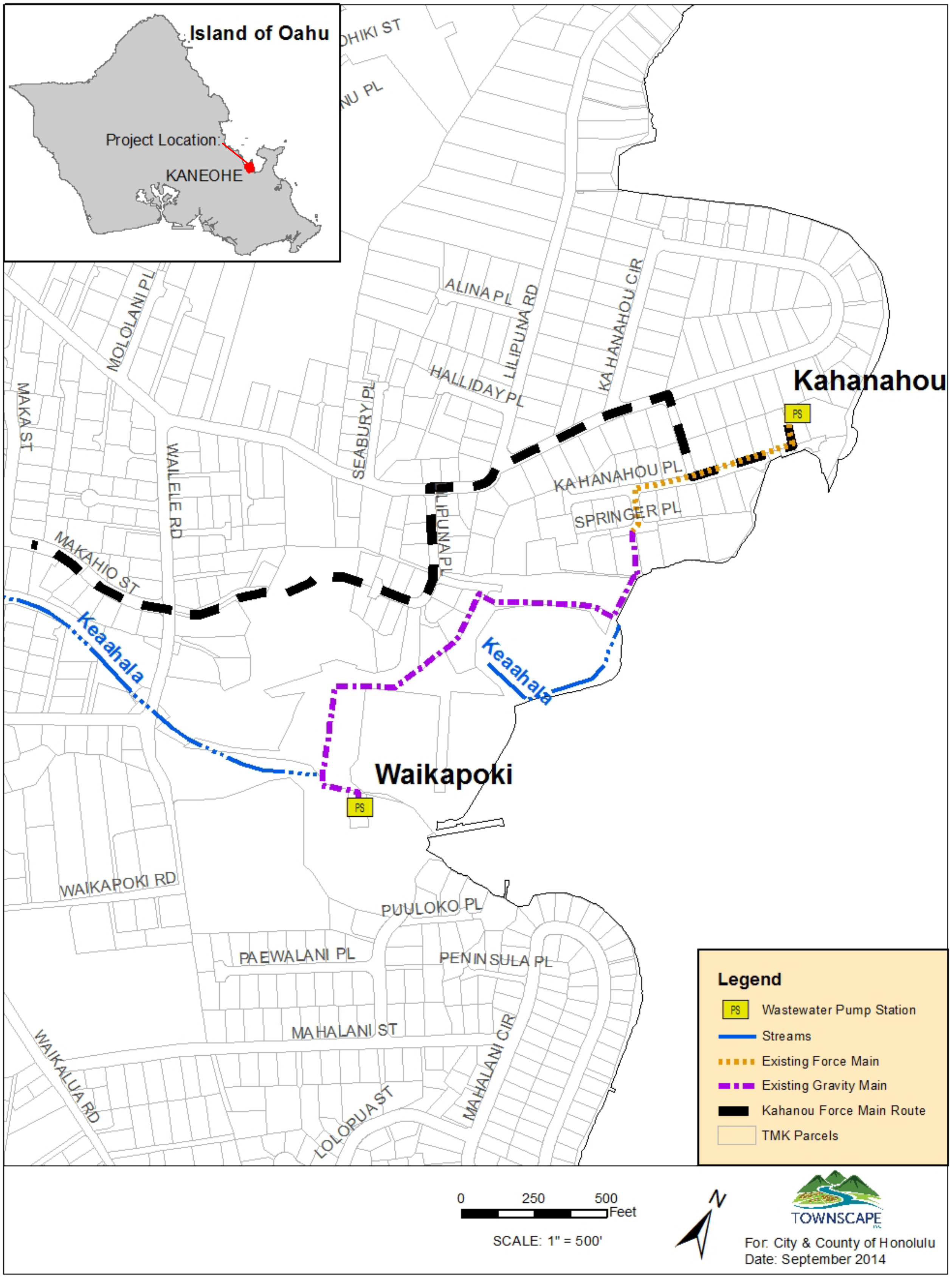
The existing Kahanahou WWPS was built in 1966 and requires additional pumping capacity. The "*Sewer Rehabilitation and Infiltration and Inflow Minimization Study, Volume 3 of 9, Kailua-Kaneohe I/I Engineering Report*" (December 1999) found high infiltration and inflow (I/I), which occurs when rain water enters the sewer system. As a result, the City Department of Design and Construction (DDC) proposes to upgrade the pump capacity of the existing WWPS, as well as upgrade piping, electrical systems and the WWPS building.

In addition to upgrades to the Kahanahou WWPS, the City proposes to replace a portion of the existing force main that carries wastewater to the Waikapoki WWPS. This existing force main has a history of leak problems and was identified for upgrades. This proposed Kahanahou WWPS and Sewer Force Main Upgrade project was initiated in response to the *2010 Global Consent Decree* between the U.S. EPA and the City to eliminate sanitary sewer overflows (SSO) to further the objectives set forth by the Clean Water Act.

The proposed Kahanahou Wastewater Pump Station and Sewer Force Main Upgrades will increase the capacity of the Kahanahou WWPS to meet future projected peak flow rates and increase its reliability. Additionally, the force main upgrades will increase the capacity to accommodate the projected peak flows and will also redirect wastewater straight towards the Kaneohe Preliminary Treatment Facility and away from Waikapoki, thus eliminating the need to upgrade the Waikapoki WWPS.

Environmental review of this project is required by Chapter 343, Hawaii Revised Statutes. The statutory triggers for preparation of this Environmental Assessment are:

1. Use of County lands and funds and;
2. Use within the Special Management Area (SMA).



Island of Oahu
Project Location:
KANEOHE
Kahanahou
Waikapoki
Keaahala
Keaahala
ALINA PL
LILIPUNA RD
KAHANAHOU CIR
HALLIDAY PL
MOLOLANI PL
MAKA ST
WAILELE RD
SEABURY PL
KAHANAHOU PL
SPRINGER PL
LILIPUNA PL
MAKAHIO ST
WAIKAPOKI RD
PUULOKO PL
PAEWALANI PL
PENINSULA PL
MAHALANI ST
MAHALANI CIR
WAIKALUA RD
LOLOPUA ST
PS
Legend
Wastewater Pump Station
Streams
Existing Force Main
Existing Gravity Main
Kahanou Force Main Route
TMK Parcels
0
250
500
Feet
SCALE: 1" = 500'
N
TOWNSCAPE
For: City & County of Honolulu
Date: September 2014

## 1.1 KAHANAHOU WWPS LOCATION AND EXISTING FACILITIES

The Kahanahou WWPS is located at 45-13 Ka Hanahou Place, Kaneohe, Hawaii 96744 (Tax Map Key [TMK] 4-5-047:095), a 7,893 square foot parcel in close proximity to Kaneohe Bay (Figure 1). There is an existing concrete masonry unit (CMU) wall on the northeast side of the property and a chain link fence enclosing the remaining sides with a double swinging gate at the driveway entrance. The WWPS and building was completed in 1966 and includes a generator room, pump station area, work area, toilet and service sink, motor control area, and steel stairway with grating landings that lead to the basement pump room.

The parcel is bordered on three sides by residential properties and a private access road, Ka Hanahou Place, provides access to the site. An existing drainage easement runs adjacent to the rear property line and encroaches slightly onto the property. On-site landscaping includes trees; hedges; and a large, flat grassy area at the front of the property.

*Kahanahou Wastewater Pump Station as seen from Ka Hanahou Place.*

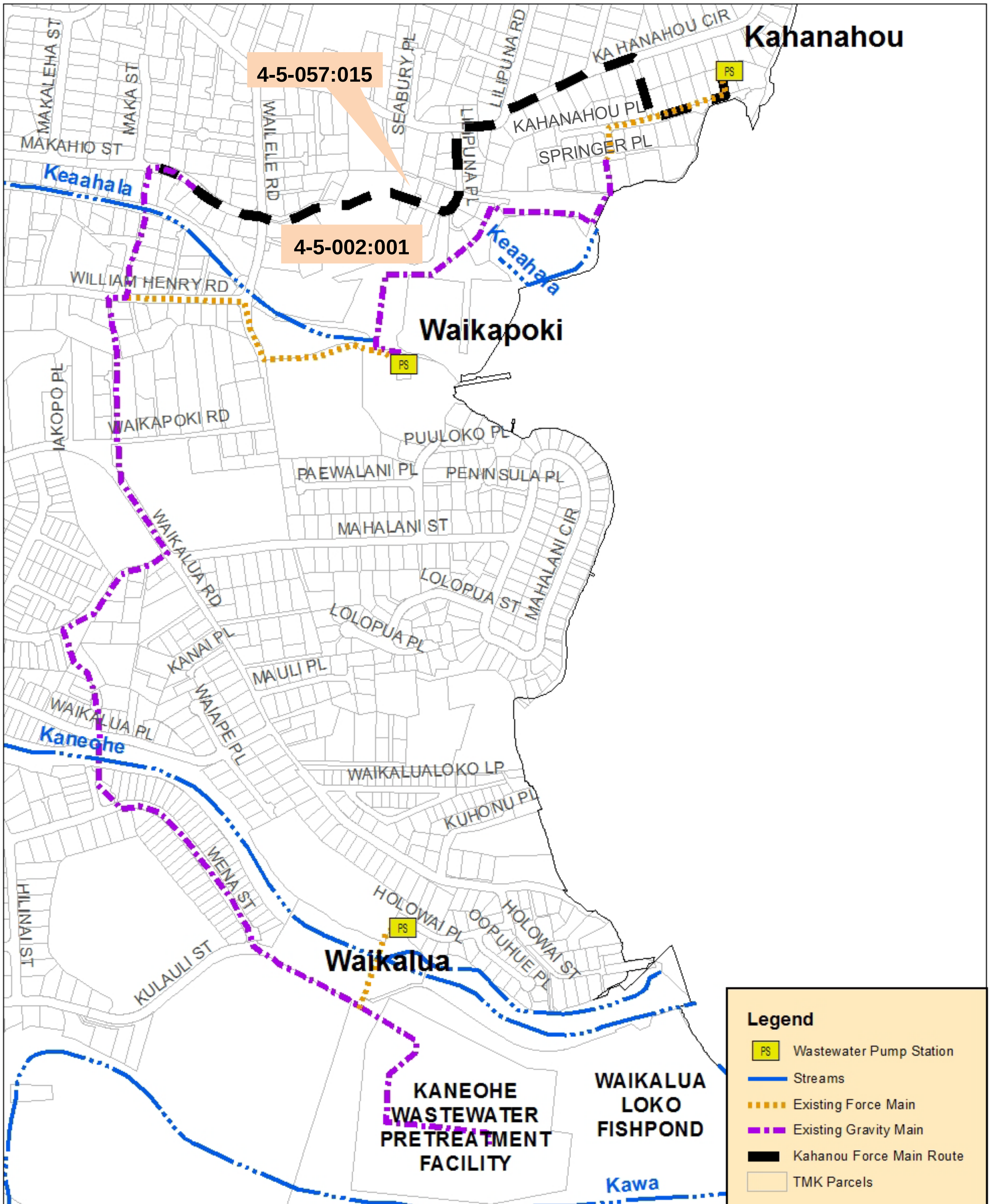
The Kahanahou WWPS was put into service in 1966 with a peak flow capacity of 460 gallons per minute (gpm) at 41 feet total dynamic head (TDH). The WWPS was retrofitted in 2006 with a new ball valve assembly and vault and the WWPS capacity was revised to 510 gpm at 41 TDH. One pump can pump 347 gpm at 45 feet TDH and two pumps can operate at 510 gpm at 47.5 feet TDH. The WWPS consists of the following components:

- One wet well measuring 21‘ 4” long, 8‘ 0” wide, and 10‘ 0” high, divided into two sections and separated with isolation stop gates
- Single 15-inch vitrified clap pipe that delivers influent sewage into the wet well via a gated distribution box
- One dry well measuring 21‘ 4” long and 11‘ 6” wide and is mechanically ventilated
- One ¼ horsepower (HP) sump pump rated for 25 gpm at 18 feet TDH
- Two 10 HP separately coupled solids handling pumps with extension shafts rated for 510 gpm at 41 feet located in the dry well
- A mechanical ventilation system
- An electrical system
- Controls
- Propane-fueled standby engine generator
- A Supervisory Control and Data Acquisition (SCADA) digital display monitors the pump station operations.

## 1.2 EXISTING SEWER FORCE MAIN

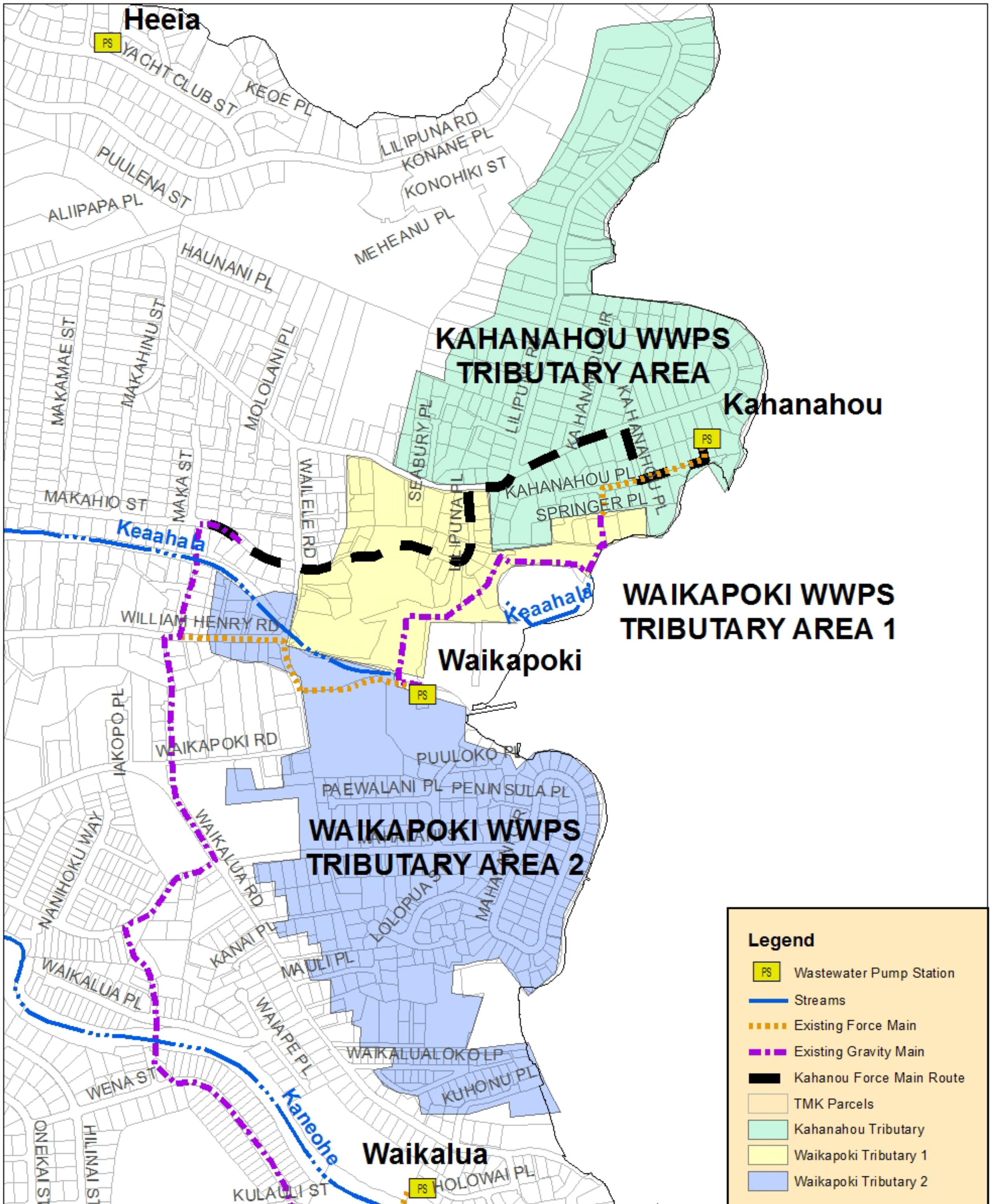
The original cast iron force main servicing the Kahanahou WWPS was put into service in 1966 and replaced in 2007 with a high density poly-ethylene (HDPE) force main to eliminate increasingly frequent pipe failures, possibly due to corrosion from age and close proximity to the ocean.  The original cast iron force main was abandoned in place.

The current 8-inch diameter force main has a capacity of 0.47 mgd and is approximately 800 lineal feet in length, running from the Kahanahou WWPS to a manhole on Springer Place (Figure 2).  At Springer Place,the line continues as a 10-inch gravity main for approximately 1,600 lineal feet through the marina area towards the Waikapoki WWPS.  The last 272 feet of gravity main before the Waikapoki WWPS are 12 inches in diameter.  The tributary areas labeled “Kahanahou Tributary,” “Waikapoki Tributary 1”, and “Waikapoki Tributary 2” all currently discharge to the Waikapoki WWPS.




KAHANAHOU WASTEWATER PUMP STATION
AND SEWER LINE UPGRADES
DRAFT ENVIRONMENTAL ASSESSMENT

**Figure 2 Existing and Proposed Sewer System**




**KAHANAHOU WASTEWATER PUMP STATION AND SEWER LINE UPGRADES**
**DRAFT ENVIRONMENTAL ASSESSMENT**

**Figure 3 Existing Tributary Areas**

0 400 800 Feet

SCALE: 1" = 800'

N

TOWNSCAPE

For: City & County of Honolulu
Date: September 2014

# 2. PROPOSED PROJECT DESCRIPTION

The existing Kahanahou Wastewater Pump Station was found to have inadequate capacity to accommodate future projected peak flows. Any upgrade to the capacity of the WWPS will also require upsizing of the force main that carries the wastewater towards the Kaneohe Wastewater Preliminary Treatment Facility. The force main upgrade is coupled with the pump station upgrade and addressed in this EA. For detailed engineering information and safety measures used, please see Appendices A and B for the engineering reports.

## 2.1 KAHANAHOU WWPS

The proposed project will replace the existing separately coupled solids handling pumps with new larger capacity constant speed dry pit submersible pumps that will increase the capacity of the WWPS from 0.654 mgd to a capacity of more than 1.26 mgd . Variable Frequency Drives (VFDs) will be installed to control electrical currents and to limit the maximum flow to avoid spills through downstream manholes. The new pump equipment will require additional power, panel space, and working clearances. This will require both interior alterations to the existing WWPS building and the construction of a new emergency generator building. Before the pump station can come online, HECO will be upgrading their surrounding wiring from 1-phase to 3-phase power to increase the voltage for the new pumps.

Within the WWPS building, the existing SCADA system and Motor Control Center (MCC) controls would be replaced and installed in a new air conditioned electrical room. All piping in the dry well would be replaced and the original wet well liner would be replaced with a corrosion-resistant polymer, monolithic lining to protect the concrete from the corrosive effects of wastewater. Additionally, in order to comply with National Fire Protection Association (NFPA) "NFPA 820" (Standard for Fire Protection in Wastewater Treatment and Collection Facilities), the ventilation system would be replaced and new supply and exhaust fans, ductwork, and intake and exhaust openings would be installed.

A new emergency generator building is proposed for construction at the front of the property to house a new diesel fueled generator to replace the existing propane fueled unit. This diesel generator has a larger capacity than the existing propane system, which is needed to accommodate the larger 15 HP pump motors. The new emergency generator building will be 350 square feet (SF) in size to accommodate the new generator and minimum work clearances in front of the electrical panel boxes that are required by code. The proposed generator building materials and finishes would complement and/or match the existing pump station building, including CMU concrete block walls, metal doors and frames, stainless steel louvers, screened openings and a low sloping concrete roof to match the pump station roof slope. Selected CMU walls, doors and louvers would be acoustically treated to minimize noise impacts.

A new 1,000 gallon fuel storage tank will be needed to power this generator with diesel fuel. Although an underground storage tank (UST) was originally intended due to City setback regulations, an aboveground storage tank (AST) was preferred by CSM due to a reduced risk of leaks and groundwater contamination, and lower costs and permitting requirements. (Note that the engineering reports in the appendices still outline details of the UST. They are currently being revised to reflect these changes and show the AST.)

Additional engineering details of pump, ventilation and electrical systems made within the facilities discussed here that are not going to affect the impacts of the project can be found in the attached Design Alternatives Report (WWPS) and Engineering Report (force main) (Appendices A and B).

**Figure 4 Location of New Generator Building**

## 2.2 SEWER FORCE MAIN REPLACEMENT

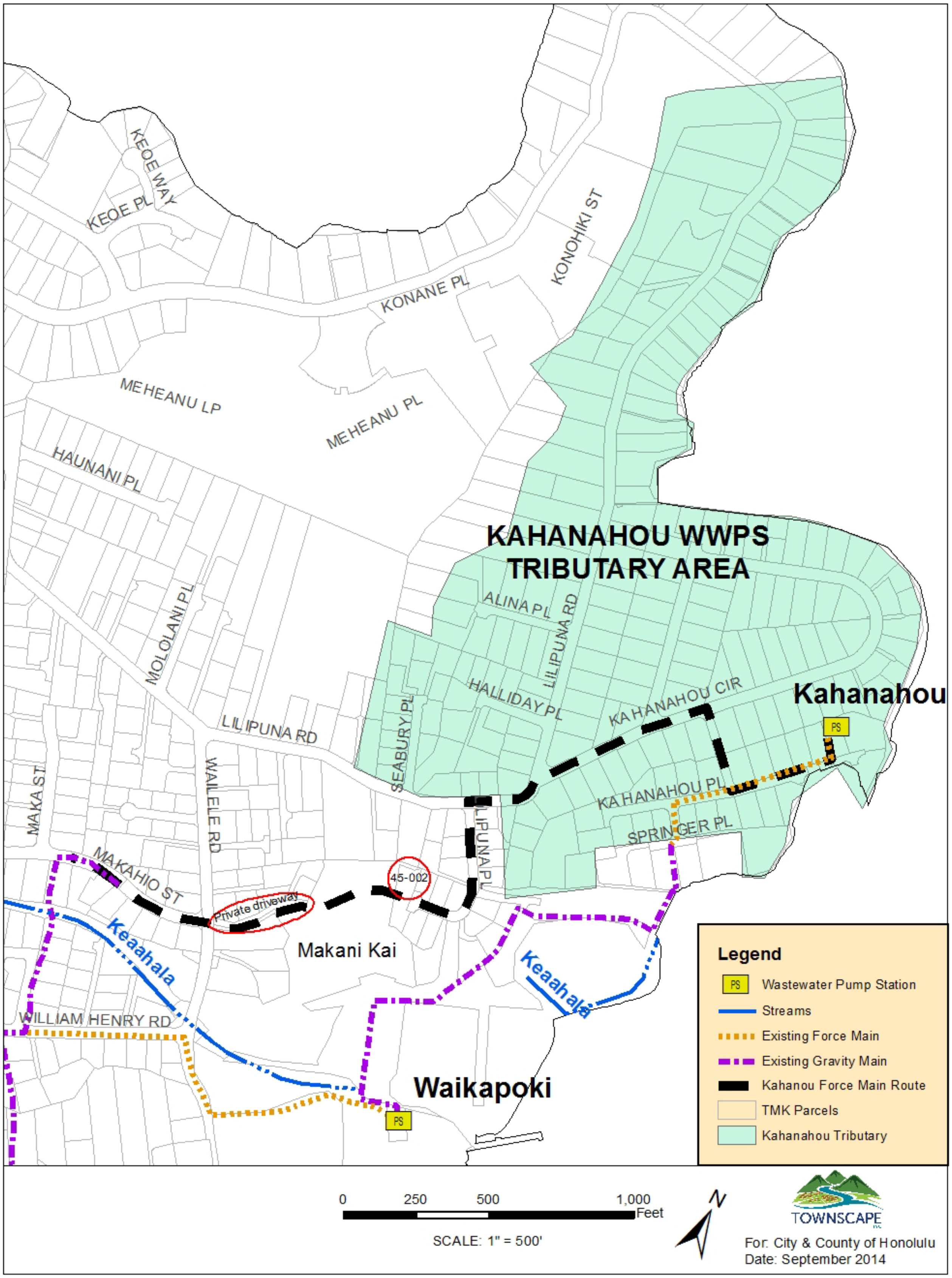
In order to accommodate the increased capacity of the Kahanahou WWPS, the existing 8-inch force main that conveys wastewater from Kahanahou WWPS to the gravity main conveying it to the Kaneohe Wastewater Preliminary Treatment Facility, must be upsized to a 10-inch force main, from the current capacity of 0.47 mgd to 1.27 mgd.

The new 10-inch force main will be about 3,100 lineal feet in length and will start at the Kahanahou WWPS, run west on Ka Hanahou Place and follow the road north to its intersection with Ka Hanahou Circle. There, it goes west along Kahanahou Circle, turning south at Lilipuna Place, and through a private residence (45-002 Lilipuna Place, TMK 4-5-057:015) at the turnaround. It then passes through the Makani Kai Marina townhouse complex (45-995 Wailele Road, TMK 4-5-002:001) and a linear extension of their parcel toward Wailele Road. The force main crosses Wailele Road and discharges at an existing sewer manhole on Makahio Street where it connects to an existing 8-inch gravity sewer line (Figure 5). Where the new force main will share the same alignment as the existing force main along Ka Hanahou Place, the old force main will be removed. The existing force main in the remainder of the alignment that runs toward the Waikapoki WWPS will be abandoned in place.

The existing 8-inch gravity sewer line at the point of connection on Makahio Street has an estimated capacity of 0.463 mgd which is not sufficient to handle the peak design flow of 1.27 mgd. However, the initial years of flow will be low enough to pass through this whole section and the City is currently looking at upgrading the existing gravity line to meet future capacity demands. Both the existing and proposed sewer systems ultimately flow to the Kaneohe Preliminary Treatment Facility; therefore there will be no change in the amount of discharge to this downstream facility.

The proposed 10-inch force main will replace the existing 8-inch force main and will no longer connect to the existing gravity main discharging to the Waikapoki WWPS. This gravity main is to remain and continue to service the Waikapoki Tributary 1 area (Figure 3). Since the proposed force main will no longer connect to the gravity main discharging to Waikapoki WWPS, the "Kahanahou Tributary" area will no longer flow to the Waikapoki WWPS. The total tributary area discharging to the Waikapoki WWPS will therefore be significantly reduced, eliminating the need for the Waikapoki WWPS to be upgraded to accommodate increased future flows.

Both trench and trenchless construction methods will be considered for this project. The final determination on which method is appropriate will be made during the design phase. Micro-tunneling will likely be used in the Marina Kai townhome complex to avoid disturbing residents.


KEOE WAY
KEOE PL
KONOHIKI ST
KONANE PL
MEHEANU LP
MEHEANU PL
HAUNANI PL
KAHANAHOU WWPS
TRIBUTARY AREA
ALINA PL
LILIPUNA RD
MOLOLANI PL
HALLIDAY PL
KAHANAHOU CIR
Kahanahou
PS
LILIPUNA RD
SEABURY PL
KAHANAHOU PL
SPRINGER PL
MAKA ST
WAILELE RD
LILIPUNA PL
MAKAHIO ST
45-002
Private driveway
Keaahala
Makani Kai
Keaahala
WILLIAM HENRY RD
Waikapoki
PS
Legend
PS Wastewater Pump Station
Streams
Existing Force Main
Existing Gravity Main
Kahanou Force Main Route
TMK Parcels
Kahanahou Tributary
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500
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SCALE: 1" = 500'
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TOWNSCAPE
For: City & County of Honolulu
Date: September 2014

## 2.3 CONSTRUCTION SEQUENCE AND COSTS

The estimated construction cost for the force main is $1,322,063. The WWPS upgrades will cost $2,959,000. These estimates are for budgetary and preliminary engineering report purposes only, and are subject to change as design progresses. Funding for the project will be provided by the City.

The general construction sequence is as follows:

1. New force main work will be completed without connection to the pump station.

2. Temporary bypass piping and pumps will be installed while connections are made to the new sewer line.

3. New emergency generator building will be constructed and pump station upgrades will then be completed.

4. New force main will be connected and new pumps will be started.

5. Temporary systems will be shut off and removed.

Design plans for the sewer main and wastewater pump station may be found in Appendices A and B.

# 3. ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION

## 3.1 TOPOGRAPHY AND SOILS

The existing ground topography along the proposed sewer force main alignment varies from roughly 4.6 feet to 65.6 feet in elevation. The beginning of the proposed force main at the Kahanahou WWPS is the low point of the line (elevation 4.6 feet). The existing ground generally slopes upward to a high point near the intersection of Lilipuna Road and Lilipuna Place (elevation 65.6 feet). The ground then varies up and down in slope until the end of the proposed force main along Makahio Street (elevation 64.6 feet). See Attachment 1 of Appendix B for the plan and profile sheets with topographic survey background.

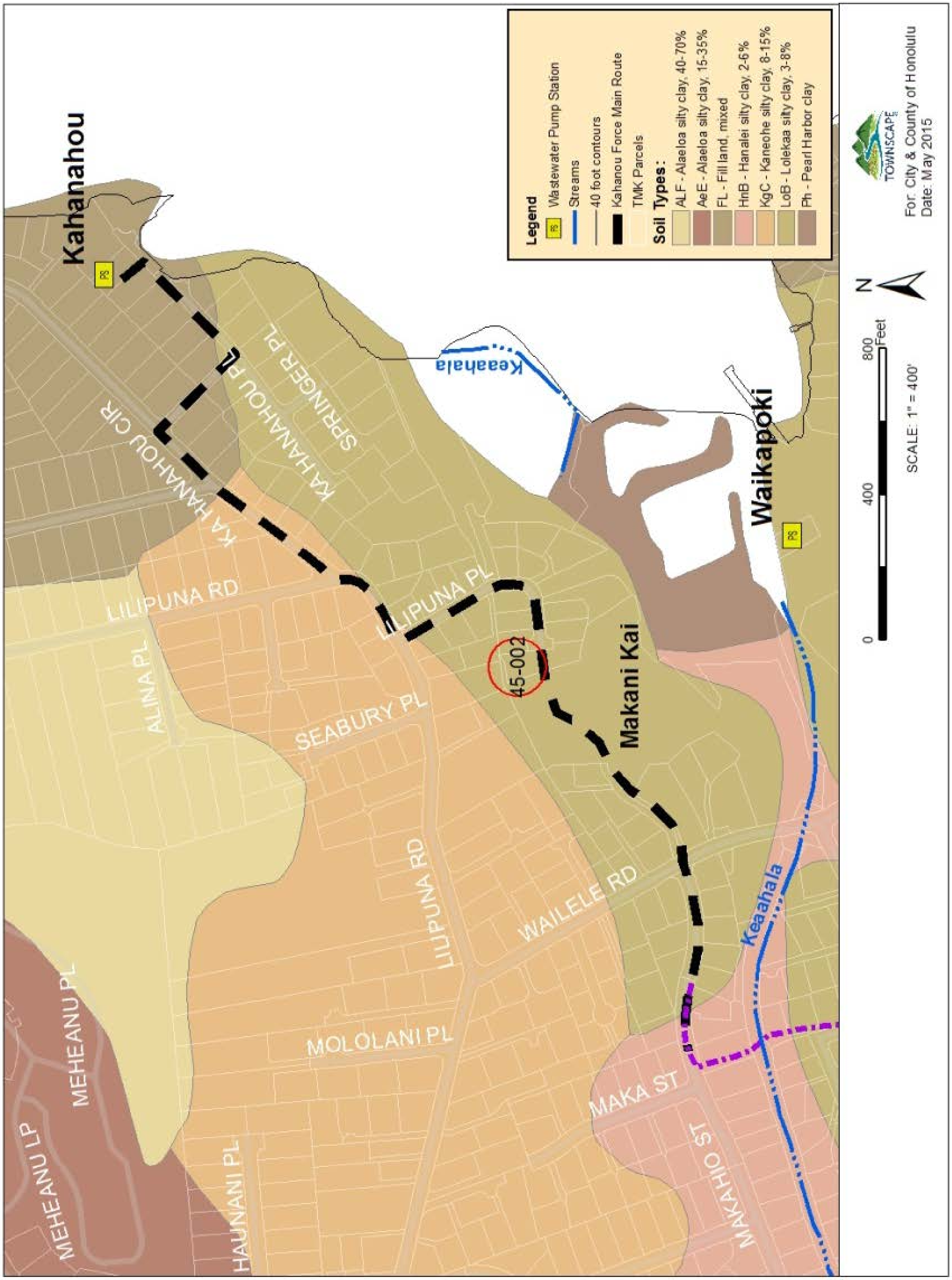
The project area is located on four soil types designated by the U.S. Department of Agriculture Soil Survey of 1972 (Figure 6). The Kahanahou Wastewater Pump Station and most of the existing sewer main to be replaced are located on “Fill land, mixed (FL)”; areas filled with material dredged from the ocean or hauled from nearby areas, or garbage and general material from other sources. Part of the existing main and the proposed new main are located on “Kaneohe silty clay, 8-15% slope (KgC)”, a well-drained soil found on terraces and alluvial fans in Windward Oahu. This soil type develops in alluvium and colluvium derived from basic igneous rock. Runoff rates are medium and erosion hazard is moderate. The proposed sewer force main then passes through “Lolekaa silty clay, 3-8% slope (LoB)”, a soil found on terraces and fans, strongly acidic with moderately rapid permeability. Runoff is slow and the erosion hazard is slight. The final portion of the new force main passes through “Hanalei silty clay, 2-6% (HnB)”, a thick, dark grey silty clay with red-brown mottles. The 10-inch thick surface layer is acidic, and the clay loam subsoil is neutral. Runoff is slow and erosion hazard is slight.

**Impacts and Mitigation**

No significant impact to ground topography or soils is expected as a result of this project. The proposed force main will be installed underground and mostly within existing road rights-of-way or easements. Minor grading may be required to return the project corridor to its pre-construction condition. The pump station upgrades are above-ground on the existing property and will not include soil disturbance or grading. For construction of the emergency generator building, there may be some soil disturbance and appropriate BMPs will be used. However, the site topography will not be affected.

Mitigation Measures: Best management practices (BMPs) will be employed to minimize erosion and soil loss during construction. Construction practices will comply with the guidelines found in the following regulations:

- *Revised Ordinances of Honolulu (ROH) Chapter 14, Articles 13-16, relating to Grading, Grubbing, Stockpiling, Soil Erosion, and Sediment Control;*
- *Rules Relating to Soil Erosion Standards and Guidelines (April 1999), Department of Planning and Permitting, City and County of Honolulu; and*
- *Erosion and Sediment Control Guide for Hawaii (1968), Soil Conservation Service, US Department of Agriculture.*



Legend
Wastewater Pump Station
Streams
40 foot contours
Kahanou Force Main Route
TMK Parcels
Soil Types:
ALF - Alaeloa silty clay, 40-70%
AeE - Alaeloa silty clay, 15-35%
FL - Fill land, mixed
HnB - Hanalei silty clay, 2-6%
KgC - Kaneohe silty clay, 8-15%
LoB - Lolekaa silty clay, 3-8%
Ph - Pearl Harbor clay
TOWNSCAPE
For: City & County of Honolulu
Date: May 2015
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SCALE: 1" = 400'
Kahanahou
Waikapoki
Makani Kai
Keaahala
PS
45-002
KA HANAHOU CIR
KA HANAHOU PL
SPRINGER PL
LILIPUNA RD
LILIPUNA PL
ALINA PL
SEABURY PL
LILIPUNA RD
WAILELE RD
MOLOLANI PL
MAKA ST
MAKAHIO ST
MEHEANU PL
MEHEANU LP
HAUNANI PL


Heeia Fishpond
Coconut Island
Mokapu Peninsula
KMCAS
Heeia Wetlands
KANEOHE BAY
Project Area
KANEOHE
Kawainui Marsh
KAILUA
Kaelepulu Pond
Likelike Hwy
Kahekili Hwy
Kaneohe Bay Dr
H-3 Freeway
Mokapu Rd
Mokapu Blvd
Kamehameha Hwy
Pali Hwy
Kailua Rd
Kalanianaole Hwy
Legend
Major Roads
Streams
Avg Annual Rainfall (in)
Watersheds
Wetlands
Ponds
CWRM Aquifer System Area
Koolaupoko
Waimanalo
0 0.75 1.5 Miles
0 2,500 5,000 Feet
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TOWNSCAPE INC
For: City & County of Honolulu
Date: May 2015

## 3.2 CLIMATE AND HYDROLOGY

Average annual rainfall in the project area is approximately 50 inches. Predominant tradewinds bring cooler, wetter weather December through April, with slightly higher temperatures and drier conditions during the summer months. The project area is located within the Commission on Water Resource Management (CWRM) Aquifer System Area of Koolaupoko, in the Keaahala watershed between Heeia and Kaneohe watersheds (Figure 7). The CWRM sustainable yield for the Koolaupoko Aquifer System Area is 30 mgd. Perennial Keaahala Stream runs in an easterly direction to the south of the project area, emptying into Kaneohe Bay.

### Impacts and Mitigation

The proposed project will have no impact on the local climate. Ground and surface water hydrology will not be affected and water quality impacts will be beneficial, if any (see Section 3.4). No mitigation measures will be needed.

## 3.3 AIR QUALITY AND NOISE

Air quality in the vicinity of the project is primarily affected by emissions from vehicular, residential and natural sources, but is considered acceptable due to the prevailing northeasterly tradewinds. Based on data from the State Department of Health (DOH), Clear Air Branch Annual Summary of the 2011 Hawaii Air Quality Data, both State and Federal ambient air quality standards are currently being met in the project vicinity.

Noise levels in the vicinity of the project are low, as land uses in the area are primarily residential. Sources of ambient noise are vehicular travel, recreational use in Kaneohe Bay, and periodic activity at and associated with Kaneohe Marine Corps Base Hawaii.

### Impacts and Mitigation

Impacts on air quality and noise from the pump station upgrades and installation of the sewer main and connections are anticipated to be minor and short-term. Installation of the sewer force main may require machinery that generates noise and dust, and emissions from construction equipment and vehicles may slightly impact air quality in the area. Force main connections are expected to be done at night during non-peak wastewater flow hours to avoid spillage, which may cause temporary noise impacts. The pump station upgrades will be completed after the force main is in place, allowing an instant connection of the new pumps and lines to bring the pump station online. The pump station and emergency generator building will be equipped with sound reducing materials, including solid walls and acoustical rated metal doors, to decrease equipment noise transmission to the neighborhood.

*Mitigation Measures*:  The short-term effects on noise and air quality during construction will be mitigated by compliance with the DOH rules on air pollution and noise control. Best management practices during construction typically include:

- Planning the different phases of construction, focusing on minimizing the amount of dust generating materials and activities, centralizing on-site vehicular traffic routes, and locating potentially dusty equipment in areas of least impact;
- Providing an adequate water source at the site prior to start-up of construction activities for dust control;
- Landscaping and rapid covering of bare areas, including slopes;
- Controlling of dust from shoulder and access roads;
- Providing adequate dust control measures during weekends, after hours, and prior to daily start-up of construction activities; and
- Controlling of dust from debris being hauled away from project site.

Heavy vehicles traveling to and from the project site must comply with the provisions of the DOH's Administrative Rules, Chapter 11-42, "Vehicular Noise Control for Oahu."  If needed, a noise variance will be obtained for any night work performed during construction.  Furthermore, activities associated with the construction phase of the project must comply with the DOH's Administrative Rules, Chapter 11-46, "Community Noise Control" which states that:

- The contractor must obtain a noise permit if the noise levels from the construction activities are expected to exceed the allowable levels of the rules as stated in Section 11-46-6(a).
- Construction equipment and on-site vehicles requiring an exhaust of gas must be equipped with mufflers as stated in Section 11-46-6(b) (1)(A).
- The contractor must comply with the requirements pertaining to construction activities as specified in the rules and the conditions issued with the permit as stated in Section 11-46-7 (d) (4).

## 3.4 WATER QUALITY

The waters of Kaneohe Bay near the project site are designated class AA by the DOH. The objective of class AA waters is to remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions (HAR 11-54). Water quality samples evaluated in DOH's "2014 State of Hawaii Water Quality Monitoring and Assessment Report" show Kaneohe Bay not attaining water quality standards for at least one parameter in each of seven locations.

### Impacts and Mitigation

No adverse impacts on surface or ground water quality are anticipated. The proposed project will reduce the risk of wastewater spills by increasing both the pump capacity of the Kahanahou WWPS and the capacity of the force main delivering wastewater to the gravity main, thereby decreasing the risk of spills and groundwater contamination. The long term impacts of the force main will be beneficial to near shore water quality and marine habitat.

*Mitigation Measures*: Best Management Practices (BMPs) will be used during the construction process to avoid dewatering effluent and construction debris from causing runoff problems. Excavated material will be hauled off-site to a site selected by the contractor. If suitable, the excavated material can be used to backfill the shafts or trenches. Excavated material will not be discharged into coastal waters.

The AST to store diesel for the emergency generator will be encased in cement to protect from damage. A double-walled tank and leak detection gauges will monitor any tank failures that could result in leaks.

Prior to construction, compliance with State water quality requirements will be sought. Construction dewatering and storm water permits will be obtained from the City and the State DOH pursuant to City Ordinance and Section 11-55 of the Hawaii Administrative Rules.

As part of the anticipated National Pollutant Discharge Elimination System (NPDES) Permit, water quality sampling and analyses will be undertaken for potential contaminants which may be anticipated. An effluent discharge control plan will be prepared incorporating BMPs, appropriate structural or non-structural mitigative measures such as containment berms and filtration or detention ponds which would control the discharge of stormwater runoff and effluent resulting from construction activities. Specific BMPs will be determined during the detailed design phase.

## 3.5 WETLANDS

The National Wetlands Inventory identifies several types of wetlands in the State of Hawaii. Estuarine and Marine Deepwater wetlands exist in the vicinity of the project area, extending along the shoreline and up Keaahala Stream (Figure 7). These wetlands provide filtration of storm water and protection against ocean waves. The WWPS and proposed sewer main do not pass through any wetlands.

### Impacts and Mitigation

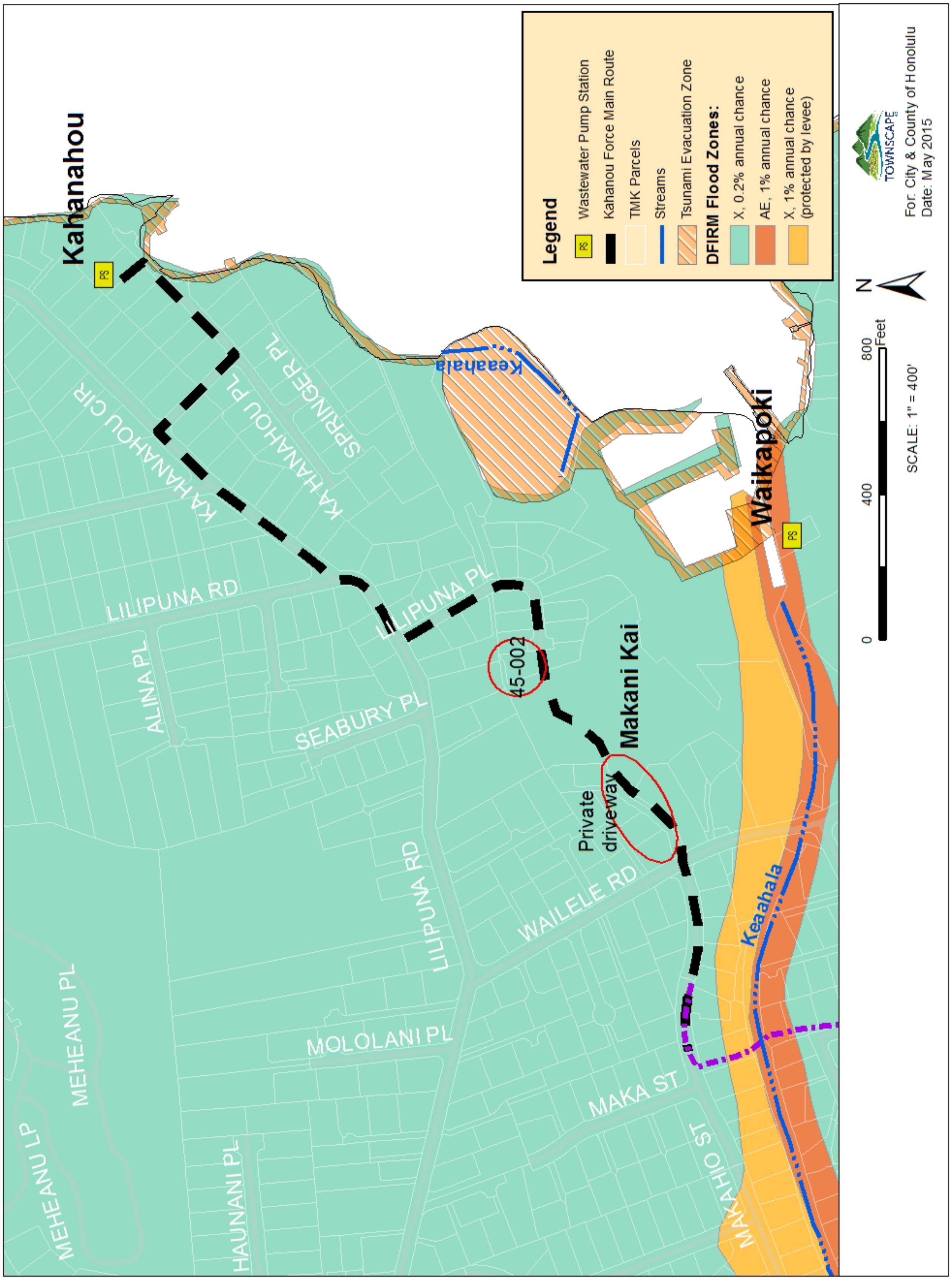
The proposed project does not pass through any wetlands and is not anticipated to have any impacts on wetlands in the area. No mitigative measures are proposed.

## 3.6 FLOODING, TSUNAMI AND FIRE HAZARDS

The entire sewer force main alignment and WWPS are in the Federal Emergency Management Agency (FEMA) Digital Flood Insurance Rate Map (DFIRM) Zone X, outside the 500-year floodplain. Just south of the project area is Zone X - protected from the 1% annual chance flood by a levee, and Zone AE, a 1% annual chance floodway. See Appendix C for the location of the flood protection levee in relation to the project area. A portion of the force main passes through the tsunami evacuation zone where it passes nearest to Kaneohe Bay (Figure 8).

### Impacts and Mitigation

The proposed project is not anticipated to have any impact on flooding, designated flood zones, or tsunami zones. To reduce any risk of leakage or fire hazards from the diesel AST, the tank will be double-walled, encased in cement and protected by leak gauges that monitor any potential tank failures.


Kahanahou
Legend
Wastewater Pump Station
Kahanou Force Main Route
TMK Parcels
Streams
Tsunami Evacuation Zone
DFIRM Flood Zones:
X, 0.2% annual chance
AE, 1% annual chance
X, 1% annual chance (protected by levee)
For: City & County of Honolulu
Date: May 2015
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Feet
SCALE: 1" = 400'
Keaahala
Waikapoki
Makani Kai
45-002
Private driveway
KAHANAHOU CIR
KAHANAHOU PL
SPRINGER PL
LILIPUNA RD
LILIPUNA PL
ALINA PL
SEABURY PL
WAILELE RD
MOLOLANI PL
MAKA ST
MAKAHIO ST
MEHEANU PL
MEHEANU LP
HAUNANI PL

## 3.7 SOCIO-ECONOMIC CONDITIONS

Land use within the project area is primarily residential. Some recreational land uses may be found along Kaneohe Bay. A private marina is associated with the Makani Kai Marina townhome complex (45-995 Wailele Road, TMK 4-5-002:001) and several small piers extend into the nearshore waters. Windward Mall, a regional shopping center, is located within a mile of the project's western extent.

As mentioned in Section 5.7, the Koolaupoko Sustainable Communities Plan designates the area in the vicinity of the planned Kahanahou WWPS upgrade project as a low density residential area with a modest projected population growth.

### Impacts and Mitigation

The proposed sewer force main and pump station upgrades will accommodate projected wastewater flows to the year 2030. This will provide adequate infrastructure to support the expected population growth in Kaneohe but is not expected to promote growth beyond the modest levels recognized in the Koolaupoko Sustainable Communities Plan (2000), as it will not greatly increase the capacity of the WWPS. However, this neighborhood is already built-out and not expected to incur any more significant development. Overall, this project is expected to benefit the community by minimizing future public health and environmental hazards. It will benefit the City and thereby taxpayers via reduced operating costs and by reducing the risk of legal actions and fines against the City for further Clean Water Act violations. The project will also provide employment for contractors and thereby benefit material suppliers and others in the construction industry.

Two private landowners are expected to be directly impacted by the proposed project: TMKs 4-5-057:015 and 4-5-002:001 (Figure 2). The selected force main alignment will run through an existing five-foot easement on TMK 4-5-057:015 (45-002 Lilipuna Place), which is a private residence. The easement is bound by an existing car port and cannot be widened. The owner of this property has been contacted and understands that a force main is proposed for this easement. While it is preferred that the easement be wider, the City can fit the proposed force main within the existing easement and has not requested that the easement be widened at this time.

The preferred route will also run through the Makani Kai Marina townhouse complex (45-995 Wailele Road, TMK 4-5-002:001). Contact has been made with the complex's General Manager and the City believes that it can route the proposed force main to accommodate the concerns of the Makani Kai Marina owners regarding landscaping and sidewalk alignments.

Additionally, the proposed force main will continue on through the Makani Kai Marina property to where the parcel runs alongside a private driveway (TMK 4-5-002:014) (Figure 5). The sewer alignment is expected to be contained within the Makani Kai Marina TMK 4-5-002:001, but the adjacent private driveway will be needed for construction access. At a minimum, a right-of-entry to this private driveway parcel will be required from the various landowners.

## 3.8 INFRASTRUCTURE

### 3.8.1 Traffic and Roads

Vehicular access to the Kahanahou WWPS is from Kahanahou Place, a paved City and County of Honolulu road (Figure 2). From the pump station, the proposed force main runs along Kahanahou Place and left onto Ka Hanahou Circle and continuing west onto Lilipuna Road, then takes a left on Lilipuna Place where it continues through private properties as discussed in Sections 2 and 3.7. The terminus of the proposed force main is on Makahio Street.

**Impacts and Mitigation**

Construction activities and the HECO 3-phase power installation will temporarily affect vehicular traffic in the vicinity of the pipe installation work, but are not expected to have a major impact on circulation. A traffic control plan will be developed during the design phase, allowing residents access to and from their homes. Portions of Kahanahou Place, Lilipuna Street and Makahio Street may be temporarily affected by construction work, and other roads in the area may see a slight increase in traffic as a result.

Transfer of construction materials and equipment will be done during off-peak hours to minimize disruption of traffic. Residents in the vicinity of the project area, the Honolulu Police Department, and Honolulu Fire Department will be informed about the timing and location of construction work and alternate routes.

### 3.8.2 Water System and Electrical Service

Potable water is provided to the Kahanahou WWPS by the Honolulu Board of Water Supply (BWS) water line on Kahanahou Place. Daily water usage consists of sanitary fixtures, landscape irrigation, washdown and other maintenance purposes. Additional water is needed on an intermittent basis for wet well cleaning and maintenance of the odor control system. Electrical power is provided to the Kahanahou WWPS by Hawaiian Electric Company (HECO) overhead service lines along Kahanahou Place. In the event of a commercial power outage, emergency generators will start and essential loads automatically transfer to emergency power.

### Impacts and Mitigation

The proposed actions are not anticipated to impact utilities such as potable water and electricity. Prior to construction, all existing utility lines along and in proximity to the force main alignment will be identified and their depths located to avoid damaging them. The contractor will contact the utility companies to ensure proper coordination. In the event of a power outage in the neighborhood, the pump station will continue to operate via its back-up generator.

## 3.8.3 Wastewater System

This project is the result of litigation aimed at inadequate wastewater systems in the County of Honolulu. The existing Kahanahou Wastewater Pump Station was found to have inadequate capacity to meet future projected flows. The proposed upgrades to the pump station will also require an upsizing of the related force main.

### Impacts and Mitigation

Since the construction of this project will upgrade the wastewater system, only beneficial long-term impacts are expected. The proposed project would reduce the risk of wastewater spills by increasing the capacity of the Kahanahou WWPS and the force main to accommodate the anticipated future peak flows from the Kahanahou tributary area. Due to flows from the Kahanahou tributary area bypassing the Waikapoki WWPS after construction of the new force main, the demands on the Waikapoki WWPS will be decreased. Temporary construction-related impacts on the conveyance system will be mitigated via temporary above-ground bypass piping systems and pumps that discharge into a mobile tanker.

## 3.9 HISTORICAL AND CULTURAL RESOURCES

Cultural Surveys Hawaii (CSH) completed a Literature Review and Field Inspection (LRFI) report in 2014 and submitted it to the State Historic Preservation Division (SHPD) for review and comment. The LRFI includes an analysis of the history of the ahupuaa and previously conducted archaeological studies in the vicinity of the project area. None of the previous archaeological studies completed in Kaneohe and analyzed for the LRFI covered the project area, however some were conducted close by. The Kaneohe ahupuaa was densely populated during pre-contact times and abundant fresh water made it an agriculturally active area with many traditional crops. In post-contact times, sugar, rice, pineapple and ranching all made their way through the ahupuaa. Fishponds were another common historic feature with some fishponds and remnants still visible today.

The field inspection conducted by CSH in 2013 revealed only one historic property close to the project area: the remnants of an old fishpond wall. This stacked stone wall is the relic of Kalokohanahou Fishpond, which will not be altered by the proposed work.

**Impacts and Mitigation**

The Kahanahou WWPS is built on a historic fishpond that was filled in decades ago. The remnants of Kalokohanahou Fishpond are still present, but will not be altered by the proposed force main and any work on the WWPS itself is not anticipated to disturb any archaeological features. The LRFI report concludes that due to the serpentine nature of the proposed work and the extensive land modifications that have taken place in modern times, the likelihood of intact cultural deposits being present in the project area is very low.

The LRFI report did not anticipate the need for an archaeological inventory survey (AIS) at this time, but an AIS will be conducted if the SHPD requires one upon completion of their review of the LRFI Report (a letter from the City requesting SHPD to review the LRFI was sent and a response is anticipated prior to construction). If SHPD concurs, an archaeological monitoring program will be implemented as part of subsurface excavation and construction activities greater than 12 inches deep. This will identify and protect any potential cultural deposits and/or burials that may be present. If subsurface archaeological materials are encountered during construction, work shall cease in the immediate area and the SHPD will be notified.

## 3.10 FLORA AND FAUNA

Vegetation in and around the immediate vicinity of the project corridor consists mainly of residential and roadway landscaping. The State GIS vegetation maps show that little to no Federal or State listed or candidate threatened or endangered plant or animal species are currently found within the project area. Wildlife in the project area is limited to mammals and birds which have adapted to the urban environment.

**Impacts and Mitigation**

Construction will occur primarily within existing road rights-of-way and previously landscaped areas. No threatened or endangered species are anticipated in the project area, due to its residential nature. To the extent possible, vegetation removal will be kept to a minimum, and the project is not expected to have a significant impact on flora and fauna in the area.

## 3.11 CUMULATIVE IMPACTS

The proposed project is not expected to have a considerable cumulative effect upon the environment, or involve a commitment to larger activities. Upgrades to the Kahanahou WWPS and sewer mains will accommodate the modest population growth outlined in the Koolaupoko Sustainable Communities Plan and are consistent with the vision expressed and by the City and

County of Honolulu's low-density residential zoning in the area. The residential nature of the project area indicates that natural and cultural resources have already been altered from their original state. No threatened or endangered species are expected to be impacted by the proposed upgrades, and archaeological surveys and/ or monitoring will be implemented if required by SHPD.

The primary impacts of the proposed action would be short-term and occur during construction. Best management practices will be used to minimize and mitigate potential negative impacts such as noise, dust, traffic and erosion. Water quality may be temporarily impacted by construction activities, but BMPS will be employed to ensure that impacts are as minimal as possible. In the long-term, water quality will be improved by the proposed upgrades.

The proposed Kahanahou WWPS and sewer main upgrades are consistent with a broader City and County of Honolulu Wastewater Division strategy to maintain adequate wastewater management facilities in Kaneohe. Both the existing and proposed sewer systems flow to the Kaneohe Wastewater Preliminary Treatment Facility; therefore there will be no change in the amount of discharge to this downstream facility. Since the proposed sewer force main will no longer connect to the existing gravity main that discharges to the Waikapoki WWPS, the "Kahanahou Tributary" area will no longer flow to the Waikapoki WWPS. Therefore the Waikapoki WWPS will not need to be upgraded.

# 4. ALTERNATIVES TO THE PROPOSED PROJECT

This project consists of two components: (1) improvements to the Kahanahou WWPS, and (2) Replacement of the sewer force main. Each component went through its own engineering/design phase with a detailed report available describing the various routes, design parameters and mechanical alternatives (see Appendices A and B). The alternatives considered and basis for selecting the best alternative are summarized below.

### Alternative 1: Preferred Alternative

The preferred alternative consists of upgrading the existing WWPS and replacing the sewer force main as described in Section 2 of this report. After evaluation of four different alternatives for the WWPS and four alternative routes for the sewer force main, this option was chosen as the least intrusive, most cost-effective and efficient alternative to comply with the requirements of the consent decree.

### Alternative 2: No Action Alternative

The "no build" or "no action" alternative would consist of not making any of the proposed upgrades, resulting in no immediate impacts. However, since this project is aimed at reducing future environmental and public health impacts by increasing the safety and capacity of an aging sewer system, which is also required by the Consent Decree between the City and EPA, this is not a feasible option. The City is legally required to upgrade the WWPS.

### Alternative 3: Postponed Action Alternative

The "postponed action" alternative would consist of postponing any of the proposed upgrades until a future date. As with the "no action" alternative, this would increase the risk of future wastewater spills and resulting environmental and public health problems. As set forth in the Consent Decree, EPA requires the City to upgrade its system within the specified timeline (2020). Postponing the construction could result in not meeting this deadline.

### Alternative 4: Alternate Locations/ Designs

a) Pump Station

The purpose of the pump station upgrade is to eliminate future sanitary sewer overflows by increasing the capacity of the pump station to meet future projected peak flow rates and increase pump station reliability. The engineering report ("Design Alternatives Report", see Appendix A) for the pump station evaluates four serious different engineering alternatives, one of which is the "no action" alternative. As discussed above, this is not feasible. The three remaining alternatives were all of a mechanical/engineering nature consisting of engineering details of the pumps themselves within the footprint of the existing building. Therefore, none of these alternatives would have a different impact on the environment as is the focus of this Environmental Assessment. However, the three alternative designs are summarized briefly as follows. Table 6-1 in the DAR shows an evaluation matrix that was used to select the best alternative.

The chosen alternative ("Alternative 4" in the DAR) involves the installation of new constant speed dry pit submersible pumps at a capacity of 0.79 mgd with one pump operating at 47 feet total dynamic head. The dismissed "Alternative 2" would have involved the installation of new constant speed dry pit submersible pumps with VFDs at a capacity of 0.90 mgd per pump at 55.5 feet total dynamic head. The dismissed "Alternative 3" would have also involved the installation of constant speed dry pit submersible pumps with a capacity of 0.90 mgd at 55.5 feet total dynamic head, but with soft starters instead of VFDs. All three alternative designs are expected to have the same environmental impacts as they only involve details of the pumping mechanism itself. The alternatives went through a rigorous cost-benefit evaluation based on six different criteria: life cycle cost, operator preferences, satisfaction of design objectives, adverse short-term impacts, adverse long-term impacts, and adequacy of addressing existing deficiencies. Alternative 4 was chosen based on this evaluation for meeting the requirements at the lowest cost with the fewest negative long-term impacts.

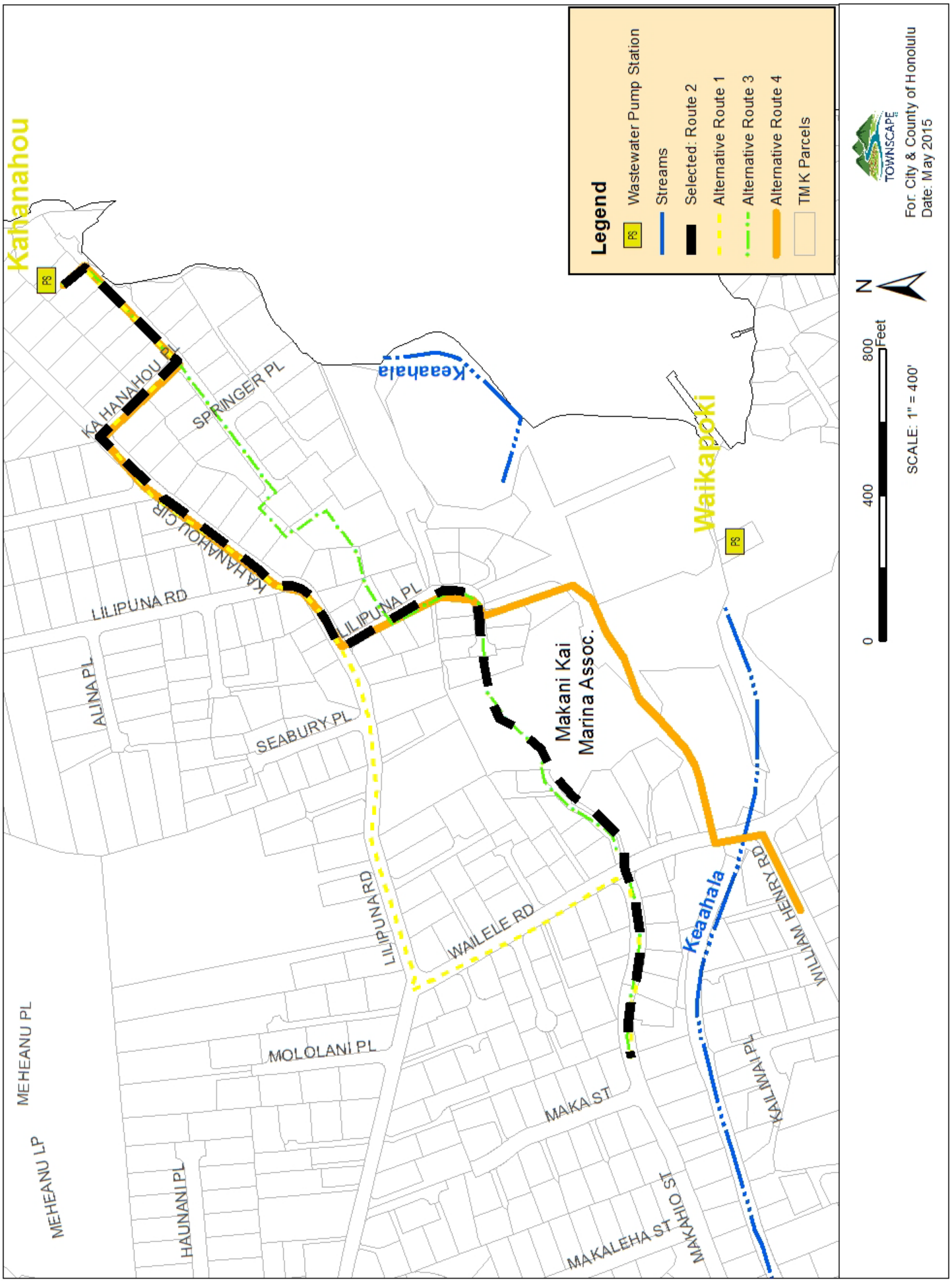
b) Sewer Force Main

The engineering report for the force main considered four different route alternatives (see Figures 9-13 in this EA). They all started at the Kahanahou WWPS and ran southwesterly, connecting to a manhole and then splitting into various directions. Route 2 was the chosen alternative due to avoiding problematic areas discovered along the other alignments and avoiding crossing of private properties, thus lessening the impacts on the neighborhood. The other three dismissed alignments and reasons for dismissal are summarized as follows:

Route 1 (Figure 10) consisted of a force main running west along Kahanahou Circle and Lilipuna Road until it reached a high point, then beginning as a gravity main down Wailele Road until Makahio Street, turning west and connecting to an existing manhole. This route was dismissed because the total dynamic head of over 100 feet exceeds the requirements in the City's Design Standards.

Route 3 consisted of a force main running west through a number of private properties and ending at the existing sewer manhole on Makahio Street (Figure 12). This route was dismissed due to narrow space along certain areas of the proposed alignment. This route also crossed the greatest number of private properties, making it the most difficult to implement. Avoidance of private properties is desired per City Design Standards.

Route 4 was an early version of the proposed alignment, consisting of a force main running west along Kahanahou Circle, turning south along Lilipuna Place and through some private properties, transiting a bridge on Wailele Road and connecting to an existing sewer manhole on William Henry Road. This route was dismissed due to potential impacts on an existing rock retaining wall and recently installed pond, as well as complications regarding the bridge crossing and the manhole connection.


Legend
Wastewater Pump Station
Streams
Selected: Route 2
Alternative Route 1
Alternative Route 3
Alternative Route 4
TMK Parcels
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Waikapoki
Keaahala
Makani Kai Marina Assoc.
KAHANAHOU PL
SPRINGER PL
KAHANAHOU CIR
LILIPUNA RD
LILIPUNA PL
ALINA PL
SEABURY PL
WAILELE RD
MOLOLANI PL
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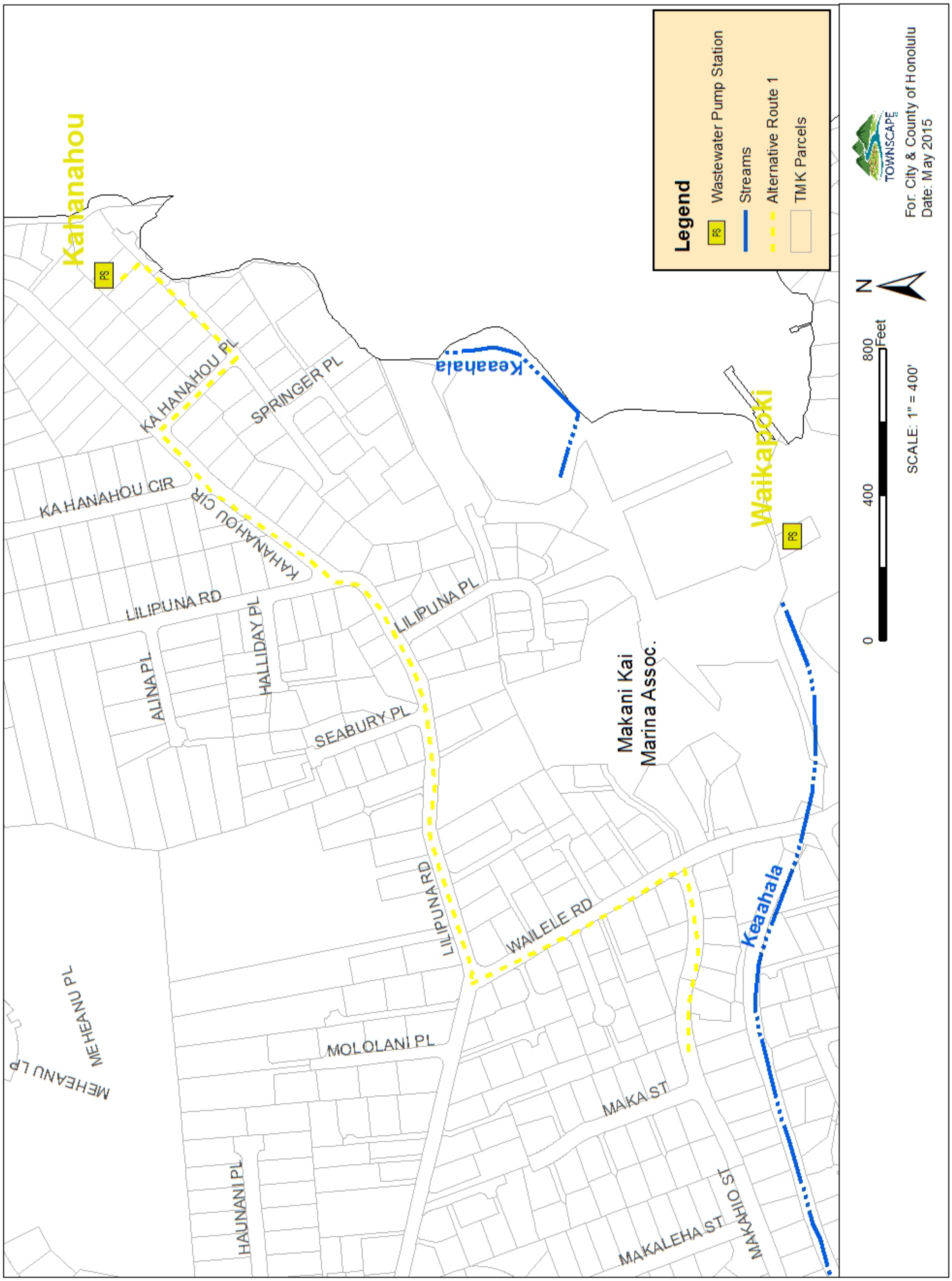
For: City & County of Honolulu
Date: May 2015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For: City & County of Honolulu
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SPRINGER PL
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HALLIDAY PL
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SEABURY PL
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WAILELE RD
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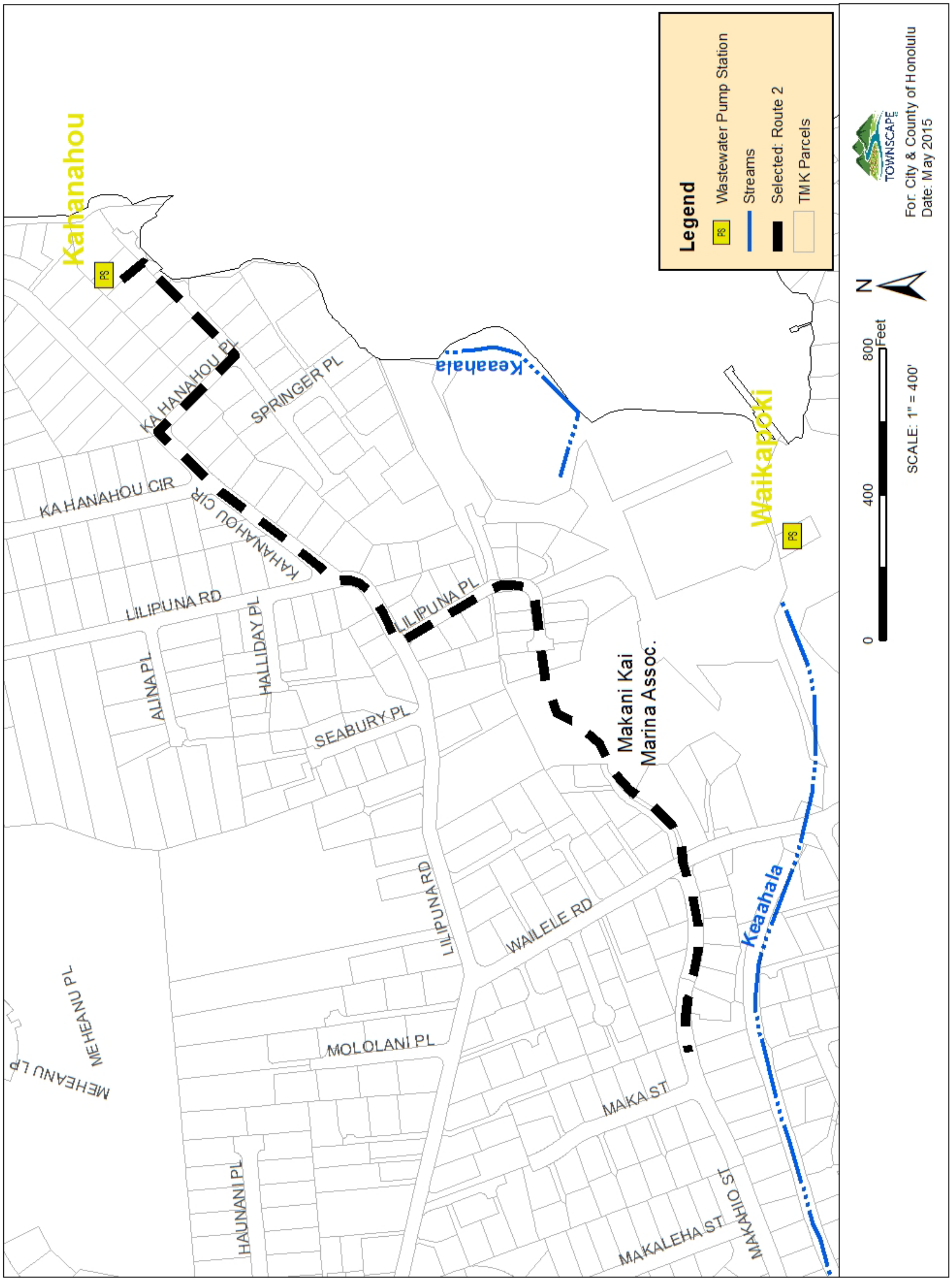
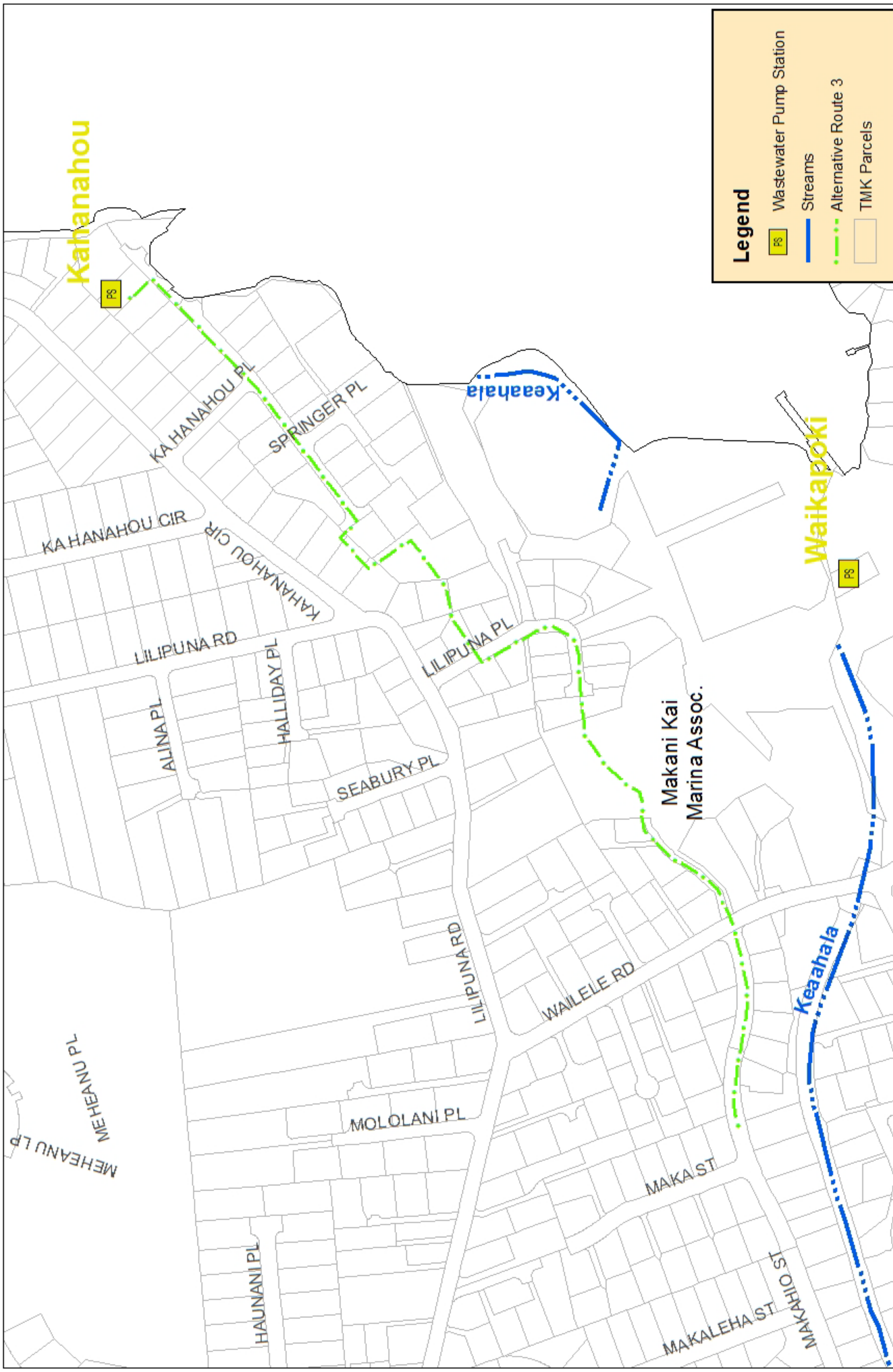
HAUNANI PL
MAKALEHA ST
MAKAHIO ST


Legend
Wastewater Pump Station
Streams
Selected: Route 2
TMK Parcels
For: City & County of Honolulu
Date: May 2015
SCALE: 1" = 400'
0
400
800
Feet
N
Kahanahou
Waikapoki
Keaahala
Makani Kai Marina Assoc.
KA HANAHOU PL
KA HANAHOU CIR
SPRINGER PL
LILIPUNA RD
LILIPUNA PL
HALLIDAY PL
ALINA PL
SEABURY PL
WAILELE RD
MOLOLANI PL
MEHEANU PL
MEHEANU LP
MAKA ST
HAUNANI PL
MAKALEHA ST
MAKAHIO ST




KAHANAHOU WASTEWATER PUMP STATION
AND SEWER LINE UPGRADES
DRAFT ENVIRONMENTAL ASSESSMENT

**Figure 12 Alternative Route 3**


KAHANAHOU WASTEWATER PUMP STATION
AND SEWER LINE UPGRADES
DRAFT ENVIRONMENTAL ASSESSMENT

**Figure 13 Alternative Route 4**

# 5. RELATIONSHIP TO FEDERAL, STATE, AND COUNTY PLANS AND POLICIES

## 5.1 HAWAII STATE PLAN

The Hawaii State Plan, Chapter 226 of the Hawaii Revised Statutes (HRS), serves as a guide for the future long-range development of the State. The Plan, first adopted in 1978, identifies the goals, objectives, policies, and priorities for the State. The proposed project is in compliance with and directly supports multiple objectives and policies of the plan by decreasing the risk of sewage spills and protecting environmental and cultural resources. The most relevant sections of the plan in relationship to the proposed project are listed below:

- §226-13 Objectives and policies for the physical environment--land, air, and water quality.
  (a)(1) Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.

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

- §226-14 Objective and policies for facility systems--in general.
  (a) Planning for the State's facility systems in general shall be directed towards achievement of the objective of water, transportation, waste disposal, and energy and telecommunication systems that support statewide social, economic, and physical objectives.

  (b) To achieve the general facility systems objective, it shall be the policy of this State to:
    (1) Accommodate the needs of Hawaii's people through coordination of facility systems and capital improvement priorities in consonance with state and county plans.
    (2) Encourage flexibility in the design and development of facility systems to promote prudent use of resources and accommodate changing public demands and priorities.
    (3) Ensure that required facility systems can be supported within resource capacities and at reasonable cost to the user.
    (4) Pursue alternative methods of financing programs and projects and cost-saving techniques in the planning, construction, and maintenance of facility systems.
- §226-15 Objectives and policies for facility systems--solid and liquid wastes.
  (a) Planning for the State's facility systems with regard to solid and liquid wastes shall be directed towards the achievement of the following objectives:

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

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

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

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

## 5.2 HAWAII ADMINISTRATIVE RULES

The Hawaii Administrative Rules, Title 11, were developed and are enforced by the State Department of Health (DOH). Chapter 62 (finalized in 2004) outlines wastewater systems management to "ensure that the disposal of wastewater from water treatment works and individual wastewater systems:

1. Does not contaminate or pollute any drinking water or potential drinking water supply, or the waters of any beaches, shores, ponds, lakes, streams, groundwater, or shellfish growing waters;
2. Does not encourage the harborage of insects, rodents or other possible vectors;
3. Does not give rise to nuisances;
4. Does not become a hazard or potential hazard to public health, safety and welfare;
5. Contributes to the achievement of wastewater management goals contained in approved county water quality management plans;
6. Reinforces state and county planning policies; and
7. Are consistent with the State's administration of the National Pollutant Discharge Elimination System (NPDES)."

The proposed project will comply with the DOH 's HAR by increasing the capacity of the Kahanahou WWPS, thus reducing the risk of overflows; potential contamination of surrounding lands and waters; nuisance conditions; and potential health impacts. It will also comply with the City's Water Quality Management Plan (1990) and National Pollutant Discharge Elimination System Permit, which were developed with the goal of preserving, restoring, and maintaining water quality. The WWPS and force main upgrades will account for planned modest growth in the area, in alignment with the City's Koolau Poko Sustainable Communities Plan. The City's NPDES permit allows for the discharge of storm water runoff and certain non-storm discharges. Wastewater spills are not a permitted non-storm discharge. This project would reduce the risk of wastewater spills and overflows.

## 5.3 STATE LAND USE LAW, CONSERVATION DISTRICT USE PERMIT

The State Land Use Law, Chapter 205 of the Hawaii Revised Statutes (HRS), established the State Land Use Commission, which classifies all lands within the state into four land use districts: Urban, Rural, Agricultural and Conservation. The project area is within the Urban District; therefore a Conservation District Use Permit is not required.

## 5.4 STATE HISTORIC AND CULTURAL SITE REVIEW

Cultural Surveys Hawaii completed a Literature Review and Field Inspection (LRFI) report, which was submitted to the State Historic Preservation Division (SHPD) in January 2014 and is currently under review. The LRFI concluded that based on “the extensive land modification and the seemingly low likelihood of intact cultural deposits in any specific location, an archaeological inventory survey (AIS) of the project area (per the requirements of HAR §13-276) does not appear warranted for development within the project area.” However, an archaeological monitoring program is recommended with an archaeological monitor to be present during all subsurface excavations greater than 12 inches deep to “ensure [that] any subsurface cultural deposits and/or burials as may be present can be identified.” A monitoring program of on-site archaeological monitoring is recommended for all ground disturbance conducted within the project area below the existing ground surface to facilitate the identification and treatment of any historic properties and/or burials that might be discovered during project construction. Any departure from this will require consultation with and written concurrence from SHPD.

The SHPD is currently reviewing the LRFI. It is possible that one or more AIS test excavations could be placed in the open area of the private property near Wailele Street in an area of former land court awards. If recommended, an AIS - and any other actions required by the SHPD - will be completed prior to beginning construction work. Information regarding review of historic sites is presented in Section 3.9 of this Environmental Assessment.

## 5.5 HAWAII COASTAL ZONE MANAGEMENT PROGRAM

The Hawaii Coastal Zone Management (CZM) Program was enacted in 1977 by Chapter 205A of the Hawaii Revised Statutes. This program was created to coordinate federal, state and county agency efforts in the comprehensive management of Hawaii’s coastal resources. The Hawaii CZM Program is administered by the State Office of Planning. The four individual counties are responsible for administering the CZM program locally through the Special Management Area (SMA) Permit and Shoreline Setback Variance.

### 5.5.1 Special Management Area (SMA) Permit

SMA permits are administered by the City Department of Planning and Permitting (DPP). Portions of the proposed project area are within the SMA boundary. However, the SMA Permit does not regulate “installation of underground utility lines and appurtenant aboveground fixtures less than four feet in height along existing corridors”, unless the “cumulative impact of which may have significant environmental or ecological effect on the special management area…” (LUO Chapter 25, Section 1.3[2][M]). DPP confirmed that the project is exempt from SMA requirements pursuant to Exemption Class #2 (Item 8) of the Department of Environmental Services Comprehensive Exemption List (See Appendix F).

### 5.5.2 Shoreline Setback Variance

HRS 12-222 defines the shoreline as “the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth.” A small portion of the project area along Kahanahou Place near the Kahanahou WWPS is within the shoreline setback area. Any proposed construction within the shoreline setback requires review and granting of a variance. In accordance with LUO Section 23-1.8(b)(2), the Director may grant a variance if the proposed construction meets the Public Interest Standard:

> *A variance may be granted for an activity or structure which is undertaken by a public agency or by a public utility regulated under HRS Chapter 269…; provided that the proposal is the practicable alternative which best conforms to the purpose of this chapter and the shoreline setback rules. Public interest shall mean principally of benefit to the general public, as determined by the director.*

A Shoreline Setback Variance will be applied for with the City DPP Land Use Permits Division.

## 5.6 CITY AND COUNTY OF HONOLULU GENERAL PLAN

The General Plan sets forth the long-range objectives and policies for the general welfare and prosperity of the people of Oahu. The proposed project is in compliance with the applicable objectives and policies, which are listed below:

**Transportation and Utilities**

- Objective B: To meet the needs of the people of Oahu for an adequate supply of water and for environmentally sound systems of waste disposal.
  - Policy 5: Provide safe, efficient, and environmentally sensitive waste-collection and waste disposal services.
- Objective C: To maintain a high level of service for all utilities.
  - Policy 2: Provide improvements to utilities in existing neighborhoods to reduce substandard conditions.
  - Policy 3: Plan for the timely and orderly expansion of utility systems.

- Objective D: To maintain transportation and utility systems which will help Oahu continue to be a desirable place to live and visit.
  - Policy 1: Give primary emphasis in the capital improvement program to the maintenance and improvement of existing roads and utilities.

## 5.7 KOOLAU POKO SUSTAINABLE COMMUNITIES PLAN

Oahu is divided into eight planning areas, each of which has a Development Plan or Sustainable Communities Plan adopted by City Council ordinance. The Koolau Poko Sustainable Communities Plan dated August 2000 designates the project area as *low density residential land use*, projected to have limited future population growth. The proposed Kahanahou WWPS upgrades are consistent with maintaining a low-density residential neighborhood in that it is designed to accommodate only a moderate increase in population and it does not oversize its capacity.

## 5.8 KANEOHE BAY MASTER PLAN

Pursuant to Act 208, Session Laws of Hawaii 1990, the Legislature established the Kaneohe Bay Master Planning Task Force to develop a comprehensive master plan for Kaneohe Bay (KBMPTF, 1992). The Kaneohe Bay Master Plan (KBMP) was developed through extensive public participation with the assistance of a Kaneohe fisherman, a commercial recreation businessperson, representatives from neighborhood boards and State agencies, as well as non-voting representatives of the KMCAS and the City and County of Honolulu.

In their development of the Master Plan, the Task Force stated the following land use positions that impact the proposed project:

1. Mitigate deteriorating water quality in key watersheds by installing pollution prevention measures.
2. Restrict development in the watershed in accordance with the Koolau Poko Development Plan. Limit development where a sewage collection system does not exist, and restrict use of septic individual waste water systems to residential lots with sufficient size (15, 000 square feet or more) for proper disposal.
3. Delay northward extension of the sewage collection system until existing infrastructure deficiencies are rectified. Repair and upgrade the existing sewage collection system to prevent by-passes of raw or partially treated sewage effluent into the Bay and to prevent sewage infiltration through groundwater to the Bay.

The planned improvements to the Kahanahou WWPS and force main respond to the above objectives and policies of the Master Plan. The project will help prevent sewage from leaking into surface waters and Kaneohe Bay, thus maintaining water quality and addressing decifiencies in the existing sewage collection system. Undeveloped areas will be able to connect to the Kahanahou tributary eliminating the need for individual wastewater systems.

## 5.9 FLOOD DISTRICT REGULATIONS

The project is located within FEMA Flood Zone X, outside of the 500-year floodplain. The National Flood Insurance Program, administered by the State Department of Land and Natural Resources Engineering Division, does not regulate developments within Zone X.

## 5.10 SPECIAL DISTRICTS

The project is not located within any special district as identified in Chapter 21, Article 9 Special District Regulation of the Revised Ordinances of Honolulu: Hawaii Capitol, Diamond Head, Punchbowl, Chinatown, Thomas Square/Honolulu Academy of Arts, Waikiki, and Haleiwa.

## 5.11 KANEOHE TOWN PLAN (2009)

The Kaneohe Town Plan (2009) planning area includes the neighborhood where the Kahanahou WWPS and force main replacement is proposed. However, the Plan focuses on five areas that exclude the Kahanahou project area: Windward Mall, the Civic Center Neighborhood Park, Windward City Shopping Center, Windward Community College, and the Bay View Golf Course. The vision articulated by this plan is:

*"The Kaneohe Town Center is a gathering place that it accessible,*
*conveniently located, safe, and open to all.*
*It captures and reflects the beauty of Kaneohe and the surrounding*
*Koolau Mountains and Kaneohe Bay.*
*It is both a resource and a place of diverse services and activities for residents and visitors,*
*and attracts a wide range of people that range in age from the very young to the elderly.*
*It incorporates the distinctive community culture (i.e. caring, local, small scale, friendly)*
*and strengthens the spirit of aloha that is Kaneohe."*

The Kahanahou WWPS Sewer Force Main Upgrades would help to protect the beauty of Kaneohe by protecting against sewer overflows and should not negatively impact the vision for Kaneohe as expressed by the Kaneohe Town Plan. The Kaneohe Town Plan had no other specific proposals for the project area or its immediate vicinity.

## 5.12 CITY AND COUNTY OF HONOLULU ZONING

The Kahanahou WWPS and the existing sewer force main are located in the City and County of Honolulu residential district R-10. Portions of the proposed force main pass through residential district R-5 and R-7.5. The proposed improvements to the Kahanahou WWPS and sewer mains are part of a project constituting "public use" under the City and County of Honolulu Land Use Ordinance (LUO), which may occur in any zoning district. The proposed emergency generator building will fall within the 30-foot front yard setback requirement.

# 6. PERMITS AND APPROVALS

## 6.1 CITY AND COUNTY OF HONOLULU PERMITS

- Permit to Discharge Effluent

  *Department of Environmental Services*
- Special Management Area (SMA) Use Permit: EXEMPT

  *Department of Planning and Permitting (DPP)*
- Shoreline Setback Variance

  *Department of Planning and Permitting*

  *State Surveyor and Department of Land and Natural Resources (certification of a map of the shoreline and shoreline setback line)*
- Sewer Connection Application

  *Department of Planning and Permitting*
- Trenching Permit

  *Department of Planning and Permitting*
- Grading and Grubbing Permit

  *Department of Planning and Permitting*
- Street Usage Permit

  *Department of Transportation Services (DTS)*
- Zoning Waiver for front yard setback

  *Department of Planning and Permitting*

## 6.2 STATE OF HAWAII PERMITS

- Chapter 6E, Hawaii Revised Statues Review – archaeological monitoring plan approval and archaeological inventory survey (if required)

  *Department of Land and Natural Resources, State Historic Preservation Division*
- National Pollutant Discharge Elimination System (NPDES) permit

  *Department of Health*
- Community noise permit and noise variance

  *Department of Health*
- HRS 130-50 Document Transmittal Form

  *Disability and Communication Access Board*

# 7. DETERMINATION

Based on the analysis of information in this EA, the proposed project is not anticipated to have significant impacts to the natural, built, or social environment. Therefore, it is anticipated that a Finding of No Significant Impact (FONSI) will be issued and that an Environmental Impact Statement (EIS) is not required.

## 7.1 FINDINGS AND REASONS SUPPORTING THE DETERMINATION

The potential effects of the proposed project are evaluated based on the significance criteria identified in the Hawaii Administrative Rules, Section 11-200-12. The following is a summary of the potential effects of the project.

1. **Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.**
   The project is not expected to involve an irrevocable commitment to loss or destruction of any natural or cultural resource. The project proposes to install a force main in areas that have been previously disturbed by utility lines, residential development, or road construction. Additional proposed work is to take place within an existing pump station facility and will not extend the footprint of the facility. There are no significant biological resources in the area and recommendations by the SHPD will be followed to protect cultural resources, should any be discovered during construction.

2. **Curtails the range of beneficial uses of the environment.**
   The project will not permanently curtail the beneficial uses of the environment. The proposed pipe replacement will be located underground, mostly within existing public roadways. Pump station upgrades will happen within an existing City property and facility.

3. **Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.**
   The project will be in conformance with Chapter 344, HRS. The proposed project will increase the capacity of the Kahanahou WWPS and force main and reduce the flow through the existing gravity main servicing the Waikapoki tributary area 1. This is anticipated to reduce the risk of future wastewater spills.

4. **Substantially affects the economic or social welfare of the community or state.**
   The project is not anticipated to have significant effects on the economic and social welfare of the community or state other than providing an improved wastewater system that would benefit the community it services.

5. **Substantially affects public health.**
The project will improve WWPS and force main reliability and is not anticipated to have any adverse effects on public health. Rather, it will have a positive impact on public health by reducing the risk of future wastewater spills.

6. **Involves substantial secondary impacts, such as population changes or effects on public facilities.**
The project is not anticipated to result in substantial secondary impacts. The project is designed only to prevent overflows and accommodate the modest population increase projected in the Koolaupoko Sustainable Communities Plan.

7. **Involves a substantial degradation of environmental quality.**
The project is not anticipated to degrade environmental quality; it is anticipated to protect environmental quality by preventing sewer overflows.

8. **Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.**
The project is not anticipated to result in cumulative effects or involve a commitment for larger actions. In fact, it will reduce the demands on another existing facility and will therefore help reduce the need for additional actions.

9. **Substantially affects a rare, threatened, or endangered species, or its habitat.**
The project is not anticipated to affect any rare, threatened, or endangered species or habitat. There are no known significant biological resources in the project area.

10. **Detrimentally affects air or water quality or ambient noise levels.**
The project is not anticipated to affect long term air quality, water quality, or ambient noise levels. The project may temporarily affect air, water, or noise quality during construction but BMPs will be implemented to minimize any impacts.

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, fresh water, or coastal waters.**
The project is located within the Special Management Area and a portion of the proposed force main is within the Shoreline Setback Area. However, the force main will be located underground and is not anticipated to be impacted by a tsunami. Appropriate permits and variances will be obtained for the SMA and shoreline setback. Best management practices will be used during construction to minimize any impacts on coastal waters. The WWPS is not located within the Tsunami zone or Shoreline Setback Area.

12. **Substantially affects scenic vistas and viewplanes identified in county or state plans or studies.**
    The project will not affect any scenic vistas or view planes identified in county or state plans or studies because most of the upgrades will be underground. Above-ground work will not change the height of the existing building or otherwise substantially affect viewplanes.

13. **Requires substantial energy consumption.**
    The project will not require substantial energy consumption. A slight increase in energy use for the new pumps will be easy to accommodate by the existing HECO system and backup generators.

# 8. REFERENCES


City and County of Honolulu, Department of Environmental Services. *Storm Water Best Management Practice Manual – Construction* (November 2011)

City and County of Honolulu, Department of Planning and Permitting. *Revised Ordinances of Honolulu (ROH) Chapter 21. Land Use Ordinance* (1990).

City and County of Honolulu. *Oahu General Plan* (2002).

City and County of Honolulu. *Koolau Poko Sustainable Communities Plan* (2000).

Okahara and Associates, Inc. *Preliminary Engineering Report for Kahanahou Wastewater Pump Station Force Main Sewer Line Study* (October 2013).

State of Hawaii. *Hawaii Administrative Rules. Chapter 11-54 Water Quality Standards*. pp. 54-13. (October 2012)

State of Hawaii. *Hawaii Revised Statutes*.

State of Hawaii Department of Health (DOH), Clear Air Branch. *Annual Summary of the 2011 Hawaii Air Quality Data*. (2012)

State of Hawaii Office of Planning. *Geographic Information System (GIS) Data Downloads* http://planning.hawaii.gov/gis/download-gis-data/. Accessed November 2013.

United States Department of Agriculture (USDA) Soil Conservation Service. *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. (1972).

# Kahanahou Wastewater Pump Station and Sewer Force Main Upgrades Kaneohe, Oahu

# DRAFT ENVIRONMENTAL ASSESSMENT

# *APPENDICES*

A Preliminary Design Alternatives Report for Kahanahou Wastewater Pump Station Upgrade (Okahara and Associates, Inc., January 2011)

B Final Engineering Report - Kahanahou Wastewater Pump Station Force Main Sewer Line Study, Kaneohe, Oahu, Hawaii (Okahara and Associates, Inc., December 2013, Revised June 2015)

C Digital Flood Insurance Map (DFIRM) (Federal Emergency Management Agency, 2013)

D Pre-Environmental Assessment Consultation

E Literature Review and Field Inspection Report (LRFI) (Cultural Surveys Hawaii, Inc., January 2014)

F Special Management Area Determination Letter (City and County of Honolulu Department of Planning and Permitting, March 2010)

**Prepared for:**
**CITY AND COUNTY OF HONOLULU**
**Department of Design and Construction**
**Wastewater Division**

**August 2015**

**Prepared by:**
**Townscape, Inc.**

# Appendix A

Preliminary Design Alternatives Report for Kahanahou Wastewater Pump Station Upgrade

Okahara and Associates, Inc., January 2011

# PRELIMINARY DESIGN ALTERNATIVES REPORT

# FOR

# KAHANAHOU WASTEWATER PUMP STATION UPGRADE

**Prepared for :**

**City and County of Honolulu**
**Department of Design and Construction**
**Wastewater Division**
**650 South King Street**
**Honolulu, Hawaii 96813**

**Prepared By:**

**Okahara and Associates, Inc.**
**677 Ala Moana Boulevard, Suite 703**
**Honolulu, Hawaii 96813**

**JANUARY 2011**

# TABLE OF CONTENTS

## CHAPTER 6 – EVALUATION OF ALTERNATIVES AND OPTIONS



## CHAPTER 7 – RECOMMENDATIONS



## APPENDIX

## LIST OF CHARTS, TABLES AND FIGURES

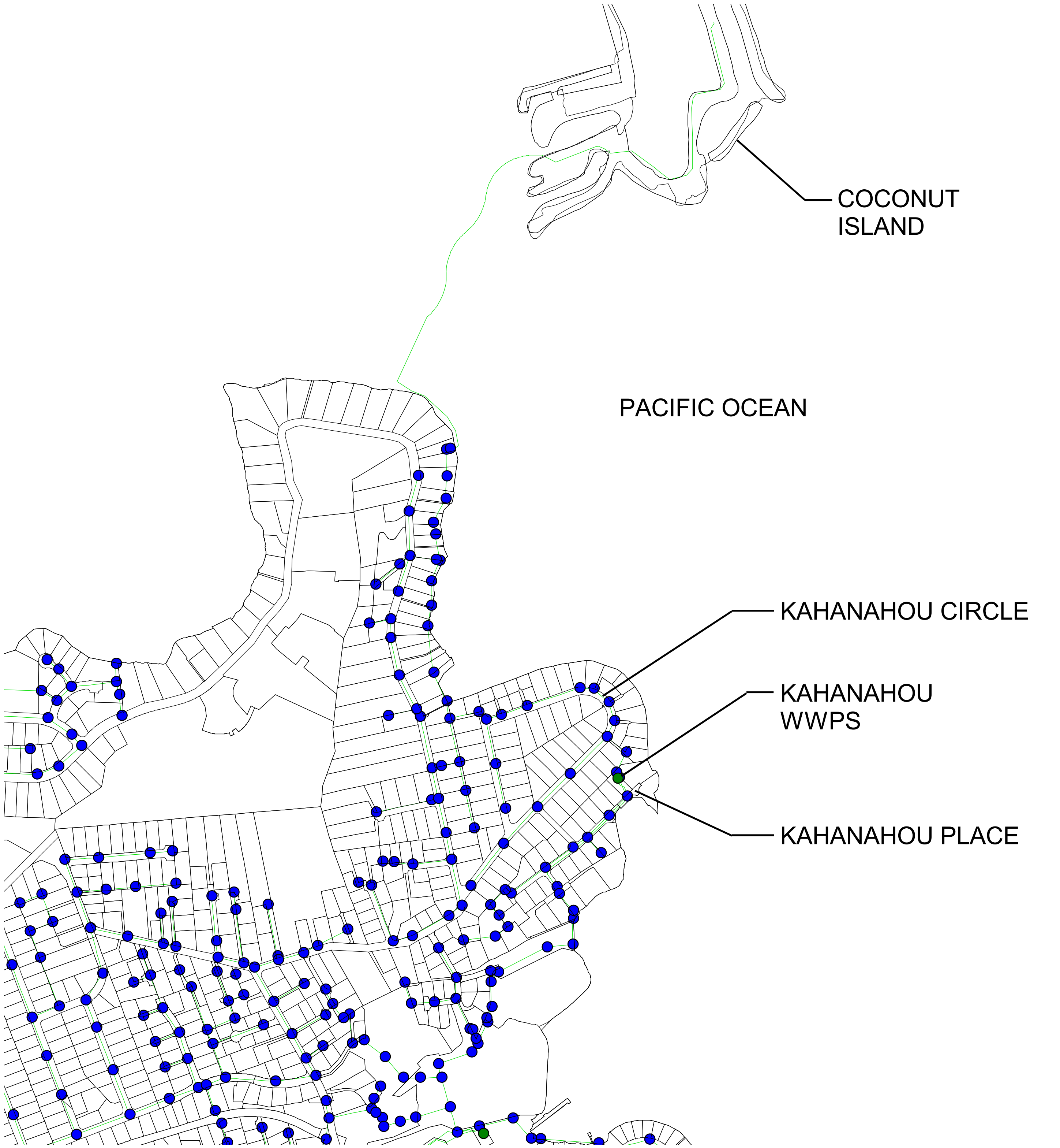
# CHAPTER 1 – EXECUTIVE SUMMARY

The City and County of Honolulu (City) Wastewater Division, Department of Design and Construction (DDC), proposes to correct hydraulic deficiencies with the Kahanahou Wastewater Pump Station (WWPS) identified in the "*Sewer Rehabilitation and Infiltration and Inflow Minimization Study, Volume 3 of 9, Kailua-Kaneohe I/I Engineering Report*", December 1999. The intent of this Design Alternatives Report (DAR) is to identify and evaluate hydraulic as well as structural, architectural, mechanical and electrical related problems with the WWPS, assemble basic information about the facility, present the results of field investigations, analyze and evaluate the results, and propose alternatives to address identified problems. The report is broken down into several chapters including Pump Station, Structural, Architectural, Electrical, Evaluation of Alternatives and Recommendations.

The facility is located at 45-13 Kahanahou Place, Kaneohe, Koolaupoko District, between Kahanahou Circle and Kahanahou Place, TMK 4-5-047:095. See Figure 1-1 for a project map of the area, and Figure 1-2 for a site plan of the facility.

Kahanahou WWPS was constructed and put into service in 1966 with two (2) constant speed pumps rated at 460 gallons per minute (gpm) @41 feet total dynamic head (TDH). The WWPS was retrofitted in 2006 with a new ball valve assembly and vault, and new replacement high density poly-ethylene (HDPE) force main. The existing cast iron force main was abandoned in place and the new WWPS capacity was revised to 510 gpm @41 feet TDH.

Due to suspected high levels of infiltration/inflow, the WWPS has been determined to be undersized based on historical flow data. The required pumping capacity for each of the two pumps is approximately 0.90 million gallons per day (mgd), or 625 gpm @53 feet TDH. This project to increase the hydraulic capacity of the WWPS was recommended in the "*Final Sewer I/I Plan*", December 1999, which was




**LEGEND:**

Sewer pipes

Existing Wastewater Pump Stations

Existing Manholes

**Kahanahou WWPS Upgrade**
**Design Alternative Report**

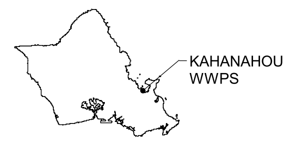
# Figure 1-1

Department of
Design & Construction

N

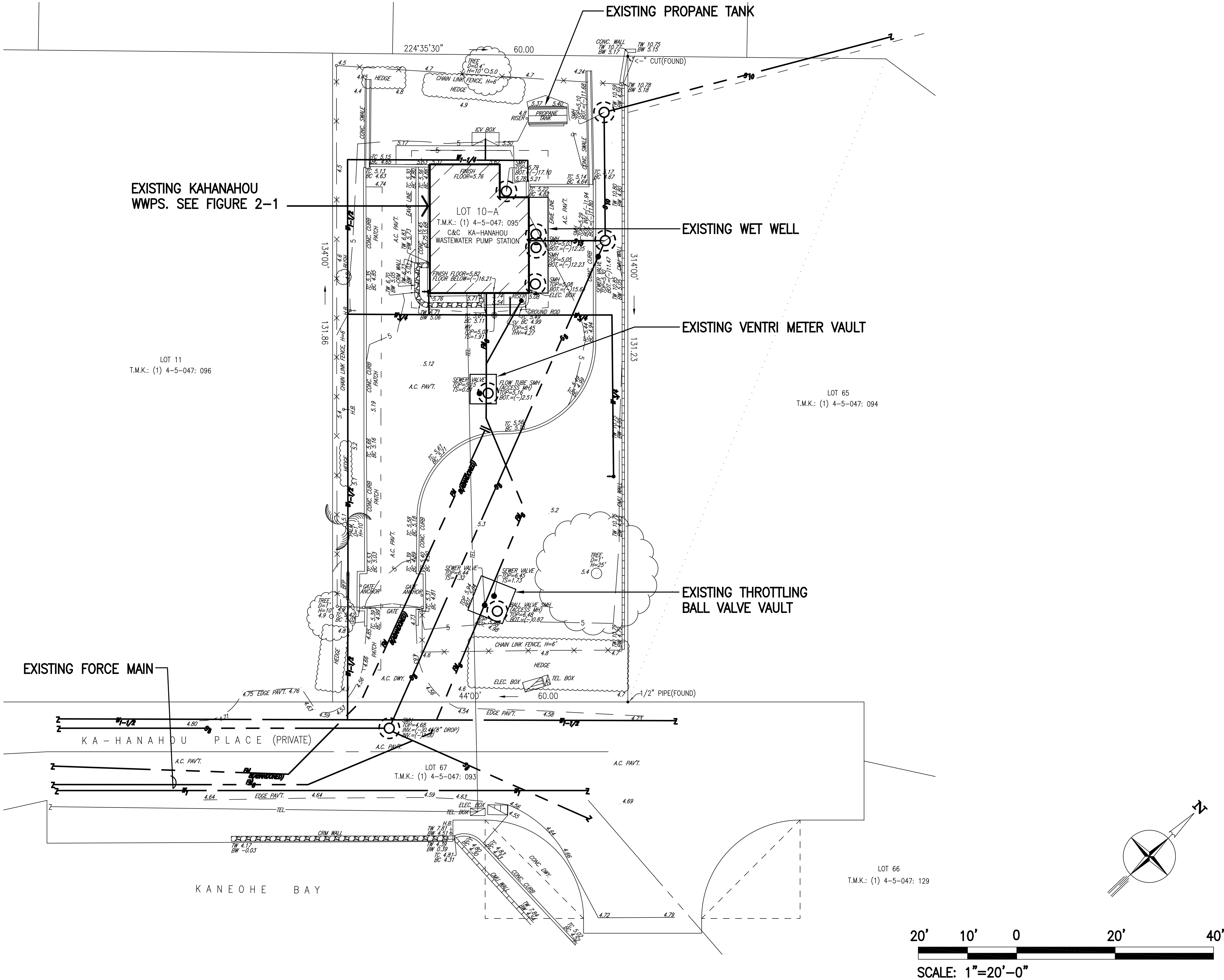
SCALE: 1" = 750'

**PROJECT MAP**




Wastewater Division

Date: January 2011




DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

# KAHANAHOU WASTEWATER PUMP STATION UPGRADE

KANEOHE, OAHU

PAGE 1-3

FIGURE 1-2

DATE JAN 2011

JOB NUMBER 2009107

## EXISTING SITE PLAN

SCALE: 1" = 20'-0"

OKAHARA AND ASSOCIATES, INC.

DESCRIPTION

JI/D:\PROJ\21002\REPORT\FIG 1-SITE.DWG/1=240/12-19-10/XREF=OA1117,x-10122 submitted to the USEPA as a requirement of consent decree CIV. No. 94-00765 DAE.

Four alternatives were investigated to increase the pumping capacity of Kahanahou WWPS. The estimated construction costs of the alternatives range from $0 for no action to $3,076,00 to replace the existing pumps with variable frequency driven submersible pumps. The recommendation of this report is to implement and proceed with Alternative No. 4. Alternative No. 4 calls for the replacement of the existing pumps with new larger capacity constant speed submersible pumps. Alternative No. 4 is estimated will cost approximately $2,959,000 to construct.

# CHAPTER 2 – PUMP STATION

## 2.1 INTRODUCTION

The intent of this project is to correct hydraulic deficiencies with the Kahanahou WWPS identified in the "*Sewer Rehabilitation and Infiltration and Inflow Minimization Study, Volume 3 of 9, Kailua-Kaneohe I/I Engineering Report*", December 1999. The intent of this DAR is to identify and evaluate hydraulic as well as structural, architectural, mechanical and electrical related problems with the WWPS, assemble basic information about the facility, present the results of field investigations, analyze and evaluate the results, and propose alternatives to address identified problems with preliminary layouts and opinions of probable construction cost. The intent of this report does not include addressing deficiencies with the sewer collection system located upstream or downstream of the WWPS.

The Pump Station chapter is broken down into the following four (4) subchapters:

- Existing Pump Station Description: This subchapter describes the major components of the existing WWPS.
- Research and Analysis: This subchapter summarizes the findings of field investigations and background research. It also presents an evaluation of the existing WWPS and force main as to their condition, capacity and constraints.
- Flow Analysis: This subchapter presents historical flow data and flow rate projections. DAR flow projections considered the results of INFIX, a City approved sewer flow modeling computer program, and an analysis of historical sewer flow data.
- Design Alternatives: This subchapter describes alternatives that are presented for consideration. It also describes alternatives that were dismissed and reasons for the dismissal.

## 2.2 EXISTING PUMP STATION DESCRIPTION

Kahanahou WWPS is comprised of a wet well, a dry well, two (2) separately coupled solids handling pumps with extension shafts, a mechanical ventilation system, an electrical system, controls and a propane fueled standby engine generator. The wet well interior measures approximately 21'-4" long by 8'-0" wide by 10'-0" high. The wet well is divided into two sections and are separated with isolation stop gates. A single 15-inch vitrified clay pipe (VCP) delivers influent sewage into the wet well via a gated distribution box. The dry well interior measures approximately 21'-4" long by 11'-6" wide and is mechanically ventilated. It has one (1) 1/4 horsepower sump pump rated for 25 gpm @18 feet TDH. Two (2) 10 horsepower, separately coupled, solids handling pumps with extension shafts rated for 510 gpm @41 feet TDH are located in the dry well and provide approximately 30.2 to 32.2 feet of lift depending on the wet well water level. The low water and high water level elevation set points are (-)13.50 and (-)11.50 feet respectively. Each pump has a 6" diameter suction connection, 8" diameter suction lateral, 4" diameter discharge connection, 6" diameter discharge lateral, inlet bell, valves and appurtenances. Both pumps are connected to an 8" diameter discharge header, venturi meter and force main.

## 2.3 RESEARCH AND ANALYSIS

Extensive research was undertaken to determine the condition of the existing WWPS, force main and equipment. Record drawings, associated design reports and Wastewater records were reviewed to ascertain the intended design of the WWPS. Wastewater Division personnel with DDC and the Department of Environmental Services (ENV), including Collection System Maintenance (CSM) and Treatment & Disposal (T&D), were consulted to verify and confirm conditions reported by reference drawings or by Wastewater Division personnel.

### 2.3.1 Existing Pump Station & Level Elevation Set Points

Copies of the original WWPS design approved in 1964 as well as improvements completed in 2007 were used to evaluate the existing WWPS conditions. Field visits were conducted to photograph and visually verify the existing WWPS conditions as shown on the design drawings. The WWPS piping configuration was found to be similar to the one shown on the design drawings. See Figures 2-1, 2-2, 2-3 and 2-4 for the existing WWPS plan and sections based on a combination of field measurements and reference drawings.

A review of on-site placards, Supervisory Control and Data Acquisition (SCADA) digital display and the O&M manual suggest that the pump level control set points were altered from the original design. The original design called for a high water level of (-)11.50 feet and a low water level of (-)14.50 feet. The placard mounted on the wall calls for a high water level of (-)11.50 feet and a low water level of (-)13.50 feet. The SCADA display indicated the lead pump started at a high water level of (-)11.28 feet and stopped at a low water level of (-)13.68 feet. It is postulated that the low wet well level elevation set point was raised such that it is higher than the top of the pumps' stuffing box to prevent the loss of prime. See Table 2-1 for a summary of operating and alarm elevations.

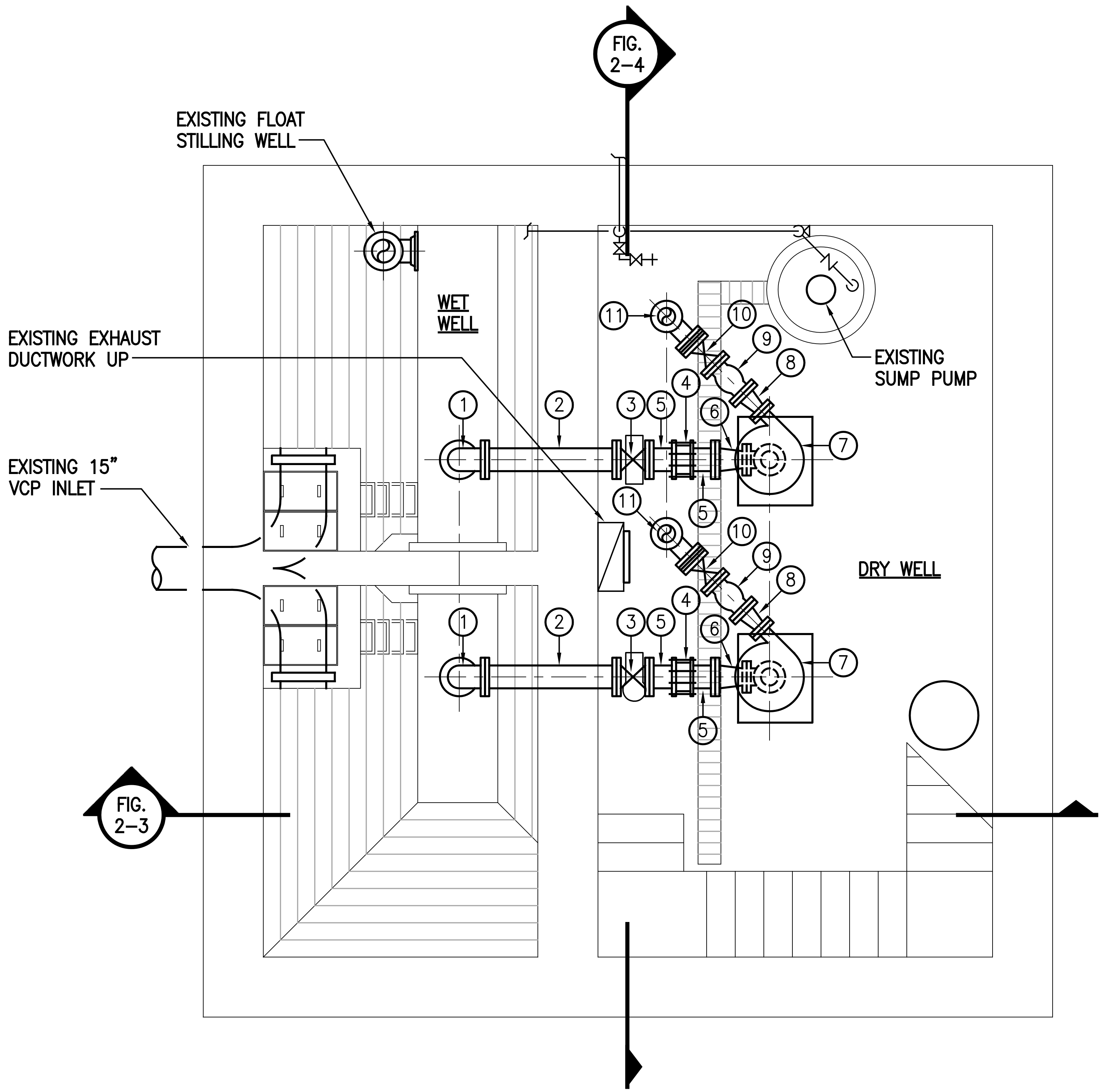
**Table 2-1: Operating and Alarm Elevations**

| Settings | Original Design Elevations[1] | Revised Elevations[2] | SCADA Elevations[3] |
|---|---|---|---|
| High Water Alarm | (-)9.25 | (-)8.75 | None Observed |
| Pump 2 On | (-)9.75 | (-)9.00 | None Observed |
| Pump 2 Off | (-)14.50 | (-)11.00 | None Observed |
| Pump 1 On | (-)11.50 | (-)11.50 | (-)11.28 |
| Pump 1 Off | (-)14.50 | (-)13.50 | (-)13.68 |
| Low Water Alarm | (-)15.50 | (-)15.50 | None Observed |

[1]Original design elevations are based on Kahanahou Sewage Pumping Station & Force Main, City Job No. 63-63 Final design drawings dated 1964.

[2]Revised elevations are based on Operating and Alarm Elevations posted at the WWPS and in the "*Kahanahou Wastewater Pump Station, Volume I of II Operating Instructions"*, February 1997. Note that the identical lead lag pump elevations were taped on the existing Healy Ruff float switch housing.

[3]SCADA elevations are based on observed readouts on the SCADA panel display. Observations were made on June 10, 2010.




EXISTING BASEMENT PLAN

SCALE: 1/4" = 1'–0"

| MATERIAL LIST | |
|---|---|
| ITEM NO. | DESCRIPTION |
| 1 | EXIST. 8" – 90° BEND, FLANGE AND BELL |
| 2 | EXIST. 8" – PIPE SPOOL, FE |
| 3 | EXIST. 8" – GATE VALVE, FE |
| 4 | EXIST. 8" – FLEXIBLE COUPLING |
| 5 | EXIST. 8" – PIPE SPOOL, FExPE |
| 6 | EXIST. 8"x6" – ECCENTRIC REDUCER, FE |
| 7 | EXIST. PATTERSON, MODEL FFN, SOLIDS HANDLING PUMP |
| 8 | EXIST. 6"x4" – ECCENTRIC REDUCER, FE |
| 9 | EXIST. 6" – CHECK VALVE W/ WEIGHT, FE |
| 10 | EXIST. 6" – GATE VALVE, FE |
| 11 | EXIST. 6" – LR BASE BEND, FE |
| 12 | EXIST. 6" – PIPE SPOOL, FE |
| 13 | EXIST. 6" – 45° BEND, FE |
| 14 | EXIST. 8"x8"x6" – WYE, FE |
| 15 | EXIST. 8" – PIPE SPOOL, FE/BE |
| 16 | EXIST. 8"x6" – REDUCER, FE |
| 17 | EXIST. 6" – PIPE SPOOL, FE |
| 18 | EXIST. 6" – 90° BEND, FE |
| 19 | EXIST. 10 HP MOTOR |
| 20 | EXIST. 6" – GATE VALVE WHEEL OPERATORS |

2' 0 4' 8' 12'

SCALE: 1/4"=1'–0"

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE

KANEOHE, OAHU

PAGE 2–4

FIGURE 2–1

ALTERNATIVE NO. 1
EXISTING BASEMENT PLAN AND MATERIAL LIST

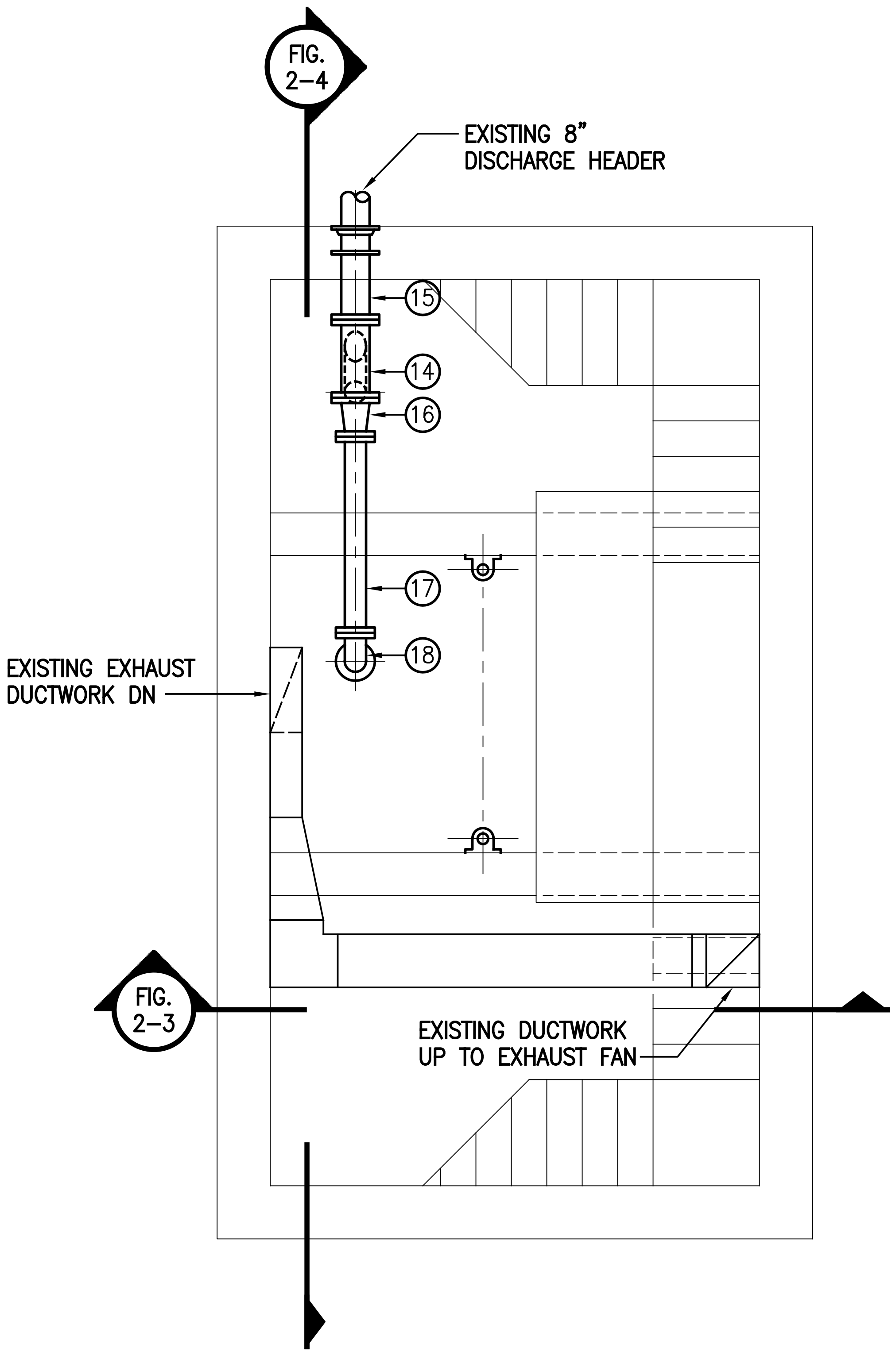
DATE JAN 2011

JOB NUMBER 2009107

DESCRIPTION

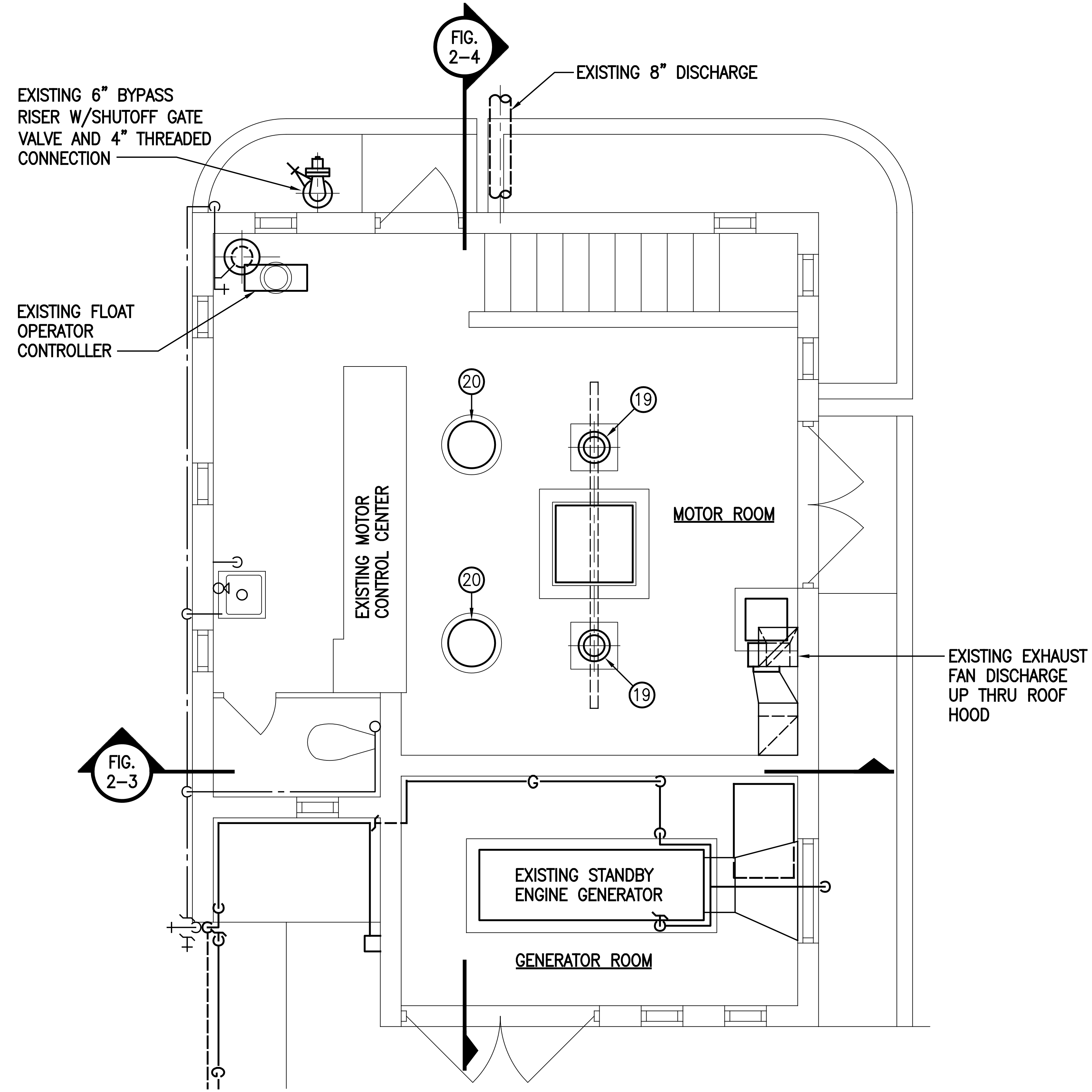
OKAHARA AND ASSOCIATES, INC.

J/D:\PROJ\21002\REPORT\FIG 2-PLAN-SECT.DWG/1=1/12-27-10/XREF=OA1117,x-Basement,x-Int,x-plan,x-sect-a, x-sect-b




## EXISTING INTERMEDIATE PLAN

SCALE: 1/4" = 1'-0"




## EXISTING GROUND FLOOR PLAN

SCALE: 1/4" = 1'-0"

2' 0 4' 8' 12'

SCALE: 1/4"=1'-0"

NOTE:
SEE FIGURE 2-1 FOR MATERIAL LIST.

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU
KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KANEOHE, OAHU

ALTERNATIVE NO. 1
EXISTING INTERMEDIATE AND GROUND FLOOR PLANS

DESCRIPTION

PAGE 2-5

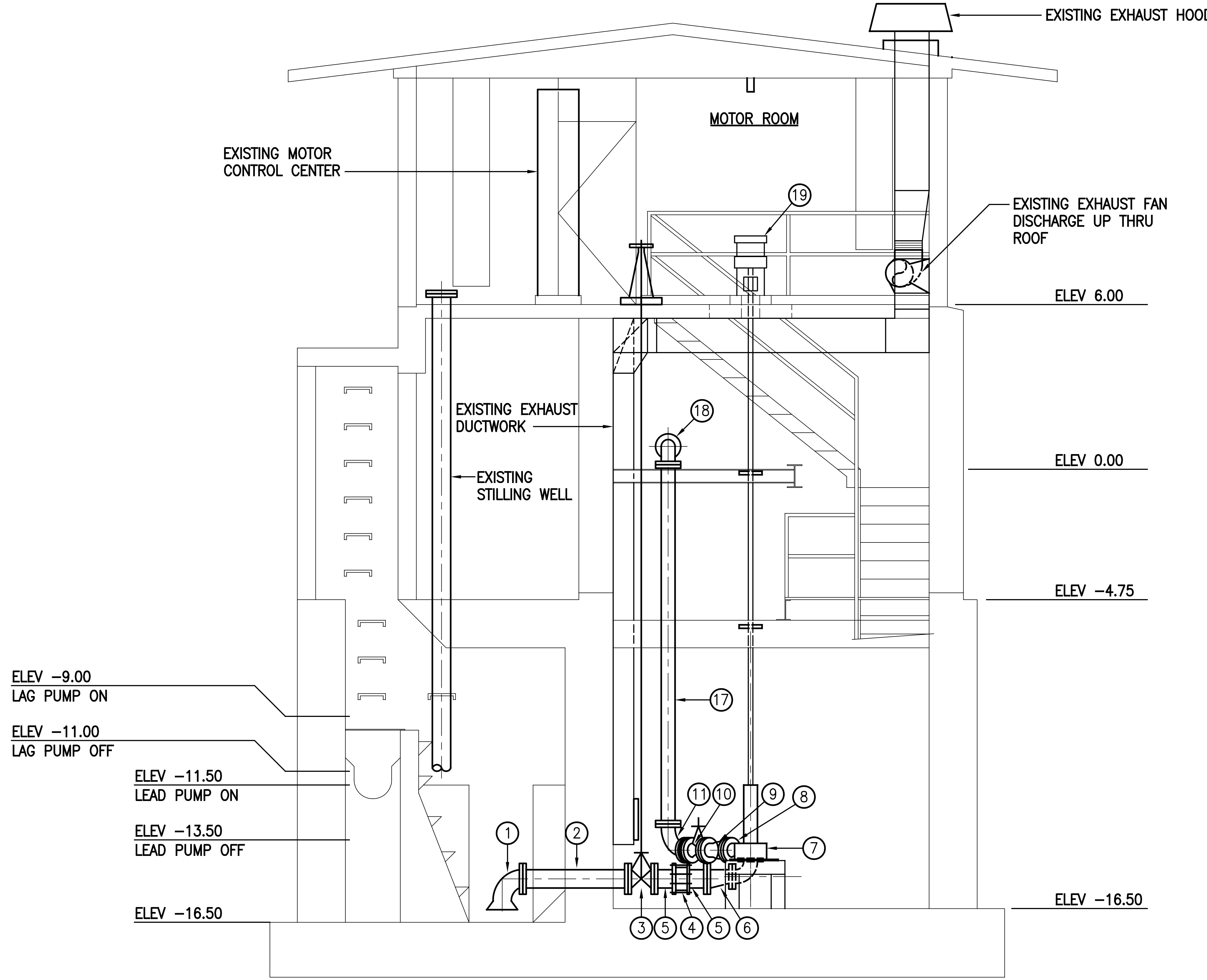
FIGURE 2-2

DATE JAN 2011

JOB NUMBER 2009107

OKAHARA AND ASSOCIATES, INC.

JI/D:\PROJ\21002\REPORT\FIG 2-PLAN-SECT.DWG/1=1/12-27-10/XREF=OA1117,x-Basement,x-Int,x-plan,x-sect-a, x-sect-b




NOTE:
SEE FIGURE 2-1 FOR MATERIAL LIST.

## EXISTING SECTION

SCALE: 1/4" = 1'-0"

2' 0 4' 8' 12'

SCALE: 1/4"=1'-0"

DESCRIPTION

DEPARTMENT OF DESIGN AND CONSTRUCTION
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CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KANEOHE, OAHU

ALTERNATIVE NO. 1
EXISTING BUILDING SECTION

OKAHARA AND ASSOCIATES, INC.

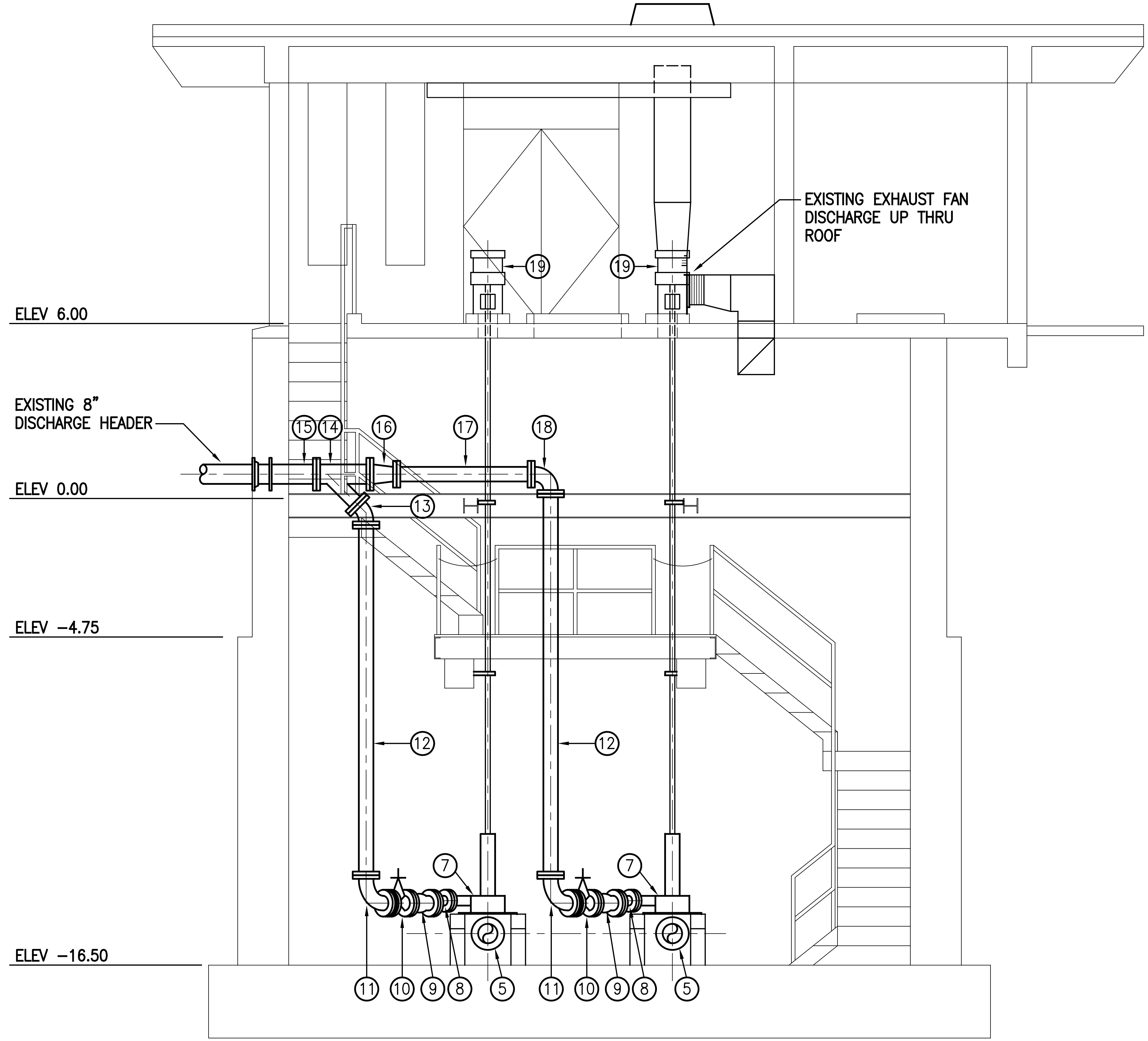
JOB NUMBER 2009107

DATE JAN 2011

FIGURE 2-3

PAGE 2-6

JI/D:\PROJ\21002\REPORT\FIG 2-PLAN-SECT.DWG/1=1/12-27-10/XREF=OA1117,x-Basement,x-Int,x-plan,x-sect-a, x-sect-b




NOTE:
SEE FIGURE 2-1 FOR MATERIAL LIST.

EXISTING SECTION
SCALE: 1/4" = 1'-0"

2' 0 4' 8' 12'
SCALE: 1/4"=1'-0"

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KANEOHE, OAHU

DESCRIPTION

ALTERNATIVE NO. 1
EXISTING BUILDING SECTION

OKAHARA AND ASSOCIATES, INC.

JOB NUMBER 2009107

DATE JAN 2011

FIGURE 2-4

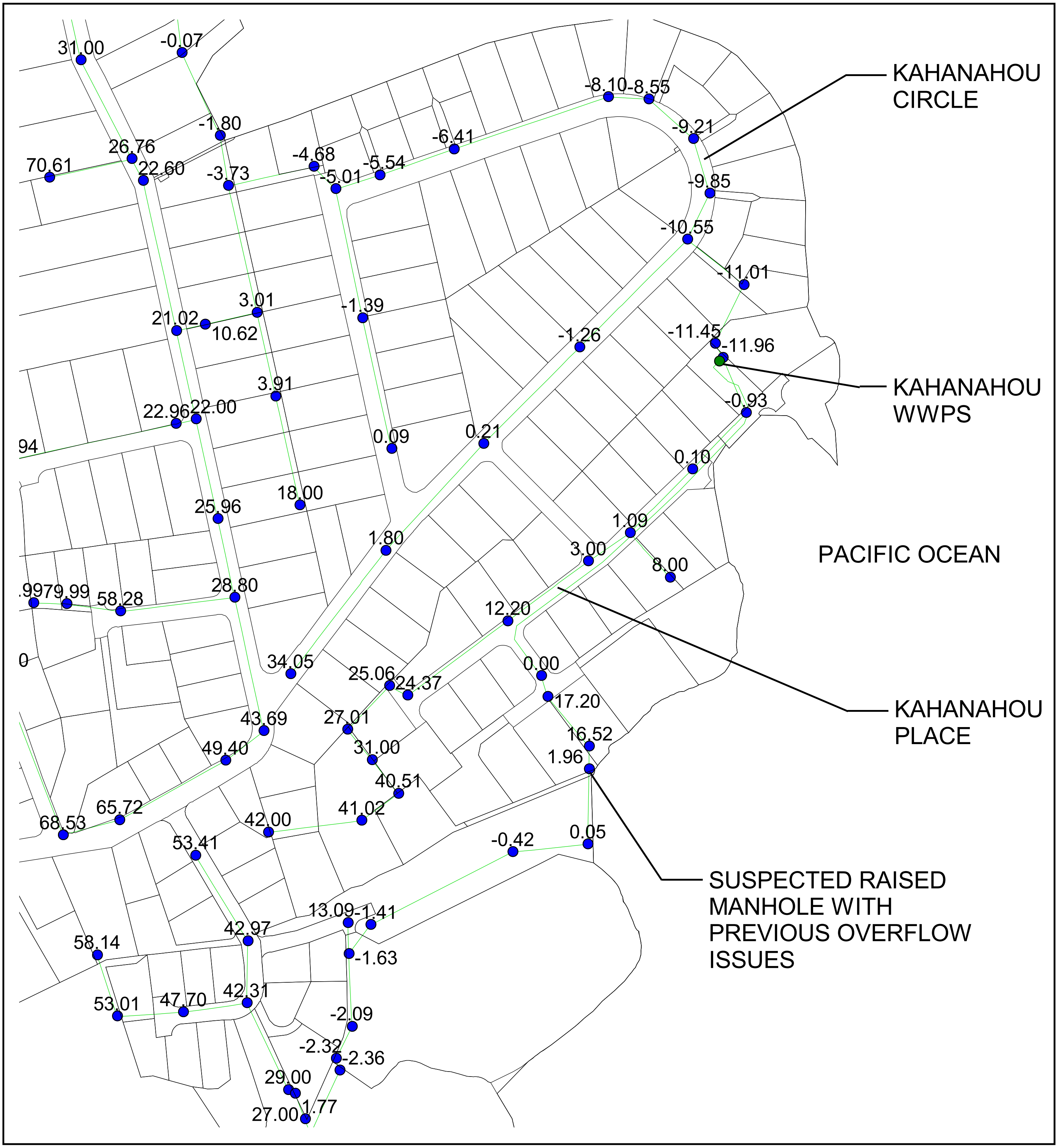
PAGE 2-7

Current operating elevation settings are in compliance with the "*Design Standards of the Department of Wastewater Management, Volume 1, July 1993*" (Standards). According to the Standards, the desired high water level is the invert of the incoming sewer and the maximum allowed high water level is the crown of the incoming sewer.

The high water level of (-)11.50 feet is equal to the invert of the incoming sewer. Note that the maximum high water level of (-)9.00 is above the crown of the incoming sewer by 15 inches.

CSM was consulted about any existing surcharging problems associated with Kahanahou WWPS to determine if there are issues with existing wet well set points or capacity shortfalls. They reported no known problems with surcharging upstream of the pump station. They did however report a problem with a portion of the downstream gravity main. One of the downstream manholes apparently suffered from sanitary sewer overflow problems. The City reportedly raised the height of the manhole and also installed a throttling ball valve on the force main at the WWPS. It should be noted that although CSM did not indicate a serious surcharging problem downstream of the pump station, "*Design Alternatives Report for Kahanahou Wastewater Pump Station Force Main Reconstruction*", September 8, 2005, did suggest that there is a notable surcharge situation downstream of the pump station.

An analysis of the existing manhole inverts revealed that GIS recorded data agree with the reported information. See Figure 2-5 of existing sewer mains, sewer manholes and invert elevations in the area. According to the GIS data, the high wet well water level of (-)11.50 is lower than all of the upstream manhole inverts. Furthermore, the maximum high wet well water level of (-)9.00 is higher than only a small portion of the upstream manholes and it would suggest that there are little, if any, surcharging problems with the upstream mains.




**LEGEND:**

Sewer pipes — Existing Wastewater Pump Stations — Existing Manholes & Invert Elevations

**Kahanahou WWPS Upgrade**
**Design Alternative Report**

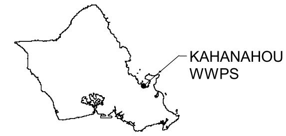
# Figure 2-5

Department of
Design & Construction

N

SCALE: 1" = 250'

## PROJECT MAP




Wastewater Division

Date: January 2011

A flow analysis of a small portion of the gravity sewer main immediately following the Kahanahou WWPS was conducted to verify the capacity of the downstream sewer system. See Table 2-2 for the results.

**Table 2-2: Limited Downstream Sewer Analysis (Manning's Equation)**

| Upstream SMH | | | Downstream SMH Inv. | Sewer Length (ft) | T Size (In.) | Slope | Max. Vel. (fps) | Max. Capacity (gpm) |
|---|---|---|---|---|---|---|---|---|
| Ground Elev. | Depth | Inv. | | | | | | |
| 24.5 | 5.8 | 18.7 | 17.5 | 40.54 | 10 | 0.031 | 6.13 | 1,500 |
| 27.7 | 10.5 | 17.2 | 16.52 | 136 | 10 | 0.005 | 2.46 | 603 |
| 23.02 | 6.5 | 16.52 | 1.96 | 33.38 | 10 | 0.43619 | 23.0 | 5,629 |
| 8.46 | 6.5 | 1.96 | 0.05 | 129 | 10 | 0.01481 | 4.24 | 1,037 |
| 4.05 | 4 | 0.05 | (-)0.42 | 139 | 10 | 0.00338 | 2.02 | 495 |
| 8.58 | 9 | (-)0.42 | (-)1.41 | 292.05 | 10 | 0.00339 | 2.02 | 496 |
| 8.59 | 10 | (-)1.41 | (-)1.63 | 65.88 | 10 | 0.00334 | 2.01 | 493 |
| 12.87 | 14.5 | (-)1.63 | (-)2.09 | 135 | 10 | 0.00341 | 2.03 | 498 |
| 6.81 | 8.9 | (-)2.09 | (-)2.32 | 69.8 | 10 | 0.00330 | 2.00 | 490 |
| 4.2 | 6.52 | (-)2.32 | (-)2.36 | 12 | 10 | 0.00333 | 2.01 | 492 |
| 4.1 | 6.46 | (-)2.36 | (-)2.74 | 119 | 10 | 0.00319 | 1.97 | 481 |

A number of things can be inferred from the analysis. 1) The maximum capacity of the downstream collection system is no greater than 490 gpm without causing surcharging. 2) The velocity through the sewer main with a slope of 0.43619 is approximately 23 ft/s. According to the Standards, the maximum recommended velocity is 10 ft/s. 3) A hydraulic jump is likely to occur at the sewer manhole immediately following the steep sloped sewer pipe. The hydraulic jump, if it is severe enough, could cause spills to occur through the manhole. 4) The maximum flow from SMH (Inv. = 0.05) to SMH (Inv. = (-)2.74) is estimated to be 1.2 mgd (833 gpm) before wastewater will spill from the SMH (Inv. = 0.05) cover. See Appendix A-1 for supporting estimated flow calculations.

Wet well level elevation set points were also evaluated to determine compliance with maximum retention and cycling times. See Appendix A-2 for the wet well volume calculations.

Appendix A-2 is comprised of four sets of wet well volume calculations. Table A-2.1 shows the maximum allowable wet well volume based on the Standards' 30-minute maximum wastewater retention time. The intent of limiting the maximum wastewater retention time is to minimize deposits of solids and prevent wastewater from becoming septic.

Table A-2.2 takes the maximum allowable wet well volume from Table A-2.1 and calculates the resultant maximum motor starts per hour. Table A-2.2 shows that the wet well volume calculated in Table A.2-1 can be decreased without exceeding the maximum motor starts per hour allowed by the Standards'. Exceeding the maximum motor starts per hour allowed by the Standards' can cause overheating and premature motor failure.

Table A-2.3 calculates the minimum required net wet well volume based on the maximum motor starts per hour allowed by the Standards'. The intent of minimizing the wet well volume is to minimize the wet well high water level elevation set point. Minimizing the wet well high water level elevation set point will help to minimize the extent of surcharging that occurs upstream of the WWPS and minimize the wastewater retention time in the wet well.

Table A-2.4 takes the minimum allowable net wet well volume from Table A-2.3 and calculates the minimum recommended wet well high water level elevation set point.

The wet well water level analysis indicates that the existing high water level elevation set point falls within acceptable limits.

### 2.3.2 Existing Force Main

Kahanahou WWPS has a force main that was originally put into service in 1966 and subsequently replaced in 2007. The existing force main is approximately 800 feet in length (16 feet of 8-inch C-900 PVC, 769 feet of 8-inch DR 17 HDPE, 6 feet of 8-inch CI, and 1 foot of 8-inch DI). The existing force main starts at the WWPS, is located within the Kahanahou Place property limits, and discharges into a manhole located beneath Springer Place. The City had the original cast iron force main replaced in 2007 due to increasingly frequent pipe failures. According to the "*Design Alternatives Report for Kahanahou Wastewater Pump Station Force Main Reconstruction*", September 8, 2005, it was feared that the force main was suffering from advanced corrosion due to its age of 40+ years and its close proximity to the ocean. At the time, the force main had already failed a couple of times and required emergency repairs on both occasions.

As a part of the replacement project, a throttling ball valve was installed downstream of the meter vault. The purpose of the throttling valve is to allow operators to throttle the flow from Kahanahou WWPS. It was anticipated by the designers that the peak flow would be reduced in the future in response to I/I reduction projects. The designers had alluded to that the ball valve was also intended to throttle flow as necessary to prevent negative impacts such as surcharging and spills in the downstream collection system. It was confirmed by Okahara and CSM in November 2010 that the ball valve was in the full open position. CSM had expressed concerns that without an a flow rate display mounted adjacent to the throttling valve, and a recommended maximum allowable flow rate, they were ill equipped to "throttle" the WWPS' flow.

### 2.3.3 Sanitary Sewer Overflow

CSM was consulted regarding sanitary sewer overflows (SSO) in the vicinity of Kahanahou WWPS. According to their records, no spills or trouble calls are recorded for 45-13 Kahanahou Place, Kaneohe, TMK: 4-5-047:095.

### 2.3.4 Existing Pump Station Flow Analysis

The existing WWPS was designed to meet the following conditions according to design documents for Kahanahou Sewage Pumping Station & Force Main, Job

No. 63-63, and Kahanahou Wastewater Pump Station Force Main Reconstruction, Job No. W16-05. The following information is only presented to highlight the existing WWPS's basis of design. It does not represent the actual operating conditions.

- $Q_{ave}$ = 0.116 mgd
- $Q_{max}$ = 0.451 mgd
- $Q_{peak}$ = 0.654 mgd
- Lead Pump = 510 gpm @41 feet TDH (C=120); 550 gpm @39 feet TDH (C=150)
- Wet Well Capacity = 2,870 gallons
- Wet Well Invert = (-)16.50 feet
- Low Water Elevation = (-)14.50 feet
- High Water Elevation = (-)11.50 feet
- Retention Time = (Not Indicated)
- Static Head = 29.2 feet (Minimum), 32.2 feet (Maximum)
- Force Main Length = 101 equivalent length feet of 6-inch CI; 33 equivalent length feet of 8-inch CI; 924 equivalent length feet of 8-inch HDPE/PVC.

Pump curves matching serial numbers obtained from Engineered Systems, a local equipment vendor, were obtained from the Patterson Pump Company and used to model pump curves for Kahanahou WWPS. Engineered Systems reported that the existing pumps are Model FFN, Serial Number 64PP1030-F4 and 64PP1031-F4, 500 gpm @43 feet TDH, 10 hp, 1150 RPM Patterson Pumps. Note that the existing operating pumps did not have a nameplate on them. During Okahara's field reconnaissance, two spare pumps were observed stored on a pallet in the dry well. The spare pumps were identified as Patterson Pumps, Model FFN, Serial Number 64PP1095-F6 (both pumps had the same serial number), 500 gpm @40 feet TDH. According to information obtained from Patterson Pumps, the serial numbers are for Waikapoki WWPS pumps with a flow capacity of 930 gpm @75 feet TDH. It was assumed that the serial numbers indicated on the spare pumps were incorrect and the associated pump curves do not correctly reflect the performance of the Kahanahou WWPS pumps.

The pump curves were adjusted for minor losses and superimposed onto the system curve. See Appendix A-3 for net positive suction head available ($NPSH_A$) calculations. See Appendix A-4 for the existing pump curves, system curves and calculations. See Appendices A-5 and A-6 for the alternative pump curves, system curves and associated calculations.

Actual WWPS operating conditions and calculated pump performance differ slightly from the design conditions and pump performance. Actual operating conditions were either field verified or extrapolated from available reference drawings. Calculated pump performance was based on installed Patterson Pump curves, Standards' frictional factors, reference drawings and adjustments by Okahara. Actual WWPS operating conditions and calculated pump performance are as follows:

- High Water Elevation = (-)11.28 (per SCADA display at WWPS)
- Low Water Elevation = (-)13.68 (per SCADA display at WWPS)
- Wet Well Invert = (-)16.50
- Wet Well Capacity = 1,724 gallons (based on (-)13.68 water level)
- Retention Time = 29.25 minutes (based on (-)11.28 water level and 139 gpm average inflow rate)
- Minimum cycle time = 27.5 minutes
- C = 100 for ductile iron
- C = 100 for PVC / HDPE (H-W factor changed from 120 to 100 to match SCADA data)
- Patterson M/N FFN; S/N 64PP1030-F4 & 64PP1031-F4; 500 gpm at 43 feet
- Pump Performance

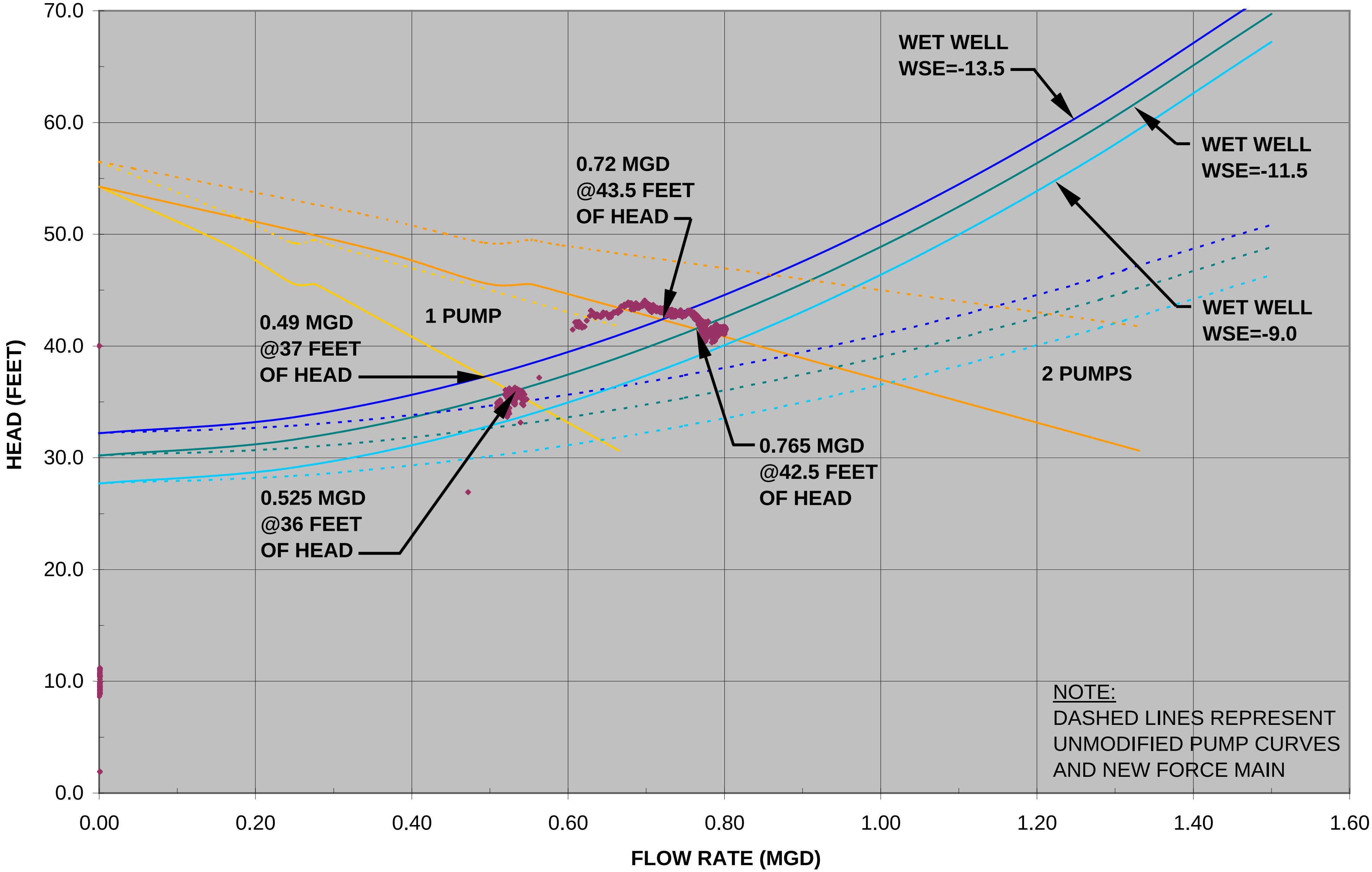
    1 Pump = 347 gpm, 0.50 mgd @45 feet TDH

2 Pumps = 510 gpm, 0.73 mgd @47.5 feet TDH

- $NPSH_A$ = 23.5 feet (One Pump Operating)
- $NPSH_R$ = Unknown
- Inlet Bell Fluid Velocity =  0.78 ft/sec (13.5-inch diameter bell)
- Suction Pipe Fluid Velocity = 2.22 ft/sec (based on 8" nominal pipe)
- Discharge Pipe Fluid Velocity = 3.94 ft/sec (based on 6" nominal pipe)
- 8" AWWA C900 PVC Force Main Fluid Velocity = 2.19 ft/sec
- 8" SDR-11 HDPE (Ductile Iron Dimensions) Force Main Fluid Velocity = 2.59 ft/sec

Actual WWPS pump performance differ slightly from the calculated pump performance using Standards' recommended Hazen-Williams friction factor of 120 for plastic pipe, 100 for metal pipe and 6-inch diameter pipe discharge. In order to match SCADA data, a Hazen-Williams friction factor of 100 was used for plastic pipe, 60 was used for metal pipe located in the pump station, and a 4-inch diameter was used to model the vertical portion of the pump discharge piping. See Chart 2-1 for pump curves, modified pump curves, family of system curves and SCADA data from October 31 through November 2, 2006. The pump curves were obtained directly from the factory (Patterson Pumps) based on serial numbers obtained from Engineered Systems, a local equipment manufacturer's representatitive. The modified pump curves were created by calculating the minor losses and subtracting them from the pump curves. The family of system curves were calculated based on several different wet well water level elevations including the LWL set point of (-)14.50 feet, the HWL set point of (-)11.50 feet, and a HHWL set point of (-)9.00 feet. See Appendices A-4, A-5 and A-6 for sample calculations. The SCADA data is a collection of WWPS operating points recorded once every 1-minute. Each point represents the total flow and corresponding discharge pressure of the WWPS. The pump station pressure tap is located immediately downstream of the discharge elbow on Pump 2 with the sensor/transmitter mounted on the wall approximately 36-inches above the finished floor (El. = (-)13.00). When Pump 1 operates, the

## CHART 2-1: KAHANAHOU WWPS
## EXIST. CENTRIFUGAL PUMP AND SYSTEM CURVES FOR OCT 31~NOV 2, 2006
### PATTERSON PUMP CO. 1175 RPM, UNKNOWN IMPELLER DIAMETER



pressure sensor measures the WWPS discharge pressure excluding minor losses. When Pump 2 (or both pumps) operates, the pressure sensor measures the WWPS pressure excluding most of the minor losses except for the minor losses between the discharge sensor pressure tap and the discharge header. Typically, the discharge pressure tap is located on the common discharge header and not on the individual pump discharge lateral. It is estimated that the total error introduced by the existing discharge pressure tap location is on the order of 0.5 to 1.0 feet of water or 1~3%. Due to the anticipated small size of the error, it was decided to ignore the incorrect discharge pressure tap location's effects on the calculated results.

The SCADA data was modified to account for varying wet well water levels and its effect on the measured discharge pressure. In effect, the modified discharge pressure data represents the total lift (minus minor losses) provided by the WWPS. Note that the total lift (minus minor losses) provided by the WWPS differ from the WWPS discharge pressure by the amount of static pressure available in the wet well.

The SCADA data points recorded between October 31 and November 2, 2006 represents data taken over a period of moderate to high rainfall. See Appendix B for SCADA data recorded between October 31 and November 2, 2006. The WWPS operated almost continuously for 3 days and required two pumps to operate simultaneously for a good portion of that time. It was expected that the data would cluster in two groups with a few scattered points. One group of operating points was expected to cluster where the pump curve for one operating pump intersects the system curve for a wet well water elevation of (-)11.50 (i.e., HWL). The second group of operating points was expected to cluster where the pump curve for two operating pumps intersect the system curves for a wet well water elevation between (-)11.00 and (-)9.00 (i.e., Pump 2 Off and Pump 2 On elevation set points). The second group of points was expected to ride the pump curve as the wet well level fluctuated. With two pumps operating, the wet well water level would rise as long as the incoming flow rate exceeding the WWPS' capacity and fall when the incoming flow rate fell below the WWPS' capacity. The system seemed to stabilize at 0.80 mgd at peak flow conditions.

Prior to adjusting the Hazen-Williams friction factor and the pump discharge lateral size utilized in the hydraulic analysis, it was found that the SCADA data points fell below the modified pump curve and to the left of the system curve as predicted by the analysis. The following can be inferred from the SCADA data and hydraulic analysis:

- Something in the WWPS piping assembly is increasing the magnitude of the minor losses. According to CSM, the vertical portion of the discharge laterals tend to be lined with solids over time, and it effectively reduces the usable inside pipe diameter.
- The Standards' recommended Hazen-Williams friction factor of 120 for plastic pipe is not a good representation of actual performance. It appears that HDPE behaves more like metallic pipe with a Hazen-Williams friction factor of 100.

A plausible alternative to the above inferences is that the existing WWPS' instrumentation is not calibrated properly. However, if that were true, both the flow meter and discharge pressure transmitter are reporting low values.

### 2.3.5 Pump Station Ventilation

The existing WWPS dry well is ventilated by an inline exhaust fan that is actived while CSM is on-site. Operating the fan 24-hours a day reportedly illicits noise complaints from neighbors. The exhaust fan intakes are ducted from the dry well and exhausted vertically through a roof mounted hood. The exhaust fan was designed to exhaust 1,920 cfm at 3/8-inch water gage static pressure.

### 2.3.6 Existing Pump Station Deficiencies

There are a number of deficiencies with the existing WWPS. The following is a summary of the deficiencies and a discussion of whether the project will address the deficiencies.

- The existing WWPS does not have sufficient capacity to meet current or future flow projections. See Section 2.4 for a flow analysis of the existing WWPS. This deficiency will be addressed by Alternatives 2, 3 and 4.
- The existing inlet bell wastewater velocity of 0.78 feet per second is low. According to *Pump Intake Design* by the Hydraulic Institute, 1998, the inlet bell fluid velocity should be kept between 2.0 and 5.5 feet per second for flow rates less than 5,000 gpm. According to *Pumping Station Design* by Sanks et. al, 1998, the inlet bell fluid velocity should be kept between 2.0 feet per second and 3.0 feet per second for constant speed pumps and 2.0 feet per second and 3.5 feet per second for variable frequency drive (VFD) driven pumps. The purpose of the minimum velocity of 2.0 feet per second is to insure proper removal of grit particles during wet well cleaning. This deficiency will be addressed by Alternatives 2, 3 and 4.
- The existing pump discharge is connected to the discharge header from the bottom. According to *Pumping Station Design* by Sanks et. al, 1998, connecting the pump discharge to the bottom of a header could result in plugging of check valves and piping. CSM has also reported that long vertical discharge laterals promote clogging of the laterals. This deficiency will be addressed by Alternatives 2, 3 and 4.
- The existing dry well is not continuously ventialted per NFPA 820 nor are all of the dry well equipment explosion proof rated. NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2008 Edition defines dry wells that are not continuously ventilated at a minimum of 6 air changes per hour a Class I, Group D, Division 2 area. This means that if

enough ventilation is not provided to unclassify the area, all of the electrical equipment within the dry well including the pump motors, starters and exhaust fan will need to be explosion proof. This deficiency will be addressed by Alternatives 2, 3 and 4.

- The existing float operated controller float tube short circuits the wet well and dry well. This deficiency will be addressed by Alternatives 2, 3 and 4.
- The existing 8-inch diameter gravity main that the force main discharges into does not have sufficient capacity for flow rates exceeding approximately 0.7 mgd (490 gpm) without surcharging the gravity main. The capacity increases to approximately 1.2 mgd (833 gpm) if the gravity main is allowed to be pressurized. Flow rates approaching 1.2 mgd will cause excessive surcharging and may result in SSOs through the manholes. The analysis is limited to approximately 800 linear feet of gravity main immediately downstream of the force main discharge. Increasing the capacity of the downstream collection system is beyond this project's scope of work. Provisions to limit the maximum wastewater flow from the pump station are included in Alternatives 2, 3 and 4.

See Section 2.5 Design Alternatives and Chapter 6 - Evaluation of Alternatives for a discussion regarding proposed alternatives and WWPS deficiencies. Note that a water hammer analysis was completed and the calculated intensity of anticipated pressure waves fall within tolerable limits. See Appendix A-7 for water hammer calculations.

## 2.4 FLOW ANALYSIS

A flow analysis was completed to develop a basis for the selection of replacement sewage pumps. Two methods of determining the appropriate design flow rates were employed. The first method employed was utilizing INFIX, a City approved flow modeling software that are based on the Standards. The second method employed was analyzing historical flow data.

### 2.4.1 INFIX Flow Data Analysis

A City flow model entitled INFIX version 3.0 was used to model current and future wastewater flow projections. INFIX is a modeling program that calculates wastewater flows within a sanitary wastewater system. INFIX uses a database consisting of manholes, sewer mains, and parcels to compute the production of wastewater summed for each sewer main starting from the highest node downward to a WWTP. Calculations are by in large based on the Standards' defined factors for wastewater generation rate, infiltration rates, inflow rates and maximum flow factors. However, calculations can also be based on user defined factors.

An extensive amount of field collected data were purportedly used to supplement the INFIX version 3.0 database to allow for more accurate flow projections.

Kahanahou WWPS, designated by INFIX as Plant/Station KK 32, is projected to have the following current and future wastewater flows shown in Table 2-3. (See Appendix C for the INFIX WWPS printout). It should be noted that INFIX version 3.0's database is current as of 2002 and updates are reportedly not available. INFIX version 3.0 does not account for the Kahanahou lateral rehabilitation pilot project and the resultant I/I reduction. Consequently caution should be exercised in assigning credibility to the INFIX projections.

**Table 2-3: INFIX Projected Wastewater Flow Rates**

| Criteria | Current Projection | Future Projection |
|---|---|---|
| Tributary Area | 68.6 Acres | 76.0 Acres |
| Residential Population | 832 | 1,123 |
| Other Population | 22 | 18 |
| Total Population | 854 | 1,141 |
| Average Flow Rate | 0.0684 mgd | 0.0913 mgd |
| Maximum Flow Factor | 5.00 | 4.87 |
| Maximum Flow Rate | 0.3418 mgd | 0.4447 mgd |
| Dry Weather I/I | 0.0149 mgd | 0.0206 mgd |
| Design Ave. Flow Rate | 0.0832 mgd | 0.1120 mgd |

| | | |
|---|---|---|
| Design Max. Flow Rate | 0.3567 mgd | 0.4653 mgd |
| Wet Weather I/I | 0.1218 mgd | 0.1422 mgd |
| Design Peak Flow Rate | 0.4784 mgd | 0.6075 mgd |

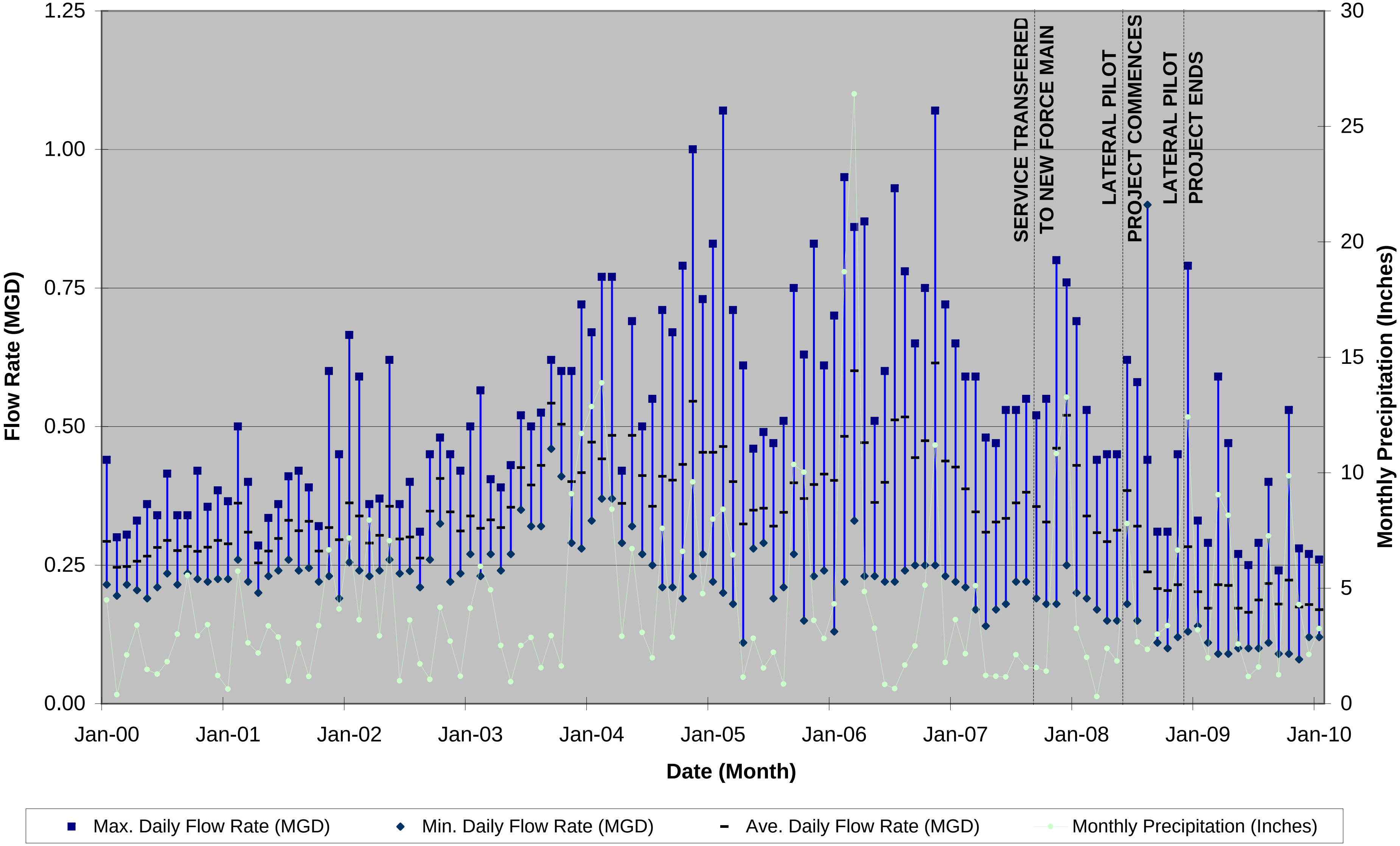
### 2.4.2 Historical Flow Data Analysis

Manually recorded flow and energy use data for the last 10 years between January 2000 and January 2010 were collected and inputted into a spreadsheet (See Appendix D) to ascertain the WWPS' average and peak flow rates. Chart 2-2 shows the monthly maximum, average and minimum daily flow rates recorded for Kahanahou WWPS. Rain data obtained from the U.S. Department of Commerce, National Oceanic & Atmospheric Administration (NOAA) for Station 513117/99999, KANEOHE 838.1, Hawaii were superimposed on the flow data to assist with identifying flow trends. Chart 2-3 shows the associated monthly total flow, power use and flow (gallons)/kWh. See Appendix E for historical rainfall data obtained from NOAA.

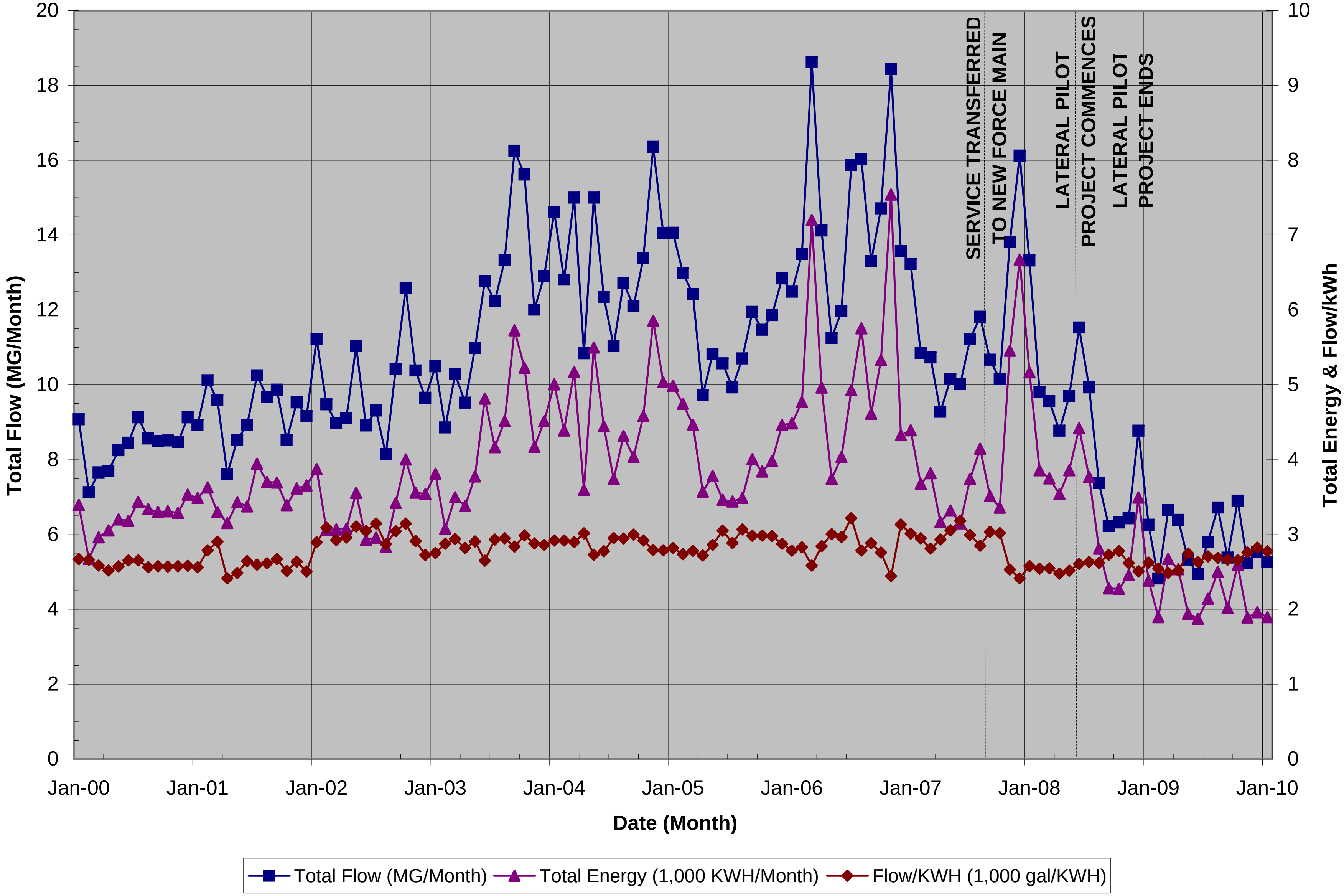
Between the years of 2000 and mid 2008, Charts 2-2 and 2-3 reveal that the daily, monthly daily average and monthly flow rates closely tracked the intensity of precipitation. Monthly daily average flow rates varied from a low of 0.25 mgd in early 2000 to a high of 0.60 mgd in early 2006. The close relationship between rain intensity and flow rate suggests that wet weather I/I had a strong influence on the WWPS flow rates. Monthly WWPS energy consumption for this period was approximately 3,000 kWh in early 2000 to 7,000 kWh in late 2006. Average wastewater pumped per kWh of energy consumption was approximately 3,000 gallons.

In August of 2007, a new HDPE force main was brought on-line and replaced an existing ductile iron force main. Immediately following the replacement, average wastewater pumped per kWh of energy fell to 2,500 gallons. The drop in wastewater pumped per kWh consumed seems counterintuitive because the HDPE pipe should be smoother than the old ductile iron pipe. It is postulated that

## CHART 2-2: KAHANAHOU WWPS
## MONTHLY MAXIMUM / AVERAGE / MINIMUM DAILY FLOW RATES
**(NOTE: BASED ON MANUALLY RECORDED DATA. DO NOT USE DAILY MONTHLY MIN. & MAX. FLOW RATES)**



## CHART 2-3: KAHANAHOU WWPS
## TOTAL FLOW PER MONTH / ENERGY USE PER MONTH / FLOW PER KWH



the smaller inside diameter of HDPE (7.04" I.D.) versus ductile iron (8.39" I.D.) caused the additional recorded frictional losses.

Between the years of mid 2008 through the end of 2008, a pilot project to rehabilitate laterals in the area was completed. Between June 2008 and November 2008, there is a noticeable drop in the average daily flow rate to levels unseen in the previous 10 years. Project specifics including scope of work are still being researched. Monthly daily average flow rates fell to approximately 0.20 mgd following the completion of the project. Monthly minimum daily flow rates, total monthly flow, total monthly power consumed also dropped as compared with previous year's data. Average wastewater pumped per kWh of energy consumed remained unchanged at 2,750 gallons. Decreased total flow, average flow and total energy consumed seems to be a direct result of the lateral rehabilitation pilot project.

Of the 10 years of manually recorded daily flow data for Kahanahou WWPS, there were seven instances of recorded daily flow approaching or exceeding 1.00 million gallons. The data indicates that the monthly maximum, average and minimum daily flow rate logs may be incorrect for one of the seven instances.

The suspected instance of incorrect recorded daily flow approaching or exceeding 1.00 million gallons occurred on July 26, 2006. The monthly logs indicate that Kahanahou WWPS pumped 2.06 million gallons of wastewater that day. The logs also indicate that 255 kWh of electricity was consumed that day. 255 kWh of electricity suggests that Kahanahou WWPS pumped 0.765 million gallons of wastewater based on a pump efficacy of 3,000 gallons per kWh. SCADA recorded data appears erratic and it was concluded that instrumentation devices may not have been operating properly on that day. The maximum recorded daily flow of 2.06 million gallons was dismissed and removed from Chart 2-1 based on the discrepancy between the calculated flow of 0.765 million gallons and the recorded flow, the erratic SCADA data, and the inability of the existing pumps to pump 2.06 million gallons. The existing pumps have a capacity of 0.792 mgd (550 gpm) per pump.

As for the remaining six (6) instances of daily flow approaching or exceeding 1.00 million gallons, a comparison of the manually recorded data versus the SCADA data suggest that the manually recorded data may be incorrect. It is suspected that the manually recorded data is not recorded at the same time everyday. This could lead to misleadingly high daily flows for days with over 24 hours recorded flow and equally misleadingly low daily flows for days with under 24 hours recorded flow.

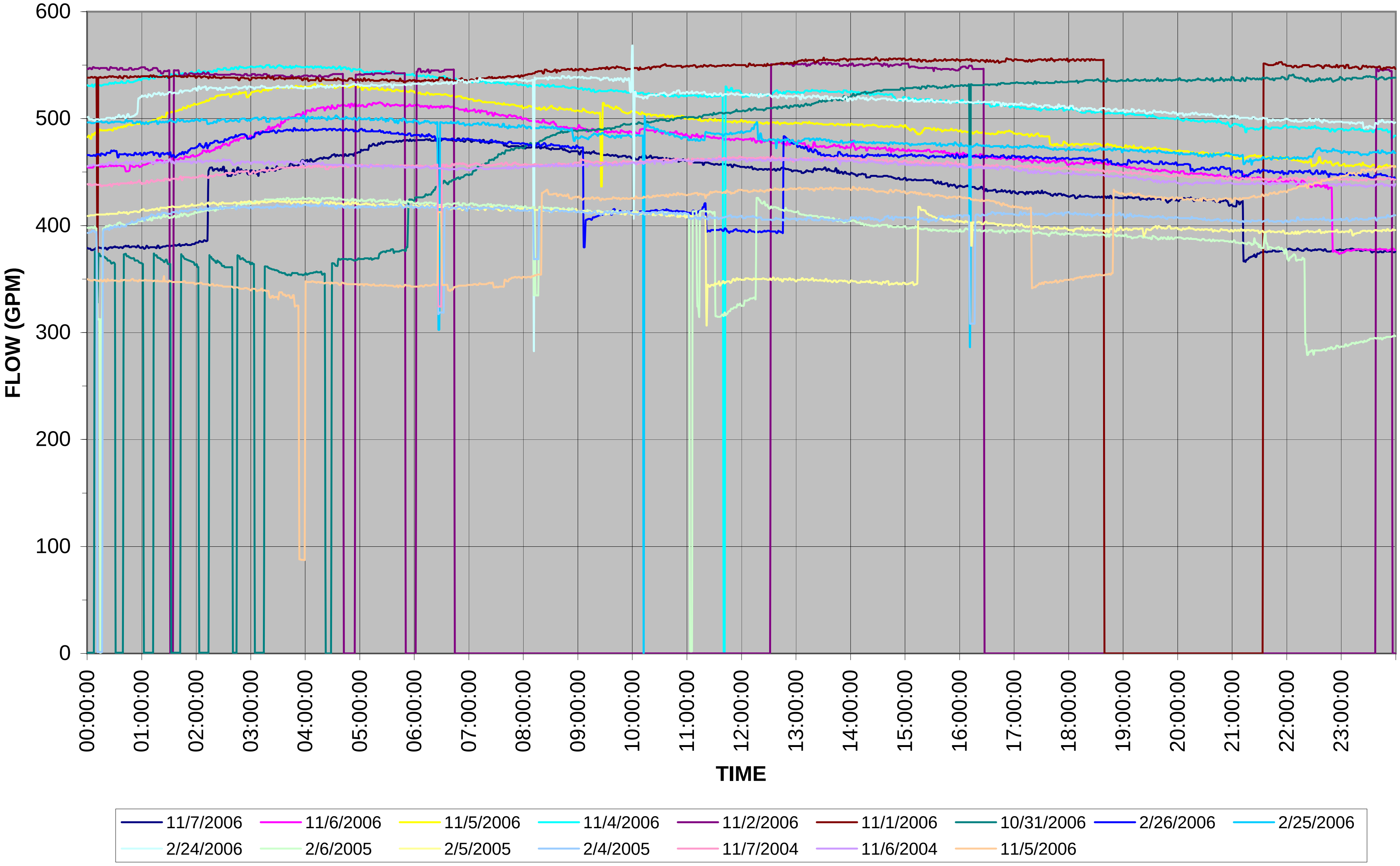
For example, between November 5 and November 7, 2004, 0.24, 1.00 and 0.66 million gallons were manually recorded for a three day total of 1.90 million gallons. According to the SCADA data, 0.57, 0.65 and 0.65 million gallons were pumped on those three days for a three day total of 1.87 million gallons. The point is that although the accuracy of the manually recorded daily minimum and maximum flows may be in question, the trends and long term data should be fairly accurate.

No other notable anomalies were found with the six (6) instances of daily flow approaching or exceeding 1.00 million gallons. SCADA flow data for the subject days were plotted on Chart 2-4. Flows for days immediately preceding and immediately following the subject days were also plotted on the chart. Based on charted data for the six highest recorded daily flows between January 2000 and January 2010, the pump station flow rate did not exceed 568 gpm or 0.82 mgd.

### 2.4.3 Flow Analysis Conclusions

It appears that the peak incoming flow rate into the WWPS wet well prior to the rehabilitation of laterals in the late 2000's was 0.85 mgd. Insufficient data is available following the lateral rehabilitation work to formulate concrete conclusions regarding its success in reducing I/I. The *Sewer Rehabilitation and*

# CHART 2-4: KAHANAHOU WWPS
# INSTANTANEOUS FLOWRATES
# FOR SELECTED DAYS WITH THE HIGHEST RECORDED DAILY FLOWRATES



*Infiltration & Inflow Minimization Study, Volume 3 of 9, Kailua-Kaneohe I/I Engineering Report*, December 1999 projects a peak flow rate of 1.19 to 1.29 mgd. INFIX projects a current peak flow rate of 0.48 to 0.61 mgd.

There is a discrepancy between the rate recommended by the December 1999 Engineering Report, INFIX version 3.0 and actual flow data. Projections presented in the December 1999 Engineering Report and INFIX version 3.0 are in large part based on guidelines presented in the Standards and old data. Actual WWPS flow data collected manually and electronically via SCADA are deemed to be more accurate. It was decided that since there are no records of SSO events at the WWPS, and Kaneohe experienced large annual rainfall in 2004 and 2006 of 30+ inches above normal, the maximum recorded flow rates would be a good approximation of the peak flow rates. Furthermore, all of the maximum recorded flows between January 2000 and January 2010 occurred before a number of the laterals were rehabilitated in 2008. Finally, the surrounding neighborhood appears to have been developed and there does not appear to be room for significant development. Arbitrarily applying a 10% "safety factor" to the maximum observed WWPS flow rate of 0.82 mgd yields a peak design flow rate of 0.90 mgd.

## 2.5 DESIGN ALTERNATIVES

The following alternatives were developed to address deficiencies with the WWPS capacity. Detailed discussions regarding architectural, structural and electrical implications are located in their respective sections. See Table 6-1 for an evaluation matrix of alternatives. See Appendix F for mechanical related catalog cuts.

### 2.5.1 Alternative No. 1 - No Action (0.50 mgd @45 feet TDH)

Alternative No. 1 calls for no action to be taken. This alternative is only discussed as a baseline for comparison purposes. The problem with taking no action is that the existing pumps do not have sufficient capacity (0.5 mgd capacity) to meet the projected peak flow rate of 0.90 mgd. Historically the peak flow rate has been met with both primary and standby pumps operating together.

See Figure 1-2 for the existing site plan and Figures 2-1, 2-2, 2-3 and 2-4 for the existing WWPS plan and sections. Alternative No. 1 has no associated adverse short-term impacts.

The main adverse long-term impacts with taking no action are that the existing pumps will not be able to meet the projected flow rates and none of the deficiencies discussed in Section 2.3.6 will be corrected. Problems that may be encountered by not correcting the deficiencies include the following:

- Pumps cannot meet existing or projected peak flow rates.
- WWPS does not have a backup pump when both pumps are operating (i.e., during high flow conditions exceeding 347 gpm.)
- Pumps will have difficulty removing grit from the wet well during pump downs due to low velocities through the intake bell.
- Long vertical discharge laterals will continue to collect solids.
- The dry well and electrical room will be classified as a Class I, Group D, Division 1 area. This may pose a safety problem if the existing equipment is not rated as explosion proof.

### 2.5.2 Alternative No. 2 - Install New Constant Speed Dry Pit Submersible Pumps with VFDs (0.90 mgd @55.5 feet TDH)

Alternative No. 2 calls for the replacement of the existing separately coupled solids handling pumps with new larger capacity constant speed dry pit submersible pumps. The pumps would be outfitted with VFDs but would be operated in constant speed mode. The following is a list of improvements that would be required in support of the pump replacement.

- Replace pumps with new larger capacity dry pit submersible pumps with a rated capacity of 0.90 mgd @55.5 feet TDH. Proposed pumps were selected to meet the projected peak flow rate of 0.90 mgd. ABS pump model number XFP100E-CB1, 1765 RPM will have a 4-inch diameter pump suction connection and require approximately 12 feet of NPSH. Each pump will have approximately 21.75 feet of NPSH available at a flow rate of 0.90 mgd and a wet well level elevation of (-)11.50.

- Install VFDs to control pump acceleration and to limit inrush electrical current. VFDs will also be used to limit the maximum flow from the pump station to avoid spills through downstream manholes. The maximum capacity of the downstream gravity main is estimated to be 1.2 mgd. Two pumps operating concurrently is projected to pump in excess of 1.26 mgd.

- Replace existing propane fueled standby emergency engine generator with a larger capacity diesel fueled unit. The engine generator needs to be upsized to accommodate the larger 15 HP pump motors, additional HVAC loads, and miscellaneous other loads.

- Install a new 1,000 gallon underground fuel storage tank. Although an above ground fuel storage tank is preferred by CSM, there is insufficient on-site space to satisfy required setbacks.

- Erect a new generator building with acoustical treatment.

- Modify existing pump building and construct a new air conditioned electrical room for new SCADA and MCC equipment.

- Replace existing controls and relocate meter vault to grassed area.

- Replace all piping located in the dry well.

- Replace existing ventilation system to comply with NFPA 820. New supply and exhaust fans, ductwork, intake and exhaust openings will be required.

See Figures 2-6, 2-7, 2-8 and 2-9 for the proposed modifications to the WWPS plan and sections.

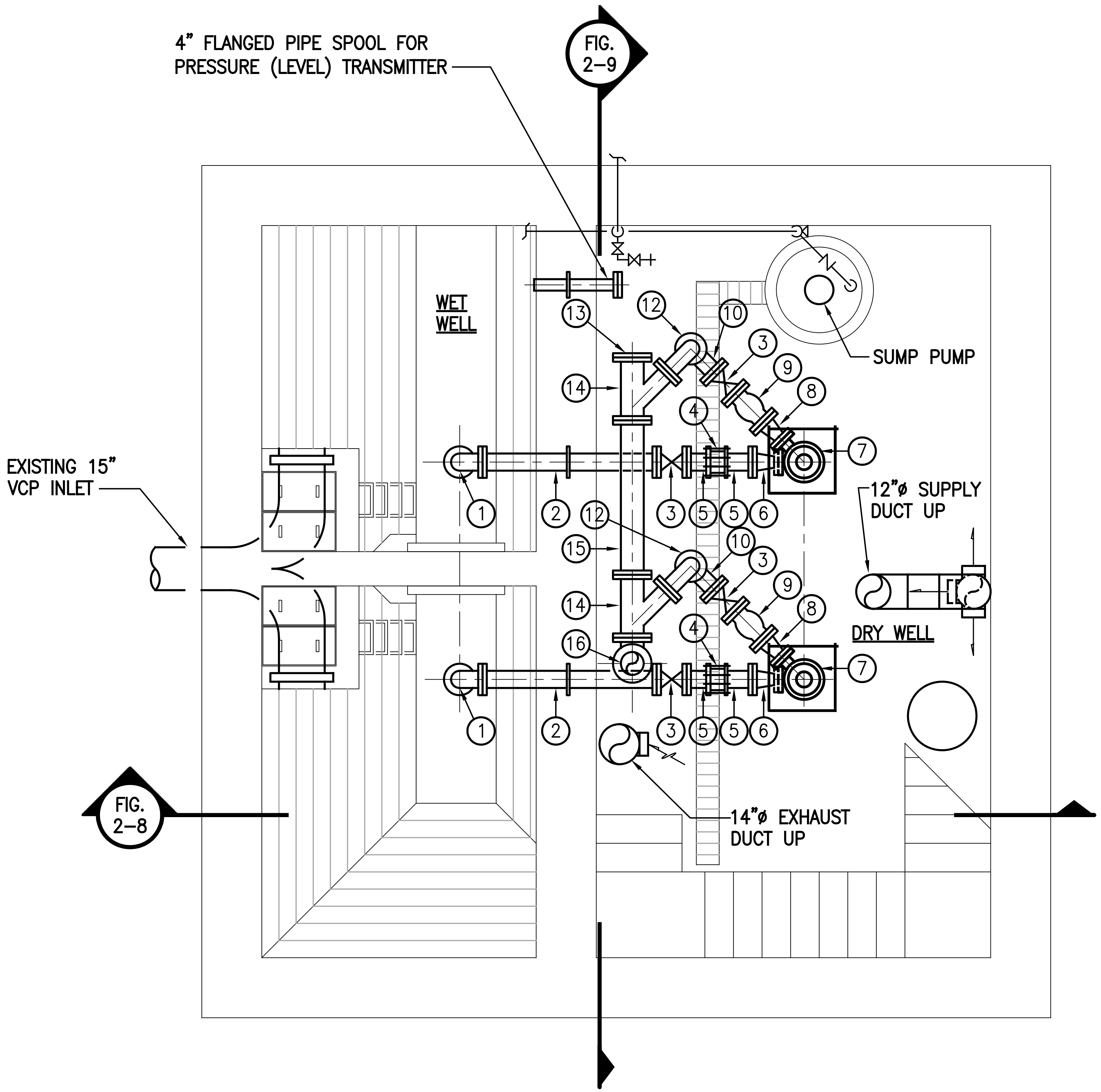
Adverse short-term impacts include significant noise and visual unsightliness both on the WWPS premises as well as in the general vicinity during construction. One adverse long-term impact is that the use of VFDs complicates the system controls and could cause issues for operators.

Wet well level elevation set points may need to be revised if the City pursues additional rehabilitation of sewer mains and laterals in the Kahanahou area. Further rehabilitation of sewer mains and laterals could decrease the average and peak wastewater flow rates. Pump impellers may need to be trimmed or pumps may need to be replaced in cases of extreme I/I reduction.

### 2.5.3 Alternative No. 3 - Install New Constant Speed Dry Pit Submersible Pumps with Soft Starters (0.90 mgd @55.5 feet TDH)

Alternative No. 3 calls for the replacement of the existing separately coupled solids handling pumps with new larger capacity constant speed dry pit submersible pumps. Alternative No. 3 is identical to Alternative No. 2 except for two differences. The VFDs would be replaced with soft starters. Similar to the VFDs, the soft starters would limit in-rush current to prevent overloading of the electrical system. The second difference is that two pumps would be prohibited from operating concurrently. Removal of the VFD will simplify the WWPS' control system. However, it also removes an operator's ability to limit the WWPS' maximum flow to 1.2 mgd. Exceeding a maximum flow of 1.2 mgd may cause spills through downstream sewer manholes. See Table 2.2 and write-up immediately following it for a discussion of maximum allowable flows.

See Figures 2-6, 2-7, 2-8 and 2-9 for the proposed modifications to the WWPS plan and sections.




NEW BASEMENT PLAN

SCALE: 1/4" = 1'-0"

| MATERIAL LIST | |
|---|---|
| ITEM NO. | DESCRIPTION |
| 1 | 6" – LR 90° BEND, FLANGE AND BELL |
| 2 | 6" – PIPE SPOOL, FE |
| 3 | 6" – GATE VALVE, FE |
| 4 | 6" – FLEXIBLE COUPLING |
| 5 | 6" – PIPE SPOOL, FExPE |
| 6 | 6"x4" – ECCENTRIC REDUCER, FE |
| 7 | ABS, SOLIDS HANDLING PUMP |
| 8 | 6"x4" – CONCENTRIC REDUCER, FE |
| 9 | 6" – CHECK VALVE W/ WEIGHT, FE |
| 10 | 6" – LR BASE BEND, FE |
| 11 | 6" – PIPE SPOOL, FE |
| 12 | 6" – LR 90° BEND, FE |
| 13 | 8" BLIND FLANGE |
| 14 | 8"x8"x6" WYE, FE |
| 15 | 8" PIPE SPOOL, F.E. |
| 16 | 8" – 90° BEND, FE |
| 17 | 8" – PIPE SPOOL, F.E. |
| 18 | 8" – PIPE SPOOL, F.E. |
| 19 | 8" – PIPE SPOOL, FE/BE |

2' 0 4' 8' 12'

SCALE: 1/4"=1'-0"

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER
PUMP STATION UPGRADE

KANEOHE, OAHU

DESCRIPTION

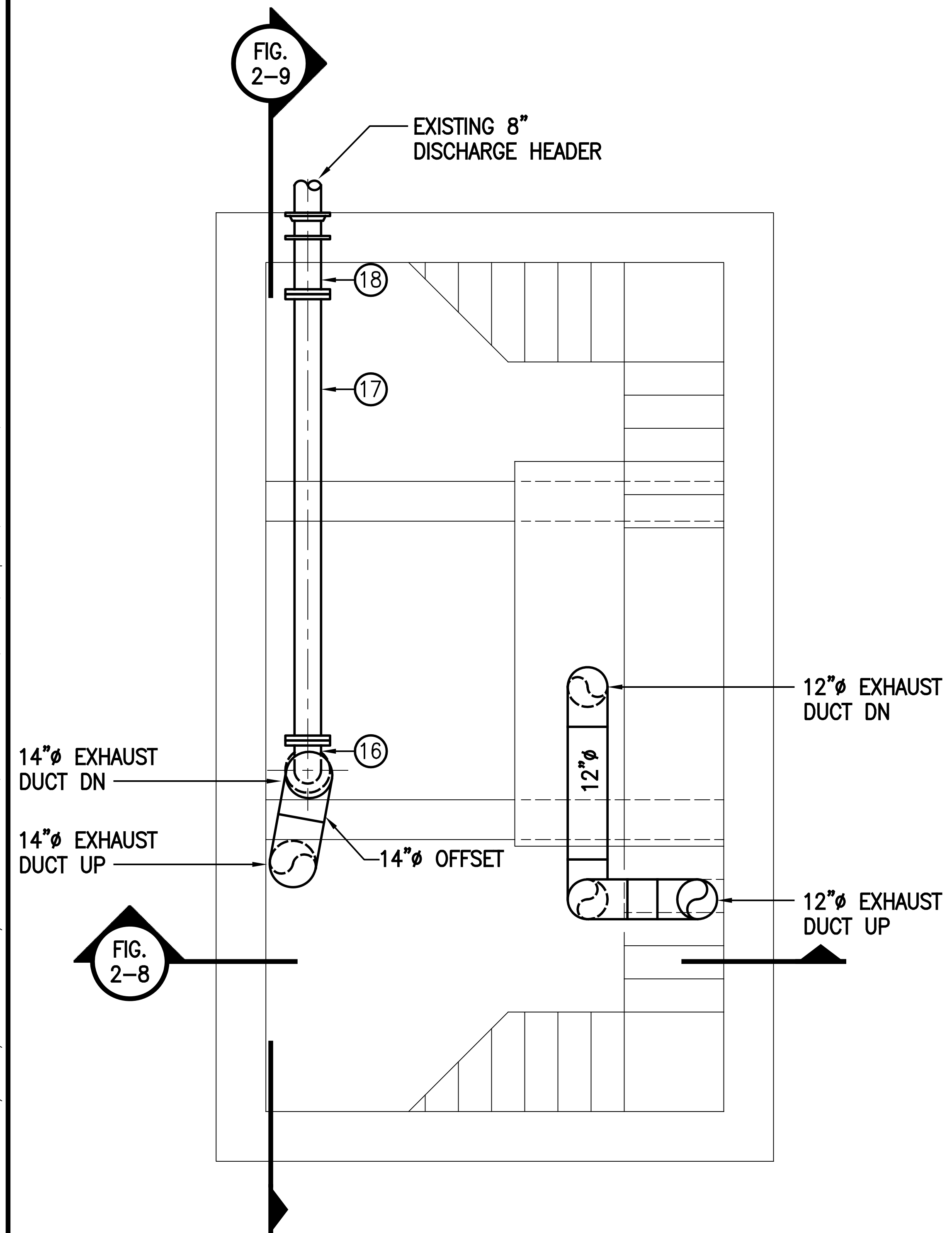
ALTERNATIVE NO. 2, 3 AND 4
NEW BASEMENT PLAN
AND MATERIAL LIST

OKAHARA AND ASSOCIATES, INC.

JOB NUMBER 2009107

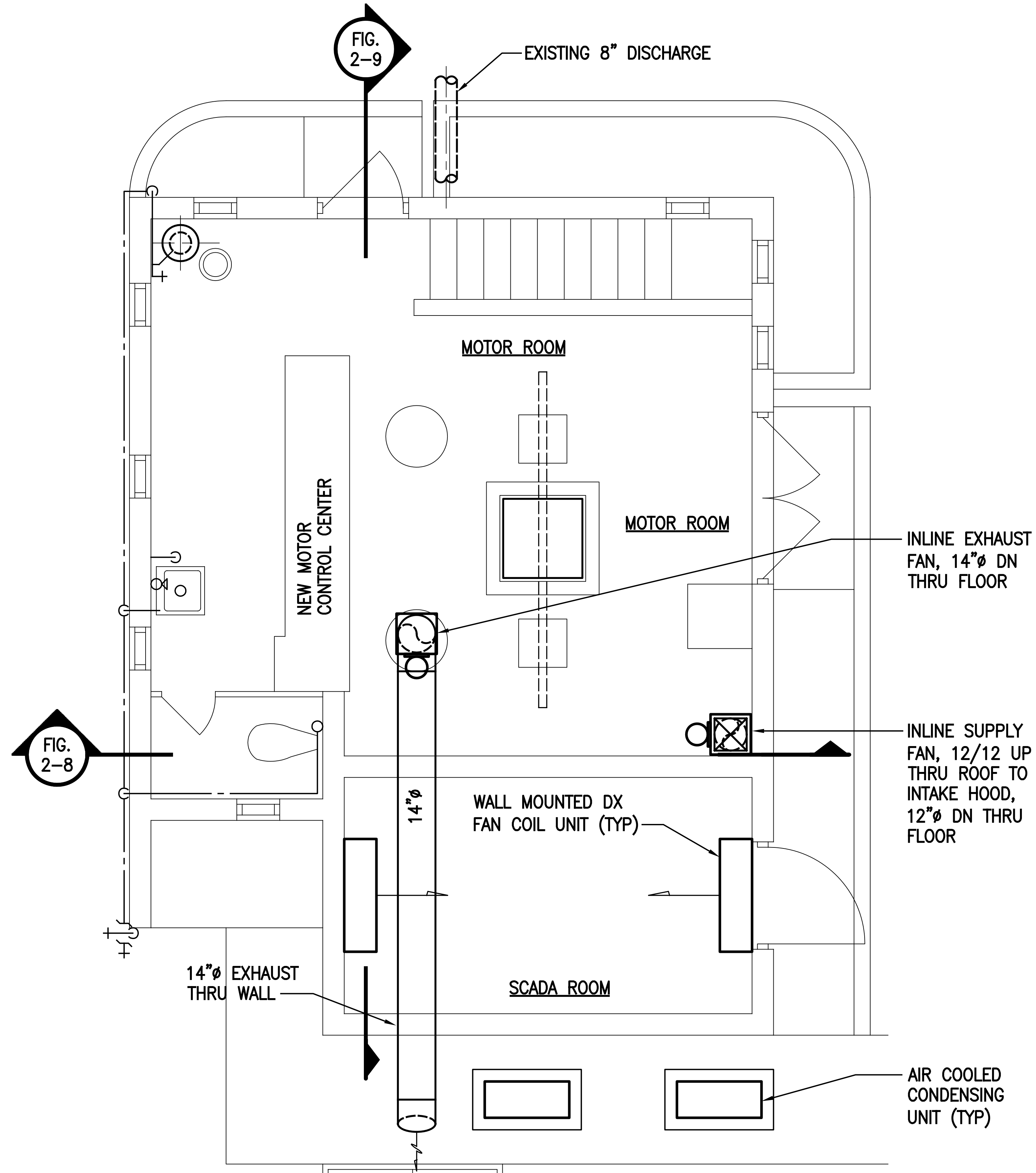
DATE JAN 2011

FIGURE 2-6




NEW INTERMEDIATE PLAN

SCALE: 1/4" = 1'-0"




NEW GROUND FLOOR PLAN

SCALE: 1/4" = 1'-0"

2' 0 4' 8' 12'

SCALE: 1/4"=1'-0"

NOTE:
SEE FIGURE 2-6 FOR MATERIAL LIST.

J:\D:\PROJ\21002\REPORT\FIG 2-PLAN-SECT.DWG/1=1/12-27-10/XREF=OA1117,x-Basement,x-Int,x-plan,x-sect-a, x-sect-b

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE

KANEOHE, OAHU

DESCRIPTION

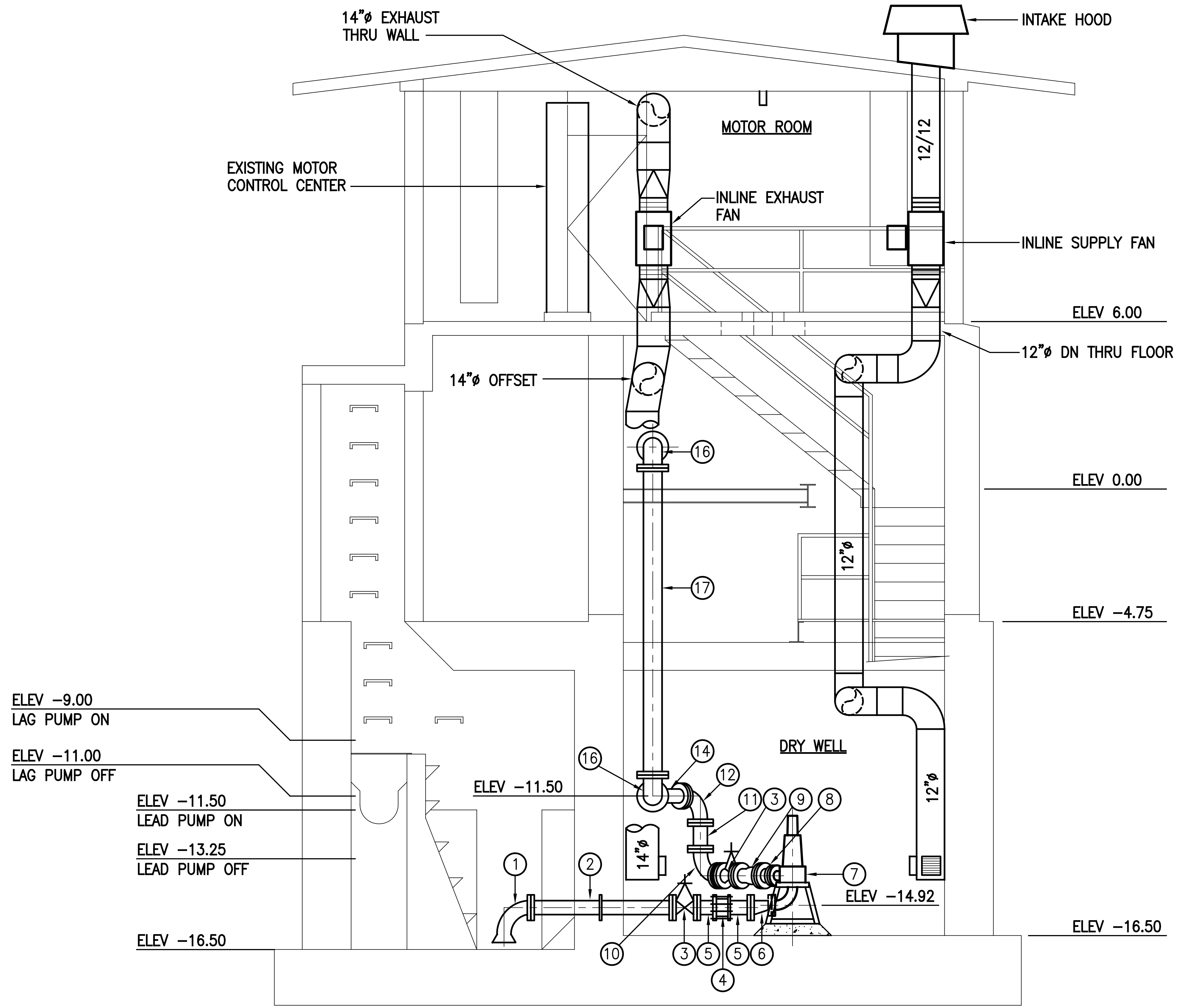
ALTERNATIVE NO. 2, 3 AND 4
NEW INTERMEDIATE AND GROUND FLOOR PLANS

OKAHARA AND ASSOCIATES, INC.

JOB NUMBER 2009107

DATE JAN 2011

FIGURE 2-7




NEW SECTION

SCALE: 1/4" = 1'-0"

**NOTE:**
SEE FIGURE 2-6 FOR MATERIAL LIST.

2' 0 4' 8' 12'
SCALE: 1/4"=1'-0"

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KANEOHE, OAHU

DESCRIPTION

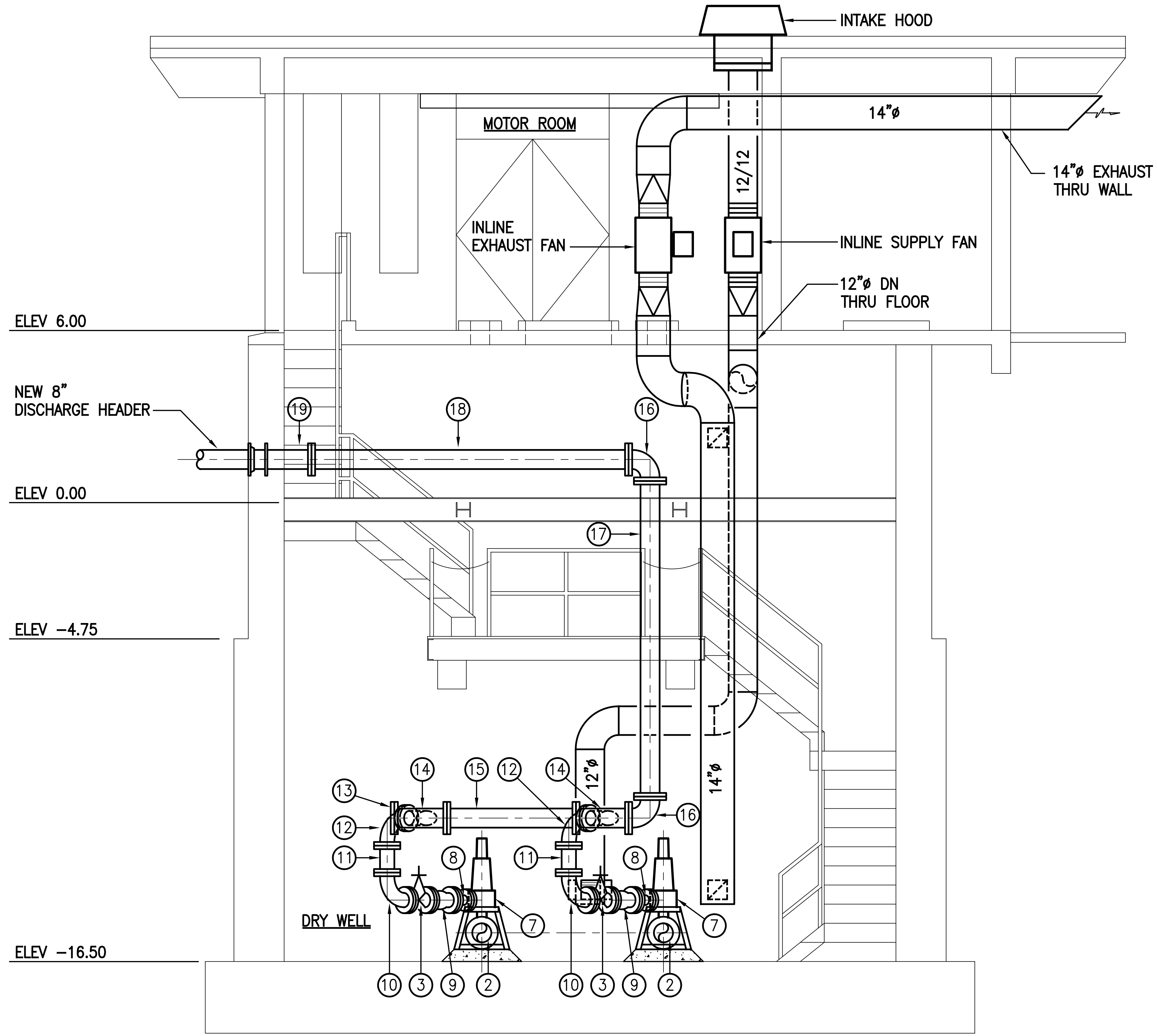
ALTERNATIVE NO. 2, 3 AND 4 NEW BUILDING SECTION

OKAHARA AND ASSOCIATES, INC.

JOB NUMBER 2009107

DATE JAN 2011

FIGURE 2-8




**NOTE:**
SEE FIGURE 2-6 FOR MATERIAL LIST.

## NEW SECTION

SCALE: 1/4" = 1'-0"

2' 0 4' 8' 12'

SCALE: 1/4"=1'-0"

DESCRIPTION

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KANEOHE, OAHU

ALTERNATIVE NO. 2, 3 AND 4
NEW BUILDING SECTION

OKAHARA AND ASSOCIATES, INC.

JOB NUMBER 2009107

DATE JAN 2011

FIGURE 2-9

Adverse short-term impacts include significant noise and visual unsightliness both on the WWPS premises as well as in the general vicinity during construction. One adverse long-term impact is that locking out one pump complicates the system controls and could cause issues for operators.

### 2.5.4 Alternative No. 4 - Install New Constant Speed Dry Pit Submersible Pumps (0.79 mgd @47 feet TDH)

Alternative No. 4 calls for the replacement of the existing separately coupled solids handling pumps with new larger capacity constant speed dry pit submersible pumps. Alternative No. 4 is identical to Alternative No. 3 except for two differences. The pumps were selected with a capacity of 0.79 mgd with one pump operating, and a capacity less than 1.14 mgd with two pumps operating. Because the maximum flow is limited to less than 1.2 mgd, no special controls are required.

Exceeding a maximum flow of 1.2 mgd may cause spills through downstream sewer manholes. See Table 2.2 and write-up immediately following it for a discussion of maximum allowable flows.

See Figures 2-6, 2-7, 2-8 and 2-9 for the proposed modifications to the WWPS plan and sections.

Adverse short-term impacts include significant noise and visual unsightliness both on the WWPS premises as well as in the general vicinity during construction. One adverse long-term impact is that sizing the pump for the peak observed current flow does not leave any room for community development. Any development that increases the wastewater flow will require increasing the capacity of the WWPS.

### 2.5.5 Alternative Options

There were a number of alternative options that were considered in response to requests by CSM. These options do not have a direct bearing on the proposed alternatives and may be implemented as DDC deems fit. See Table 6-2 for discussion regarding proposed alternative options.

### 2.5.5 Dismissed Alternatives

The following alternatives were briefly considered but dismissed because of what were deemed unacceptable adverse impacts. These opinions were based on designer preferences and does not account for City preferences.

- Variable speed pumps: Variable speed pumps were dismissed from consideration because they will not provide a significant benefit over constant speed pumps at Kahanahou WWPS. The relative small size of the pump station coupled with low average incoming flows severely limits the range of acceptable operating speeds that a variable speed pump could operate at while satisfying minimum required fluid velocities. For example, at a flow rate of 625 gpm, which is equivalent to the peak projected flow rate of 0.90 mgd, the velocity through the entrance of a 6-inch inlet bell is 2.1 feet per second. The minimum recommended velocity through the entrance of an inlet bell is 2.0 feet per second. A velocity of 2.0 feet per second through a 6-inch inlet bell is 592 gpm. Reducing the inlet bell to 4-inches would result in a velocity exceeding 15 feet per second through the suction pipe. Based on an acceptable flow range of 592 gpm to 625 gpm, the use of VFDs were dismissed from consideration.
- Separately coupled pumps: Separately coupled solids handling pumps with extension shafts were dismissed from consideration because the City operators prefer dry pit submersibles over separately coupled pumps and the life cycle cost difference between the two is negligible.

- Semi permanent engine driven pumps: The use of semi permanent, self priming, engine driven pumps was briefly considered because of the limited capacity of the existing electrical service. The WWPS has single phase electrical service and experiences noticeable voltage sags when pumps activate. Based on the estimated loads associated with necessary upgrades, it is believed that the existing electrical service will be sufficient. Furthermore, the use of semi permanent engine driven pumps may require an air permit. DOH reported that although emergency engine generators are exempt from air permits, emergency engine driven pumps are not exempt. They did add however that there is a mechanism to acquire an air permit exemption and that there is precedence for it at other City wastewater facilities. However, based on sufficient available electrical service, possible air permit triggers, and the temporary nature of these pumps, the use of them were dismissed from consideration.

# CHAPTER 3 – ARCHITECTURAL

## 3.1 INTRODUCTION

The Kahanahou WWPS site is located on the island of Oahu, at 45-13 Ka Hanahou Place, Kaneohe, Hawaii on a property owned by the City. This existing utility wastewater pump station serves the surrounding residential properties. This chapter provides general information on the existing Kahanahou WWPS site and infrastructure.

## 3.2 EXISTING CONDITIONS

The project site is 7,893 SF in lot area and is in very close proximity of Kaneohe Bay. It is bordered on three sides by residential properties, and a private access road - Ka Hanahou Place, is located at the front of the property. There is also an existing drainage easement that runs adjacent to the rear property line and encroaches slightly into the site. There is landscaping on site, which includes a few trees, hedges and a large, relatively flat, grassed area at the front of the property.

The wastewater pump station building permit was issued in 1964, with the construction of the building completed sometime in 1966. There is an existing CMU wall on the North East side of the property, a chain link fence surrounds the remaining sides with a double swinging gate at the driveway entrance.

The existing pump station building has CMU walls, a concrete roof with built-up roofing and concrete eaves with edge flashing. The existing doors, frames and louvers are aluminum. The building includes a generator room, pump station area, work area, toilet and service sink, motor control area, and an existing steel stairway with grating landings that lead to the basement level, which is the pump room. In reference to available records at the Department of Planning and Permitting, it appears there have been no improvements or upgrades to the pump station building since it was built in 1966.

### 3.2.1 GENERAL PROPERTY AND LAND USE INFORMATION

| | |
|---|---|
| Fee Owner: | City & County of Honolulu |
| Address: | 45-13 Ka Hanahou Place<br>Kaneohe, Hawaii 96744 |
| Tax Map Key: | 4-5-047: 095 |
| Total Lot Area: | 7,893 SF |

***PROJECT CODE INFORMATION:***
*(Based on 2003 International Building Code)*

| | |
|---|---|
| Occupancy Group: | F-1 |
| Type of Construction: | Type V-B (minimum)<br>Type V-A (existing) |
| Allowable Building Area: | 8,500 sf per story for V-B<br>14,000 sf per story for V-A<br><u>Actual:</u> 506 SF |
| Allowable No. of Stories: | 1 story for V-B<br>2 stories for V-A<br><u>Actual:</u> 1 story with basement |
| Automatic Fire Sprinkler: | Not required when built -<br>None installed |

***LAND USE CONTROL CODES:***

| | | |
|---|---|---|
| a) | Zoning: | R-10 (Residential District) |
| b) | Principal Use: | Utility Wastewater Pump Station – Type A<br>*Permitted use in R-10 zoning* |
| c) | Flood Zone: | Firm Zone X (Beyond 500 flood plain)<br>*NOT subject to flood hazard district regulations of the LUO*. |
| d) | Height Limit: | 25 feet unless sloping |
| e) | Historic Site: | No |
| f) | Lot Restrictions: | None |
| g) | SMA / Shoreline: | Special Management Area |
| h) | Special District: | No |
| i) | State Land Use: | Urban district |
| j) | Street Setback (road widening): None | |
| k) | Lot Development Standards: | |
| | Min. Lot Area: | 10,000 SF<br>Actual lot area: 7,893 SF<br>*The lot is non-conforming because it does not meet the min. lot area.* |
| | Min. Lot Width: | 65 ft for dwellings, 100 ft for other uses<br>Actual width: 60.0’ min width<br>*The lot is non-conforming because it does not meet the min. lot width.* |
| | Min. Lot Depth: | 65 ft for dwellings, 100 ft for other uses<br>Actual depth: 131.23’ min width |
| | Max. Bldg Area: | 50% of zoning lot<br>Max. Allowable: 3,946.50 SF<br>Actual: less than 50% |

l) Building Setbacks (yards):

Front: required: 10 ft for dwellings<br>30 ft for other uses<br><u>Actual:</u> exceeds 30 feet

Sides/Rear: 5 ft for dwellings<br>15 ft for other uses<br><u>Actual:</u> exceeds 15 feet

m) Transitional Height Setback: none

n) Zoning of Adjoining Property: R-10

o) Easements: Existing drainage easement contiguous to rear property line.
Existing access easement (road) at front of site.
Refer to site plan or Exhibit 3-1.

p) Encroachments: Drainage easement at rear.
Refer to site plan or Exhibit 3-1.

q) Parking Requirements:

No. of stalls required: 1 stall / employee
Stall Size Required: 18’-0” X 8’-3” (standard)
Off-Street Loading Requirements: not applicable – residential property

## 3.3 <u>DESIGN ALTERNATIVES</u>

Although the existing wastewater pump station force main pipe equipment was replaced in 2006, in reference to Chapter 2, the pumping station still has deficiencies to the system and will not be capable to handle projected peak wastewater flows. The following Architectural Design Alternatives were developed to meet the space requirements for the new pumps and other related equipment, and to comply with the current building code requirements as applicable.

***<u>Alternative No. 1:</u>*** Calls out for no action to be taken.

***Alternative Nos. 2, 3 & 4:***

Proposed improvements to upgrade the existing wastewater pump system warrants building alterations to accommodate the new mechanical and electrical equipment and to address additional space needed for required work clearances. Interior renovations to the existing wastewater pump station building, includes a conversion of the existing generator room to a new electrical room. A new emergency generator building required to support the new, upgraded pump equipment is also proposed for these alternatives. The following is required to support Alternative Nos. 2, 3 & 4:

- The existing generator room in the pump station building will be converted into an electrical room to house new SCADA equipment. In reference to Chapter 5 – Electrical, the new pump equipment will require additional power, panel space and working clearances. The double doors and louvers will be removed and openings filled in with CMU. There will be a new single door located at the existing exhaust louver location. This room will have computer equipment that requires a controlled environment, therefore, the room will be provided with an air conditioner.

- Exterior areas that are currently painted will be repainted to improve the appearance and to match the colors of the new generator building. The existing painted floors need to be repainted because they show signs of wear. Although the interior ceiling and walls below grade level appear acceptable, it is an option to paint these areas also to give the renovated pump station a good, consistent overall appearance.

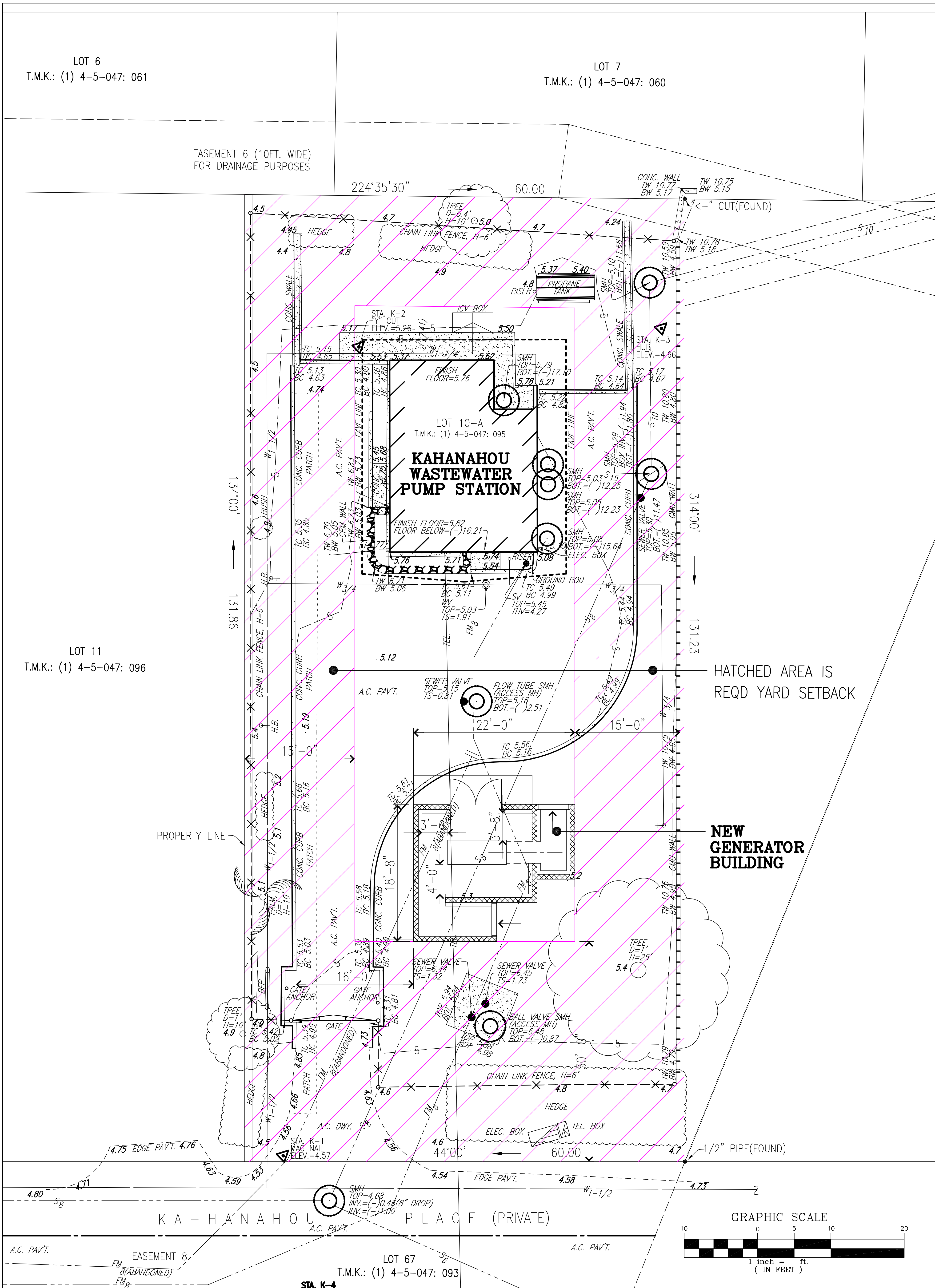
- A new emergency generator building located at the front of the property to support the existing pump station is proposed. Refer to Chapter 4 – Structural, for possible settlement issues observed around the building.

As a result of this observation, any addition or major alteration to the existing structure is discouraged due to high cost impact and possible unforeseen conditions. The proposed location and separate generator building provides minimal impact to the existing pump station building. Alternate locations of the new building were considered but are limited due to the required yard setbacks that need to be maintained for R-10 zoned lots with uses other than residential. Any encroachments into the yard setbacks will require a zoning waiver (special permit).

- Sufficient outdoor air intake and exhaust is required for the new generator. The generator size and minimum work clearances in front of the electrical panel boxes that are required by code are other factors that determine the size of the building. See attached site plan, Figure 3-1, for the proposed location of the new building.

- The proposed generator building materials and finishes shall complement and/or match the existing pump station building. This includes CMU concrete block walls, metal doors and frames, stainless steel louvers, screened openings and a low sloping concrete roof to match the pump station roof slope. Selected CMU walls, doors and louvers will be acoustically treated.

- The proposal of a new building may trigger special zoning permits, such as an Environmental Impact Statement (EIS), Special Management Area (SMA) and/or shoreline permit. Any special permits that require processing will impact the project schedule. Upon final selection of the Alternative by DDC, it is recommended that a letter be submitted to the Dept. of Planning & Permitting Director to evaluate the proposed scope and determine if any special permits are required. There may be a possibility of exemption to these special permits due to the use and function of the facility and pursuant to applicable exemption class of the Dept. of Environmental Services Comprehensive Exemption List.




DESCRIPTION

ALTERNATE NOS. 2, 3 & 4

ARCHITECTURAL SITE PLAN

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER
PUMP STATION UPGRADE
KANEOHE, OAHU

| | | | | |
|---|---|---|---|---|
| OKAHARA AND ASSOCIATES, INC. | JOB NUMBER 2009107 | DATE JAN 2011 | FIGURE 3-1 | 3-8 |

# CHAPTER 4 – STRUCTURAL

## 4.1 INTRODUCTION

The structural related issues included in the renovation of the Kahanahou Wastewater Pump Station include the following:

a. The construction of a new emergency generator building that will be independent of the pump station structure.
b. The relining of the wet well concrete surfaces.

## 4.2 EMERGENCY GENERATOR SHED

The emergency generator building will be constructed of CMU concrete block walls and a cast-in-place concrete roof. Acoustically treated openings will provide ventilation for the generator when in operation. The support of the building will be determined once the geotechnical soil borings and analysis report is complete. The options will include a concrete spread footing, or a deep foundation, such as micropiles or driven piles. The factors that will be considered in the foundation decision will be the weight of the shed structure and the bearing capacity of the soil.

## 4.3 LINING OF THE WET WELL

On December 28, 2010, a cursory inspection was conducted of the wet well at Kahanahou WWPS. The inspection found that the access shafts that lead down to the wet well chambers are lined with a black coating, possibly a coal tar epoxy. Below that, within the visible portions of the wet well chambers, the black coating appears to be worn away, exposing the concrete substrate to the corrosive wastewater. In addition, the existing 8 inch pump suction pipe that currently penetrates through the concrete wall into the wet wells is being replaced with a new 6 inch pipe. This work will require partial demolition of the existing wall surrounding the suction pipe. This demolition work will destroy whatever lining is left in that area. For long term performance, the concrete needs to be protected against the corrosive effects of the wastewater, which will erode away the concrete and reinforcing steel over time. A tactile inspection of the wet well chambers can be conducted once the wet well chambers are drained and properly ventilated. This inspection would determine what, if any, damage has occurred to the concrete surfaces by the wastewater.

Regardless of the results of any further inspection work, the wet well surfaces should be properly protected. The original protective liner should be replaced with a new, corrosion-resistant polymer, monolithic lining. One such lining system is manufactured by Sauereisen, Inc. See Appendix G for material data sheets for SewerGard No. 210T. This lining material is currently being installed in the Beachwalk WWPS wet well.

# CHAPTER 5 – ELECTRICAL SYSTEM

## 5.1 EXISTING ELECTRICAL SYSTEM

Electric service for the Kahanahou WWPS is provided by Hawaiian Electric Company (HECO) via underground facilities on Kahanahou Place. Their existing service transformer is mounted on a utility pole located on Kahanahou Place. The HECO pole-top transformer bank steps down their single-phase medium voltage to 120/240 volts, 1-phase, 3-wire service which feeds the WWPS. The existing 120/240 volts, 1-phase, 3-wire secondary service conductors are run underground from the utility pole to an existing service pullbox located outside the fence line of the WWPS. From the pullbox, the service conductors are extended through an existing meter socket located on the exterior wall of the building and terminate at the existing motor control center (MCC). See the Existing Electrical Site Plan on Figure 5-1.

The existing interior electrical system consists of the existing MCC which includes the main circuit breaker for the building, an automatic transfer switch, distribution switches for the station pumps and ventilation system, and a 120/240 volt, 1-phase, 3-wire electrical panelboard to feed general electrical loads. See the Existing Electrical Plan and Existing One-Line Diagram on Figures 5-3 and 5-6.

The normal power system is backed-up by an existing propane fueled emergency generator. The existing generator is a 120/240 volt, 1-phase, 3-wire, 45 kilowatt (kW) standby generator. The existing 120/240 volt, 1-phase, 3-wire emergency power feeder is routed through the existing automatic transfer switch located in the MCC.

The existing SCADA System for the WWPS consists of a single SCADA cabinet equipped with Barrington equipment.

### 5.1.1 EXISTING ELECTRICAL SYSTEM DEFICIENCIES

The existing electrical system has a number of deficiencies currently affecting the operation of the WWPS. The deficiencies listed below have been identified through extensive research of the existing electrical system. Each item will include a brief discussion on how the deficiencies will be addressed by the design alternatives being proposed.

- The existing electrical system experiences large voltage dips during operation of the station pumps. Specifically, when the station pumps are started. The voltage dips are significant enough to cause the light fixtures throughout the WWPS to dim momentarily. Large voltage dips do have the potential to cause premature failure of the pumps and the pump control equipment due to the increase in current draw associated with a decrease in voltage. Alternatives 2, 3 and 4 will address this deficiency.

  Based on information provided HECO, the WWPS does not share its secondary electric service conductors with any of the neighboring residences so the voltage dips should not be transferred to the electrical systems of those residences.

- The existing electric service for the WWPS is a 120/240 volt, 1-phase, 3-wire service. The station pumps require a 240 volt, 3-phase, 3-wire feeder. To accommodate the electrical requirements of the pumps, phase converters are required which add a level of complexity to the electrical system that is not common at other pump stations. The process of converting a 1-phase power source to a 3-phase power source is not 100% efficient and therefore requires more energy to feed the pump than if the pump was connected directly to a 3-phase power source. This deficiency will not be addressed by the alternatives being proposed however, it is listed as an alternative option. This alternative option is discussed at the end of this Chapter and in the alternative options list in Chapter 6, Table 6-2.

- The electrical equipment including the MCC and emergency generator are very old and deteriorating. The existing equipment was installed in 1965. Typically, the life cycle of an MCC and generator ranges between 30 and 40 years. Alternative 2, 3 and 4 will address this deficiency.

- The existing light fixtures in the WWPS consist of a mix of incandescent and fluorescent light fixtures. Fluorescent light fixtures have been installed throughout pump stations at other sites on the island to decrease energy usage. This deficiency will not be addressed by the alternatives being proposed however, it is listed as an alternative option. See Chapter 6, Table 6-2 for the alternative options.

- The existing SCADA system is based on the Barrington system. The Barrington system is no longer supported by the manufacturer and replacement parts have become difficult to source. Future repairs will become more difficult as the supply for parts is diminished. Alternative 2, 3 and 4 will address this deficiency.

- Signs of corrosion were observed on the exterior light fixtures and exterior exposed conduits feeding various light fixtures and other electrical items. The corrosion did not appear to be to the point of complete penetration of the material however, if penetration does occur, it is potentially a safety hazard if it results in the exposure of live conductors. This deficiency will not be addressed by any of the alternatives being proposed however, it is listed as an alternative option. See Chapter 6, Table 6-2 for the alternative options.

- The exterior lighting system consists of a mix of incandescent and high intensity discharge (HID) light fixtures. The existing fixtures do not feature cutoff optics and complaints have been made by the neighboring residences about light pollution. The deficiency will not be addressed by the alternatives being proposed however, it is listed as an alternative option. See Chapter 6, Table 6-2 for the alternative options.

## 5.2 NEW ELECTRICAL SYSTEMS

The following proposed new electrical systems were developed to support the Alternatives described in Chapter 2. See the New Electrical Site Plan, Electrical Plans, and One-Line Diagram on Figures 5-2, 5-4, 5-5 and 5-7. Electrical load calculations for each of the proposed alternative are included in Appendix H.

### 5.2.1 Alternative No. 1 – No Action

No methods of construction will need to be undertaken. No action taken will result in the WWPS continuing to suffer from the deficiencies listed above. The voltage dips experienced by the WWPS are of the greatest concern as prolonged exposure to this condition could prematurely damage the station pumps and the associated control equipment.

Short term impacts that would result without an upgrade to the electrical system would be that the WWPS will be unable to accommodate the equipment required to meet the demand described in Chapter 2.

Long term impacts include potential failure of the MCC and emergency generator and the inability to get replacement parts for the existing

Barrington SCADA system should a failure occur.

### 5.2.2 Alternative No. 2

Alternative No. 2 calls for the replacement of the existing MCC, replacement of the existing Barrington SCADA system, and replacement of the existing emergency generator. The following is a list of improvements that will be required.

- Replacement the existing MCC with a new smart MCC. The new MCC will be DeviceNet capable and based on the Allen Bradley Intellicenter MCC. Based on the meter data provided by HECO, the capacity of the existing electric service is sufficient to support the load of 2-15HP pumps operating concurrently however, the inrush current due to the startup of the station pumps is likely to overload the electrical system. To address this issue, variable frequency drives (VFDs) will need to be provided to limit the inrush current at the time of startup. Because the electric service is a 120/240 volt, 1-phase, 3-wire service and the station pumps are 240 volt, 3-phase, 3-wire pumps, phase converters will need to be provided in the MCC to feed the 3-phase pumps from the 1-phase electrical system.

  To avoid an electrical outage to the WWPS, a temporary exterior MCC would need to be provided to operate and control the WWPS while the new MCC is installed in the existing MCC's location. The temporary MCC will remain until the installation of the new MCC has been completed.

- Replacement the existing Barrington SCADA system with a new PLC based SCADA system per the current City standards. The new SCADA equipment cabinet will be located in the existing generator room which will be emptied upon the replacement of the existing generator.

City standards require that the WWPS be equipped with two sources of power at all times. To allow the new SCADA equipment to be installed in the existing generator room, a temporary generator will need to be provided on the site while the existing generator is removed. The temporary generator will remain until the installation of the new emergency generator has been completed. It is also possible that the replacement of the emergency generator could be phased such that the installation of the new generator is completed prior to the replacement of the SCADA equipment. This would eliminate the need for a temporary generator. The replacement of the existing generator is discussed below.

To avoid an outage to the SCADA system, the existing Barrington system will remain until the installation of the new PLC based SCADA system has been completed.

- Replace the existing propane fueled emergency generator with a new diesel engine generator. Due to the increase in size of the station pumps, the generator capacity will need to be increased to 100kW to account for the possible inrush current requirements of the pumps. Manufacturer's data for a typical 100kW generator are included in Appendix H. The new generator will be installed in a new remote generator building located on the property. A new automatic transfer switch will be located in the generator building.

  The proposed location of the new generator building is directly over the existing electric and telephone service ductline. The ductlines will need to be rerouted around the generator building footprint to allow the new building footings to be installed.

- Adverse short term impacts will include long periods of increased noise due to construction. Construction will need to be phased to avoid electrical, SCADA, and emergency system outages at all times. This phasing will result in an extended duration of construction. The project will realize increased costs due to the construction phasing.

- Adverse long term impacts will include increased complexity of the electrical system due to the presence of the phase converters required to feed the 3-phase pumps from the 1-phase electrical system. Increased complexity will also be evident in the control system due the presence of the VFDs for the larger pumps. Both items are uncommon to pump stations on the island and special training will be required for the operators to ensure proper operation of this pump station.

### 5.2.3 Alternative No. 3

Alternative No. 3 will also include the replacement of the MCC, SCADA system and emergency generator as described in Alternative No. 2. The addition of a lockout feature to limit the operation of the station pumps to only one pump at any given time will allow the new emergency generator size to be reduced to 60kW. Manufacturer’s data for a typical 60kW generator are included in Appendix H. The VFDs for the station pumps would not be required under this alternative due to the addition of the lockout feature. Soft starters would be utilized to limit the inrush current of the station pumps resulting in less complex control system. Adverse short term and long term impacts will be similar to those listed in Alternative No. 2.

### 5.2.4 Alternative No. 4

Alternative No. 4 will include replacement of the MCC, SCADA system and emergency generator as described in Alternatives No. 2 and 3. The reduction of the station pump sizes from 15HP in Alternatives No. 2 and 3 to 10HP will allow the new emergency generator size to be reduced to 60kW. In addition to the reduction of the generator size, the decreased pump sizes will not require the use of a VFD to limit the inrush current of the pump on startup. Soft starters would be utilized in lieu of VFDs similar to Alternative No. 3.

### 5.2.5 Alternative Option – Upgrade Electric Service to 480 volt, 3-phase, 3-wire

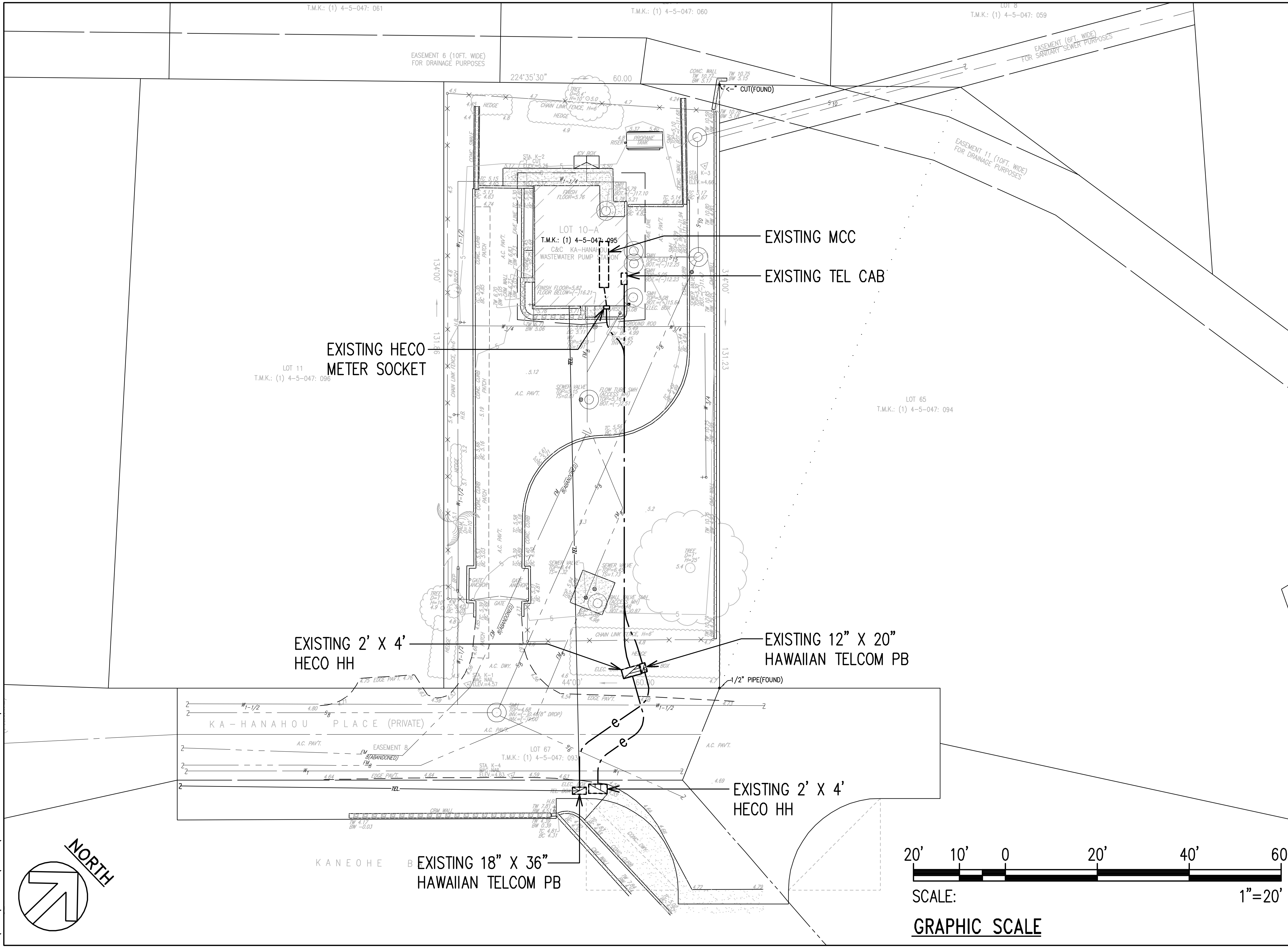
An alternative option to upgrade the electric service for the WWPS from 120/240 volt, 1-phase, 3-wire to 480 volt, 3-phase, 3-wire is indicated in the alternative options list included in Chapter 6, Table 6-2. This option directly addresses two deficiencies previously discussed in this section.

The first is the use of phase converters to feed the 3-phase station pumps from the 1-phase electrical system. Upgrading the system to a 3-phase system will eliminate the need to use such devices and simplify the electrical system to be similar to other pump stations on the island. It will also eliminate the inefficiency of the phase converter resulting in lower energy consumption by the station pumps.

The second deficiency addressed is the voltage dips caused by the large in rush current during the starting of the station pumps. Increasing the service voltage from 240 volt, 1-phase to 480 volt, 3-phase will reduce the amount of current drawn by the pumps. This decrease in startup current will reduce and/or eliminate the voltage dips being observed by the pump station in its current condition without the use of complex control devices like the VFDs proposed in Alternate No. 2 or the soft starters in Alternative No. 3 and 4. The elimination of the VFD and/or soft starter simplifies the control system to be similar to other pump stations on the island and eliminated the need for special training to operate this pump station.

Upgrading the electric service to 480 volt, 3-phase, 3-wire will also allow for a decrease in size of the emergency generator to 50kW.

The cost of implementing this alternative option will be very high due to the current condition of HECO's electrical distribution system along Kahanahou Place. HECO's existing distribution system does not include 3-phase service along Kahanahou Place. To extend 3-phase service to the pump station, HECO's 3-phase primary distribution system will need to be extended from Lilipuna Road, down, Kahanahou Circle, and then down Kahanahou Place. Preliminary estimates to extend HECO's 3-phase distribution system to Kahanahou Place are in the range of $150,000 to $200,000. This cost does not include the cost of the new MCC, metering equipment, and emergency generator that would be required to implement this option.

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KAHANAHOU WASTEWATER
PUMP STATION UPGRADE
KAILUA, OAHU

PAGE 5-10

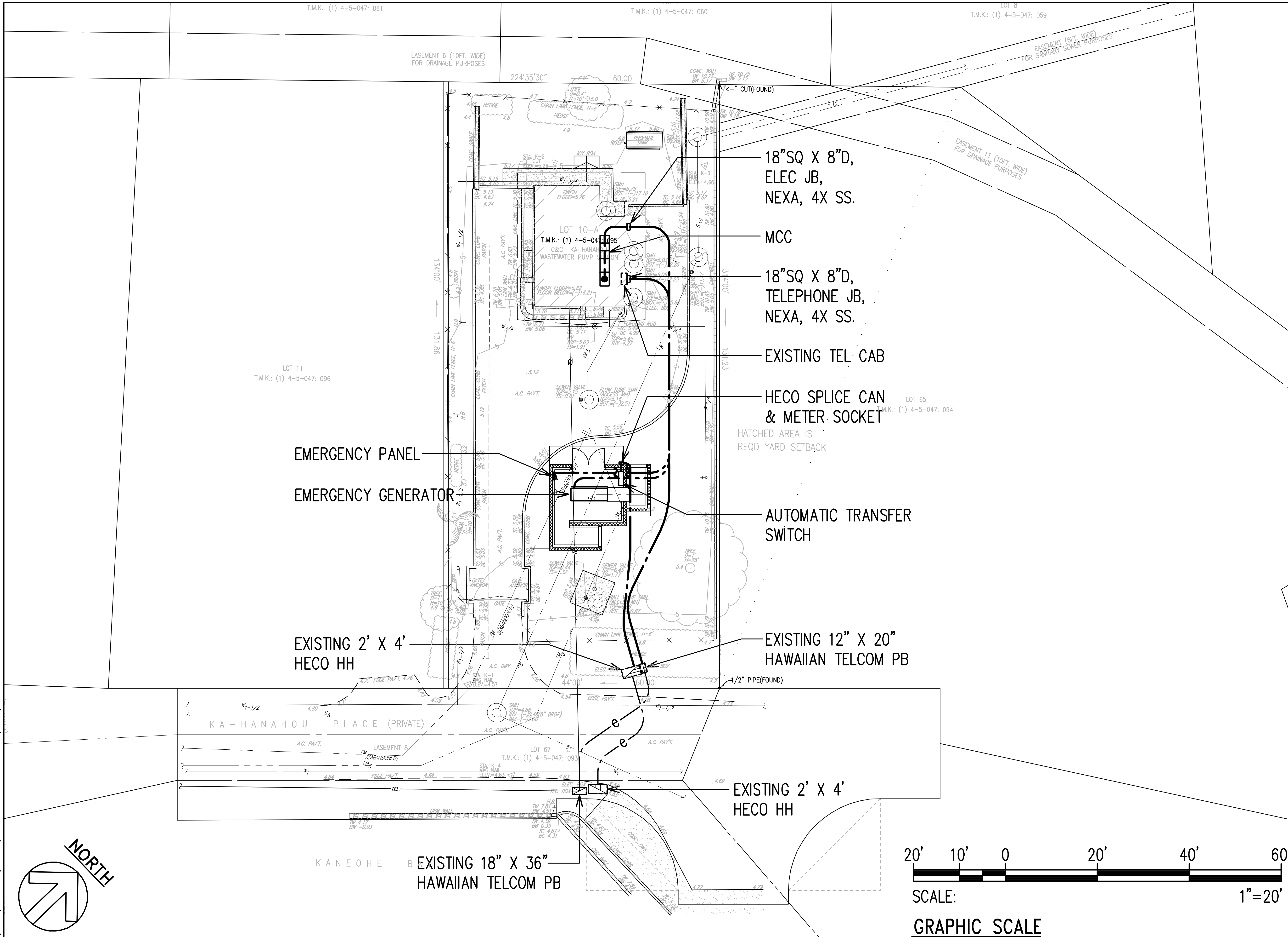
FIGURE 5-1

# ALTERNATIVE NO. 1
# EXISTING ELECTRICAL SITE PLAN

DESCRIPTION

| JOB NUMBER | DATE |
|---|---|
| 2009107 | JAN 2011 |

OKAHARA AND ASSOCIATES, INC.

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KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KAILUA, OAHU

DESCRIPTION

# ALTERNATIVE NO. 2, 3, AND 4 ELECTRICAL SITE PLAN

OKAHARA AND ASSOCIATES, INC.

| JOB NUMBER | DATE |
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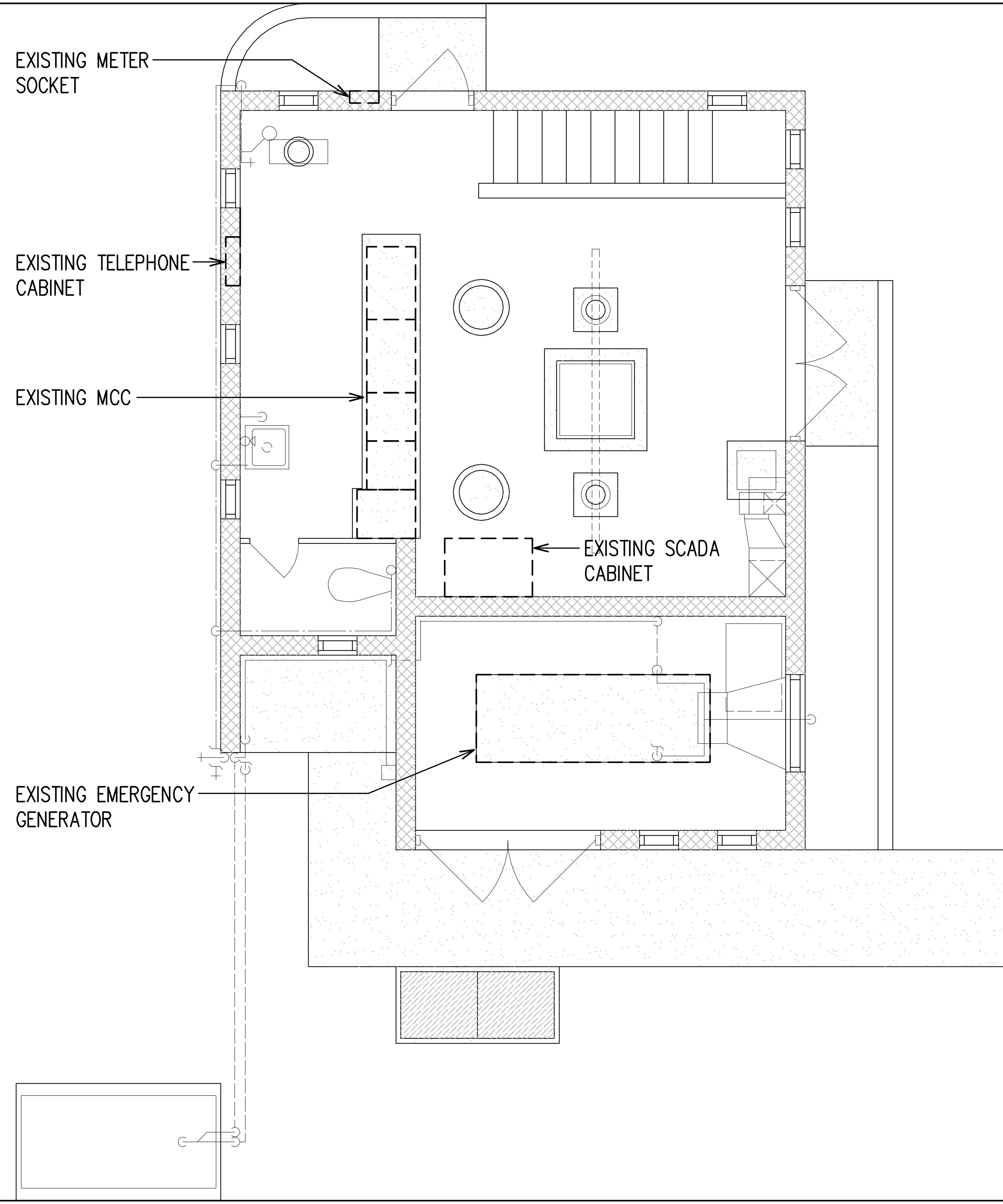
| 2009107 | JAN 2011 |

FIGURE 5-2

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KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KAILUA, OAHU

DESCRIPTION

# ALTERNATIVE NO. 1
# EXISTING ELECTRICAL PLAN

OKAHARA AND ASSOCIATES, INC.

| JOB NUMBER | DATE |
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| 2009107 | JAN 2011 |

FIGURE 5-3



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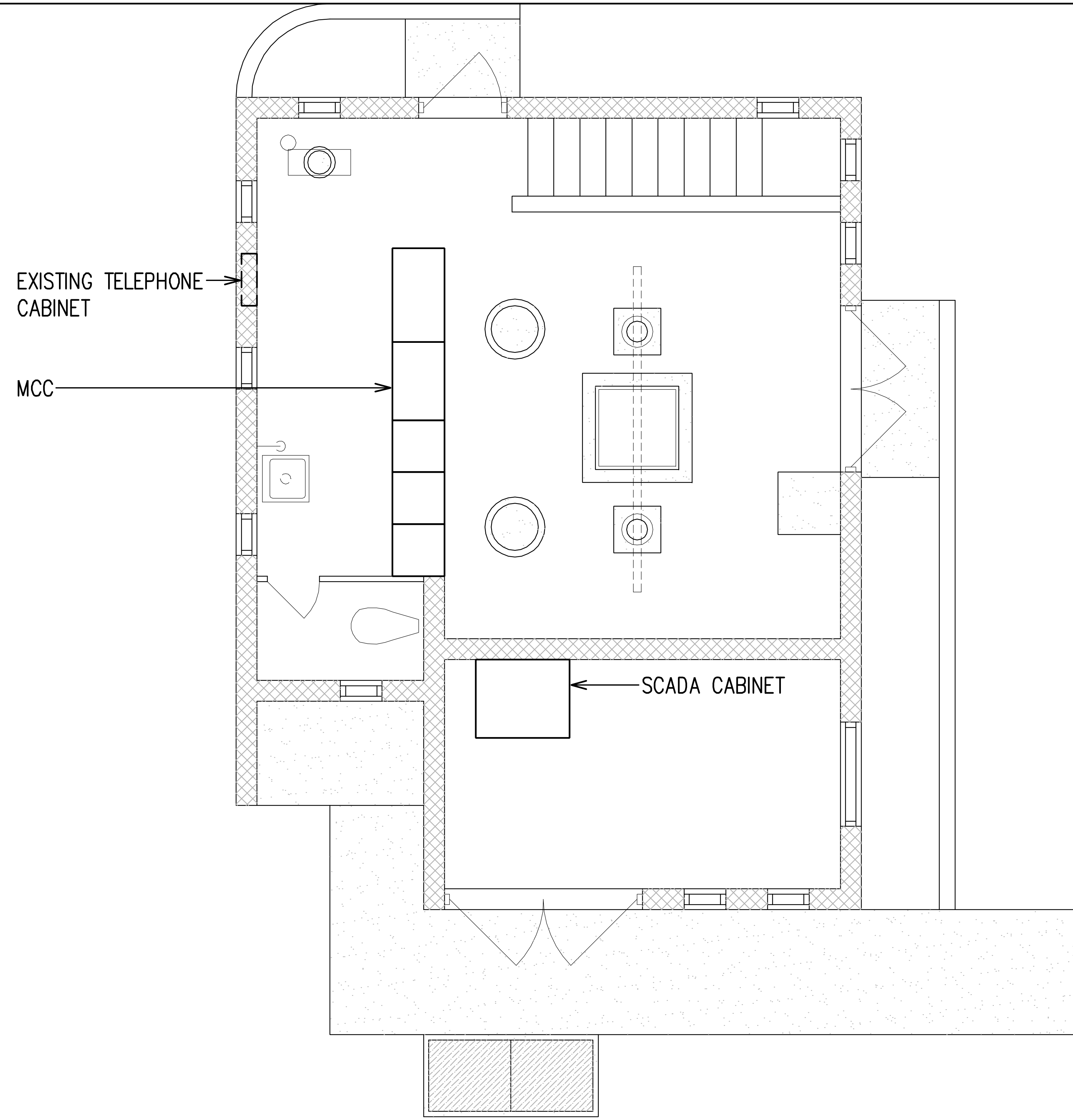


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PUMP STATION UPGRADE
KAILUA, OAHU

DESCRIPTION

# ALTERNATIVE NO. 2, 3, AND 4
# ELECTRICAL PLAN

OKAHARA AND ASSOCIATES, INC.

| JOB NUMBER | DATE |
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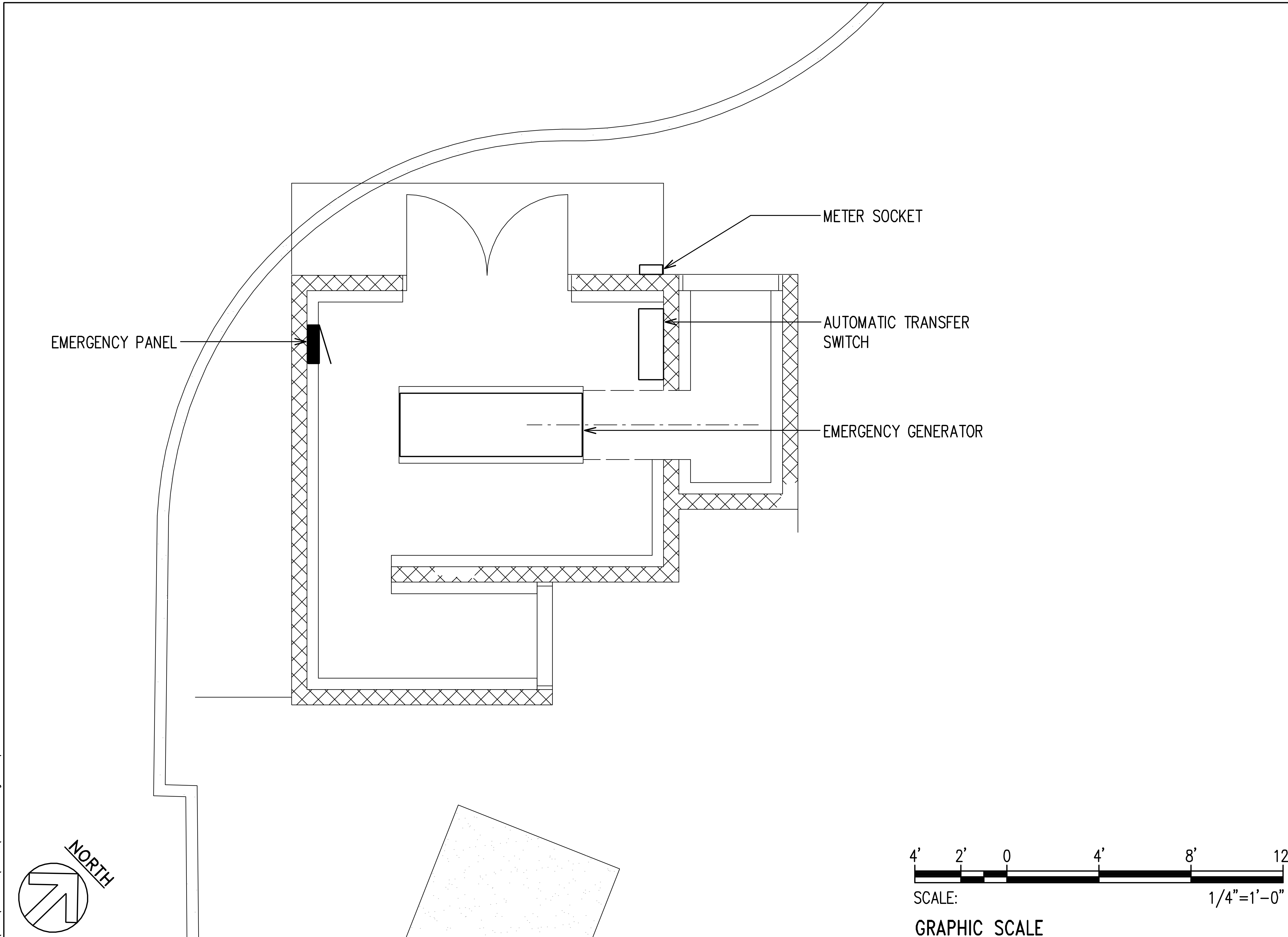
| 2009107 | JAN 2011 |

FIGURE 5-4

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KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KAILUA, OAHU

PAGE 5-14

FIGURE 5-5

DESCRIPTION

# ALTERNATIVE NO. 2, 3, AND 4 GENERATOR ROOM - ELECTRICAL PLAN

| JOB NUMBER | DATE |
|---|---|
| 2009107 | JAN 2011 |

OKAHARA AND ASSOCIATES, INC.

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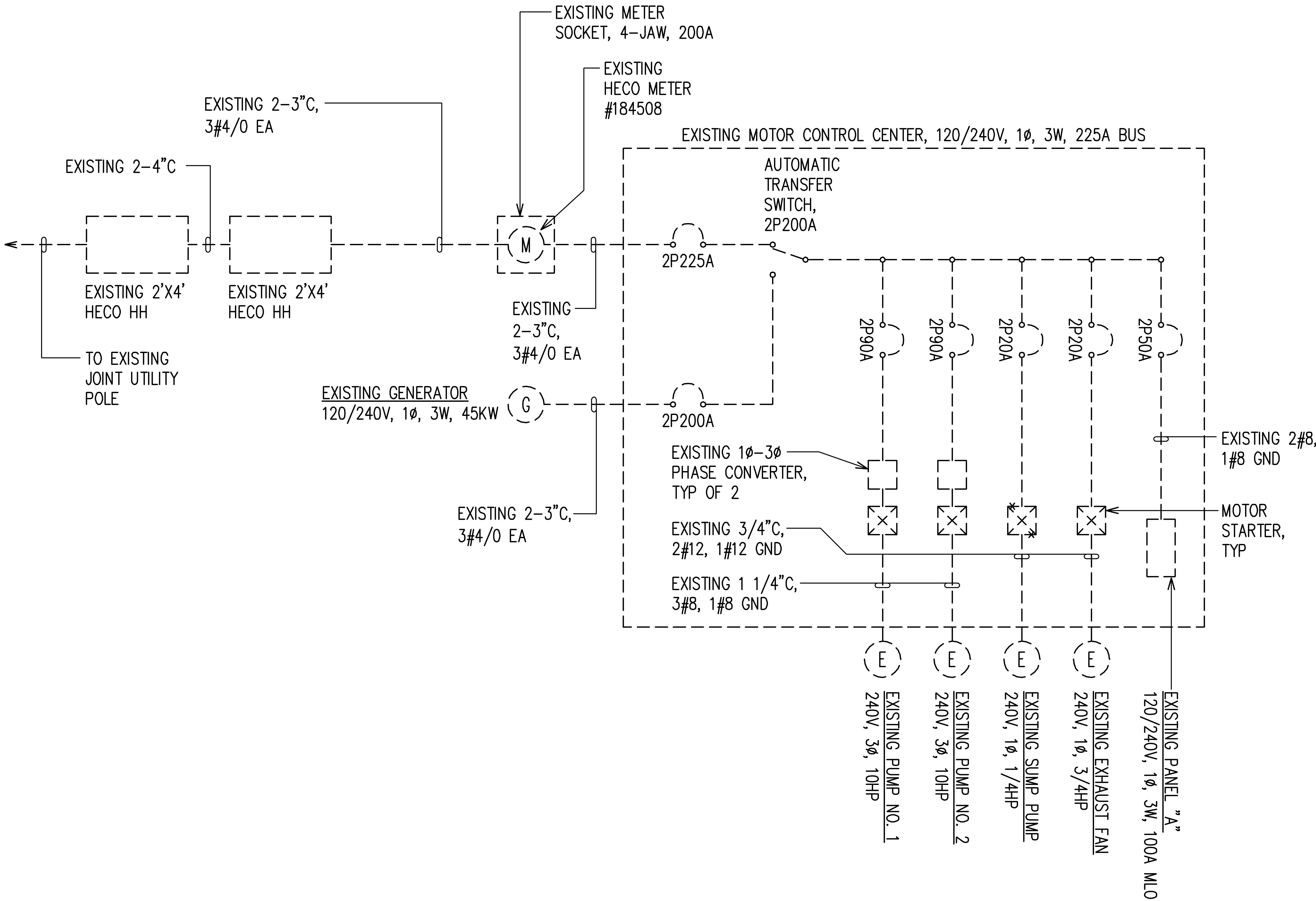


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KAHANAHOU WASTEWATER
PUMP STATION UPGRADE
KAILUA, OAHU

PAGE 5-15

FIGURE 5-6

DESCRIPTION

ALTERNATIVE NO. 1
EXISTING ONE-LINE DIAGRAM

| JOB NUMBER | DATE |
|---|---|
| 2009107 | JAN 2011 |

OKAHARA AND ASSOCIATES, INC.

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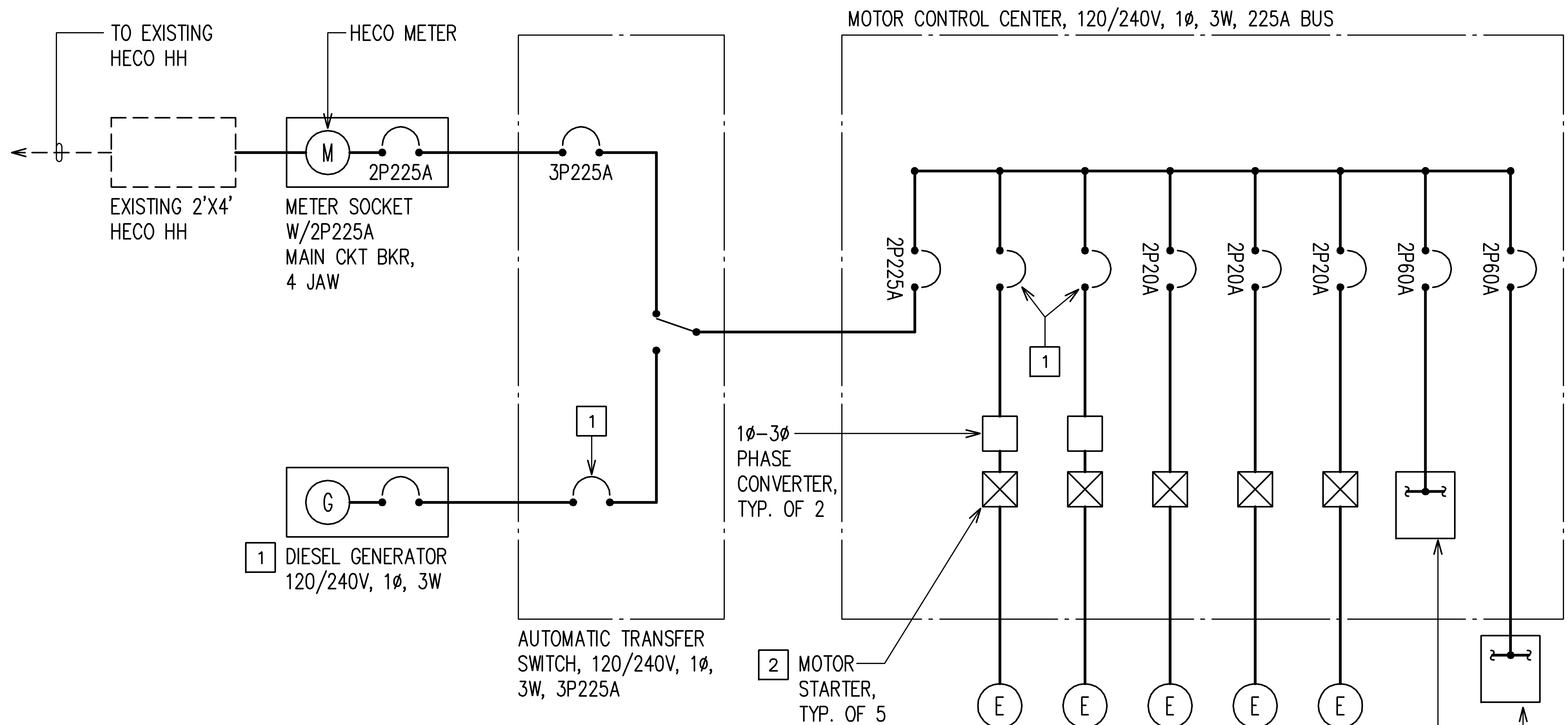


**NOTES:**

1. SIZE TO VARY BASED ON MECHANICAL DESIGN ALTERNATIVES.
2. STARTER TO FEATURE VARIABLE FREQUENCY DRIVE OF SOFT START BASED ON MECHANICAL DESIGN ALTERNATIVES.

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DESCRIPTION

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU
KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KAILUA, OAHU

# ALTERNATIVE NO. 2, 3, AND 4 ONE-LINE DIAGRAM

OKAHARA AND ASSOCIATES, INC.

JOB NUMBER 2009107 | DATE JAN 2011

FIGURE 5-7

# CHAPTER 6 – EVALUATION OF ALTERNATIVES AND OPTIONS

## 6.1 INTRODUCTION

This chapter compares the proposed design alternatives based on a summary of technical evaluations presented in the previous chapters. The purpose of this comparison is to determine the recommended course of action to upgrade Kahanahou WWPS.

This chapter also evaluates a number of options that CSM personnel requested. These options run the gambit of "nice to haves" to addressing deficiencies that are unrelated to any particular code or standard.

## 6.2 ALTERNATIVE SELECTION EVALUATION CRITERIA

Evaluation criteria were created in order to rank the suggested alternatives. Each alternative was ranked 1 to 5 for each criterion with 1 representing an excellent score and 5 representing a poor score. The following criteria were used to evaluate the recommended alternatives:

- Life Cycle Cost: This includes all design, capital, operational and maintenance costs of an alternative. A life span of 20 years and a discount rate of 5% were used to evaluate each alternative.
- Operator Preferences: This is a rating of each alternative in the order of operator (Kailua WWTP) preference.
- Satisfy Design Objective: This is a rating of how well the alternative will increase the capacity of the WWPS to meet projected peak flow rates.
- Adverse Short-Term Impacts: Adverse short-term impacts were limited to impacts that occur during the implementation of an alternative.
- Adverse Long-Term Impacts: Adverse long-term impacts were limited to impacts that occur after the implementation of an alternative.

- Adequately Address Existing Deficiencies: This is a rating of an alternative's ability to address existing deficiencies noted in the respective sections. Deficiencies that occur beyound the boundaries of the WWPS were in large part excluded from the evaluation.

All of the alternatives and scores were inputted into an evaluation matrix. The matrix also has a weighting factor that is used to emphasize the importance of one criterion over another. See Table 6-1 for the Alternative Selection Evaluation Matrix.

### 6.2.1 Life Cycle Cost Criterion Description

The first criterion is the life cycle cost of an alternative. This includes the cost to construct, operate and maintain Kahanahou WWPS. The intent of the criterion is to evaluate each alternative on its expected lifetime cost as opposed to evaluating capital, energy and maintenance costs separately. The following general assumptions were made to complete the evaluation. See Appendix I for rough budgetary cost estimates. See Appendix J for life cycle cost calculations and additional assumptions.

- Project will not commence till 2012. An Annual inflation rate of 5% per year was applied to all of the estimated capital costs.
- An annual discount rate of 5% per year was used.
- Electricity costs of $0.234 per kWh (Based on HECO Schedule G Rates effective 12-01-2010)
- Maintenance costs coordinated based on professional judgment and input from CSM personnel.

## TABLE 6-1 KAHANAHOU WWPS
## ALTERNATIVE SELECTION EVALUATION MATRIX

| Alt. No. | Description | Flow Rate (MGD) | Motor (HP) | Construction Cost | Present Worth Life Cycle Cost[1] | Life Cycle Cost Points | Life Cycle Cost Weight | Operator Preferences Points | Operator Preferences Weight | Meet Req'd Flows Points | Meet Req'd Flows Weight | Adverse Short Term Impacts Points | Adverse Short Term Impacts Weight | Adverse Long Term Impacts Points | Adverse Long Term Impacts Weight | Address Deficiencies Points | Address Deficiencies Weight | Total Points[2] | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No Action | 0.50 | 10 | $0 | $426,000 | 5 | 4 | 3 | 2 | 5 | 5 | 1 | 1 | 5 | 3 | 5 | 3 | 82 | 4 |
| 2 | New Dry Pit Submersible Pumps with VFD | 0.90 | 15 | $3,076,000 | $3,363,000 | 5 | 4 | 1 | 2 | 1 | 5 | 4 | 1 | 3 | 3 | 2 | 3 | 46 | T2 |
| 3 | New Dry Pit Submersible Pumps with Soft Starter | 0.90 | 15 | $3,019,000 | $3,306,000 | 5 | 4 | 1 | 2 | 1 | 5 | 4 | 1 | 3 | 3 | 2 | 3 | 46 | T2 |
| 4 | New Dry Pit Submersible Pumps | 0.79 | 10 | $2,959,000 | $3,296,000 | 5 | 4 | 1 | 2 | 2 | 5 | 4 | 1 | 2 | 3 | 1 | 3 | 45 | 1 |

Note: Criteria columns are grouped under "Alternative Selection Rankings and Weighting".

Notes:
na = Not Applicable
[1]Alternative No. 1's life cycle cost does not include possible cleanup costs and fines.
[2]Low points are indicative of a good alternative while high points are indicative of a poor alternative. Lowest possible point total is 18. Highest possible point total is 83.

Alternative No. 1 calls for no pump station improvements to be made and is estimated to have a 20-year life cycle present worth cost of $426,000. Points were assigned to each alternative as follows with $500,000 equal to 1 point:

- 1 Point: $0 to $750,000
- 2 Points: $751,000 to $1,500,000
- 3 Points: $1,501,000 to $2,250,000
- 4 Points: $2,251,000 to $3,000,000
- 5 Points: $3,001,000 and up

### 6.2.2 Operator Preferences Criterion Description

Operator preferences are a ranking of the alternatives as expressed by City operators based at Kailua WWTP. The operators reported that they prefer submersible pumps over line shaft pumps. They also reported that they prefer variable speed pumps over constant speed pumps. Submersible pumps are preferred because they require little maintenance and are not adversely affected to flooding of the dry well. Variable speed pumps are preferred over constant speed pumps because they are able to mitigate some of the flow surges associated with activation/deactivation of constant speed pumps. Points were assigned to each alternative as follows:

- 1 Point: 2 preference met
- 2 Points: 1 preference met
- 3 Points: 0 preferences met

### 6.2.3 Satisfy Design Objectives Criterion Description

The primary objective of this project is to increase the capacity of the pump station to meet projected peak flow rates. This criterion evaluates each alternative for its ability to satisfy this objective. The projected peak design flow rate is estimated to be 0.90 mgd based on 10 years of historical daily flow data. Points were assigned based on each alternative's primary pump capacity as follows:

- 1 Point: 0.90 mgd or higher
- 2 Points: 0.81 mgd to 0.90 mgd (90% to 100% of peak design flow rate)
- 3 Points: 0.72 mgd to 0.81 mgd (80% to 90% of peak design flow rate)
- 4 Points: 0.63 mgd to 0.72 mgd (70% to 80% of peak design flow rate)
- 5 Points: 0.54 mgd to 0.63 mgd (60% to 70% of peak design flow rate)

### 6.2.4 Adverse Short-Term Impacts Criterion Description

Short-term impacts are defined as construction related impacts and are limited to the duration of construction and implementation of an alternative. Alternatives were assigned points based on anticipated construction time as follows:

- 1 Point: 0 to 6 months
- 2 Points: 6 to 12 months
- 3 Points: 12 to 18 months
- 4 Points: 18 to 24 months
- 5 Points: 24 months and over

### 6.2.5 Adverse Long-Term Impacts Criterion Description

Long-term impacts are defined as impacts that will continue to plague the WWPS long after construction is completed. Alternatives were assigned points based on qualitative evaluation as follows:

- 1 Point: No impact
- 2 Points: Minimal impact
- 3 Points: Moderate impact
- 4 Points: Large impact
- 5 Points: Severe impact resulting in compromising public safety or legal action against the City

### 6.2.6 Adequately Addresses Existing Deficiencies Criterion Description

This criterion evaluates whether an alternative addresses deficiencies described in the previous sections. It specifically excludes satisfying peak flow rates which is covered by another criterion. Points were assigned as follows:

- 1 Point: 0 outstanding deficiencies
- 2 Points: 1 outstanding deficiencies
- 3 Points: 2 outstanding deficiencies
- 4 Points: 3 outstanding deficiencies
- 5 Points: 4+ outstanding deficiencies

### 6.2.7 Criterion Score Weighting

In addition to the scores given for each criterion, weights were applied to each score with a weight of 1 representing important and a weight of 5 representing extremely important. The intent of applying weights to the scores is to assign degrees of importance based on City preferences. Each criterion was weighted as follows:

- Life Cycle Cost (Weight = 4): It was assumed that life cycle cost is very important and almost as important as Satisfy Design Objectives.

- Operator Preferences (Weight = 2): It was assumed that operator preferences are not as important as Satisfy Design Objects, Adverse Long-Term Impacts or Life Cycle Cost.

- Satisfy Design Objectives (Weight = 5): It was assumed that that satisfying the design objectives of increasing the capacity of the pump station to meet peak flow rates is the project's number one priority.

- Adverse Short-Term Impacts (Weight = 1): Short-term impacts are temporary and only last for the duration of construction.

- Adverse Long-Term Impacts (Weight = 3): Long-term impacts can have a perpetual negative impact on the WWPS if not corrected. It was assumed that adverse long-term impacts are as important as correcting existing deficiencies.

- Adequately Addresses Existing Deficiencies (Weight = 3): It was assumed that addressing existing deficiencies are very important but not if the benefits outweighed the costs.

## 6.3 ALTERNATIVE EVALUATION

The following is a discussion of each alternative and how they were scored.

### 6.3.1 Alternative No. 1 - No Action (0.50 mgd @45 feet TDH)

- Life Cycle Cost: A score of 5 was assigned. Although Alternative No. 1 only has a present worth life cycle cost of approximately $426,000, significant costs can be incurred should the backup pump fail during a heavy rainstorm event and a wastewater spill occur. Cleanup costs and possible fines could significantly increase the life cycle cost of the alternative.

- Operator Preferences: A score of 3 was assigned based on operator preferences.

- Satisfy Design Objectives: A score of 5 was assigned because the existing pumps do not have sufficient capacity to satisfy the design flow rates.
- Adverse Short-Term Impacts: A score of 1 was assigned because no construction is involved.
- Adverse Long-Term Impacts: A score of 5 was assigned because not upgrading the WWPS could result in SSOs. It would also violate the 1995 EPA consent decree and pending 2011 EPA consent decree.
- Adequately Address Existing Deficiencies: A score of 5 was assigned because there are more than 5 deficiencies associated with the existing WWPS.
    - Insufficient pump capacity.
    - Inlet bell velocity too low.
    - Pump discharge connected to header from bottom.
    - Dry well not continuously ventilated.
    - Dry well and wet well are not completely isolated from one another.
    - Lack of throttling valve feedback.
    - WWPS experiences large voltage dips.
    - Equipment and building components have reached the end of their useful lives.
    - Barrington SCADA system is dated and parts are difficult to find.

### 6.3.2 Alternative No. 2 - Install New Constant Speed Dry Pit Submersible Pumps with VFDs (0.90 mgd @55.5 feet TDH)

- Life Cycle Cost: A score of 5 was assigned for a present worth life cycle cost of approximately $3,363,000.

- Operator Preferences: A score of 1 was assigned based on operator preferences.

- Satisfy Design Objectives: A score of 1 was assigned because the pumps were sized to meet the project peak flow rates.

- Adverse Short-Term Impacts: A score of 4 was assigned because construction is anticipated to last 18-24 months.

- Adverse Long-Term Impacts: A score of 3 was assigned because there is the potential to surcharge and overwhelm the downstream collection system should the controls fail. The controls will be unique to the City and will add a level of complexity uncommon to other stations.

- Adequately Address Existing Deficiencies: A score of 2 was assigned because this alternative will not address operator concerns regarding adequate real time feedback as the throttling ball valve is adjusted.

### 6.3.3 Alternative No. 3 - Install New Constant Speed Dry Pit Submersible Pumps with Soft Starters (0.90 mgd @55.5 feet TDH)

- Life Cycle Cost: A score of 5 was assigned for a present worth life cycle cost of approximately $3,306,000.

- Operator Preferences: A score of 1 was assigned based on operator preferences. Note that a soft starter should achieve similar success in limiting flow surges upon activation of a pump.

- Satisfy Design Objectives: A score of 1 was assigned because the pumps were sized to meet the project peak flow rates.

- Adverse Short-Term Impacts: A score of 4 was assigned because construction is anticipated to last 18-24 months.

- Adverse Long-Term Impacts: A score of 3 was assigned because there is the potential to surcharge and overwhelm the downstream collection system should someone fail to adhere to designed protocols. Operation of two pumps simultaneously will likely overwhelm the downstream collection system. This protocol will be unique to the City and will add a level of complexity uncommon to other stations.

- Adequately Address Existing Deficiencies: A score of 2 was assigned because this alternative will not address operator concerns regarding adequate real time feedback as the throttling ball valve is adjusted.

### 6.3.4 Alternative No. 4 - Install New Constant Speed Dry Pit Submersible Pumps (0.79 mgd @44 feet TDH)

- Life Cycle Cost: A score of 5 was assigned for a present worth life cycle cost of approximately $3,296,000.

- Operator Preferences: A score of 1 was assigned based on operator preferences. Note that a soft starter should achieve similar success in limiting flow surges upon activation of a pump.

- Satisfy Design Objectives: A score of 2 was assigned because the pumps were sized to avoid surcharging the downstream collection system rather than meeting the project peak flow rates. Note that each pump should have sufficient capacity to meet all of the recorded peak flow rates that have occurred over the past 10 years.

- Adverse Short-Term Impacts: A score of 4 was assigned because construction is anticipated to last 18-24 months.

- Adverse Long-Term Impacts: A score of 2 was assigned because the pumps will have marginal capacity to meet peak flow rates but will not add complexity that Alternatives 2 and 3 will.

- Adequately Address Existing Deficiencies: A score of 1 was assigned because this alternative will address all non-capacity related deficiencies. Although this alternative will not specifically satisfy operators' request for throttling valve flow feedback, the pumps were sized to avoid the need to throttle the flow.

## 6.4 ALTERNATIVE OPTIONS EVALUATION

The purpose of this evaluation is to document and discuss requests that CSM made to repair and/or improve the existing WWPS. See Table 6-2. The goal of this evaluation was to provide a non-biased opinion as to the merit and relative need of each request. The requests were dubbed alternative options as they are not alternatives in themselves. Rather they are options that may be implemented somewhat independently of the alternatives.

Some of the requests are necessary to implement because they are required by the proposed upgrades. For example, CSM requested that the pump station piping be replaced. The piping is required to be replaced to physically accommodate replacement equipment and to address hydraulic deficiencies. Other requests are not necessitated by proposed hydraulic upgrades but will address a number of concerns including replacing components/elements that have reached the end of their useful lives, improve safety and improve efficiency. For example, the building is in need of painting to extend the life of building surfaces.

**TABLE 6-2 KAHANAHOU WWPS**
**ALTERNATIVE OPTIONS EVALUATION SUMMARY**

| No. | CITY REQUEST | CONSULTANT COMMENT | COST | STRONG SUPPORT | SUPPORT | DECLINE COMMENT |
|---|---|---|---|---|---|---|
| 1 | Install new roof. | Architectural Comment: It is not known when the existing roof was re-roofed. If it is not currently leaking, then, don't install a new roof. | TBD | | | X |
| | | Structural Comment: A significant percentage of the pitch and gravel roofing is in poor condition. Over 50% of the gravel is missing, and along the roof ridge, the tar paper is completely exposed and has worn through several layers. It is likely that the roofing material is not providing any protection against moisture infiltration. | TBD | | | |
| 2 | Install new interior and exterior lights. Exterior lights shall shine straight downwards. Neighbors may complain about lights that illuminate their houses. | Electrical Comment: Replacement of the interior light fixtures is recommended to reduce energy consumption for the WWPS. At a minimum, the existing fluorescent light fixtures should be cleaned and relamped and the existing incandescent light fixtures replaced with new linear fluorescent or compact fluorescent alternatives. Replacement of the exterior light fixtures is recommended to address complaints from the neighboring residences and to address the corrosion observed on the existing fixtures. | $10,857 | X | | |
| 3 | Paint interior and exterior of station. | Architectural Comment: It appears that the existing walls (interior and exterior CMU - Grade Level) is not painted. The exterior roof eaves are painted and show peeling. The eaves should be repainted. The interior ceiling and walls below Grade Level appear in good shape and probably don't need repainting. The floors appear painted and show wear. The floors should be repainted.<br><br>Construction of a new generator building is proposed under Alternative No. 2, 3 and 4. Painting of the generator building should match the existing pump station building if the generator building is constructed of CMU walls and low sloped concrete roof. Painting of the existing pump station building should match the painting of the generator building if the generator building is constructed of concrete wall. | TBD | | X | |
| 4 | Replace suction elbows in wet well. | Civil/Mechanical Comment: Suction elbows are proposed to be replaced as a part of Alternative No. 2, 3 and 4. Replacement of the elbows are recommended to correct a low suction fluid velocity issue. Replacement is also recommended because the elbows are approaching the end of their useful lives. The elbows are assumed to be from the original installation and are 44+ years in age. | Included in Alternative Costs. | X | | |
| 5 | Replace suction piping through wall. | Civil/Mechanical Comment: Suction pipes through wall are proposed to be replaced as a part of Alternative No. 2, 3 and 4. Replacement of the pipes are recommended to correct a low suction fluid velocity issue. Replacement is also recommended because the pipes are approaching the end of their useful lives. The pipes are currently 44+ years old. | Included in Alternative Costs. | X | | |

**TABLE 6-2 KAHANAHOU WWPS**
**ALTERNATIVE OPTIONS EVALUATION SUMMARY**

| No. | CITY REQUEST | CONSULTANT COMMENT | COST | STRONG SUPPORT | SUPPORT | DECLINE COMMENT |
|---|---|---|---|---|---|---|
| 6 | Replace all suction and discharge piping up to venturi meter pit. | Civil/Mechanical Comment: All of the on-site suction and discharge piping up to the existing throttling valve is intended to be replaced as a part of Alternative No. 2, 3 and 4 to facilitate construction phasing. | Included in Alternative Costs. | X | | |
| 7 | Replace all suction and discharge valves. Install gate valves. | Civil/Mechanical Comment: All of the on-site suction and discharge valves up to the existing throttling valve are intended to be replaced as a part of Alternative No. 2, 3 and 4 to facilitate construction phasing. | Included in Alternative Costs. | X | | |
| 8 | Install new water line from meter to station and inside of station. | Civil/Mechanical Comment: Replacement of the underground piping is strongly supported due to the close proximity to the ocean. Replacement piping is recommended to be Type K piping with protective polyethylene sheet covers. | $10,000 | X | | |
| 9 | Install new diesel fueled standby engine generator. | Civil/Mechanical Comment: The propane fueled standby engine generator is proposed to be replaced as a part of Alternative No. 2, 3 and 4. Replacement of the standby engine generator with a larger capacity unit is necessary to provide sufficient emergency standby power for the proposed replacement equipment. Replacement standby engine generator is recommended to be diesel fueled to be consistent with other wastewater facilities. | Included in Alternative Costs. | X | | |
| 10 | Install dry pit submersible pumps. | Civil/Mechanical Comment: Replacement pumps are proposed to be dry pit submersible pumps as a part of Alternative No. 2, 3 and 4. The life cycle cost difference between dry pit submersible and separately coupled pumps is negligible. | Included in Alternative Costs. | X | | |
| 11 | Install new MCC cabinets. New MCC cabinets shall be smart type similar to the ones installed at Enchanted Lake Wastewater Pump Station. | Electrical Comment: Replacement of the existing MCC is proposed in Alternatives 2, 3 and 4. Replacement is recommended due to the age of the existing MCC. | Included in Alternative Costs | X | | |
| 12 | Get rid of Healy Ruff float and cable - install 2 pressure transducers. | Civil/Mechanical Comment: The Healy Ruff float and cable are proposed to be replaced as a part of Alternative No. 2, 3 and 4. Replacement of the float and cable is recommended to help comply with the City's effort to modernize and standardize wastewater facility controls. | Included in Alternative Costs. | X | | |
| 13 | Remove existing windows and install new stainless steel louvers with screens. No glass windows. | Architectural Comment: Replacement of the existing louvers and windows is up to the City. If the windows above the main entry double doors are replaced, the doors would have to be replaced because the window and door frames are integral. This is also the case with the doors to the current emergency generator room because of the louver frames are integral with the louvered doors below. | TBD | | | X |
| 14 | Replace toilet and wash sink. New toilets and wash sink shall be outfitted with new sewer lines to the wet well. | Civil/Mechanical Comment: The condition of the existing plumbing is unknown. CSM will be consulted to clarify the reason for this request. | $4,000 | | | X |

**TABLE 6-2 KAHANAHOU WWPS**
**ALTERNATIVE OPTIONS EVALUATION SUMMARY**

| No. | CITY REQUEST | CONSULTANT COMMENT | COST | STRONG SUPPORT | SUPPORT | DECLINE COMMENT |
|---|---|---|---|---|---|---|
| 15 | Install a permanent suction and discharge line for portable pump hook up. Install a new suction pipe to the bottom of the wet well. Add a new underground bypass line to the venturi tube from the wet well. The connection at the wet well should be a 4-inch cam lock type connection. The bypass line will be used in case the pump station needs to be bypassed. | Civil/Mechanical Comment: A permanent bypass line will help simplify the connection of emergency bypass pumps for the operators. Installation of a bypass line is recommended budget permitting. | Included in Alternative Costs | | X | |
| 16 | Install a drain line so venturi pit sump pumps discharge into the wet well. | Civil/Mechanical Comment: Relocation of the meter vault to the grassed area without a top cover will require sump pumps. Collected water should primarily be rainwater but there is a possibility of sewer discharging into the meter vault during maintenance efforts. It would be safer to discharge collected water into the wet well to avoid the possibility of inadvertently and improperly discharging sewer laden water into waterways. The only drawback is that the City will need to issue an exemption to allow discharging rainwater into the sewer collection system. | Included in Alternative Costs | X | | |
| 17 | Replace dry well sump pump discharge line. | Civil/Mechanical Comment: The condition of the existing discharge line is unknown. However, the discharge line is a relatively inexpensive item and is recommended to be replaced along with the sump pump. | Included in Alternative Costs | X | | |
| 18 | Verify that floors slope towards floor drains. Modify pump room floors to slope towards drain channels if the existing floors do not slope towards the floor drains. | In the process of verifying floor slope. | TBD | | | |
| 19 | Install an aboveground fuel storage tank if possible. Above ground fuel tank - match sticks around tank, with ladder fiberglass or stainless steel. | Civil/Mechanical Comment: There is insufficient space on the property to install an aboveground fuel storage tank. | Not Applicable | X | | |
| 20 | Widen driveway entrance to the pump station. Entrance is presently about 11-feet in width. Entrance should be widened to a width of 16~19 feet with half gates. Needed for fuel truck entry. | Civil/Mechanical Comment: The existing driveway is a bit narrow and no objections are noted to widening of the entrance and driveway if it will facilitate ease of maintenance. Estimated Costs are for chain link fence only. | $10,000 | X | | |
| 21 | Repave station driveway. | Civil/Mechanical Comment: It is likely that the existing driveway will take a beating during construction and hence should be repaved at the end of construction. | $20,000 | | X | |
| 22 | Install plastic barrier and rock where dirt or grass is at. | Civil/Mechanical Comment: Removal of existing onsite vegetation will reduce required landscape maintenance and will improve security by allowing for clear site vision from the property line. | TBD | X | | |

**TABLE 6-2 KAHANAHOU WWPS**
**ALTERNATIVE OPTIONS EVALUATION SUMMARY**

| No. | CITY REQUEST | CONSULTANT COMMENT | COST | STRONG SUPPORT | SUPPORT | DECLINE COMMENT |
|---|---|---|---|---|---|---|
| 23 | Bring new HECO power into station. 3-phase, 480 volt underground. If upgrading to 3-phase power is not possible, replace electrical wires from down pole to station. | Electrical Comment: Upgrading the existing electric service from a 120/240 volt, 1-phase, 3-wire service to a 480 volt, 3-phase, 3-wire service would help in alleviating the voltage dip issue however, the cost to achieve this will be very high. HECO does not have 3-phase facilities along Kahanahou Place and would need to extend 3-phase service from Lilipuna Road to provide 480V service to the WWPS. Replacement of the conductors between the existing utility pole and the WWPS electric service equipment is an issue that will be decided by HECO. The conductors are owned and maintained by HECO. | $174,283 | | X | |
| 24 | Install SCADA connection to water meter. | Civil/Mechanical Comment: A SCADA connection should be made to the water meter to enable the City to monitor water usage in real time. The connection should be made to be consistent with other pump stations on the island. | Included in Alternative Costs | X | | |
| 25 | Install SCADA connection to HECO meter. | Electrical Comment: This is consistent with other pump stations on the island. | TBD | | X | |
| 26 | Install outside plug connection for portable generator. | Electrical Comment: The installation of a plug for a portable generator is consistent with other pump stations on the island. | $3,242 | X | | |
| 27 | Install new ventilation system - stainless steel duct. | Civil/Mechanical Comment: Stainless steel should be installed in lieu of galvanized steel due to the close proximity to sewer gases, salt-laden air, and in the interest of longevity. | Included in Alternative Costs | | X | |
| 28 | Install new SCADA PLC to include a screen of Waikapoki WWPS if onsite ball valve is used for throttling. | Civil/Mechanical Comment: Will need to discuss further. | TBD | | | X |
| 29 | Replace flow meter with a new flow meter located in the grassed area outside of the paved area. Meter should be located in an open vault to eliminate confined space entry requirements. Install sump pumps in pit. | Civil/Mechanical Comment: The meter vault should be relocated if it will help ease maintenance efforts. | Included in Alternative Costs | X | | |
| 30 | Install new standby emergency engine generator - sound abatement on walls - exhaust thru the wall, not thru the roof. | Electrical Comment: Replacement of the emergency generator is proposed in Alternative 2, 3, and 4. Replacement is recommended due to the age of the existing generator. | Included in Alternative Costs | X | | |
| 31 | Install new smoke detectors and connect to SCADA. | Electrical Comment: This is consistent with other pump stations on the island. | $12,663 | X | | |
| 32 | Install day tank for standby emergency engine generator. | Civil/Mechanical Comment: A day tank is intended to be installed as a part of Alternative No. 2, 3 and 4. | Included in Alternative Costs | X | | |
| 33 | Fuel lines shall be stainless steel with flanged joints. Do not use threaded pipe. | Civil/Mechanical Comment: Aboveground fuel lines are intended to be constructed of stainless steel with flanged joints to the extent necessary as a part of Alternative No. 2, 3 and 4. | Included in Alternative Costs | X | | |

**TABLE 6-2 KAHANAHOU WWPS**
**ALTERNATIVE OPTIONS EVALUATION SUMMARY**

| No. | CITY REQUEST | CONSULTANT COMMENT | COST | STRONG SUPPORT | SUPPORT | DECLINE COMMENT |
|---|---|---|---|---|---|---|
| 34 | Check condition of wet well - replace lining if necessary and install larger manholes for wet well cleaning. | Structural Comment: Existing lining is over 45 years old. If it is the intention to utilize the pump station for another 10 to 20 years then the liner should be replaced. Further, the 8 inch pump suction pipe that currently penetrates through the concrete wall into the wet wells is being replaced with a new 6 inch pipe. This work will require partial demolition of the existing wall surrounding the suction pipe. This demolition work will destroy whatever lining is left in that area. | Included in Alternative Costs | X | | |
| 35 | Remove irrigation lines. | Civil/Mechanical Comment: Removal of existing onsite vegetation will reduce required landscape maintenance and will improve security by allowing for clear site vision from the property line. Cost reflects abandoning lines in place. | $0 | X | | |
| 36 | The new force main discharges into a submerged manhole. Address if possible. | Civil/Mechanical Comment: See Chapter 2 writeup. | TBD | | | |
| 37 | Lower discharge header down to lower level. | Civil/Mechanical Comment: Discharge header is proposed to be lowered to minimize the length of idle vertical laterals. Reducing the length of the idle vertical headers should help alleviate the rate at which the laterals are plugged by non moving sewage. | Included in Alternative Costs | X | | |
| 38 | Install A-Frames for replacement of pumps. | Civil/Mechanical Comment: Will need to discuss further to clarify request. | TBD | | | X |
| 39 | Consider downstream collection system and onsite throttling ball valve in analysis. | Civil/Mechanical Comment: Onsite throttling ball valve and limited downstream collection system analysis is included in the DAR. See Chapter 2 - Pump Station. | $0 | X | | |
| 40 | Install sluice gate between the two wet wells. (Recommended by Structural) | Structural Comment: If work needs to be done in one of the wet wells, the facility personnel have to climb down to the bottom of the wet well and insert timber boards into the wall guides to block the flow between wells. | TBD | X | | |

## 6.5 DESCRIPTION OF METHODS FOR REPLACEMENT

The following describes the methods that will be employed to implement each alternative.

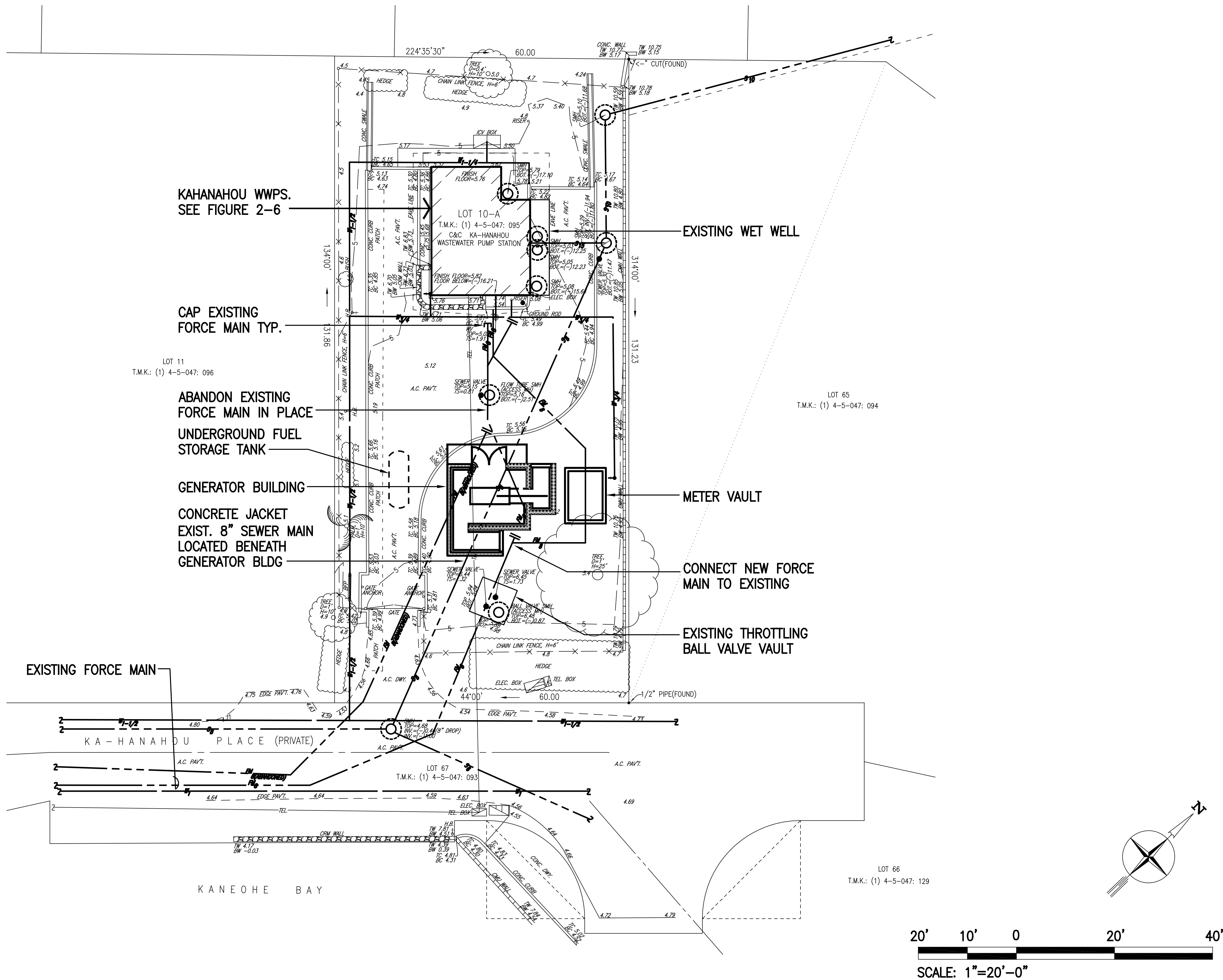
### 6.5.1 Alternative No. 1 - No Action (0.50 mgd @45 feet TDH)

No methods of construction will need to be undertaken.

### 6.5.2 Alternative No. 2 - Install New Constant Speed Dry Pit Submersible Pumps with VFDs (0.90 mgd @55.5 feet TDH)

The following is a description of minimum steps that need to be undertaken to implement Alternative No. 2. See Figure 6-1 for proposed site plan. Proposed site plan does not reflect any of the alternative option upgrades.

- Concrete jacket gravity sewer line beneath new electrical building.
- Install new force with temporary capped ends.
- Install new meter vault, bypass piping and sump pumps.
- Construct new electrical building with piles.
- Install new underground fuel storage tank.
- Install new diesel fueled standby engine generator, fuel system, exhaust system, electrical connections, automatic transfer switch and appurtenances.
- Remove existing propane fueled standby engine generator and propane tank.
- Renovate existing generator room into a new SCADA room.
- Install new SCADA system.
- Install temporary self priming pumps and temporary motor control center.




DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER PUMP STATION UPGRADE
KANEOHE, OAHU

NEW SITE PLAN
SCALE: 1" = 20'-0"

DESCRIPTION

OKAHARA AND ASSOCIATES, INC.

| JOB NUMBER | DATE |
|---|---|
| 2009107 | JAN 2011 |

FIGURE 6-1

PAGE 6-18

JI/D:\PROJ\21002\REPORT\FIG 1-SITE.DWG/1=240/12-19-10/XREF=OA1117,x-10122

- Rehabilitate and line wet well.
- Install new pump suction piping through wet well / dry well wall.
- Replace motor control center.
- Remove both existing pumps, supports, motors, shafts and piping.
- Install new submersible pumps, supports, piping and appurtenances.
- Install new controls.
- Install new ventilation system.
- Startup, test and commission system.
- Remove temporary equipment.

### 6.5.3 Alternative No. 3 - Install New Constant Speed Dry Pit Submersible Pumps with Soft Starters (0.90 mgd @55.5 feet TDH)

The steps to be undertaken for Alternative No. 3 is identical to the steps in Alternative No. 2.

### 6.5.4 Alternative No. 4 - Install New Constant Speed Dry Pit Submersible Pumps (0.79 mgd @44 feet TDH)

The steps to be undertaken for Alternative No. 4 is identical to the steps in Alternative No. 2.

# CHAPTER 7 – RECOMMENDATIONS

Based on the result of the Alternative Selection Evaluation Matrix presented in Chapter 6, Alternative No. 4 is recommended. Alternative No. 4 calls for the replacement of the existing pumps with new larger capacity constant speed submersible pumps. Alternative No. 4 is estimated will cost approximately $2,959,000 to construct.

Alternatives No. 2 and 3 were very close in score to Alternative No. 4 but it is recommended that they not be pursued for the following reasons:

Alternative No. 2 will satisfy projected peak flow rates but could result in overflowing the downstream 10-inch gravity main. Should two pumps operate simultaneously, the downstream system will likely experience SSOs. In order to combat this, SCADA will monitor WWPS flow rates and adjust the speed of the VFDs to limit the maximum flow rate from the pump station. The flow limiting controls will complicate the operation of the WWPS and could cause problems if operators are not thoroughly familiar with the system.

Alternative No. 3 is identical to Alternative No. 2 except VFDs are replaced with soft starters. In order to limit WWPS flow rates and combat possible SSOs in the downstream collection system, one pump will always be locked out to prevent two pumps from operating simultaneously. Locking out one pump with SCADA will introduce operating procedures uncommon to City WWPS. Complications could arise if operators are unaware of the unique operating procedures.

Alternative No. 4 has a slightly reduced capacity that will not quite meet projected peak flow rates. Note that a 10% safety factor was added to the peak flow rates recorded over the past 10 years to develop a future projected peak flow rate. Alternative No. 4 will be able to satisfy flow rates that are in line with peak flow rates recorded over the past 10 years. Furthermore, a pilot project that rehabilitated sewer laterals in the area was completed in Late 2008. Insufficient time has elapsed to determine if the pilot project was successful in reducing I/I and associated peak flow rates.

In summary, it is recommended that Alternative No. 4 be implemented. Alternative No. 4 utilizes features that are common to City WWPS and will not introduce unique controls or operating procedures. It is also more energy efficient than Alternatives No. 2 and 3 due to the reduced fluid velocities through the force main. Finally, it has a slightly lower first cost and life cycle cost as compared with Alternatives No. 2 and 3.

As for the Alternative Options, it is recommended that the City implement as many options as the budget allows. Most of the alternative options will go towards ensuring that the WWPS provide reliable service for a long time to come. Upgrading components that have reached or are approaching the end of their useful lives will all at once will also result in cost savings due to economies of scale.

# APPENDIX A
# PUMP STATION CALCULATIONS

**OKAHARA & ASSOCIATES, INC.**
677 Ala Moana Blvd. Suite 703
HONOLULU, HAWAII 96813
(808) 524-1224

JOB Kahanahou WWPS (210-002)
SHEET NO. 1 OF 3
CALCULATED BY T.T. DATE Jan 6, 2011
CHECKED BY ______ DATE ______
SCALE Downstream Gravity Main Capacity

Reference: Table 2-2: Limited Downstream Sewer Analysis (Manning's Eq)

Calculate Capacity of Downstream Gravity Main

The following were obtained from City GIS Data and only applies to the first 1,150 linear feet of gravity main downstream of force main outlet.

Min size = 10"
Min slope = 0.00319

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

Where: V = velocity (ft/s)
n = mannings coefficient (0.015 from City standards)
R = hydraulic radius (ft)
S = slope

For Full Flow

$$R = \frac{\pi r^2}{2\pi r} = \frac{r}{2}$$

$$V = \left(\frac{1.486}{0.015}\right)\left(\frac{5/12}{2}\right)^{2/3}\left(0.00319\right)^{1/2} = 1.97 \text{ ft/s} = 481 \text{ gpm}$$

∴ Maximum capacity = 480 gpm without surcharging main.

**OKAHARA & ASSOCIATES, INC.**
677 Ala Moana Blvd. Suite 703
HONOLULU, HAWAII 96813
(808) 524-1224



Calculate maximum capacity of downstream gravity main assuming pressurized flow and no SSOs.

Bernoulli Equation: $E_t = \frac{P}{\rho} + \frac{v^2}{2g_c} + \frac{zg}{g_c}$

Where: $E_t$ = Total Specific Energy (ft-lbf/lbm)
$P$ = Pressure (lbf/ft²)
$\rho$ = Density (lbm/ft³)
$v$ = Velocity (ft/s)
$g_c$ = Gravitational constant (32.2 lbm-ft/lbf·s²)
$g$ = acceleration due to gravity (32.2 ft/s²)

Hazen Williams Equation: $h_f = \frac{(3.022)(v)^{1.85} L}{(C)^{1.85}(D)^{1.165}}$

Where: $h_f$ = Frictional head loss (ft)
$V$ = Velocity (ft/s)
$L$ = Pipe length (ft)
$C$ = Hazen-Williams roughness coefficient (C = 100)
$D$ = Pipe Diameter (ft)

Given: Upstream SMH
- Ground El = 4.05 ft
- Depth = 4 ft
- Inv = 0.05

Downstream SMH
- Inv = (-)2.74 ft

Distance Between SMHs = 833 ft

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Set point 1 at upstream SMH Rim

$P_1 = 0$

$V_1 = 0$

$Z_1 = 4.05$ ft

Set point 2 at downstream SMH Rim

$P_2 = 0$

$Z_2 = (-) 2.74$ ft

$$E_{t(1)} = E_{t(2)} + h_f(1 \text{ to } 2)$$

$$\frac{Z_1 g}{g_c} = \frac{V_2^2}{2g_c} + \frac{Z_2 g}{g_c} - h_{f(1-2)}$$

$$V_2 = \left[(2g_c)\left(\frac{Z_1 g}{g_c} - \frac{Z_2 g}{g_c} - h_{f(1-2)}\right)\right]^{1/2}$$

$$V_2 = \left[(2g)(Z_1 - Z_2) - 2g_c h_{f(1-2)}\right]^{1/2}$$

$$V_2 = \left[(2)\left(32.2\frac{ft}{s^2}\right)(4.05\,ft + 2.74\,ft) - (2)\left(32.2\,\frac{lb_m \cdot ft}{lb_f \cdot s^2}\right) h_{f(1-2)}\right]^{1/2}$$

$$h_f = \frac{(3.022)(V_2)^{1.85}(833\,ft)}{(100)^{1.85}(10/12)^{1.165}}$$

After several rounds of iteration

$V_2 = 3.58$ ft/s $\longrightarrow$ $Q_{max} = 1.26$ mgd

Assuming 6" of safety factor $V_2 = 3.44$ ft/s $\longrightarrow$ $Q_{max} = 1.21$ mgd

### TABLE: A-2.1 MAXIMUM WET WELL VOLUME BASED ON MAXIMUM WASTEWATER RETENTION TIME

| Alternative | Wastewater Inflow Rate i (gpm) | Pump Flow Rate q (gpm) | Max Wastewater Retention Time (min) | Maximum Wet Well Volume (gallons) | Maximum Wet Well Volume ($ft^3$) | Wet Well Volume Between LWL and Wet Well Floor (gallons) | Wet Well Volume Between LWL and Wet Well Floor ($ft^3$) | Net Wet Well Volume (gallons) | Net Wet Well Volume ($ft^3$) | LWL Elevation (ft) | HWL Elevation[1] (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 139 | 347 | 30.0 | 4,170 | 557 | 1,724 | 230 | 2,446 | 327 | -13.68 | -11.20 |
| 2 | 139 | 625 | 30.0 | 4,170 | 557 | 1,889 | 253 | 2,281 | 305 | -13.25 | -11.20 |
| 3 | 139 | 625 | 30.0 | 4,170 | 557 | 1,889 | 253 | 2,281 | 305 | -13.25 | -11.20 |
| 4 | 139 | 520 | 30.0 | 4,170 | 557 | 1,889 | 253 | 2,281 | 305 | -13.25 | -11.20 |

### TABLE: A-2.2 MOTOR STARTS PER HOUR BASED ON MAXIMUM WET WELL VOLUME

| Alternative | Net Wet Well Volume (gallons) | Net Wet Well Volume ($ft^3$) | Pump Flow Rate q (gpm) | Min. Cycle Time Between Starts[2] (min) | Maximum Motor Starts Per Hour | Manufacturer Suggested Maximum Motor Starts Per Hour |
|---|---|---|---|---|---|---|
| 1 | 2,446 | 327 | 347 | 28.2 | 2.13 | 12 Based on Standards |
| 2 | 2,281 | 305 | 625 | 14.6 | 4.11 | 12 Based on Standards |
| 3 | 2,281 | 305 | 625 | 14.6 | 4.11 | 12 Based on Standards |
| 4 | 2,281 | 305 | 520 | 17.5 | 3.42 | 12 Based on Standards |

### TABLE: A-2.3 MINIMUM NET WET WELL VOLUME BASED ON MAXIMUM MOTOR STARTS PER HOUR

| Alternative | Net Wet Well Volume (gallons) | Net Wet Well Volume ($ft^3$) | Pump Flow Rate q (gpm) | Min. Cycle Time Between Starts[2,3] (min) | Maximum Motor Starts Per Hour | Manufacturer Suggested Maximum Motor Starts Per Hour |
|---|---|---|---|---|---|---|
| 1 | 434 | 58 | 347 | 5.0 | 12.00 | Based on Standards |
| 2 | 781 | 104 | 625 | 5.0 | 12.00 | Based on Standards |
| 3 | 781 | 104 | 625 | 5.0 | 12.00 | Based on Standards |
| 4 | 650 | 87 | 520 | 5.0 | 12.00 | Based on Standards |

### TABLE: A-2.4 MINIMUM RECOMMENDED WET WELL HWL ELEVATION SET POINT

| Alternative | Wastewater Inflow Rate i (gpm) | Pump Flow Rate q (gpm) | Cycle Time Between Starts[2] (min) | Minimum Wet Well Volume (gallons) | Minimum Wet Well Volume ($ft^3$) | Wet Well Volume Between LWL and Wet Well Floor (gallons) | Wet Well Volume Between LWL and Wet Well Floor ($ft^3$) | Net Wet Well Volume (gallons) | Net Wet Well Volume ($ft^3$) | LWL Elevation (ft) | HWL Elevation (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 139 | 347 | 5.2 | 2,158 | 288 | 1,724 | 230 | 434 | 58 | -13.50 | -13.14 |
| 2 | 139 | 625 | 7.2 | 2,670 | 357 | 1,889 | 253 | 781 | 104 | -13.25 | -12.01 |
| 3 | 139 | 625 | 7.2 | 2,670 | 357 | 1,889 | 253 | 781 | 104 | -13.25 | -12.01 |
| 4 | 139 | 520 | 6.4 | 2,539 | 339 | 1,889 | 253 | 650 | 87 | -13.25 | -12.22 |

[1]Alternative No. 1 HWL elevation is currently set at -11.50.

[2]Minimum cycle time between starts assumes two pumps alternate after every start. Minimum Cycle time is per pump. Actual WWPS cycle time is half of reported cycle time.

[3]Minimum cycle time between starts occurs when i = 0.5*q.

Table A-2.1 Sample Calculations

Wastewater inflow rate (i) = 0.20 mgd = 139 gpm
Pump flow rate (q) = 347 gpm (From Chart A-4.1)
Max. wastewater retention time = 30 minutes (From C&C WW Standards)
LWL elevation = -13.68 (From SCADA display at WWPS)
Wet well invert = -16.50 (From reference drawings)

Calculate Wet Well Volume Between LWL and Floor
Wet well volume between LWL and floor = (floor area)*(LWL-invert) - (wet well taper) = 1,724 gallons
*Due to varying cross section area, the net volume was solved for through an interative process.

Calculate Maximum Allowable Wet Well Wastewater Volume Based on a Retention Time of 30 Minutes
V = i*t
Where: i = Average wastewater inflow rate (gpm)
t = Retention time (minutes)
V = (139 gpm)*(30 minutes) = 4,170 gallons = 557 $ft^3$

Calculate Net Wet Well Wastewater Volume
Volume = 4,170 gallons - 1,724 gallons = 2,446 gallons = 327 $ft^3$

Calculate HWL Elevation
HWL = LWL + (Net wet well wastewater volume)/(wet well area) = -11.20 feet
*Due to varying cross section area, the HWL was solved for through an interative process.

Table A-2.2 Sample Calculations

Net wet well volume (From Table A-2.1)
Pump flow rate (q) = 347 gpm (From Chart A-4.1)
Assume pumps alternate starting

Calculate Minimum Cycle Time Between Starts For Each Pump
T = 4V/q
Where: T = Cycle time between starts (minutes)
V = Wet well wastewater volume (gallons)

q = Pump flow rate (gpm)
T = (4*(2,446 gallons)/(347 gpm)) = 28.2 minutes

Calculate Maximum Motor Starts Per Hour For Each Pump
Max. motor starts per hour per pump = (60 minutes)/(28.2 minutes) = 2.13

Table A-2.3 Sample Calculations

Maximum motor starts per hour based on WW Standards
Pump flow rate (q) = 347 gpm (From Chart A-4.1)

Calculate Minimum Cycle Time Between Starts For Each Pump
Min. cycle time per pump = (60 minutes)/(12.00 minutes) = 5.0

Calculate Minimum Net Wet Well Wastewater Volume
V = Tq/4
Where: V = Wet well wastewater volume (gallons)
T = Cycle time between starts (minutes)
q = Pump flow rate (gpm)
V = (5.0 minutes)*(347 gpm)/4 = 434 gallons

Table A-2.4 Sample Calculations

Wastewater inflow rate (i) = 0.20 mgd = 139 gpm
Pump flow rate (q) = 347 gpm (From Chart A-4.1)
Wet well volume between LWL and wet well floor = 1,724 gallons (See Table A-2.1 sample calculations)
Net wet well wastewater volume = 425 gallons (See Table A-2.3 sample calculations)

Calculate Minimum Wet Well Wastewater Volume
Volume = (Wet well volume between LWL and floor) + (Net wet well volume)
= (1,724 gallons + 434 gallons) = 2,158 gallons

Calculate Cycle Time Between Starts Per Pump
$T = V/(i-i^2/q)$
Where: V = Wet well wastewater volume (gallons)
i = Wastewater inflow rate (gpm)
q = Pump flow rate (gpm)
T = Cycle time between starts (minutes)
T = (434 gallons)/(139 gpm - (139 gpm)$^2$/347 gpm) = 5.2 minutes

Calculate HWL Elevation

HWL = LWL + (Net wet well wastewater volume)/(wet well area) = -13.14 feet

*Due to varying cross section area, the HWL was solved for through an interative process.

# TABLE A-3: KAHANAHOU WWPS
# NET POSITIVE SUCTION HEAD AVAILABLE
# FOR ALTERNATIVE NO. 2, 3 AND 4

**4-Inch Pump Suction Connection**

| Flow Rate | | Fluid Velocity | | $NPSH_A$ | | |
|---|---|---|---|---|---|---|
| | | 4-inch | 6-inch | $h_s$=1.75 ft, wse = -11.5 | $h_s$=4.25 ft, wse = -9.0 | $h_s$=4.5 ft, wse = -8.75 |
| (gpm) | (mgd) | (ft/sec) | (ft/sec) | (ft) | (ft) | (ft) |
| 100 | 0.14 | 2.55 | 1.13 | 23.98 | 25.83 | 26.01 |
| 200 | 0.29 | 5.11 | 2.27 | 23.80 | 25.65 | 25.84 |
| 300 | 0.43 | 7.66 | 3.40 | 23.51 | 25.36 | 25.54 |
| 400 | 0.58 | 10.21 | 4.54 | 23.10 | 24.95 | 25.13 |
| 500 | 0.72 | 12.77 | 5.67 | 22.57 | 24.42 | 24.61 |
| 600 | 0.86 | 15.32 | 6.81 | 21.93 | 23.79 | 23.97 |
| 700 | 1.01 | 17.87 | 7.94 | 21.18 | 23.03 | 23.22 |
| 800 | 1.15 | 20.43 | 9.08 | 20.31 | 22.16 | 22.35 |
| 900 | 1.30 | 22.98 | 10.21 | 19.33 | 21.18 | 21.37 |
| 1,000 | 1.44 | 25.53 | 11.35 | 18.24 | 20.09 | 20.27 |

$NPSH_A = H_{bar} + h_s - H_{vap} - h_f - h_l - h_{vol} - FS$

Where: $H_{bar}$=barametric pressure (33.9 feet)
$h_s$=static head of water
$H_{vap}$=vapor pressure of fluid (1.2 feet at 80 deg F)
$h_f$=pipe friction
$h_l$=minor losses
$h_{vol}$=partial pressure of dissolved gasses (2 feet)
FS=factor of safety (5 feet or 0.35 $NPSH_R$)

$v = Q/A = Q/(pi*r^2)$

Where: v = velocity (ft/sec)
A = Force main cross sectional area $(\text{feet})^2$
r = Force main radius (feet)

$v_{4"}$ = (200 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(2/12\text{ feet})^2$) = 5.11 ft/sec
$v_{6"}$ = (200 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(6/12\text{ feet})^2$) = 2.27 ft/sec

$h_l = (0.45*(v_{6"})^2+0.613*(v_{4"})^2)/(2*32.2\text{ ft/sec}^2)$
$= (0.45*(2.27\text{ ft/sec})^2+0.613*(5.11\text{ ft/sec})^2)/(2*32.2\text{ ft/sec}^2) = 0.28$ feet
(See Renovated Pump Station Minor Losses)

$h_f = (3.022/100^{1.85})*(v_{6"}{}^{1.85}*(6.0\text{ feet})/(6/12\text{ feet})^{1.165})$
$= (3.022/100^{1.85})*((2.27\text{ ft/sec})^{1.85}*(6.0\text{ feet})/(6/12\text{ feet})^{1.165}) = 0.04$ feet
(See Renovated Pump Station Minor Losses)

$NPSH_A$ = (33.9 ft + 1.75 ft - 1.2 ft - 0.28 ft - 0.04 ft - 2 ft)/1.35 = 23.80 feet

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JOB Kahanahou WWPS (210-002)
SHEET NO. 1 OF 1
CALCULATED BY T.T. DATE Dec 9, 2010
CHECKED BY DATE
SCALE Existing Net Positive Suction Head Available

$NPSH_A = H_{bar} + h_s - H_{vap} - h_f - h_L - h_{vol} - FS$

WHERE: $H_{bar}$ = barametric pressure (ft of $H_2O$) 33.9 ft
$h_s$ = static head of water (ft of $H_2O$)
$H_{vap}$ = Vapor pressure of fluid (ft of $H_2O$) 1.2 ft @ 80°F
$h_f$ = pipe friction (ft of $H_2O$)
$h_L$ = minor pipe friction losses (ft of $H_2O$)
$h_{vol}$ = partial pressure of dissolved gases (ft of $H_2O$) 2 ft
FS = factor of safety 5 ft or 0.35 $NPSH_R$

$h_s$ = 0 ft ~ 2.4 ft
WHERE: Top of pump impellers at = -13.67
Lead pump on/off at = -11.28 / -13.68

$$h_f = \frac{(3.022)(V_{(8''\phi)})^{1.85}(5'-9'')}{(60)^{1.85}(8/12\ ft)^{1.165}}$$ SEE EXISTING PUMP STATION MINOR LOSSES

$$h_L = \frac{(0.385)(V_{(8''\phi)})^2 + (0.578)(V_{(6''\phi)})^2}{2(32.2\ ft/s^2)}$$ SEE EXISTING PUMP STATION MINOR LOSSES

$NPSH_A$ @ 0.50 mgd

$$h_f = \frac{(3.022)(2.22\ ft/s)^{1.85}(5'-9'')}{(60)^{1.85}(8/12\ ft)^{1.165}} = 0.06\ ft$$

$$h_L = \frac{(0.385)(2.22\ ft/s)^2 + (0.578)(3.94\ ft/s)^2}{2(32.2\ ft/s^2)} = 0.17\ ft$$

$NPSH_A$ (0.50 mgd) = 33.9 + ((-)13 - (-) 14.25) - 1.2 - 0.06 - 0.17 - 2 - FS

= 31.72 - FS (ASSUME FS = 31.72 / 1.35)

= 23.5 ft

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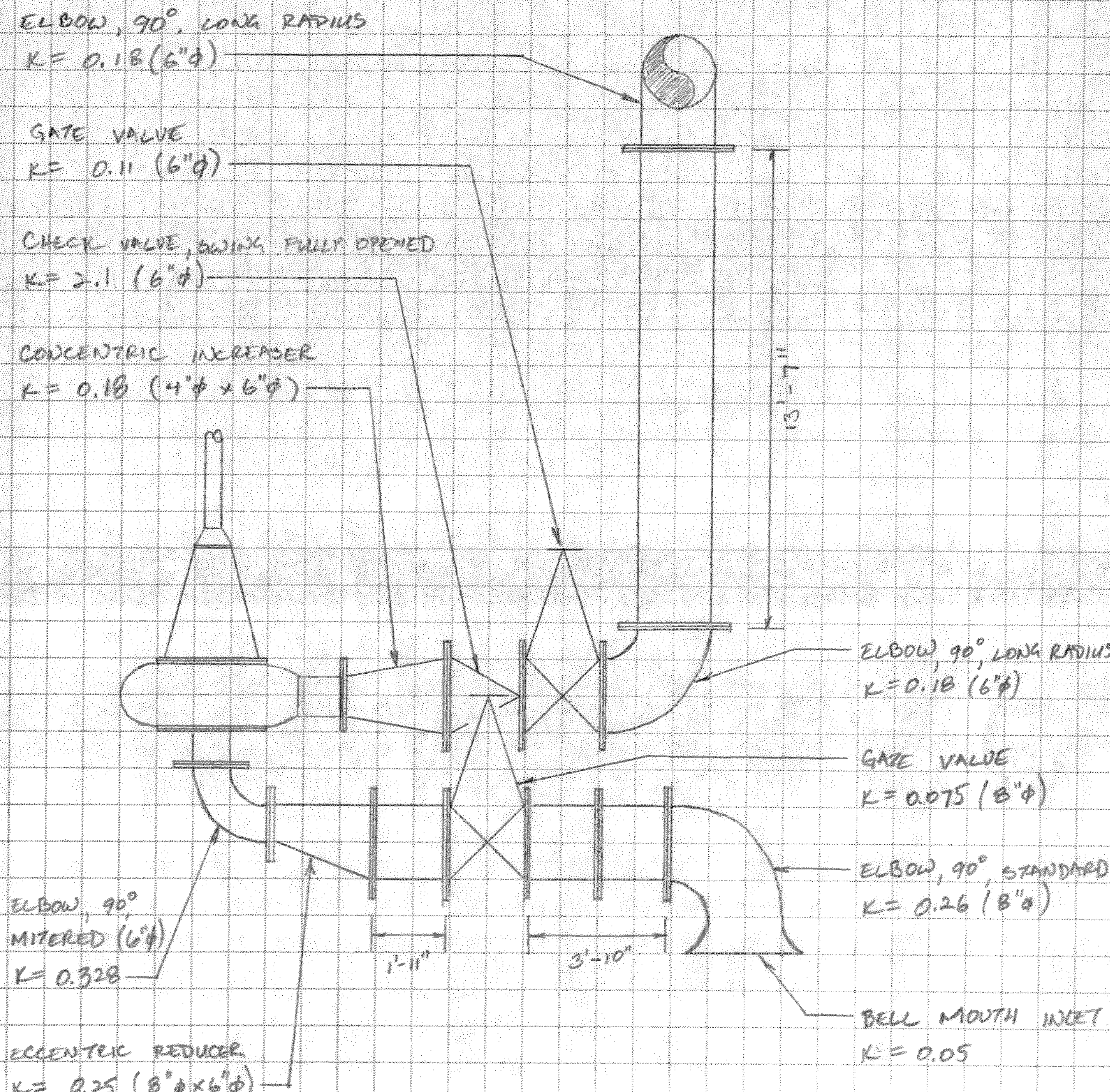
JOB Kahanahou WWPS (210-002)
SHEET NO. 1 OF 3
CALCULATED BY T.T. DATE Nov 24, 2010
CHECKED BY ______ DATE ______
SCALE Existing Pump Station Minor Losses

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CALCULATED BY TT DATE Nov 26, 2010
CHECKED BY ______ DATE ______
SCALE Existing Pump Station Minor Losses

MINOR LOSSES THROUGH FITTINGS AND VALVES

$$h_L = \frac{KV^2}{2g}$$

WHERE: $h_L$ = HEAD LOSS (FT)
K = RESISTANCE COEFFICIENT
V = VELOCITY (FT/S)
g = GRAVITATIONAL ACCELERATION (32.2 FT/S²)

$$\Sigma K(8''\phi) = 0.05 + 0.26 + 0.075 = 0.385$$
$$\Sigma K(6''\phi) = 0.25 + 0.328 + 0.18 + 2.1 + 0.11 + 0.18 + 0.18 = 3.328$$

$$h_L = \frac{0.385(V_{(8''\phi)})^2 + 3.328(V_{(6''\phi)})^2}{2(32.2\ ft/s^2)}$$

MINOR LOSSES THROUGH STRAIGHT PIPE

$$h_f = \frac{(3.022)(V)^{1.85} L}{(C)^{1.85}(D)^{1.165}}$$

WHERE: $h_f$ = FRICTIONAL HEAD LOSS (FT)
V = VELOCITY (FT/S)
L = PIPE LENGTH (FT)
C = HAZEN-WILLIAMS ROUGHNESS COEFFICIENT (C=60)
D = PIPE DIAMETER (FT)

$$\Sigma L(8''\phi) = 3'\text{-}10'' + 1'\text{-}11'' = 5'\text{-}9''$$

$$\Sigma L(6''\phi) = 13'\text{-}7''$$ (CHANGED TO 4"ϕ)

FLOW MODEL MODIFICATION NOTES
- ACCORDING TO T&D, VERTICAL PORTIONS OF PUMP DISCHARGE PIPING TENDS TO BE LINED WITH DEBRIS. THIS LINING REDUCES THE EFFECTIVE PIPE DIAMETER AND IS POSTULATED INCREASES LOSSES.

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JOB KAHANA HOU WWPS (210-002)

CALCULATED BY T.T. DATE DEC 5, 2010
CHECKED BY ____ DATE ____
SCALE Existing Pump Station Minor Losses

- 6" VERTICAL DISCHARGE PIPING MODELED AS 4"
- HAZEN-WILLIAMS COEFFICIENT OF 60 USED TO ADJUST MINOR LOSSES TO MATCH SCADA DATA

$$h_f = \frac{(3.022)}{(60)^{1.85}}\left[\frac{(V_{(8"\phi)})^{1.85}(5'\text{-}9")}{(8/12\ FT)^{1.165}} + \frac{(V_{(4"\phi)})^{1.85}(13'\text{-}7")}{(4/12\ FT)^{1.165}}\right]$$

MINOR LOSSES THROUGH COUNTER WEIGHTED CHECK VALVES

$h_c$ = ESTIMATED HEAD LOSS THROUGH CHECK VALVE

$h_c = 2.25'$

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JOB Kahanahou WWPS (210-002)
SHEET NO. 1 OF 1
CALCULATED BY T.T DATE Nov 26, 2010
CHECKED BY DATE
SCALE Existing Force Main System Curve

FRICTIONAL LOSSES

$$h_f = \frac{(3.022)(V)^{1.85} L}{(C)^{1.85}(D)^{1.165}}$$

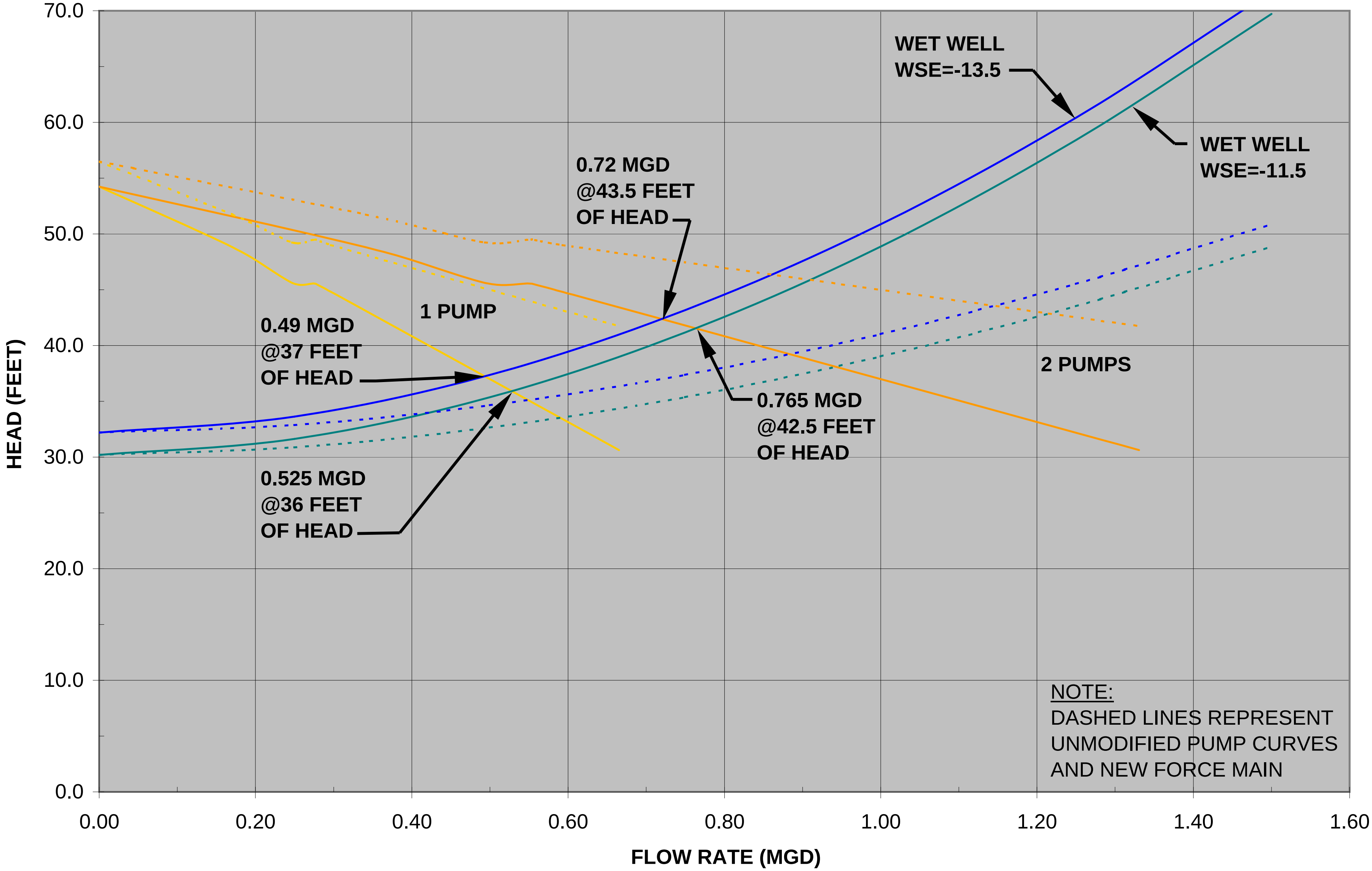
Where: $h_f$ = FRICTIONAL HEAD LOSS (FT)
V = VELOCITY (FT/S)
L = PIPE LENGTH (FT)
C = HAZEN-WILLIAMS ROUGHNESS COEFFICIENT
D = PIPE DIAMETER (FT)

| STN FROM | STN TO | L | D | C | MATERIAL | NOTES |
|---|---|---|---|---|---|---|
| | | 25 | 8/12 | 120 | C900 PVC | ID = 8.04" |
| 0+00 | 7+69 | 769 | 8/12 | 120 | DR 11 HDPE | ID = 6.963" |

FORCE MAIN DISCHARGE INV = 18.70

FORCE MAIN DATA OBTAINED FROM C&C WASTEWATER JOB NO. W16-05.

# CHART A-4.1: KAHANAHOU WWPS
# ALTERNATIVE No. 1: EXISTING CENTRIFUGAL PUMP AND SYSTEM CURVES
## PATTERSON PUMP CO. 1175 RPM, UNKNOWN IMPELLER DIAMETER



# TABLE A-4.1: KAHANAHOU WWPS
## ALTERNATIVE No. 1: EXISTING CENTRIFUGAL PUMP AND SYSTEM CURVES
### PATTERSON PUMP CO. 1175 RPM, UNKNOWN IMPELLER DIAMETER

| Impeller Size Unknown[a] | | | Adjusted[b] | 1 Pump | | 2 Pumps | | System | System Velocity | | System Curve (feet)[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDH | Flow Rate | | TDH | Flow Rate | | Flow Rate | | Flow Rate | 8" PVC[d] | 8" HDPE[e] | wse (-11.5) | | wse (-13.50) | |
| (feet) | (gpm) | (mgd) | (feet) | (gpm) | (mgd) | (gpm) | (mgd) | (mgd) | (ft/sec) | (ft/sec) | $C_{old}$[f] | $C_{new}$[g] | $C_{old}$[f] | $C_{new}$[g] |
| 56.5 | 0 | 0.00 | 54.3 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 30.2 | 30.2 | 32.2 | 32.2 |
| 51.8 | 119 | 0.17 | 48.8 | 119 | 0.17 | 237 | 0.34 | 0.25 | 1.10 | 1.29 | 31.6 | 30.9 | 33.6 | 32.9 |
| 49.3 | 172 | 0.25 | 45.6 | 172 | 0.25 | 343 | 0.49 | 0.50 | 2.19 | 2.59 | 35.4 | 32.6 | 37.4 | 34.6 |
| 49.5 | 192 | 0.28 | 45.5 | 192 | 0.28 | 384 | 0.55 | 0.75 | 3.29 | 3.88 | 41.2 | 35.4 | 43.2 | 37.4 |
| 49 | 206 | 0.30 | 44.8 | 206 | 0.30 | 412 | 0.59 | 1.00 | 4.39 | 5.18 | 48.9 | 39.0 | 50.9 | 41.0 |
| 41.8 | 462 | 0.67 | 30.6 | 462 | 0.67 | 924 | 1.33 | 1.25 | 5.49 | 6.47 | 58.4 | 43.5 | 60.4 | 45.5 |
| | | | | | | | | 1.50 | 6.58 | 7.76 | 69.7 | 48.9 | 71.7 | 50.9 |

[a]Pump curve data taken from Mathcad data based on

[b]Adjusted TDH = Pump Rated TDH - Minor Losses (i.e. TDH - ($h_l$-$h_f$))

Sample Calculation

$v = Q/A = Q/(pi*r^2)$

Where: v = velocity (ft/sec)

A = Force main cross sectional area $(feet)^2$

r = Force main radius (feet)

$v_{4"}$ = (119 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(2/12\ feet)^2$) = 3.03 ft/sec

$v_{6"}$ = (119 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(3/12\ feet)^2$) = 1.34 ft/sec

$v_{8"}$ = (119 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(4/12\ feet)^2$) = 0.76 ft/sec

$h_l = (0.385*(v_{8"})^2+1.438*(v_{6"})^2)/(2*32.2\ ft/sec^2) = (0.385*(0.76\ ft/sec)^2+1.438*(1.34\ ft/sec)^2)/(2*32.2\ ft/sec^2) = 0.10$ feet

$h_f = (3.022/60^{1.85})*(v_{8"}{}^{1.85}*(5.75\ feet)/(8/12\ feet)^{1.165} + v_{4"}{}^{1.85}*(13.58\ feet)/(4/12\ feet)^{1.165})$

$= (3.022/60^{1.85})*((0.76\ ft/sec)^{1.85}*(5.75\ feet)/(8/12\ feet)^{1.165} + (3.03\ ft/sec)^{1.85}*(13.58\ feet)/(4/12\ feet)^{1.165}) = 0.60$ feet

$h_c$ = 2.25 feet

Adjusted TDH = 51.8 feet - (0.10 feet + 0.60 feet + 2.25 feet) = 48.8 feet

[c]Force main data (i.e. pipe size, length, material) obtained from C&C Wastewater Job No. W16-05.

# TABLE A-4.1: KAHANAHOU WWPS
# ALTERNATIVE No. 1: EXISTING CENTRIFUGAL PUMP AND SYSTEM CURVES
## PATTERSON PUMP CO. 1175 RPM, UNKNOWN IMPELLER DIAMETER

[d]Pipe dimensions based on AWWA C-900 standards

[e]Pipe dimensions based on HDPE SDR 11 ductile iron pipe dimensions

[f]Hazen-Williams Coefficient = 100 for old PVC and HDPE

[g]Hazen-Williams Coefficient = 150 for new PVC and HDPE

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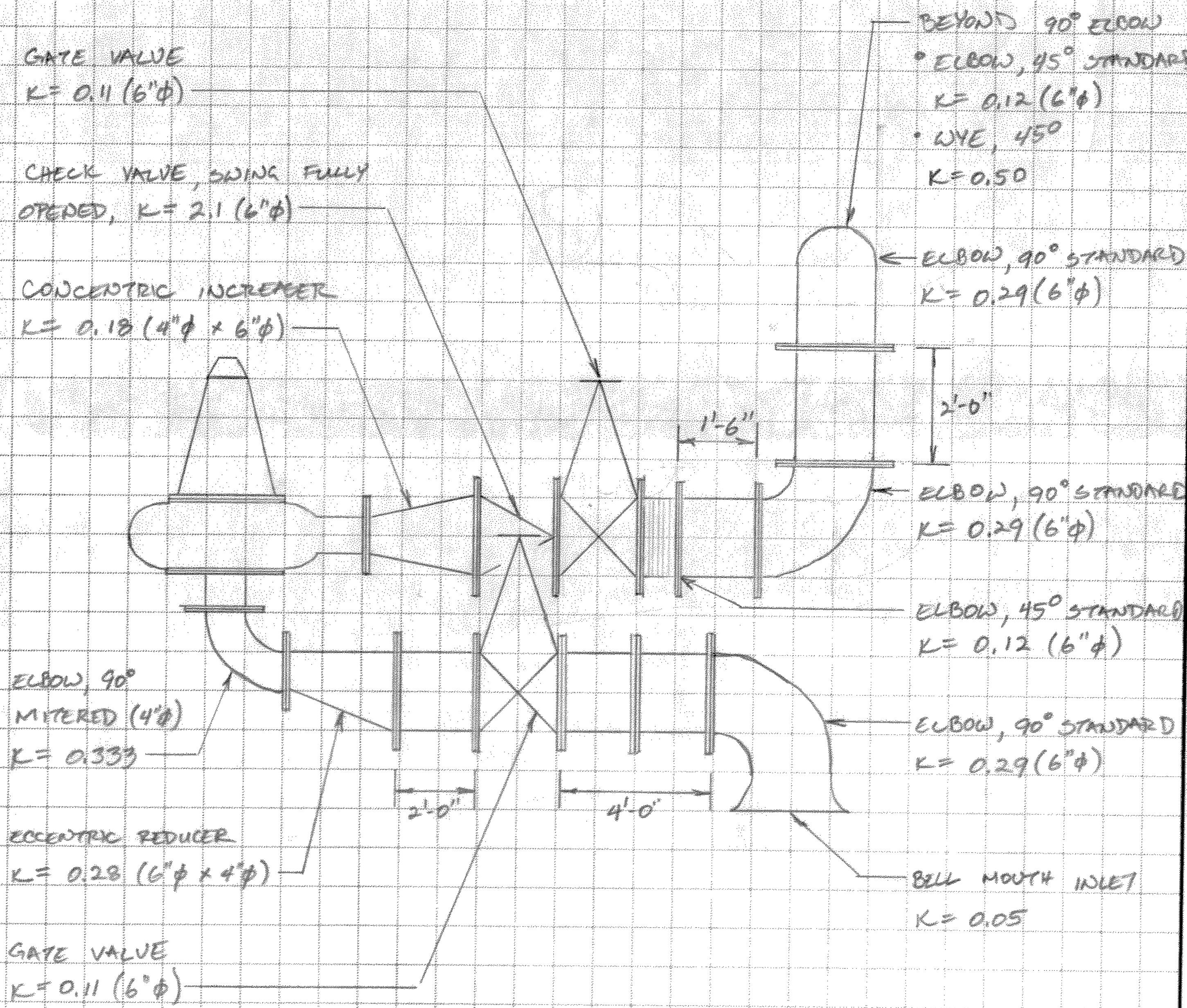
JOB Kahanahou WWPS (210-002)
SHEET NO. 1 OF 2
CALCULATED BY T.T DATE DEC 8, 2010
CHECKED BY ______ DATE ______
SCALE Renovated Pump Station Minor Losses

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JOB Kahanahou WWPS (210-002)
SHEET NO. 2 OF 2
CALCULATED BY T.T. DATE DEC 23, 2010
CHECKED BY ______ DATE ______
SCALE Renovated Pump Station Minor Losses

MINOR LOSSES THROUGH FITTINGS AND VALVES

$$h_L = \frac{K V^2}{2g}$$

WHERE: $h_L$ = HEAD LOSS (FT)
$K$ = RESISTANCE COEFFICIENT
$V$ = VELOCITY (FT/S)
$g$ = GRAVITATIONAL ACCELERATION (32.2 FT/S)

$\Sigma K(6"\phi) = 0.05 + 0.29 + 0.11 + 2.1 + 0.11 + 0.12 + 0.29 + 0.29 + 0.12 + 0.50 = 3.98$
$\Sigma K(4"\phi) = 0.28 + 0.333 + 0.18 = 0.793$

$$h_L = \frac{3.98\,(V_{(6"\phi)})^2 + 0.793\,(V_{(4"\phi)})^2}{2(32.2\ ft/s^2)}$$

MINOR LOSSES THROUGH STRAIGHT PIPE

$$h_f = \frac{(3.022)(V)^{1.85} L}{(C)^{1.85}(D)^{1.165}}$$

WHERE: $h_f$ = FRICTIONAL HEAD LOSS (FT)
$V$ = VELOCITY (FT/S)
$L$ = PIPE LENGTH (FT)
$C$ = HAZEN-WILLIAMS ROUGHNESS COEFFICIENT (C=100)
$D$ = PIPE DIAMETER (FT)

$\Sigma L(6"\phi) = 4'\text{-}0" + 2'\text{-}0" + 1'\text{-}6" + 2'\text{-}0" = 9'\text{-}6"$

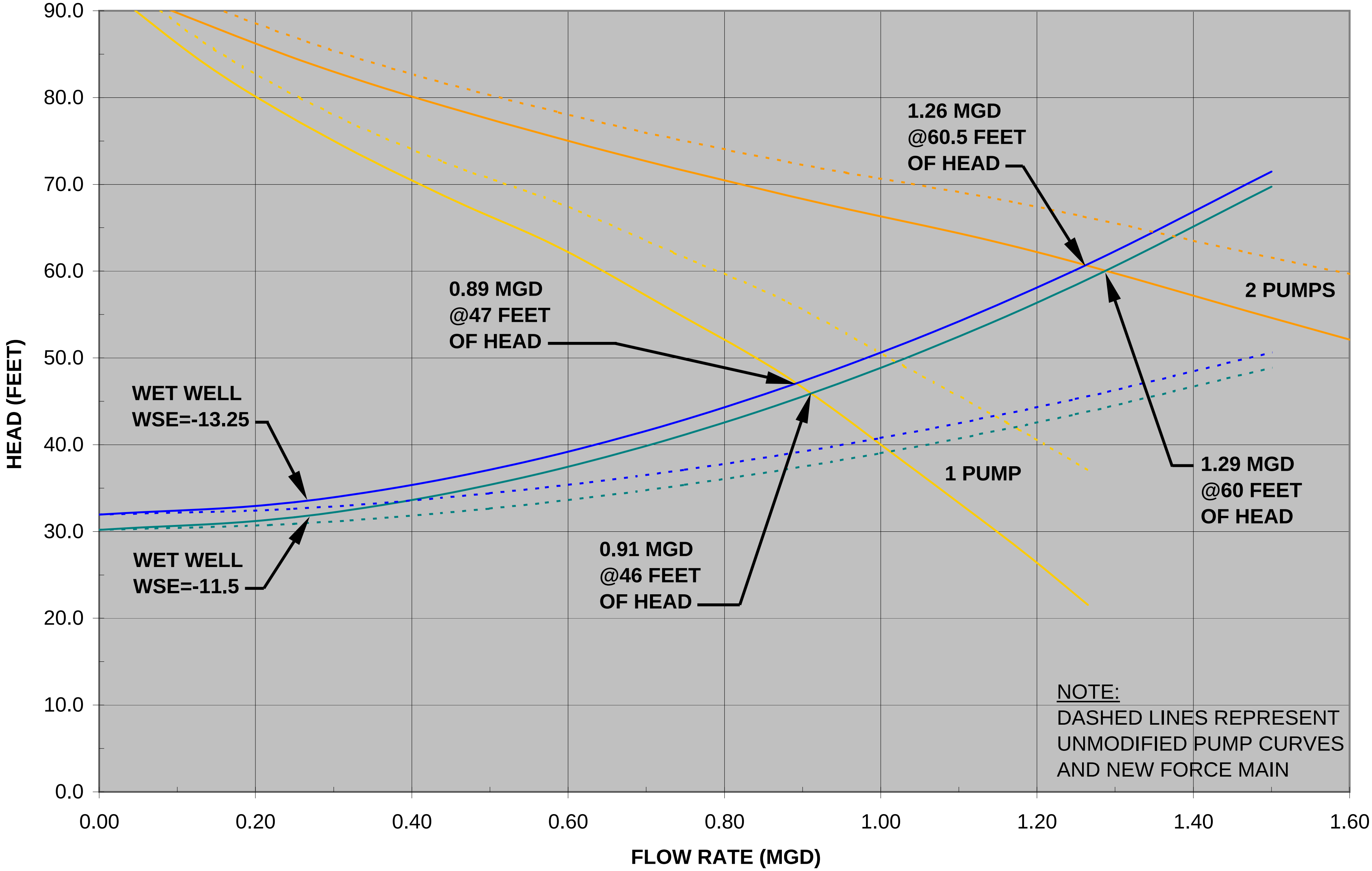
$$h_f = \frac{(3.022)\,(V_{(6"\phi)})^{1.85}\,(9'\text{-}6")}{(100)^{1.85}\,(6/12\ FT)^{1.165}}$$

MINOR LOSSES THROUGH COUNTER WEIGHTED CHECK VALVES

$h_c$ = ESTIMATED HEAD LOSS THROUGH CHECK VALVE

$h_c = 2.25'$

## CHART A-5.1: KAHANAHOU WWPS
## ALT No. 2 & 3: DRY PIT SUBMERSIBLE PUMP AND SYSTEM CURVES
### ABS XFP100E-CB1, 1765 RPM, 9.05" IMPELLER DIAMETER



# TABLE A-5.1: KAHANAHOU WWPS
## ALTERNATIVE No. 2 & 3: DRY PIT SUBMERSIBLE PUMP AND SYSTEM CURVES
### ABS XFP100E-CB1, 1765 RPM, 9.05" IMPELLER DIAMETER

| 8.858 Inch Impeller[a] | | | 9.05 Inch Impeller[b] | | | Adjusted[c] | 1 Pump | | 2 Pumps | | System | System Velocity | | System Curve (feet)[d] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDH | Flow Rate | | TDH | Flow Rate | | TDH | Flow Rate | | Flow Rate | | Flow Rate | 8" PVC[e] | 8" HDPE[f] | wse (-11.5) | | wse (-13.25) | |
| (feet) | (gpm) | (mgd) | (feet) | (gpm) | (mgd) | (feet) | (gpm) | (mgd) | (gpm) | (mgd) | (mgd) | (ft/sec) | (ft/sec) | $C_{old}$[g] | $C_{new}$[h] | $C_{old}$[g] | $C_{new}$[h] |
| 91.5 | 0 | 0.00 | 95.5 | 0 | 0.00 | 93.3 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 30.2 | 30.2 | 32.0 | 32.0 |
| 82 | 100 | 0.14 | 85.6 | 102 | 0.15 | 83.2 | 102 | 0.15 | 204 | 0.29 | 0.25 | 1.10 | 1.29 | 31.6 | 30.9 | 33.4 | 32.6 |
| 75 | 200 | 0.29 | 78.3 | 204 | 0.29 | 75.3 | 204 | 0.29 | 409 | 0.59 | 0.50 | 2.19 | 2.59 | 35.4 | 32.6 | 37.1 | 34.4 |
| 69.5 | 300 | 0.43 | 72.5 | 307 | 0.44 | 68.7 | 307 | 0.44 | 613 | 0.88 | 0.75 | 3.29 | 3.88 | 41.2 | 35.4 | 42.9 | 37.1 |
| 65 | 400 | 0.58 | 67.8 | 409 | 0.59 | 62.7 | 409 | 0.59 | 817 | 1.18 | 1.00 | 4.39 | 5.18 | 48.9 | 39.0 | 50.6 | 40.8 |
| 59.5 | 500 | 0.72 | 62.1 | 511 | 0.74 | 55.4 | 511 | 0.74 | 1,022 | 1.47 | 1.25 | 5.49 | 6.47 | 58.4 | 43.5 | 60.2 | 45.3 |
| 54 | 600 | 0.86 | 56.4 | 613 | 0.88 | 47.6 | 613 | 0.88 | 1,226 | 1.77 | 1.50 | 6.58 | 7.76 | 69.7 | 48.9 | 71.5 | 50.6 |
| 47 | 700 | 1.01 | 49.1 | 715 | 1.03 | 38.0 | 715 | 1.03 | 1,430 | 2.06 | | | | | | | |
| 40 | 800 | 1.15 | 41.8 | 817 | 1.18 | 28.0 | 817 | 1.18 | 1,635 | 2.35 | | | | | | | |
| 35.5 | 860 | 1.24 | 37.1 | 879 | 1.27 | 21.6 | 879 | 1.27 | 1,757 | 2.53 | | | | | | | |

[a]Pump curve taken from catalog data

[b]Pump curve data adjusted using affinity laws

Sample Calculation

$Q_1/Q_2 = D_1/D_2$

Where: Q = Flow rate (gpm)

D = Impeller diameter (inches)

$Q_2 = Q_1 * D_2/D_1$ = (200 gpm)*(9.05"/8.858") = 204 gpm

$H_1/H_2 = (D_1/D_2)^2$

Where: H = Head (feet)

$H_2 = H_1 * (D_2/D_1)^2$ = (75 feet)*(9.05"/8.858")$^2$ = 78.3 feet

[c]Adjusted TDH = Pump Rated TDH - Minor Losses (i.e. TDH - ($h_l$-$h_f$))

Sample Calculation

$v = Q/A = Q/(pi*r^2)$

Where: v = velocity (ft/sec)

A = Force main cross sectional area (feet)$^2$

r = Force main radius (feet)

$v_{4"}$ = (204 gpm)*(1 min/60 sec)*(1 ft$^3$/7.48 gal.)/((pi)*(2/12 feet)$^2$) = 5.22 ft/sec

# TABLE A-5.1: KAHANAHOU WWPS
# ALTERNATIVE No. 2 & 3: DRY PIT SUBMERSIBLE PUMP AND SYSTEM CURVES
## ABS XFP100E-CB1, 1765 RPM, 9.05" IMPELLER DIAMETER

$v_{6"}$ = (204 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(3/12 \text{ feet})^2$) = 2.32 ft/sec
$v_{8"}$ = (204 gpm)*(1 min/60 sec)*(1 $ft^3$/7.48 gal.)/((pi)*$(4/12 \text{ feet})^2$) = 1.30 ft/sec

$h_l = (3.98*(v_{6"})^2+0.793*(v_{4"})^2)/(2*32.2 \text{ ft/sec}^2) = (3.98*(2.32 \text{ ft/sec})^2+0.793*(5.22 \text{ ft/sec})^2)/(2*32.2 \text{ ft/sec}^2) = 0.67$ feet

$h_f = (3.022/100^{1.85})*(v_{6"}{}^{1.85}*(9.5 \text{ feet})/(6/12 \text{ feet})^{1.165}) = (3.022/100^{1.85})*((2.32 \text{ ft/sec})^{1.85}*(9.5 \text{ feet})/(6/12 \text{ feet})^{1.165} = 0.06$ feet

$h_c$ = 2.25 feet

Adjusted TDH = 78.3 feet - (0.67 feet + 0.06 feet + 2.25 feet) = 75.3 feet

[d]Force main data (i.e. pipe size, length, material) obtained from C&C Wastewater Job No. W16-05.

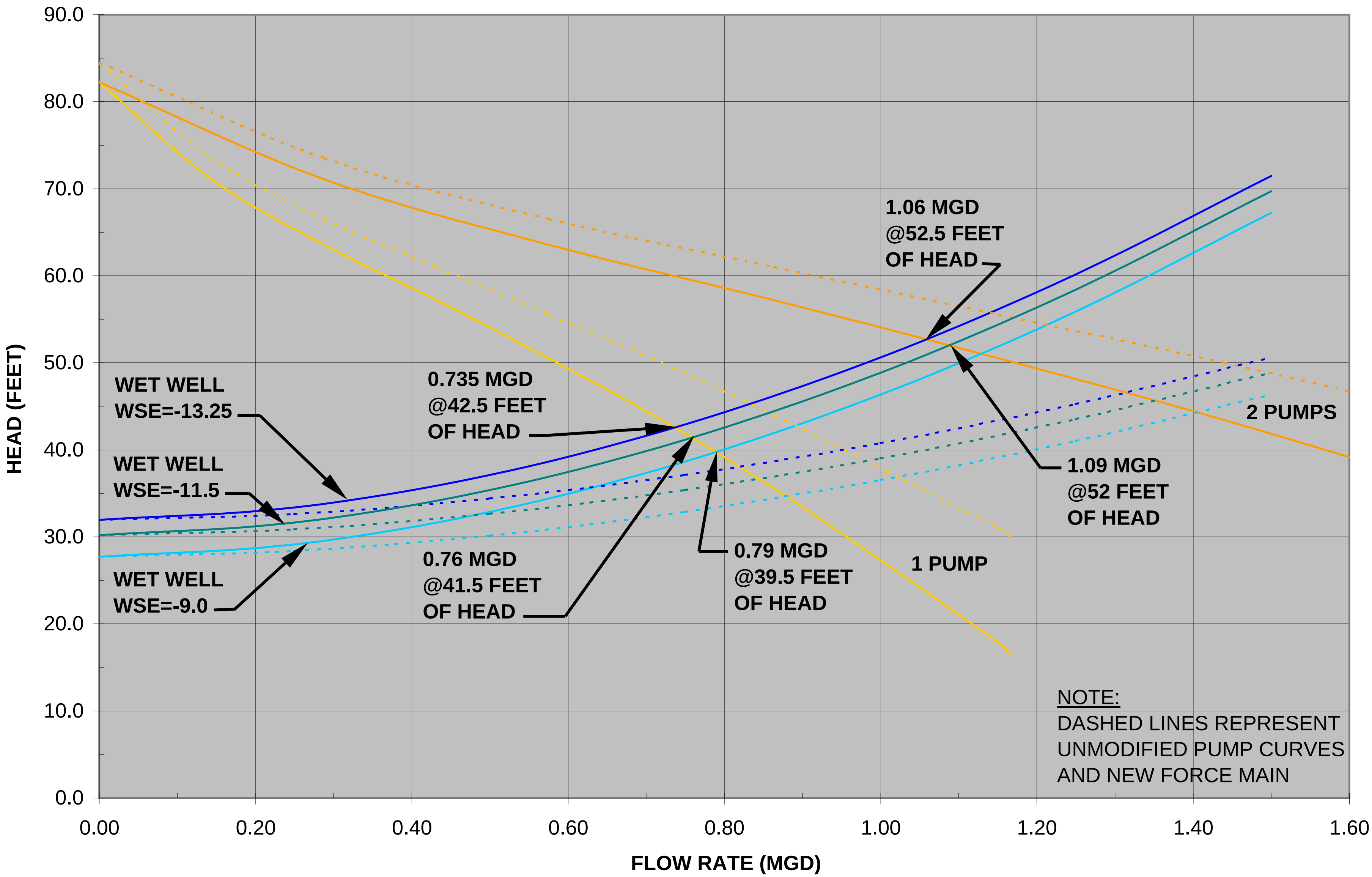
[e]Pipe dimensions based on AWWA C-900 standards

[f]Pipe dimensions based on HDPE SDR 11 ductile iron pipe dimensions

[g]Hazen-Williams Coefficient = 100 for old PVC and HDPE

[h]Hazen-Williams Coefficient = 150 for new PVC and HDPE

# CHART A-6.1: KAHANAHOU WWPS
## ALTERNATIVE No. 4: DRY PIT SUBMERSIBLE PUMP AND SYSTEM CURVES
### ABS XFP100E-CB1, 1765 RPM, 8.465" (215 mm) IMPELLER DIAMETER



# TABLE A-6.1: KAHANAHOU WWPS
# ALTERNATIVE No. 4: DRY PIT SUBMERSIBLE PUMP AND SYSTEM CURVES
## ABS XFP100E-CB1, 1765 RPM, 8.465" (215 mm) IMPELLER DIAMETER

| 8.465 Inch Impeller[a] | | | Adjusted[b] | 1 Pump | | 2 Pumps | | System | System Velocity | | System Curve (feet)[c] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TDH | Flow Rate | | TDH | Flow Rate | | Flow Rate | | Flow Rate | 8" PVC[d] | 8" HDPE[e] | wse (-9.00) | | wse (-11.5) | | wse (-13.25) | |
| (feet) | (gpm) | (mgd) | (feet) | (gpm) | (mgd) | (gpm) | (mgd) | (mgd) | (ft/sec) | (ft/sec) | $C_{old}$[f] | $C_{new}$[g] | $C_{old}$[f] | $C_{new}$[g] | $C_{old}$[f] | $C_{new}$[g] |
| 84.5 | 0 | 0.00 | 82.3 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 27.7 | 27.7 | 30.2 | 30.2 | 32.0 | 32.0 |
| 73.5 | 100 | 0.14 | 71.1 | 100 | 0.14 | 200 | 0.29 | 0.25 | 1.10 | 1.29 | 29.1 | 28.4 | 31.6 | 30.9 | 33.4 | 32.6 |
| 66.5 | 200 | 0.29 | 63.6 | 200 | 0.29 | 400 | 0.58 | 0.50 | 2.19 | 2.59 | 32.9 | 30.1 | 35.4 | 32.6 | 37.1 | 34.4 |
| 61 | 300 | 0.43 | 57.2 | 300 | 0.43 | 600 | 0.86 | 0.75 | 3.29 | 3.88 | 38.7 | 32.9 | 41.2 | 35.4 | 42.9 | 37.1 |
| 55.5 | 400 | 0.58 | 50.5 | 400 | 0.58 | 800 | 1.15 | 1.00 | 4.39 | 5.18 | 46.4 | 36.5 | 48.9 | 39.0 | 50.6 | 40.8 |
| 50 | 500 | 0.72 | 43.4 | 500 | 0.72 | 1,000 | 1.44 | 1.25 | 5.49 | 6.47 | 55.9 | 41.0 | 58.4 | 43.5 | 60.2 | 45.3 |
| 44 | 600 | 0.86 | 35.5 | 600 | 0.86 | 1,200 | 1.73 | 1.50 | 6.58 | 7.76 | 67.2 | 46.4 | 69.7 | 48.9 | 71.5 | 50.6 |
| 37.5 | 700 | 1.01 | 26.8 | 700 | 1.01 | 1,400 | 2.02 | | | | | | | | | |
| 31 | 800 | 1.15 | 17.8 | 800 | 1.15 | 1,600 | 2.30 | | | | | | | | | |
| 30 | 810 | 1.17 | 16.5 | 810 | 1.17 | 1,620 | 2.33 | | | | | | | | | |

[a]Pump curve taken from catalog data

[b]Adjusted TDH = Pump Rated TDH - Minor Losses (i.e. TDH - ($h_l$-$h_f$))

Sample Calculation

$v = Q/A = Q/(pi*r^2)$

Where: v = velocity (ft/sec)

A = Force main cross sectional area (feet)$^2$

r = Force main radius (feet)

$v_{4"}$ = (200 gpm)*(1 min/60 sec)*(1 ft$^3$/7.48 gal.)/((pi)*(2/12 feet)$^2$) = 5.11 ft/sec

$v_{6"}$ = (200 gpm)*(1 min/60 sec)*(1 ft$^3$/7.48 gal.)/((pi)*(3/12 feet)$^2$) = 2.27 ft/sec

$v_{8"}$ = (200 gpm)*(1 min/60 sec)*(1 ft$^3$/7.48 gal.)/((pi)*(4/12 feet)$^2$) = 1.28 ft/sec

$h_l = (3.98*(v_{6"})^2+0.793*(v_{4"})^2)/(2*32.2\ ft/sec^2) = (3.98*(2.27\ ft/sec)^2+0.793*(5.11\ ft/sec)^2)/(2*32.2\ ft/sec^2) = 0.64$ feet

$h_f = (3.022/100^{1.85})*(v_{6"}{}^{1.85}*(9.5\ feet)/(6/12\ feet)^{1.165}) = (3.022/100^{1.85})*((2.27\ ft/sec)^{1.85}*(9.5\ feet)/(6/12\ feet)^{1.165} = 0.06$ feet

$h_c$ = 2.25 feet

Adjusted TDH = 66.5 feet - (0.64 feet + 0.06 feet + 2.25) = 63.6 feet

# TABLE A-6.1: KAHANAHOU WWPS
# ALTERNATIVE No. 4: DRY PIT SUBMERSIBLE PUMP AND SYSTEM CURVES
## ABS XFP100E-CB1, 1765 RPM, 8.465" (215 mm) IMPELLER DIAMETER

[c]Force main data (i.e. pipe size, length, material) obtained from C&C Wastewater Job No. W16-05.

[d]Pipe dimensions based on AWWA C-900 standards

[e]Pipe dimensions based on HDPE SDR 11 ductile iron pipe dimensions

[f]Hazen-Williams Coefficient = 100 for old PVC and HDPE

[g]Hazen-Williams Coefficient = 150 for new PVC and HDPE

**OKAHARA & ASSOCIATES, INC.**
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JOB Kahanahou WWPS (210-002)
SHEET NO. 1 OF 2
CALCULATED BY T.T. DATE DEC 23, 2010
CHECKED BY ______ DATE ______
SCALE Water Hammer Calculations

Reference: Design Standards of the Department of Wastewater Management, Volume 1, July 1993, Section 38.10

Determine maximum water hammer pressure

Max water hammer pressure (ft) = static head (ft) + $\frac{aV}{g}$

where: $a = \frac{4660}{(1+KB)^{1/2}}$ = velocity of sound in water in the force main in fps

K = ratio of the elastic modulus of water to that of the pipe material
B = ratio of pipe diameter to wall thickness
V = maximum velocity in the force main at peak flow or the destroyed velocity
g = acceleration due to gravity = 32.2 ft/s²

Assume 8" HDPE Pipe (Most of force main pipe comprised of 8" HDPE)

@ 0.90 mgd → 136 psi water hammer (4.66 ft/s velocity)
(See Table A-_ for calculations)
∴ 136 psi is less than strength of pipe (160 psi, SDR 11)

@ 1.30 mgd → 194 psi water hammer (6.88 ft/s velocity)
(See Table A-_ for calculations)
∴ 194 psi is greater than strength of pipe (160 psi, SDR 11)
Further investigation required.

**OKAHARA & ASSOCIATES, INC.**
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JOB: Kahanahou WWPS (210-002)
SHEET NO. 2 OF 2
CALCULATED BY: T.T. DATE: DEC 23, 2010
CHECKED BY: DATE:
SCALE: Water Hammer Calculations

ASSUME SDR 11 HDPE PIPE (160 psi pressure class)

One Cycle Period $= \frac{2L}{a}$

Where: L = Length of Force Main (794 ft)

One Cycle Period $= \frac{(2)(794\ ft)}{843\ fps} = 1.88$

Line Constant $= \frac{av}{2gH}$

Where: H = Static head in feet

Line Constant $= \frac{(843\ ft/s)(6.88\ ft/s)}{(2)(32.2\ ft/s^2)(31.95\ ft)} = 2.82$

Determine allowable pressure rise in Force Main

Allowable pressure rise $= \frac{\text{Allowable pipe strength (ft)}}{\text{Static head (ft)}}$

$= \frac{(160\ psi)(2.31\ ft/psi)}{31.95\ ft} = 11.6$

Apply factors to Allievi chart (Fig 38.10 of Design Standards)

For: Line Constant = 2.82
Allowable Press Rise = 11.6

Time Constant $\left(\frac{aT}{2L}\right) = < 1$ sec

∴ No special design conditions required

# APPENDIX B
# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2, 2006

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| Kahanahou WWPS | | Discharge Pressure | Flow Rate | Wetwell Level | Flow | Pump Lift |
|---|---|---|---|---|---|---|
| DATE: | TIME: | (Feet) | (mgd) | (Feet) | (gpm) | (Feet) |
| 10/31/06 | 00:00:00 | 10.7640 | 0.0010 | -13.1840 | 0.694444444 | 10.9480 |
| 10/31/06 | 00:01:00 | 10.6600 | 0.0010 | -12.8050 | 0.694444444 | 10.4650 |
| 10/31/06 | 00:02:00 | 10.6600 | 0.0010 | -12.8050 | 0.694444444 | 10.4650 |
| 10/31/06 | 00:03:00 | 10.5560 | 0.0010 | -12.3890 | 0.694444444 | 9.9450 |
| 10/31/06 | 00:04:00 | 10.5560 | 0.0010 | -12.3890 | 0.694444444 | 9.9450 |
| 10/31/06 | 00:05:00 | 10.4520 | 0.0010 | -12.0460 | 0.694444444 | 9.4980 |
| 10/31/06 | 00:06:00 | 10.4520 | 0.0010 | -12.0460 | 0.694444444 | 9.4980 |
| 10/31/06 | 00:07:00 | 10.4170 | 0.0010 | -11.7210 | 0.694444444 | 9.1380 |
| 10/31/06 | 00:08:00 | 37.5000 | 0.5410 | -11.4870 | 375.6944444 | 35.9870 |
| 10/31/06 | 00:09:00 | 37.5000 | 0.5410 | -11.4870 | 375.6944444 | 35.9870 |
| 10/31/06 | 00:10:00 | 37.4650 | 0.5380 | -11.5680 | 373.6111111 | 36.0330 |
| 10/31/06 | 00:11:00 | 29.0280 | 0.4720 | -10.9000 | 327.7777778 | 26.9280 |
| 10/31/06 | 00:12:00 | 37.4650 | 0.5380 | -11.5680 | 373.6111111 | 36.0330 |
| 10/31/06 | 00:13:00 | 37.4650 | 0.5380 | -11.5680 | 373.6111111 | 36.0330 |
| 10/31/06 | 00:14:00 | 36.9100 | 0.5350 | -11.9200 | 371.5277778 | 35.8300 |
| 10/31/06 | 00:15:00 | 36.9100 | 0.5350 | -11.9200 | 371.5277778 | 35.8300 |
| 10/31/06 | 00:16:00 | 37.0840 | 0.5350 | -12.0640 | 371.5277778 | 36.1480 |
| 10/31/06 | 00:17:00 | 37.0840 | 0.5350 | -12.0640 | 371.5277778 | 36.1480 |
| 10/31/06 | 00:18:00 | 36.7020 | 0.5340 | -12.2090 | 370.8333333 | 35.9110 |
| 10/31/06 | 00:19:00 | 36.7020 | 0.5340 | -12.2090 | 370.8333333 | 35.9110 |
| 10/31/06 | 00:20:00 | 36.9100 | 0.5320 | -12.3620 | 369.4444444 | 36.2720 |
| 10/31/06 | 00:21:00 | 36.9100 | 0.5320 | -12.3620 | 369.4444444 | 36.2720 |
| 10/31/06 | 00:22:00 | 36.4240 | 0.5290 | -12.5070 | 367.3611111 | 35.9310 |
| 10/31/06 | 00:23:00 | 36.3200 | 0.5290 | -12.6240 | 367.3611111 | 35.9440 |
| 10/31/06 | 00:24:00 | 36.3200 | 0.5290 | -12.6240 | 367.3611111 | 35.9440 |
| 10/31/06 | 00:25:00 | 35.9030 | 0.5280 | -12.7960 | 366.6666667 | 35.6990 |
| 10/31/06 | 00:26:00 | 36.0070 | 0.5250 | -12.9580 | 364.5833333 | 35.9650 |
| 10/31/06 | 00:27:00 | 36.0070 | 0.5250 | -12.9580 | 364.5833333 | 35.9650 |
| 10/31/06 | 00:28:00 | 35.7990 | 0.5260 | -13.1390 | 365.2777778 | 35.9380 |
| 10/31/06 | 00:29:00 | 35.7990 | 0.5260 | -13.1390 | 365.2777778 | 35.9380 |
| 10/31/06 | 00:30:00 | 35.4860 | 0.5240 | -13.3370 | 363.8888889 | 35.8230 |
| 10/31/06 | 00:31:00 | 10.7640 | 0.0010 | -13.2830 | 0.694444444 | 11.0470 |
| 10/31/06 | 00:32:00 | 10.7640 | 0.0010 | -13.2830 | 0.694444444 | 11.0470 |
| 10/31/06 | 00:33:00 | 10.6250 | 0.0010 | -12.8770 | 0.694444444 | 10.5020 |
| 10/31/06 | 00:34:00 | 10.6250 | 0.0010 | -12.8770 | 0.694444444 | 10.5020 |
| 10/31/06 | 00:35:00 | 10.4860 | 0.0010 | -12.4350 | 0.694444444 | 9.9210 |
| 10/31/06 | 00:36:00 | 10.4860 | 0.0010 | -12.4350 | 0.694444444 | 9.9210 |
| 10/31/06 | 00:37:00 | 10.3820 | 0.0010 | -12.0280 | 0.694444444 | 9.4100 |
| 10/31/06 | 00:38:00 | 10.3820 | 0.0010 | -12.0280 | 0.694444444 | 9.4100 |
| 10/31/06 | 00:39:00 | 10.3820 | 0.0010 | -11.7120 | 0.694444444 | 9.0940 |
| 10/31/06 | 00:40:00 | 37.2220 | 0.5370 | -11.4870 | 372.9166667 | 35.7090 |
| 10/31/06 | 00:41:00 | 37.2220 | 0.5370 | -11.4870 | 372.9166667 | 35.7090 |
| 10/31/06 | 00:42:00 | 37.3610 | 0.5380 | -11.5680 | 373.6111111 | 35.9290 |
| 10/31/06 | 00:43:00 | 37.0840 | 0.5350 | -11.6940 | 371.5277778 | 35.7780 |
| 10/31/06 | 00:44:00 | 37.0840 | 0.5350 | -11.6940 | 371.5277778 | 35.7780 |
| 10/31/06 | 00:45:00 | 37.0490 | 0.5350 | -11.8480 | 371.5277778 | 35.8970 |
| 10/31/06 | 00:46:00 | 36.9450 | 0.5330 | -11.9560 | 370.1388889 | 35.9010 |
| 10/31/06 | 00:47:00 | 36.9450 | 0.5330 | -11.9560 | 370.1388889 | 35.9010 |
| 10/31/06 | 00:48:00 | 36.8750 | 0.5320 | -12.0830 | 369.4444444 | 35.9580 |
| 10/31/06 | 00:49:00 | 36.8750 | 0.5320 | -12.0830 | 369.4444444 | 35.9580 |
| 10/31/06 | 00:50:00 | 36.5970 | 0.5320 | -12.2360 | 369.4444444 | 35.8330 |
| 10/31/06 | 00:51:00 | 36.5970 | 0.5320 | -12.2360 | 369.4444444 | 35.8330 |
| 10/31/06 | 00:52:00 | 36.4240 | 0.5290 | -12.3990 | 367.3611111 | 35.8230 |
| 10/31/06 | 00:53:00 | 36.4240 | 0.5290 | -12.3990 | 367.3611111 | 35.8230 |
| 10/31/06 | 00:54:00 | 36.2150 | 0.5290 | -12.5520 | 367.3611111 | 35.7670 |
| 10/31/06 | 00:55:00 | 36.2150 | 0.5290 | -12.5520 | 367.3611111 | 35.7670 |
| 10/31/06 | 00:56:00 | 35.7640 | 0.5280 | -12.7240 | 366.6666667 | 35.4880 |
| 10/31/06 | 00:57:00 | 36.1810 | 0.5260 | -12.9040 | 365.2777778 | 36.0850 |
| 10/31/06 | 00:58:00 | 36.1810 | 0.5260 | -12.9040 | 365.2777778 | 36.0850 |
| 10/31/06 | 00:59:00 | 36.1460 | 0.5250 | -13.0760 | 364.5833333 | 36.2220 |
| 10/31/06 | 01:00:00 | 36.1460 | 0.5250 | -13.0760 | 364.5833333 | 36.2220 |
| 10/31/06 | 01:01:00 | 35.5900 | 0.5240 | -13.2650 | 363.8888889 | 35.8550 |
| 10/31/06 | 01:02:00 | 10.7990 | 0.0010 | -13.3190 | 0.694444444 | 11.1180 |
| 10/31/06 | 01:03:00 | 10.7990 | 0.0010 | -13.3190 | 0.694444444 | 11.1180 |
| 10/31/06 | 01:04:00 | 10.6250 | 0.0010 | -12.8050 | 0.694444444 | 10.4300 |
| 10/31/06 | 01:05:00 | 10.6250 | 0.0010 | -12.8050 | 0.694444444 | 10.4300 |
| 10/31/06 | 01:06:00 | 10.4860 | 0.0010 | -12.4620 | 0.694444444 | 9.9480 |
| 10/31/06 | 01:07:00 | 10.4860 | 0.0010 | -12.4620 | 0.694444444 | 9.9480 |
| 10/31/06 | 01:08:00 | 10.4170 | 0.0010 | -12.1730 | 0.694444444 | 9.5900 |
| 10/31/06 | 01:09:00 | 10.3820 | 0.0010 | -11.8660 | 0.694444444 | 9.2480 |
| 10/31/06 | 01:10:00 | 10.3820 | 0.0010 | -11.8660 | 0.694444444 | 9.2480 |
| 10/31/06 | 01:11:00 | 10.3470 | 0.0010 | -11.6040 | 0.694444444 | 8.9510 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/31/06 | 01:12:00 | 10.3470 | 0.0010 | -11.6040 | 0.694444444 | 8.9510 |
| 10/31/06 | 01:13:00 | 37.1530 | 0.5380 | -11.4960 | 373.6111111 | 35.6490 |
| 10/31/06 | 01:14:00 | 37.2570 | 0.5360 | -11.6310 | 372.2222222 | 35.8880 |
| 10/31/06 | 01:15:00 | 37.2570 | 0.5360 | -11.6310 | 372.2222222 | 35.8880 |
| 10/31/06 | 01:16:00 | 37.1180 | 0.5360 | -11.7490 | 372.2222222 | 35.8670 |
| 10/31/06 | 01:17:00 | 36.9100 | 0.5330 | -11.8930 | 370.1388889 | 35.8030 |
| 10/31/06 | 01:18:00 | 36.9100 | 0.5330 | -11.8930 | 370.1388889 | 35.8030 |
| 10/31/06 | 01:19:00 | 36.6320 | 0.5320 | -12.0740 | 369.4444444 | 35.7060 |
| 10/31/06 | 01:20:00 | 36.6320 | 0.5320 | -12.0740 | 369.4444444 | 35.7060 |
| 10/31/06 | 01:21:00 | 36.5630 | 0.5300 | -12.2360 | 368.0555556 | 35.7990 |
| 10/31/06 | 01:22:00 | 36.5630 | 0.5300 | -12.2360 | 368.0555556 | 35.7990 |
| 10/31/06 | 01:23:00 | 36.4930 | 0.5290 | -12.3710 | 367.3611111 | 35.8640 |
| 10/31/06 | 01:24:00 | 36.1460 | 0.5270 | -12.5250 | 365.9722222 | 35.6710 |
| 10/31/06 | 01:25:00 | 36.1460 | 0.5270 | -12.5250 | 365.9722222 | 35.6710 |
| 10/31/06 | 01:26:00 | 36.0420 | 0.5300 | -12.6870 | 368.0555556 | 35.7290 |
| 10/31/06 | 01:27:00 | 36.0420 | 0.5300 | -12.6870 | 368.0555556 | 35.7290 |
| 10/31/06 | 01:28:00 | 35.9380 | 0.5250 | -12.8770 | 364.5833333 | 35.8150 |
| 10/31/06 | 01:29:00 | 36.0770 | 0.5240 | -13.0390 | 363.8888889 | 36.1160 |
| 10/31/06 | 01:30:00 | 36.0770 | 0.5240 | -13.0390 | 363.8888889 | 36.1160 |
| 10/31/06 | 01:31:00 | 35.7290 | 0.5240 | -13.2200 | 363.8888889 | 35.9490 |
| 10/31/06 | 01:32:00 | 10.8330 | 0.0010 | -13.3460 | 0.694444444 | 11.1790 |
| 10/31/06 | 01:33:00 | 10.8330 | 0.0010 | -13.3460 | 0.694444444 | 11.1790 |
| 10/31/06 | 01:34:00 | 10.5900 | 0.0010 | -13.0030 | 0.694444444 | 10.5930 |
| 10/31/06 | 01:35:00 | 10.5900 | 0.0010 | -13.0030 | 0.694444444 | 10.5930 |
| 10/31/06 | 01:36:00 | 10.3820 | 0.0010 | -12.5340 | 0.694444444 | 9.9160 |
| 10/31/06 | 01:37:00 | 10.3820 | 0.0010 | -12.5340 | 0.694444444 | 9.9160 |
| 10/31/06 | 01:38:00 | 10.3130 | 0.0010 | -12.2360 | 0.694444444 | 9.5490 |
| 10/31/06 | 01:39:00 | 10.3130 | 0.0010 | -12.2360 | 0.694444444 | 9.5490 |
| 10/31/06 | 01:40:00 | 10.2780 | 0.0010 | -11.9650 | 0.694444444 | 9.2430 |
| 10/31/06 | 01:41:00 | 10.2430 | 0.0010 | -11.6760 | 0.694444444 | 8.9190 |
| 10/31/06 | 01:42:00 | 10.2430 | 0.0010 | -11.6760 | 0.694444444 | 8.9190 |
| 10/31/06 | 01:43:00 | 37.3610 | 0.5370 | -11.4870 | 372.9166667 | 35.8480 |
| 10/31/06 | 01:44:00 | 36.8400 | 0.5350 | -11.6040 | 371.5277778 | 35.4440 |
| 10/31/06 | 01:45:00 | 36.8400 | 0.5350 | -11.6040 | 371.5277778 | 35.4440 |
| 10/31/06 | 01:46:00 | 36.9450 | 0.5330 | -11.7300 | 370.1388889 | 35.6750 |
| 10/31/06 | 01:47:00 | 36.9450 | 0.5310 | -11.8570 | 368.75 | 35.8020 |
| 10/31/06 | 01:48:00 | 36.9450 | 0.5310 | -11.8570 | 368.75 | 35.8020 |
| 10/31/06 | 01:49:00 | 36.8060 | 0.5300 | -12.0100 | 368.0555556 | 35.8160 |
| 10/31/06 | 01:50:00 | 36.8060 | 0.5300 | -12.0100 | 368.0555556 | 35.8160 |
| 10/31/06 | 01:51:00 | 36.5630 | 0.5290 | -12.1730 | 367.3611111 | 35.7360 |
| 10/31/06 | 01:52:00 | 36.5630 | 0.5290 | -12.1730 | 367.3611111 | 35.7360 |
| 10/31/06 | 01:53:00 | 36.1110 | 0.5280 | -12.3620 | 366.6666667 | 35.4730 |
| 10/31/06 | 01:54:00 | 36.1110 | 0.5280 | -12.3620 | 366.6666667 | 35.4730 |
| 10/31/06 | 01:55:00 | 35.6950 | 0.5270 | -12.5070 | 365.9722222 | 35.2020 |
| 10/31/06 | 01:56:00 | 35.6950 | 0.5270 | -12.5070 | 365.9722222 | 35.2020 |
| 10/31/06 | 01:57:00 | 36.0420 | 0.5260 | -12.6420 | 365.2777778 | 35.6840 |
| 10/31/06 | 01:58:00 | 35.2430 | 0.5230 | -12.8320 | 363.1944444 | 35.0750 |
| 10/31/06 | 01:59:00 | 35.2430 | 0.5230 | -12.8320 | 363.1944444 | 35.0750 |
| 10/31/06 | 02:00:00 | 35.6600 | 0.5240 | -13.0120 | 363.8888889 | 35.6720 |
| 10/31/06 | 02:01:00 | 35.3820 | 0.5200 | -13.2110 | 361.1111111 | 35.5930 |
| 10/31/06 | 02:02:00 | 35.3820 | 0.5200 | -13.2110 | 361.1111111 | 35.5930 |
| 10/31/06 | 02:03:00 | 10.7990 | 0.0010 | -13.3190 | 0.694444444 | 11.1180 |
| 10/31/06 | 02:04:00 | 10.7990 | 0.0010 | -13.3190 | 0.694444444 | 11.1180 |
| 10/31/06 | 02:05:00 | 10.5210 | 0.0010 | -12.8770 | 0.694444444 | 10.3980 |
| 10/31/06 | 02:06:00 | 10.5210 | 0.0010 | -12.8770 | 0.694444444 | 10.3980 |
| 10/31/06 | 02:07:00 | 10.3820 | 0.0010 | -12.5160 | 0.694444444 | 9.8980 |
| 10/31/06 | 02:08:00 | 10.3820 | 0.0010 | -12.5160 | 0.694444444 | 9.8980 |
| 10/31/06 | 02:09:00 | 10.3470 | 0.0010 | -12.2360 | 0.694444444 | 9.5830 |
| 10/31/06 | 02:10:00 | 10.2780 | 0.0010 | -11.9650 | 0.694444444 | 9.2430 |
| 10/31/06 | 02:11:00 | 10.2780 | 0.0010 | -11.9650 | 0.694444444 | 9.2430 |
| 10/31/06 | 02:12:00 | 10.2430 | 0.0010 | -11.6940 | 0.694444444 | 8.9370 |
| 10/31/06 | 02:13:00 | 10.2430 | 0.0010 | -11.6940 | 0.694444444 | 8.9370 |
| 10/31/06 | 02:14:00 | 37.0490 | 0.5360 | -11.4870 | 372.2222222 | 35.5360 |
| 10/31/06 | 02:15:00 | 36.7360 | 0.5340 | -11.5680 | 370.8333333 | 35.3040 |
| 10/31/06 | 02:16:00 | 36.7360 | 0.5340 | -11.5680 | 370.8333333 | 35.3040 |
| 10/31/06 | 02:17:00 | 36.7710 | 0.5310 | -11.6850 | 368.75 | 35.4560 |
| 10/31/06 | 02:18:00 | 36.7710 | 0.5310 | -11.6850 | 368.75 | 35.4560 |
| 10/31/06 | 02:19:00 | 36.2150 | 0.5290 | -11.8930 | 367.3611111 | 35.1080 |
| 10/31/06 | 02:20:00 | 36.2150 | 0.5290 | -11.8930 | 367.3611111 | 35.1080 |
| 10/31/06 | 02:21:00 | 36.7020 | 0.5260 | -12.0830 | 365.2777778 | 35.7850 |
| 10/31/06 | 02:22:00 | 36.7020 | 0.5260 | -12.0830 | 365.2777778 | 35.7850 |
| 10/31/06 | 02:23:00 | 36.1110 | 0.5290 | -12.2360 | 367.3611111 | 35.3470 |
| 10/31/06 | 02:24:00 | 36.1810 | 0.5270 | -12.3890 | 365.9722222 | 35.5700 |
| 10/31/06 | 02:25:00 | 36.1810 | 0.5270 | -12.3890 | 365.9722222 | 35.5700 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/31/06 | 02:26:00 | 35.8680 | 0.5250 | -12.5520 | 364.5833333 | 35.4200 |
| 10/31/06 | 02:27:00 | 35.8680 | 0.5250 | -12.5520 | 364.5833333 | 35.4200 |
| 10/31/06 | 02:28:00 | 35.7640 | 0.5220 | -12.6960 | 362.5 | 35.4600 |
| 10/31/06 | 02:29:00 | 35.4860 | 0.5220 | -12.8860 | 362.5 | 35.3720 |
| 10/31/06 | 02:30:00 | 35.4860 | 0.5220 | -12.8860 | 362.5 | 35.3720 |
| 10/31/06 | 02:31:00 | 36.0070 | 0.5200 | -13.0580 | 361.1111111 | 36.0650 |
| 10/31/06 | 02:32:00 | 36.0070 | 0.5200 | -13.0580 | 361.1111111 | 36.0650 |
| 10/31/06 | 02:33:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:34:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:35:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:36:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:37:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:38:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:39:00 | 35.4170 | 0.5200 | -13.3100 | 361.1111111 | 35.7270 |
| 10/31/06 | 02:40:00 | 10.4170 | 0.0010 | -12.2090 | 0.694444444 | 9.6260 |
| 10/31/06 | 02:41:00 | 10.4170 | 0.0010 | -12.2090 | 0.694444444 | 9.6260 |
| 10/31/06 | 02:42:00 | 10.3820 | 0.0010 | -11.8930 | 0.694444444 | 9.2750 |
| 10/31/06 | 02:43:00 | 10.3470 | 0.0010 | -11.6220 | 0.694444444 | 8.9690 |
| 10/31/06 | 02:44:00 | 10.3470 | 0.0010 | -11.6220 | 0.694444444 | 8.9690 |
| 10/31/06 | 02:45:00 | 37.5350 | 0.5360 | -11.4960 | 372.2222222 | 36.0310 |
| 10/31/06 | 02:46:00 | 37.1530 | 0.5350 | -11.6310 | 371.5277778 | 35.7840 |
| 10/31/06 | 02:47:00 | 37.1530 | 0.5350 | -11.6310 | 371.5277778 | 35.7840 |
| 10/31/06 | 02:48:00 | 37.0490 | 0.5310 | -11.8210 | 368.75 | 35.8700 |
| 10/31/06 | 02:49:00 | 37.0490 | 0.5310 | -11.8210 | 368.75 | 35.8700 |
| 10/31/06 | 02:50:00 | 36.9100 | 0.5320 | -11.9560 | 369.4444444 | 35.8660 |
| 10/31/06 | 02:51:00 | 36.9100 | 0.5320 | -11.9560 | 369.4444444 | 35.8660 |
| 10/31/06 | 02:52:00 | 36.6670 | 0.5300 | -12.1550 | 368.0555556 | 35.8220 |
| 10/31/06 | 02:53:00 | 36.6670 | 0.5300 | -12.1550 | 368.0555556 | 35.8220 |
| 10/31/06 | 02:54:00 | 36.3200 | 0.5280 | -12.2900 | 366.6666667 | 35.6100 |
| 10/31/06 | 02:55:00 | 36.3540 | 0.5270 | -12.4620 | 365.9722222 | 35.8160 |
| 10/31/06 | 02:56:00 | 36.3540 | 0.5270 | -12.4620 | 365.9722222 | 35.8160 |
| 10/31/06 | 02:57:00 | 36.4930 | 0.5270 | -12.5790 | 365.9722222 | 36.0720 |
| 10/31/06 | 02:58:00 | 36.4930 | 0.5270 | -12.5790 | 365.9722222 | 36.0720 |
| 10/31/06 | 02:59:00 | 36.2150 | 0.5240 | -12.7960 | 363.8888889 | 36.0110 |
| 10/31/06 | 03:00:00 | 36.2150 | 0.5240 | -12.7960 | 363.8888889 | 36.0110 |
| 10/31/06 | 03:01:00 | 36.1810 | 0.5260 | -12.9580 | 365.2777778 | 36.1390 |
| 10/31/06 | 03:02:00 | 35.9720 | 0.5240 | -13.1390 | 363.8888889 | 36.1110 |
| 10/31/06 | 03:03:00 | 35.9720 | 0.5240 | -13.1390 | 363.8888889 | 36.1110 |
| 10/31/06 | 03:04:00 | 1.5280 | 0.0010 | -13.3740 | 0.694444444 | 1.9020 |
| 10/31/06 | 03:05:00 | 1.5280 | 0.0010 | -13.3740 | 0.694444444 | 1.9020 |
| 10/31/06 | 03:06:00 | 10.7290 | 0.0010 | -13.0670 | 0.694444444 | 10.7960 |
| 10/31/06 | 03:07:00 | 10.7290 | 0.0010 | -13.0670 | 0.694444444 | 10.7960 |
| 10/31/06 | 03:08:00 | 10.5560 | 0.0010 | -12.6330 | 0.694444444 | 10.1890 |
| 10/31/06 | 03:09:00 | 10.4520 | 0.0010 | -12.3080 | 0.694444444 | 9.7600 |
| 10/31/06 | 03:10:00 | 10.4520 | 0.0010 | -12.3080 | 0.694444444 | 9.7600 |
| 10/31/06 | 03:11:00 | 10.4170 | 0.0010 | -12.0100 | 0.694444444 | 9.4270 |
| 10/31/06 | 03:12:00 | 10.4170 | 0.0010 | -12.0100 | 0.694444444 | 9.4270 |
| 10/31/06 | 03:13:00 | 10.3470 | 0.0010 | -11.7670 | 0.694444444 | 9.1140 |
| 10/31/06 | 03:14:00 | 10.3470 | 0.0010 | -11.4960 | 0.694444444 | 8.8430 |
| 10/31/06 | 03:15:00 | 35.7990 | 0.5210 | -11.5230 | 361.8055556 | 34.3220 |
| 10/31/06 | 03:16:00 | 35.7990 | 0.5210 | -11.5230 | 361.8055556 | 34.3220 |
| 10/31/06 | 03:17:00 | 36.0420 | 0.5210 | -11.6580 | 361.8055556 | 34.7000 |
| 10/31/06 | 03:18:00 | 36.0420 | 0.5210 | -11.6580 | 361.8055556 | 34.7000 |
| 10/31/06 | 03:19:00 | 35.2430 | 0.5190 | -11.7760 | 360.4166667 | 34.0190 |
| 10/31/06 | 03:20:00 | 35.2430 | 0.5190 | -11.7760 | 360.4166667 | 34.0190 |
| 10/31/06 | 03:21:00 | 35.4860 | 0.5180 | -11.8930 | 359.7222222 | 34.3790 |
| 10/31/06 | 03:22:00 | 35.4860 | 0.5180 | -11.8930 | 359.7222222 | 34.3790 |
| 10/31/06 | 03:23:00 | 35.0700 | 0.5170 | -11.9920 | 359.0277778 | 34.0620 |
| 10/31/06 | 03:24:00 | 35.2780 | 0.5170 | -12.0830 | 359.0277778 | 34.3610 |
| 10/31/06 | 03:25:00 | 35.2780 | 0.5170 | -12.0830 | 359.0277778 | 34.3610 |
| 10/31/06 | 03:26:00 | 35.2780 | 0.5160 | -12.1370 | 358.3333333 | 34.4150 |
| 10/31/06 | 03:27:00 | 35.2780 | 0.5160 | -12.1370 | 358.3333333 | 34.4150 |
| 10/31/06 | 03:28:00 | 35.1740 | 0.5160 | -12.2090 | 358.3333333 | 34.3830 |
| 10/31/06 | 03:29:00 | 34.8610 | 0.5150 | -12.2540 | 357.6388889 | 34.1150 |
| 10/31/06 | 03:30:00 | 34.8610 | 0.5150 | -12.2540 | 357.6388889 | 34.1150 |
| 10/31/06 | 03:31:00 | 34.8610 | 0.5130 | -12.3350 | 356.25 | 34.1960 |
| 10/31/06 | 03:32:00 | 34.8610 | 0.5130 | -12.3350 | 356.25 | 34.1960 |
| 10/31/06 | 03:33:00 | 34.6180 | 0.5130 | -12.3800 | 356.25 | 33.9980 |
| 10/31/06 | 03:34:00 | 34.8610 | 0.5120 | -12.4890 | 355.5555556 | 34.3500 |
| 10/31/06 | 03:35:00 | 34.8610 | 0.5120 | -12.4890 | 355.5555556 | 34.3500 |
| 10/31/06 | 03:36:00 | 34.8270 | 0.5120 | -12.5700 | 355.5555556 | 34.3970 |
| 10/31/06 | 03:37:00 | 34.8270 | 0.5120 | -12.5700 | 355.5555556 | 34.3970 |
| 10/31/06 | 03:38:00 | 35.0000 | 0.5100 | -12.6330 | 354.1666667 | 34.6330 |
| 10/31/06 | 03:39:00 | 35.0000 | 0.5100 | -12.6330 | 354.1666667 | 34.6330 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/31/06 | 03:40:00 | 34.6880 | 0.5090 | -12.6960 | 353.4722222 | 34.3840 |
| 10/31/06 | 03:41:00 | 34.6530 | 0.5100 | -12.7600 | 354.1666667 | 34.4130 |
| 10/31/06 | 03:42:00 | 34.6530 | 0.5100 | -12.7600 | 354.1666667 | 34.4130 |
| 10/31/06 | 03:43:00 | 34.7220 | 0.5090 | -12.7960 | 353.4722222 | 34.5180 |
| 10/31/06 | 03:44:00 | 34.7220 | 0.5090 | -12.7960 | 353.4722222 | 34.5180 |
| 10/31/06 | 03:45:00 | 34.6180 | 0.5120 | -12.8590 | 355.5555556 | 34.4770 |
| 10/31/06 | 03:46:00 | 34.6180 | 0.5120 | -12.8770 | 355.5555556 | 34.4950 |
| 10/31/06 | 03:47:00 | 34.6180 | 0.5120 | -12.8770 | 355.5555556 | 34.4950 |
| 10/31/06 | 03:48:00 | 34.8960 | 0.5120 | -12.8950 | 355.5555556 | 34.7910 |
| 10/31/06 | 03:49:00 | 34.6530 | 0.5120 | -12.8950 | 355.5555556 | 34.5480 |
| 10/31/06 | 03:50:00 | 34.7570 | 0.5120 | -12.9310 | 355.5555556 | 34.6880 |
| 10/31/06 | 03:51:00 | 34.7570 | 0.5120 | -12.9310 | 355.5555556 | 34.6880 |
| 10/31/06 | 03:52:00 | 34.6880 | 0.5100 | -12.9490 | 354.1666667 | 34.6370 |
| 10/31/06 | 03:53:00 | 34.5490 | 0.5100 | -13.0030 | 354.1666667 | 34.5520 |
| 10/31/06 | 03:54:00 | 34.5490 | 0.5100 | -13.0030 | 354.1666667 | 34.5520 |
| 10/31/06 | 03:55:00 | 34.3750 | 0.5100 | -13.0120 | 354.1666667 | 34.3870 |
| 10/31/06 | 03:56:00 | 34.3750 | 0.5100 | -13.0120 | 354.1666667 | 34.3870 |
| 10/31/06 | 03:57:00 | 34.8610 | 0.5090 | -13.0300 | 353.4722222 | 34.8910 |
| 10/31/06 | 03:58:00 | 34.7570 | 0.5100 | -13.0390 | 354.1666667 | 34.7960 |
| 10/31/06 | 03:59:00 | 34.7570 | 0.5100 | -13.0390 | 354.1666667 | 34.7960 |
| 10/31/06 | 04:00:00 | 34.8610 | 0.5120 | -13.0670 | 355.5555556 | 34.9280 |
| 10/31/06 | 04:01:00 | 34.8270 | 0.5100 | -13.0760 | 354.1666667 | 34.9030 |
| 10/31/06 | 04:02:00 | 34.8270 | 0.5100 | -13.0760 | 354.1666667 | 34.9030 |
| 10/31/06 | 04:03:00 | 34.6180 | 0.5110 | -13.1030 | 354.8611111 | 34.7210 |
| 10/31/06 | 04:04:00 | 34.6180 | 0.5110 | -13.1030 | 354.8611111 | 34.7210 |
| 10/31/06 | 04:05:00 | 34.7220 | 0.5120 | -13.1300 | 355.5555556 | 34.8520 |
| 10/31/06 | 04:06:00 | 34.7220 | 0.5120 | -13.1300 | 355.5555556 | 34.8520 |
| 10/31/06 | 04:07:00 | 34.5840 | 0.5120 | -13.1300 | 355.5555556 | 34.7140 |
| 10/31/06 | 04:08:00 | 34.5840 | 0.5120 | -13.1300 | 355.5555556 | 34.7140 |
| 10/31/06 | 04:09:00 | 34.7920 | 0.5130 | -13.1570 | 356.25 | 34.9490 |
| 10/31/06 | 04:10:00 | 34.7220 | 0.5130 | -13.1840 | 356.25 | 34.9060 |
| 10/31/06 | 04:11:00 | 34.7220 | 0.5130 | -13.1840 | 356.25 | 34.9060 |
| 10/31/06 | 04:12:00 | 34.7570 | 0.5140 | -13.2020 | 356.9444444 | 34.9590 |
| 10/31/06 | 04:13:00 | 34.9310 | 0.5130 | -13.2110 | 356.25 | 35.1420 |
| 10/31/06 | 04:14:00 | 34.9310 | 0.5130 | -13.2110 | 356.25 | 35.1420 |
| 10/31/06 | 04:15:00 | 34.5140 | 0.5130 | -13.2470 | 356.25 | 34.7610 |
| 10/31/06 | 04:16:00 | 34.5140 | 0.5130 | -13.2470 | 356.25 | 34.7610 |
| 10/31/06 | 04:17:00 | 34.4450 | 0.5140 | -13.2830 | 356.9444444 | 34.7280 |
| 10/31/06 | 04:18:00 | 34.6530 | 0.5100 | -13.3190 | 354.1666667 | 34.9720 |
| 10/31/06 | 04:19:00 | 34.6530 | 0.5100 | -13.3190 | 354.1666667 | 34.9720 |
| 10/31/06 | 04:20:00 | 34.3750 | 0.5110 | -13.3460 | 354.8611111 | 34.7210 |
| 10/31/06 | 04:21:00 | 34.3750 | 0.5110 | -13.3460 | 354.8611111 | 34.7210 |
| 10/31/06 | 04:22:00 | 10.4170 | 0.0000 | -13.2740 | 0 | 10.6910 |
| 10/31/06 | 04:23:00 | 10.4170 | 0.0000 | -13.2740 | 0 | 10.6910 |
| 10/31/06 | 04:24:00 | 10.0700 | 0.0000 | -12.6240 | 0 | 9.6940 |
| 10/31/06 | 04:25:00 | 10.0700 | 0.0000 | -12.6240 | 0 | 9.6940 |
| 10/31/06 | 04:26:00 | 9.9650 | 0.0000 | -12.2090 | 0 | 9.1740 |
| 10/31/06 | 04:27:00 | 9.8960 | 0.0000 | -11.7760 | 0 | 8.6720 |
| 10/31/06 | 04:28:00 | 9.8960 | 0.0000 | -11.7760 | 0 | 8.6720 |
| 10/31/06 | 04:29:00 | 35.4520 | 0.5250 | -11.4960 | 364.5833333 | 33.9480 |
| 10/31/06 | 04:30:00 | 35.9720 | 0.5250 | -11.4960 | 364.5833333 | 34.4680 |
| 10/31/06 | 04:31:00 | 35.9720 | 0.5250 | -11.4960 | 364.5833333 | 34.4680 |
| 10/31/06 | 04:32:00 | 35.6250 | 0.5240 | -11.5590 | 363.8888889 | 34.1840 |
| 10/31/06 | 04:33:00 | 35.0700 | 0.5220 | -11.6130 | 362.5 | 33.6830 |
| 10/31/06 | 04:34:00 | 35.0700 | 0.5220 | -11.6130 | 362.5 | 33.6830 |
| 10/31/06 | 04:35:00 | 35.0700 | 0.5220 | -11.6130 | 362.5 | 33.6830 |
| 10/31/06 | 04:36:00 | 36.2150 | 0.5310 | -11.6850 | 368.75 | 34.9000 |
| 10/31/06 | 04:37:00 | 36.2150 | 0.5310 | -11.6850 | 368.75 | 34.9000 |
| 10/31/06 | 04:38:00 | 36.8060 | 0.5300 | -11.6940 | 368.0555556 | 35.5000 |
| 10/31/06 | 04:39:00 | 36.6320 | 0.5310 | -11.7490 | 368.75 | 35.3810 |
| 10/31/06 | 04:40:00 | 36.6320 | 0.5310 | -11.7490 | 368.75 | 35.3810 |
| 10/31/06 | 04:41:00 | 36.7360 | 0.5310 | -11.7670 | 368.75 | 35.5030 |
| 10/31/06 | 04:42:00 | 36.7360 | 0.5310 | -11.7670 | 368.75 | 35.5030 |
| 10/31/06 | 04:43:00 | 36.4240 | 0.5310 | -11.8210 | 368.75 | 35.2450 |
| 10/31/06 | 04:44:00 | 36.9100 | 0.5310 | -11.8480 | 368.75 | 35.7580 |
| 10/31/06 | 04:45:00 | 36.9100 | 0.5310 | -11.8480 | 368.75 | 35.7580 |
| 10/31/06 | 04:46:00 | 36.0420 | 0.5300 | -11.8570 | 368.0555556 | 34.8990 |
| 10/31/06 | 04:47:00 | 35.9380 | 0.5310 | -11.8660 | 368.75 | 34.8040 |
| 10/31/06 | 04:48:00 | 35.9380 | 0.5310 | -11.8660 | 368.75 | 34.8040 |
| 10/31/06 | 04:49:00 | 36.8060 | 0.5310 | -11.8930 | 368.75 | 35.6990 |
| 10/31/06 | 04:50:00 | 36.8060 | 0.5310 | -11.8930 | 368.75 | 35.6990 |
| 10/31/06 | 04:51:00 | 36.1110 | 0.5300 | -11.9110 | 368.0555556 | 35.0220 |
| 10/31/06 | 04:52:00 | 36.1110 | 0.5300 | -11.9110 | 368.0555556 | 35.0220 |
| 10/31/06 | 04:53:00 | 36.2150 | 0.5290 | -11.9110 | 367.3611111 | 35.1260 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 04:54:00 | 36.2150 | 0.5290 | -11.9110 | 367.3611111 | 35.1260 |
| 10/31/06 | 04:55:00 | 36.3540 | 0.5290 | -11.9110 | 367.3611111 | 35.2650 |
| 10/31/06 | 04:56:00 | 36.5970 | 0.5300 | -11.9110 | 368.0555556 | 35.5080 |
| 10/31/06 | 04:57:00 | 36.5970 | 0.5300 | -11.9110 | 368.0555556 | 35.5080 |
| 10/31/06 | 04:58:00 | 36.5630 | 0.5320 | -11.9110 | 369.4444444 | 35.4740 |
| 10/31/06 | 04:59:00 | 36.3200 | 0.5310 | -11.9110 | 368.75 | 35.2310 |
| 10/31/06 | 05:00:00 | 36.3200 | 0.5310 | -11.9110 | 368.75 | 35.2310 |
| 10/31/06 | 05:01:00 | 36.4590 | 0.5310 | -11.8840 | 368.75 | 35.3430 |
| 10/31/06 | 05:02:00 | 36.4590 | 0.5310 | -11.8840 | 368.75 | 35.3430 |
| 10/31/06 | 05:03:00 | 36.3890 | 0.5310 | -11.8570 | 368.75 | 35.2460 |
| 10/31/06 | 05:04:00 | 36.3890 | 0.5310 | -11.8570 | 368.75 | 35.2460 |
| 10/31/06 | 05:05:00 | 36.4930 | 0.5320 | -11.8120 | 369.4444444 | 35.3050 |
| 10/31/06 | 05:06:00 | 36.0420 | 0.5320 | -11.7760 | 369.4444444 | 34.8180 |
| 10/31/06 | 05:07:00 | 36.0420 | 0.5320 | -11.7760 | 369.4444444 | 34.8180 |
| 10/31/06 | 05:08:00 | 36.5280 | 0.5320 | -11.7670 | 369.4444444 | 35.2950 |
| 10/31/06 | 05:09:00 | 36.5280 | 0.5320 | -11.7670 | 369.4444444 | 35.2950 |
| 10/31/06 | 05:10:00 | 36.4240 | 0.5310 | -11.7120 | 368.75 | 35.1360 |
| 10/31/06 | 05:11:00 | 36.2500 | 0.5320 | -11.6940 | 369.4444444 | 34.9440 |
| 10/31/06 | 05:12:00 | 36.2500 | 0.5320 | -11.6940 | 369.4444444 | 34.9440 |
| 10/31/06 | 05:13:00 | 36.4930 | 0.5300 | -11.6670 | 368.0555556 | 35.1600 |
| 10/31/06 | 05:14:00 | 36.3200 | 0.5310 | -11.6310 | 368.75 | 34.9510 |
| 10/31/06 | 05:15:00 | 36.1460 | 0.5310 | -11.6310 | 368.75 | 34.7770 |
| 10/31/06 | 05:16:00 | 36.1460 | 0.5320 | -11.6220 | 369.4444444 | 34.7680 |
| 10/31/06 | 05:17:00 | 36.3540 | 0.5320 | -11.5950 | 369.4444444 | 34.9490 |
| 10/31/06 | 05:18:00 | 36.3540 | 0.5320 | -11.5950 | 369.4444444 | 34.9490 |
| 10/31/06 | 05:19:00 | 36.6670 | 0.5320 | -11.5320 | 369.4444444 | 35.1990 |
| 10/31/06 | 05:20:00 | 36.6670 | 0.5320 | -11.5320 | 369.4444444 | 35.1990 |
| 10/31/06 | 05:21:00 | 37.2920 | 0.5380 | -11.4960 | 373.6111111 | 35.7880 |
| 10/31/06 | 05:22:00 | 37.2920 | 0.5380 | -11.4960 | 373.6111111 | 35.7880 |
| 10/31/06 | 05:23:00 | 37.0840 | 0.5400 | -11.4420 | 375 | 35.5260 |
| 10/31/06 | 05:24:00 | 37.0840 | 0.5400 | -11.4420 | 375 | 35.5260 |
| 10/31/06 | 05:25:00 | 37.0140 | 0.5410 | -11.3960 | 375.6944444 | 35.4100 |
| 10/31/06 | 05:26:00 | 37.2920 | 0.5410 | -11.3780 | 375.6944444 | 35.6700 |
| 10/31/06 | 05:27:00 | 37.2920 | 0.5410 | -11.3780 | 375.6944444 | 35.6700 |
| 10/31/06 | 05:28:00 | 37.2570 | 0.5400 | -11.2700 | 375 | 35.5270 |
| 10/31/06 | 05:29:00 | 37.6740 | 0.5420 | -11.2160 | 376.3888889 | 35.8900 |
| 10/31/06 | 05:30:00 | 37.6740 | 0.5420 | -11.2160 | 376.3888889 | 35.8900 |
| 10/31/06 | 05:31:00 | 37.4310 | 0.5420 | -11.1980 | 376.3888889 | 35.6290 |
| 10/31/06 | 05:32:00 | 37.4310 | 0.5420 | -11.1980 | 376.3888889 | 35.6290 |
| 10/31/06 | 05:33:00 | 37.1530 | 0.5420 | -11.1080 | 376.3888889 | 35.2610 |
| 10/31/06 | 05:34:00 | 37.6040 | 0.5440 | -11.0710 | 377.7777778 | 35.6750 |
| 10/31/06 | 05:35:00 | 37.6040 | 0.5440 | -11.0710 | 377.7777778 | 35.6750 |
| 10/31/06 | 05:36:00 | 37.6040 | 0.5440 | -11.0710 | 377.7777778 | 35.6750 |
| 10/31/06 | 05:37:00 | 37.6040 | 0.5390 | -10.9540 | 374.3055556 | 35.5580 |
| 10/31/06 | 05:38:00 | 37.3610 | 0.5410 | -10.8820 | 375.6944444 | 35.2430 |
| 10/31/06 | 05:39:00 | 37.3610 | 0.5410 | -10.8820 | 375.6944444 | 35.2430 |
| 10/31/06 | 05:40:00 | 37.3610 | 0.5410 | -10.8820 | 375.6944444 | 35.2430 |
| 10/31/06 | 05:41:00 | 37.1180 | 0.5410 | -10.7550 | 375.6944444 | 34.8730 |
| 10/31/06 | 05:42:00 | 37.1530 | 0.5410 | -10.6740 | 375.6944444 | 34.8270 |
| 10/31/06 | 05:43:00 | 37.1530 | 0.5410 | -10.6740 | 375.6944444 | 34.8270 |
| 10/31/06 | 05:44:00 | 37.1880 | 0.5420 | -10.5930 | 376.3888889 | 34.7810 |
| 10/31/06 | 05:45:00 | 37.1880 | 0.5420 | -10.5930 | 376.3888889 | 34.7810 |
| 10/31/06 | 05:46:00 | 37.5000 | 0.5430 | -10.5120 | 377.0833333 | 35.0120 |
| 10/31/06 | 05:47:00 | 37.2570 | 0.5430 | -10.4490 | 377.0833333 | 34.7060 |
| 10/31/06 | 05:48:00 | 37.2570 | 0.5430 | -10.4490 | 377.0833333 | 34.7060 |
| 10/31/06 | 05:49:00 | 37.5350 | 0.5420 | -10.3760 | 376.3888889 | 34.9110 |
| 10/31/06 | 05:50:00 | 37.5350 | 0.5420 | -10.3760 | 376.3888889 | 34.9110 |
| 10/31/06 | 05:51:00 | 37.9520 | 0.5470 | -10.2770 | 379.8611111 | 35.2290 |
| 10/31/06 | 05:52:00 | 37.9520 | 0.5470 | -10.2770 | 379.8611111 | 35.2290 |
| 10/31/06 | 05:53:00 | 44.2360 | 0.6060 | -10.2320 | 420.8333333 | 41.4680 |
| 10/31/06 | 05:54:00 | 44.9310 | 0.6110 | -10.2050 | 424.3055556 | 42.1360 |
| 10/31/06 | 05:55:00 | 44.9310 | 0.6110 | -10.2050 | 424.3055556 | 42.1360 |
| 10/31/06 | 05:56:00 | 44.5840 | 0.6110 | -10.1960 | 424.3055556 | 41.7800 |
| 10/31/06 | 05:57:00 | 44.5840 | 0.6110 | -10.1960 | 424.3055556 | 41.7800 |
| 10/31/06 | 05:58:00 | 44.9660 | 0.6090 | -10.1510 | 422.9166667 | 42.1170 |
| 10/31/06 | 05:59:00 | 44.9660 | 0.6090 | -10.1510 | 422.9166667 | 42.1170 |
| 10/31/06 | 06:00:00 | 44.7920 | 0.6110 | -10.1050 | 424.3055556 | 41.8970 |
| 10/31/06 | 06:01:00 | 45.1040 | 0.6140 | -10.0600 | 426.3888889 | 42.1640 |
| 10/31/06 | 06:02:00 | 45.1040 | 0.6140 | -10.0600 | 426.3888889 | 42.1640 |
| 10/31/06 | 06:03:00 | 45.1390 | 0.6140 | -9.9880 | 426.3888889 | 42.1270 |
| 10/31/06 | 06:04:00 | 45.1390 | 0.6140 | -9.9880 | 426.3888889 | 42.1270 |
| 10/31/06 | 06:05:00 | 45.0700 | 0.6140 | -9.9610 | 426.3888889 | 42.0310 |
| 10/31/06 | 06:06:00 | 45.0700 | 0.6140 | -9.9610 | 426.3888889 | 42.0310 |
| 10/31/06 | 06:07:00 | 45.1040 | 0.6140 | -9.9250 | 426.3888889 | 42.0290 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 06:08:00 | 45.1040 | 0.6140 | -9.9250 | 426.3888889 | 42.0290 |
| 10/31/06 | 06:09:00 | 44.8270 | 0.6140 | -9.8890 | 426.3888889 | 41.7160 |
| 10/31/06 | 06:10:00 | 45.1040 | 0.6150 | -9.8440 | 427.0833333 | 41.9480 |
| 10/31/06 | 06:11:00 | 45.1040 | 0.6150 | -9.8440 | 427.0833333 | 41.9480 |
| 10/31/06 | 06:12:00 | 44.8610 | 0.6180 | -9.7890 | 429.1666667 | 41.6500 |
| 10/31/06 | 06:13:00 | 44.8610 | 0.6180 | -9.7890 | 429.1666667 | 41.6500 |
| 10/31/06 | 06:14:00 | 45.1740 | 0.6170 | -9.7440 | 428.4722222 | 41.9180 |
| 10/31/06 | 06:15:00 | 44.9660 | 0.6180 | -9.7080 | 429.1666667 | 41.6740 |
| 10/31/06 | 06:16:00 | 44.9660 | 0.6180 | -9.7080 | 429.1666667 | 41.6740 |
| 10/31/06 | 06:17:00 | 45.1740 | 0.6180 | -9.6270 | 429.1666667 | 41.8010 |
| 10/31/06 | 06:18:00 | 45.1740 | 0.6180 | -9.6270 | 429.1666667 | 41.8010 |
| 10/31/06 | 06:19:00 | 45.1390 | 0.6210 | -9.5820 | 431.25 | 41.7210 |
| 10/31/06 | 06:20:00 | 45.1390 | 0.6210 | -9.5820 | 431.25 | 41.7210 |
| 10/31/06 | 06:21:00 | 45.7640 | 0.6240 | -9.5100 | 433.3333333 | 42.2740 |
| 10/31/06 | 06:22:00 | 45.7640 | 0.6240 | -9.5100 | 433.3333333 | 42.2740 |
| 10/31/06 | 06:23:00 | 46.2500 | 0.6280 | -9.4370 | 436.1111111 | 42.6870 |
| 10/31/06 | 06:24:00 | 46.2500 | 0.6280 | -9.4370 | 436.1111111 | 42.6870 |
| 10/31/06 | 06:25:00 | 46.7710 | 0.6290 | -9.3830 | 436.8055556 | 43.1540 |
| 10/31/06 | 06:26:00 | 46.7710 | 0.6290 | -9.3830 | 436.8055556 | 43.1540 |
| 10/31/06 | 06:27:00 | 46.7710 | 0.6290 | -9.3830 | 436.8055556 | 43.1540 |
| 10/31/06 | 06:28:00 | 46.7710 | 0.6290 | -9.3830 | 436.8055556 | 43.1540 |
| 10/31/06 | 06:29:00 | 46.7710 | 0.6290 | -9.3830 | 436.8055556 | 43.1540 |
| 10/31/06 | 06:30:00 | 46.7710 | 0.6330 | -9.1480 | 439.5833333 | 42.9190 |
| 10/31/06 | 06:31:00 | 46.7710 | 0.6330 | -9.1480 | 439.5833333 | 42.9190 |
| 10/31/06 | 06:32:00 | 46.6670 | 0.6360 | -9.0670 | 441.6666667 | 42.7340 |
| 10/31/06 | 06:33:00 | 46.6670 | 0.6360 | -9.0670 | 441.6666667 | 42.7340 |
| 10/31/06 | 06:34:00 | 46.6670 | 0.6340 | -8.9770 | 440.2777778 | 42.6440 |
| 10/31/06 | 06:35:00 | 46.6670 | 0.6340 | -8.9770 | 440.2777778 | 42.6440 |
| 10/31/06 | 06:36:00 | 46.8750 | 0.6320 | -8.9140 | 438.8888889 | 42.7890 |
| 10/31/06 | 06:37:00 | 46.8750 | 0.6320 | -8.9140 | 438.8888889 | 42.7890 |
| 10/31/06 | 06:38:00 | 46.8060 | 0.6350 | -8.8330 | 440.9722222 | 42.6390 |
| 10/31/06 | 06:39:00 | 46.8060 | 0.6350 | -8.7780 | 440.9722222 | 42.5840 |
| 10/31/06 | 06:40:00 | 46.8060 | 0.6350 | -8.7780 | 440.9722222 | 42.5840 |
| 10/31/06 | 06:41:00 | 47.1180 | 0.6370 | -8.7150 | 442.3611111 | 42.8330 |
| 10/31/06 | 06:42:00 | 47.1180 | 0.6370 | -8.7150 | 442.3611111 | 42.8330 |
| 10/31/06 | 06:43:00 | 47.1180 | 0.6380 | -8.6700 | 443.0555556 | 42.7880 |
| 10/31/06 | 06:44:00 | 47.0840 | 0.6380 | -8.6160 | 443.0555556 | 42.7000 |
| 10/31/06 | 06:45:00 | 47.0840 | 0.6380 | -8.6160 | 443.0555556 | 42.7000 |
| 10/31/06 | 06:46:00 | 47.0840 | 0.6400 | -8.5800 | 444.4444444 | 42.6640 |
| 10/31/06 | 06:47:00 | 47.0840 | 0.6400 | -8.5800 | 444.4444444 | 42.6640 |
| 10/31/06 | 06:48:00 | 47.1530 | 0.6410 | -8.5530 | 445.1388889 | 42.7060 |
| 10/31/06 | 06:49:00 | 47.2220 | 0.6390 | -8.4800 | 443.75 | 42.7020 |
| 10/31/06 | 06:50:00 | 47.2220 | 0.6390 | -8.4800 | 443.75 | 42.7020 |
| 10/31/06 | 06:51:00 | 47.2570 | 0.6410 | -8.4350 | 445.1388889 | 42.6920 |
| 10/31/06 | 06:52:00 | 47.2570 | 0.6410 | -8.4350 | 445.1388889 | 42.6920 |
| 10/31/06 | 06:53:00 | 47.2570 | 0.6410 | -8.4350 | 445.1388889 | 42.6920 |
| 10/31/06 | 06:54:00 | 47.2220 | 0.6420 | -8.3630 | 445.8333333 | 42.5850 |
| 10/31/06 | 06:55:00 | 47.5350 | 0.6440 | -8.3180 | 447.2222222 | 42.8530 |
| 10/31/06 | 06:56:00 | 47.5350 | 0.6440 | -8.3180 | 447.2222222 | 42.8530 |
| 10/31/06 | 06:57:00 | 47.5700 | 0.6450 | -8.2820 | 447.9166667 | 42.8520 |
| 10/31/06 | 06:58:00 | 47.5700 | 0.6450 | -8.2820 | 447.9166667 | 42.8520 |
| 10/31/06 | 06:59:00 | 47.4660 | 0.6440 | -8.2190 | 447.2222222 | 42.6850 |
| 10/31/06 | 07:00:00 | 47.4660 | 0.6440 | -8.2190 | 447.2222222 | 42.6850 |
| 10/31/06 | 07:01:00 | 47.8470 | 0.6450 | -8.1730 | 447.9166667 | 43.0200 |
| 10/31/06 | 07:02:00 | 47.7780 | 0.6450 | -8.1370 | 447.9166667 | 42.9150 |
| 10/31/06 | 07:03:00 | 47.7780 | 0.6450 | -8.1370 | 447.9166667 | 42.9150 |
| 10/31/06 | 07:04:00 | 48.0210 | 0.6490 | -7.9300 | 450.6944444 | 42.9510 |
| 10/31/06 | 07:05:00 | 48.0210 | 0.6490 | -7.9300 | 450.6944444 | 42.9510 |
| 10/31/06 | 07:06:00 | 48.0560 | 0.6500 | -7.7400 | 451.3888889 | 42.7960 |
| 10/31/06 | 07:07:00 | 48.0560 | 0.6500 | -7.7400 | 451.3888889 | 42.7960 |
| 10/31/06 | 07:08:00 | 48.0210 | 0.6520 | -7.5140 | 452.7777778 | 42.5350 |
| 10/31/06 | 07:09:00 | 48.2640 | 0.6550 | -7.3430 | 454.8611111 | 42.6070 |
| 10/31/06 | 07:10:00 | 48.2640 | 0.6550 | -7.3430 | 454.8611111 | 42.6070 |
| 10/31/06 | 07:11:00 | 48.5420 | 0.6540 | -7.2710 | 454.1666667 | 42.8130 |
| 10/31/06 | 07:12:00 | 48.5420 | 0.6540 | -7.2710 | 454.1666667 | 42.8130 |
| 10/31/06 | 07:13:00 | 48.6460 | 0.6560 | -7.1800 | 455.5555556 | 42.8260 |
| 10/31/06 | 07:14:00 | 48.8890 | 0.6580 | -7.0630 | 456.9444444 | 42.9520 |
| 10/31/06 | 07:15:00 | 48.8890 | 0.6580 | -7.0630 | 456.9444444 | 42.9520 |
| 10/31/06 | 07:16:00 | 49.0280 | 0.6580 | -6.9820 | 456.9444444 | 43.0100 |
| 10/31/06 | 07:17:00 | 49.0280 | 0.6580 | -6.9820 | 456.9444444 | 43.0100 |
| 10/31/06 | 07:18:00 | 49.2020 | 0.6600 | -6.8280 | 458.3333333 | 43.0300 |
| 10/31/06 | 07:19:00 | 49.2020 | 0.6600 | -6.8280 | 458.3333333 | 43.0300 |
| 10/31/06 | 07:20:00 | 49.2710 | 0.6600 | -6.7110 | 458.3333333 | 42.9820 |
| 10/31/06 | 07:21:00 | 49.2710 | 0.6600 | -6.7110 | 458.3333333 | 42.9820 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 07:22:00 | 49.5490 | 0.6640 | -6.6120 | 461.1111111 | 43.1610 |
| 10/31/06 | 07:23:00 | 49.5490 | 0.6640 | -6.6120 | 461.1111111 | 43.1610 |
| 10/31/06 | 07:24:00 | 49.6880 | 0.6640 | -6.5120 | 461.1111111 | 43.2000 |
| 10/31/06 | 07:25:00 | 49.7570 | 0.6650 | -6.4400 | 461.8055556 | 43.1970 |
| 10/31/06 | 07:26:00 | 49.7570 | 0.6650 | -6.4400 | 461.8055556 | 43.1970 |
| 10/31/06 | 07:27:00 | 49.5840 | 0.6640 | -6.3680 | 461.1111111 | 42.9520 |
| 10/31/06 | 07:28:00 | 49.8270 | 0.6670 | -6.2960 | 463.1944444 | 43.1230 |
| 10/31/06 | 07:29:00 | 49.8270 | 0.6670 | -6.2960 | 463.1944444 | 43.1230 |
| 10/31/06 | 07:30:00 | 50.3470 | 0.6680 | -6.2140 | 463.8888889 | 43.5610 |
| 10/31/06 | 07:31:00 | 50.3470 | 0.6680 | -6.2140 | 463.8888889 | 43.5610 |
| 10/31/06 | 07:32:00 | 50.5560 | 0.6720 | -6.1510 | 466.6666667 | 43.7070 |
| 10/31/06 | 07:33:00 | 50.5560 | 0.6720 | -6.1510 | 466.6666667 | 43.7070 |
| 10/31/06 | 07:34:00 | 50.4520 | 0.6720 | -6.0610 | 466.6666667 | 43.5130 |
| 10/31/06 | 07:35:00 | 50.4520 | 0.6720 | -6.0610 | 466.6666667 | 43.5130 |
| 10/31/06 | 07:36:00 | 50.6250 | 0.6740 | -5.9980 | 468.0555556 | 43.6230 |
| 10/31/06 | 07:37:00 | 50.6250 | 0.6740 | -5.9980 | 468.0555556 | 43.6230 |
| 10/31/06 | 07:38:00 | 50.7290 | 0.6730 | -5.9710 | 467.3611111 | 43.7000 |
| 10/31/06 | 07:39:00 | 50.7290 | 0.6730 | -5.9710 | 467.3611111 | 43.7000 |
| 10/31/06 | 07:40:00 | 50.7990 | 0.6770 | -5.9350 | 470.1388889 | 43.7340 |
| 10/31/06 | 07:41:00 | 50.9380 | 0.6770 | -5.9170 | 470.1388889 | 43.8550 |
| 10/31/06 | 07:42:00 | 50.9380 | 0.6770 | -5.9170 | 470.1388889 | 43.8550 |
| 10/31/06 | 07:43:00 | 51.0420 | 0.6770 | -5.8620 | 470.1388889 | 43.9040 |
| 10/31/06 | 07:44:00 | 51.0420 | 0.6770 | -5.8620 | 470.1388889 | 43.9040 |
| 10/31/06 | 07:45:00 | 50.8680 | 0.6770 | -5.8080 | 470.1388889 | 43.6760 |
| 10/31/06 | 07:46:00 | 51.0420 | 0.6790 | -5.7810 | 471.5277778 | 43.8230 |
| 10/31/06 | 07:47:00 | 51.0420 | 0.6790 | -5.7810 | 471.5277778 | 43.8230 |
| 10/31/06 | 07:48:00 | 51.1110 | 0.6780 | -5.7360 | 470.8333333 | 43.8470 |
| 10/31/06 | 07:49:00 | 51.1110 | 0.6780 | -5.7360 | 470.8333333 | 43.8470 |
| 10/31/06 | 07:50:00 | 51.1460 | 0.6800 | -5.6820 | 472.2222222 | 43.8280 |
| 10/31/06 | 07:51:00 | 51.1460 | 0.6800 | -5.6820 | 472.2222222 | 43.8280 |
| 10/31/06 | 07:52:00 | 51.2160 | 0.6810 | -5.6280 | 472.9166667 | 43.8440 |
| 10/31/06 | 07:53:00 | 51.2160 | 0.6810 | -5.6280 | 472.9166667 | 43.8440 |
| 10/31/06 | 07:54:00 | 51.0420 | 0.6800 | -5.5550 | 472.2222222 | 43.5970 |
| 10/31/06 | 07:55:00 | 51.0420 | 0.6800 | -5.5550 | 472.2222222 | 43.5970 |
| 10/31/06 | 07:56:00 | 51.1810 | 0.6810 | -5.5010 | 472.9166667 | 43.6820 |
| 10/31/06 | 07:57:00 | 51.1460 | 0.6810 | -5.4380 | 472.9166667 | 43.5840 |
| 10/31/06 | 07:58:00 | 51.1460 | 0.6810 | -5.4380 | 472.9166667 | 43.5840 |
| 10/31/06 | 07:59:00 | 51.3540 | 0.6800 | -5.3840 | 472.2222222 | 43.7380 |
| 10/31/06 | 08:00:00 | 51.3540 | 0.6800 | -5.3840 | 472.2222222 | 43.7380 |
| 10/31/06 | 08:01:00 | 50.9380 | 0.6810 | -5.3390 | 472.9166667 | 43.2770 |
| 10/31/06 | 08:02:00 | 51.0070 | 0.6840 | -5.2850 | 475 | 43.2920 |
| 10/31/06 | 08:03:00 | 51.0070 | 0.6840 | -5.2850 | 475 | 43.2920 |
| 10/31/06 | 08:04:00 | 51.3200 | 0.6850 | -5.1940 | 475.6944444 | 43.5140 |
| 10/31/06 | 08:05:00 | 51.3200 | 0.6850 | -5.1940 | 475.6944444 | 43.5140 |
| 10/31/06 | 08:06:00 | 51.3200 | 0.6850 | -5.1940 | 475.6944444 | 43.5140 |
| 10/31/06 | 08:07:00 | 51.3890 | 0.6870 | -5.0860 | 477.0833333 | 43.4750 |
| 10/31/06 | 08:08:00 | 51.3890 | 0.6870 | -5.0860 | 477.0833333 | 43.4750 |
| 10/31/06 | 08:09:00 | 51.2160 | 0.6850 | -5.0770 | 475.6944444 | 43.2930 |
| 10/31/06 | 08:10:00 | 51.2160 | 0.6850 | -5.0770 | 475.6944444 | 43.2930 |
| 10/31/06 | 08:11:00 | 51.3890 | 0.6870 | -5.0500 | 477.0833333 | 43.4390 |
| 10/31/06 | 08:12:00 | 51.3890 | 0.6870 | -5.0500 | 477.0833333 | 43.4390 |
| 10/31/06 | 08:13:00 | 51.3890 | 0.6870 | -5.0500 | 477.0833333 | 43.4390 |
| 10/31/06 | 08:14:00 | 51.3890 | 0.6870 | -5.0500 | 477.0833333 | 43.4390 |
| 10/31/06 | 08:15:00 | 51.8750 | 0.6870 | -4.9690 | 477.0833333 | 43.8440 |
| 10/31/06 | 08:16:00 | 51.8750 | 0.6870 | -4.9690 | 477.0833333 | 43.8440 |
| 10/31/06 | 08:17:00 | 51.4930 | 0.6890 | -4.9140 | 478.4722222 | 43.4070 |
| 10/31/06 | 08:18:00 | 51.8060 | 0.6900 | -4.8600 | 479.1666667 | 43.6660 |
| 10/31/06 | 08:19:00 | 51.8060 | 0.6900 | -4.8600 | 479.1666667 | 43.6660 |
| 10/31/06 | 08:20:00 | 51.8060 | 0.6900 | -4.8600 | 479.1666667 | 43.6660 |
| 10/31/06 | 08:21:00 | 51.5970 | 0.6910 | -4.7970 | 479.8611111 | 43.3940 |
| 10/31/06 | 08:22:00 | 51.8410 | 0.6920 | -4.7160 | 480.5555556 | 43.5570 |
| 10/31/06 | 08:23:00 | 51.8410 | 0.6920 | -4.7160 | 480.5555556 | 43.5570 |
| 10/31/06 | 08:24:00 | 52.0490 | 0.6940 | -4.6440 | 481.9444444 | 43.6930 |
| 10/31/06 | 08:25:00 | 52.0490 | 0.6940 | -4.6440 | 481.9444444 | 43.6930 |
| 10/31/06 | 08:26:00 | 51.9450 | 0.6950 | -4.6170 | 482.6388889 | 43.5620 |
| 10/31/06 | 08:27:00 | 52.1530 | 0.6950 | -4.5620 | 482.6388889 | 43.7150 |
| 10/31/06 | 08:28:00 | 52.1530 | 0.6950 | -4.5620 | 482.6388889 | 43.7150 |
| 10/31/06 | 08:29:00 | 52.3610 | 0.6960 | -4.5260 | 483.3333333 | 43.8870 |
| 10/31/06 | 08:30:00 | 52.4310 | 0.6970 | -4.4900 | 484.0277778 | 43.9210 |
| 10/31/06 | 08:31:00 | 52.4310 | 0.6970 | -4.4900 | 484.0277778 | 43.9210 |
| 10/31/06 | 08:32:00 | 52.6740 | 0.6980 | -4.4000 | 484.7222222 | 44.0740 |
| 10/31/06 | 08:33:00 | 52.6740 | 0.6980 | -4.4000 | 484.7222222 | 44.0740 |
| 10/31/06 | 08:34:00 | 52.3610 | 0.6980 | -4.3010 | 484.7222222 | 43.6620 |
| 10/31/06 | 08:35:00 | 52.3610 | 0.6980 | -4.3010 | 484.7222222 | 43.6620 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/31/06 | 08:36:00 | 52.4660 | 0.7000 | -4.1920 | 486.1111111 | 43.6580 |
| 10/31/06 | 08:37:00 | 52.4660 | 0.7000 | -4.1920 | 486.1111111 | 43.6580 |
| 10/31/06 | 08:38:00 | 52.7090 | 0.7010 | -4.0840 | 486.8055556 | 43.7930 |
| 10/31/06 | 08:39:00 | 52.7090 | 0.7010 | -4.0840 | 486.8055556 | 43.7930 |
| 10/31/06 | 08:40:00 | 52.4660 | 0.7010 | -4.0300 | 486.8055556 | 43.4960 |
| 10/31/06 | 08:41:00 | 52.5000 | 0.7030 | -4.0120 | 488.1944444 | 43.5120 |
| 10/31/06 | 08:42:00 | 52.5000 | 0.7030 | -4.0120 | 488.1944444 | 43.5120 |
| 10/31/06 | 08:43:00 | 52.6040 | 0.7010 | -3.9940 | 486.8055556 | 43.5980 |
| 10/31/06 | 08:44:00 | 52.5700 | 0.7020 | -3.9940 | 487.5 | 43.5640 |
| 10/31/06 | 08:45:00 | 52.5700 | 0.7020 | -3.9940 | 487.5 | 43.5640 |
| 10/31/06 | 08:46:00 | 52.3960 | 0.7020 | -3.9940 | 487.5 | 43.3900 |
| 10/31/06 | 08:47:00 | 52.8130 | 0.7020 | -3.9850 | 487.5 | 43.7980 |
| 10/31/06 | 08:48:00 | 52.8130 | 0.7020 | -3.9850 | 487.5 | 43.7980 |
| 10/31/06 | 08:49:00 | 52.7430 | 0.7030 | -3.9850 | 488.1944444 | 43.7280 |
| 10/31/06 | 08:50:00 | 52.7430 | 0.7030 | -3.9850 | 488.1944444 | 43.7280 |
| 10/31/06 | 08:51:00 | 52.6390 | 0.7040 | -3.9670 | 488.8888889 | 43.6060 |
| 10/31/06 | 08:52:00 | 52.6390 | 0.7040 | -3.9670 | 488.8888889 | 43.6060 |
| 10/31/06 | 08:53:00 | 52.5350 | 0.7040 | -3.9670 | 488.8888889 | 43.5020 |
| 10/31/06 | 08:54:00 | 52.5350 | 0.7040 | -3.9670 | 488.8888889 | 43.5020 |
| 10/31/06 | 08:55:00 | 52.7430 | 0.7040 | -3.9670 | 488.8888889 | 43.7100 |
| 10/31/06 | 08:56:00 | 52.7430 | 0.7040 | -3.9670 | 488.8888889 | 43.7100 |
| 10/31/06 | 08:57:00 | 52.5700 | 0.7040 | -3.9570 | 488.8888889 | 43.5270 |
| 10/31/06 | 08:58:00 | 52.6040 | 0.7030 | -3.9480 | 488.1944444 | 43.5520 |
| 10/31/06 | 08:59:00 | 52.6040 | 0.7030 | -3.9480 | 488.1944444 | 43.5520 |
| 10/31/06 | 09:00:00 | 52.3270 | 0.7040 | -3.9390 | 488.8888889 | 43.2660 |
| 10/31/06 | 09:01:00 | 52.3270 | 0.7040 | -3.9390 | 488.8888889 | 43.2660 |
| 10/31/06 | 09:02:00 | 52.3960 | 0.7040 | -3.9480 | 488.8888889 | 43.3440 |
| 10/31/06 | 09:03:00 | 52.3960 | 0.7040 | -3.9480 | 488.8888889 | 43.3440 |
| 10/31/06 | 09:04:00 | 52.5000 | 0.7040 | -3.9570 | 488.8888889 | 43.4570 |
| 10/31/06 | 09:05:00 | 52.5000 | 0.7040 | -3.9570 | 488.8888889 | 43.4570 |
| 10/31/06 | 09:06:00 | 52.6740 | 0.7050 | -3.9570 | 489.5833333 | 43.6310 |
| 10/31/06 | 09:07:00 | 52.4310 | 0.7040 | -3.9570 | 488.8888889 | 43.3880 |
| 10/31/06 | 09:08:00 | 52.5700 | 0.7040 | -3.9570 | 488.8888889 | 43.5270 |
| 10/31/06 | 09:09:00 | 52.4660 | 0.7050 | -3.9390 | 489.5833333 | 43.4050 |
| 10/31/06 | 09:10:00 | 52.4660 | 0.7050 | -3.9390 | 489.5833333 | 43.4050 |
| 10/31/06 | 09:11:00 | 52.3960 | 0.7030 | -3.9390 | 488.1944444 | 43.3350 |
| 10/31/06 | 09:12:00 | 52.3270 | 0.7040 | -3.9390 | 488.8888889 | 43.2660 |
| 10/31/06 | 09:13:00 | 52.3270 | 0.7040 | -3.9390 | 488.8888889 | 43.2660 |
| 10/31/06 | 09:14:00 | 52.3960 | 0.7040 | -3.9390 | 488.8888889 | 43.3350 |
| 10/31/06 | 09:15:00 | 52.3960 | 0.7040 | -3.9390 | 488.8888889 | 43.3350 |
| 10/31/06 | 09:16:00 | 52.5350 | 0.7050 | -3.9390 | 489.5833333 | 43.4740 |
| 10/31/06 | 09:17:00 | 52.5350 | 0.7050 | -3.9390 | 489.5833333 | 43.4740 |
| 10/31/06 | 09:18:00 | 52.4660 | 0.7040 | -3.9390 | 488.8888889 | 43.4050 |
| 10/31/06 | 09:19:00 | 52.4660 | 0.7040 | -3.9390 | 488.8888889 | 43.4050 |
| 10/31/06 | 09:20:00 | 52.6740 | 0.7050 | -3.9390 | 489.5833333 | 43.6130 |
| 10/31/06 | 09:21:00 | 52.6740 | 0.7050 | -3.9390 | 489.5833333 | 43.6130 |
| 10/31/06 | 09:22:00 | 52.6740 | 0.7060 | -3.9390 | 490.2777778 | 43.6130 |
| 10/31/06 | 09:23:00 | 52.6740 | 0.7060 | -3.9390 | 490.2777778 | 43.6130 |
| 10/31/06 | 09:24:00 | 52.4660 | 0.7050 | -3.9390 | 489.5833333 | 43.4050 |
| 10/31/06 | 09:25:00 | 52.4660 | 0.7050 | -3.9390 | 489.5833333 | 43.4050 |
| 10/31/06 | 09:26:00 | 52.2220 | 0.7050 | -3.9300 | 489.5833333 | 43.1520 |
| 10/31/06 | 09:27:00 | 52.6390 | 0.7050 | -3.9300 | 489.5833333 | 43.5690 |
| 10/31/06 | 09:28:00 | 52.6390 | 0.7050 | -3.9300 | 489.5833333 | 43.5690 |
| 10/31/06 | 09:29:00 | 52.5000 | 0.7070 | -3.9300 | 490.9722222 | 43.4300 |
| 10/31/06 | 09:30:00 | 52.6040 | 0.7060 | -3.9030 | 490.2777778 | 43.5070 |
| 10/31/06 | 09:31:00 | 52.6040 | 0.7060 | -3.9030 | 490.2777778 | 43.5070 |
| 10/31/06 | 09:32:00 | 52.6740 | 0.7070 | -3.8670 | 490.9722222 | 43.5410 |
| 10/31/06 | 09:33:00 | 52.5700 | 0.7070 | -3.8310 | 490.9722222 | 43.4010 |
| 10/31/06 | 09:34:00 | 52.5700 | 0.7070 | -3.8310 | 490.9722222 | 43.4010 |
| 10/31/06 | 09:35:00 | 52.6390 | 0.7070 | -3.8130 | 490.9722222 | 43.4520 |
| 10/31/06 | 09:36:00 | 52.6390 | 0.7050 | -3.8130 | 489.5833333 | 43.4520 |
| 10/31/06 | 09:37:00 | 52.2570 | 0.7070 | -3.7860 | 490.9722222 | 43.0430 |
| 10/31/06 | 09:38:00 | 52.2570 | 0.7070 | -3.7860 | 490.9722222 | 43.0430 |
| 10/31/06 | 09:39:00 | 52.6740 | 0.7070 | -3.7770 | 490.9722222 | 43.4510 |
| 10/31/06 | 09:40:00 | 52.6740 | 0.7070 | -3.7770 | 490.9722222 | 43.4510 |
| 10/31/06 | 09:41:00 | 52.9860 | 0.7090 | -3.7050 | 492.3611111 | 43.6910 |
| 10/31/06 | 09:42:00 | 52.5350 | 0.7090 | -3.6780 | 492.3611111 | 43.2130 |
| 10/31/06 | 09:43:00 | 52.5350 | 0.7090 | -3.6780 | 492.3611111 | 43.2130 |
| 10/31/06 | 09:44:00 | 52.5700 | 0.7090 | -3.6600 | 492.3611111 | 43.2300 |
| 10/31/06 | 09:45:00 | 52.9170 | 0.7090 | -3.6510 | 492.3611111 | 43.5680 |
| 10/31/06 | 09:46:00 | 52.9170 | 0.7090 | -3.6510 | 492.3611111 | 43.5680 |
| 10/31/06 | 09:47:00 | 52.9520 | 0.7110 | -3.5600 | 493.75 | 43.5120 |
| 10/31/06 | 09:48:00 | 52.9520 | 0.7110 | -3.5600 | 493.75 | 43.5120 |
| 10/31/06 | 09:49:00 | 52.8470 | 0.7120 | -3.4790 | 494.4444444 | 43.3260 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 09:50:00 | 52.8820 | 0.7130 | -3.4520 | 495.1388889 | 43.3340 |
| 10/31/06 | 09:51:00 | 52.8820 | 0.7130 | -3.4520 | 495.1388889 | 43.3340 |
| 10/31/06 | 09:52:00 | 52.7430 | 0.7120 | -3.4520 | 494.4444444 | 43.1950 |
| 10/31/06 | 09:53:00 | 52.7430 | 0.7120 | -3.4520 | 494.4444444 | 43.1950 |
| 10/31/06 | 09:54:00 | 52.8820 | 0.7120 | -3.4520 | 494.4444444 | 43.3340 |
| 10/31/06 | 09:55:00 | 52.8820 | 0.7120 | -3.4520 | 494.4444444 | 43.3340 |
| 10/31/06 | 09:56:00 | 52.8130 | 0.7120 | -3.4520 | 494.4444444 | 43.2650 |
| 10/31/06 | 09:57:00 | 52.8130 | 0.7120 | -3.4520 | 494.4444444 | 43.2650 |
| 10/31/06 | 09:58:00 | 52.9170 | 0.7130 | -3.4520 | 495.1388889 | 43.3690 |
| 10/31/06 | 09:59:00 | 52.9170 | 0.7130 | -3.4520 | 495.1388889 | 43.3690 |
| 10/31/06 | 10:00:00 | 52.8470 | 0.7140 | -3.4520 | 495.8333333 | 43.2990 |
| 10/31/06 | 10:01:00 | 52.8470 | 0.7140 | -3.4520 | 495.8333333 | 43.2990 |
| 10/31/06 | 10:02:00 | 52.7090 | 0.7130 | -3.4250 | 495.1388889 | 43.1340 |
| 10/31/06 | 10:03:00 | 52.7090 | 0.7130 | -3.4250 | 495.1388889 | 43.1340 |
| 10/31/06 | 10:04:00 | 52.8820 | 0.7130 | -3.4070 | 495.1388889 | 43.2890 |
| 10/31/06 | 10:05:00 | 52.8820 | 0.7130 | -3.4070 | 495.1388889 | 43.2890 |
| 10/31/06 | 10:06:00 | 52.8470 | 0.7150 | -3.4070 | 496.5277778 | 43.2540 |
| 10/31/06 | 10:07:00 | 52.8470 | 0.7150 | -3.4070 | 496.5277778 | 43.2540 |
| 10/31/06 | 10:08:00 | 53.0210 | 0.7140 | -3.4070 | 495.8333333 | 43.4280 |
| 10/31/06 | 10:09:00 | 53.0210 | 0.7140 | -3.4070 | 495.8333333 | 43.4280 |
| 10/31/06 | 10:10:00 | 52.7090 | 0.7130 | -3.3980 | 495.1388889 | 43.1070 |
| 10/31/06 | 10:11:00 | 52.7090 | 0.7130 | -3.3980 | 495.1388889 | 43.1070 |
| 10/31/06 | 10:12:00 | 52.8130 | 0.7130 | -3.3980 | 495.1388889 | 43.2110 |
| 10/31/06 | 10:13:00 | 52.8820 | 0.7140 | -3.3710 | 495.8333333 | 43.2530 |
| 10/31/06 | 10:14:00 | 52.8820 | 0.7140 | -3.3710 | 495.8333333 | 43.2530 |
| 10/31/06 | 10:15:00 | 52.8470 | 0.7160 | -3.3710 | 497.2222222 | 43.2180 |
| 10/31/06 | 10:16:00 | 52.8470 | 0.7160 | -3.3710 | 497.2222222 | 43.2180 |
| 10/31/06 | 10:17:00 | 53.0210 | 0.7150 | -3.3070 | 496.5277778 | 43.3280 |
| 10/31/06 | 10:18:00 | 53.0210 | 0.7150 | -3.3070 | 496.5277778 | 43.3280 |
| 10/31/06 | 10:19:00 | 52.9520 | 0.7150 | -3.2890 | 496.5277778 | 43.2410 |
| 10/31/06 | 10:20:00 | 52.9520 | 0.7150 | -3.2890 | 496.5277778 | 43.2410 |
| 10/31/06 | 10:21:00 | 52.9860 | 0.7160 | -3.2530 | 497.2222222 | 43.2390 |
| 10/31/06 | 10:22:00 | 52.8470 | 0.7160 | -3.2530 | 497.2222222 | 43.1000 |
| 10/31/06 | 10:23:00 | 52.8470 | 0.7160 | -3.2620 | 497.2222222 | 43.1090 |
| 10/31/06 | 10:24:00 | 52.8470 | 0.7170 | -3.2530 | 497.9166667 | 43.1000 |
| 10/31/06 | 10:25:00 | 52.8470 | 0.7170 | -3.2530 | 497.9166667 | 43.1000 |
| 10/31/06 | 10:26:00 | 52.9170 | 0.7180 | -3.2260 | 498.6111111 | 43.1430 |
| 10/31/06 | 10:27:00 | 52.9520 | 0.7170 | -3.2260 | 497.9166667 | 43.1780 |
| 10/31/06 | 10:28:00 | 52.9520 | 0.7170 | -3.2260 | 497.9166667 | 43.1780 |
| 10/31/06 | 10:29:00 | 53.1950 | 0.7180 | -3.1990 | 498.6111111 | 43.3940 |
| 10/31/06 | 10:30:00 | 53.1950 | 0.7180 | -3.1990 | 498.6111111 | 43.3940 |
| 10/31/06 | 10:31:00 | 53.1950 | 0.7190 | -3.1720 | 499.3055556 | 43.3670 |
| 10/31/06 | 10:32:00 | 53.1250 | 0.7180 | -3.1720 | 498.6111111 | 43.2970 |
| 10/31/06 | 10:33:00 | 53.1250 | 0.7180 | -3.1720 | 498.6111111 | 43.2970 |
| 10/31/06 | 10:34:00 | 53.0560 | 0.7180 | -3.1720 | 498.6111111 | 43.2280 |
| 10/31/06 | 10:35:00 | 53.0560 | 0.7180 | -3.1720 | 498.6111111 | 43.2280 |
| 10/31/06 | 10:36:00 | 53.0560 | 0.7180 | -3.1720 | 498.6111111 | 43.2280 |
| 10/31/06 | 10:37:00 | 52.9520 | 0.7170 | -3.1540 | 497.9166667 | 43.1060 |
| 10/31/06 | 10:38:00 | 52.9520 | 0.7170 | -3.1540 | 497.9166667 | 43.1060 |
| 10/31/06 | 10:39:00 | 53.1950 | 0.7170 | -3.1540 | 497.9166667 | 43.3490 |
| 10/31/06 | 10:40:00 | 53.1950 | 0.7170 | -3.1540 | 497.9166667 | 43.3490 |
| 10/31/06 | 10:41:00 | 53.0210 | 0.7180 | -3.1540 | 498.6111111 | 43.1750 |
| 10/31/06 | 10:42:00 | 52.9520 | 0.7190 | -3.1540 | 499.3055556 | 43.1060 |
| 10/31/06 | 10:43:00 | 52.9520 | 0.7190 | -3.1540 | 499.3055556 | 43.1060 |
| 10/31/06 | 10:44:00 | 52.8470 | 0.7180 | -3.1540 | 498.6111111 | 43.0010 |
| 10/31/06 | 10:45:00 | 52.8470 | 0.7180 | -3.1540 | 498.6111111 | 43.0010 |
| 10/31/06 | 10:46:00 | 52.8470 | 0.7200 | -3.1450 | 500 | 42.9920 |
| 10/31/06 | 10:47:00 | 53.1600 | 0.7200 | -3.1450 | 500 | 43.3050 |
| 10/31/06 | 10:48:00 | 53.1600 | 0.7200 | -3.1450 | 500 | 43.3050 |
| 10/31/06 | 10:49:00 | 53.1600 | 0.7210 | -3.1450 | 500.6944444 | 43.3050 |
| 10/31/06 | 10:50:00 | 53.1600 | 0.7210 | -3.1450 | 500.6944444 | 43.3050 |
| 10/31/06 | 10:51:00 | 53.1950 | 0.7210 | -3.1450 | 500.6944444 | 43.3400 |
| 10/31/06 | 10:52:00 | 53.1950 | 0.7210 | -3.1450 | 500.6944444 | 43.3400 |
| 10/31/06 | 10:53:00 | 53.1950 | 0.7200 | -3.1450 | 500 | 43.3400 |
| 10/31/06 | 10:54:00 | 53.2290 | 0.7220 | -3.1450 | 501.3888889 | 43.3740 |
| 10/31/06 | 10:55:00 | 53.2290 | 0.7220 | -3.1450 | 501.3888889 | 43.3740 |
| 10/31/06 | 10:56:00 | 53.1600 | 0.7220 | -3.1450 | 501.3888889 | 43.3050 |
| 10/31/06 | 10:57:00 | 53.1600 | 0.7220 | -3.1450 | 501.3888889 | 43.3050 |
| 10/31/06 | 10:58:00 | 53.2290 | 0.7220 | -3.1450 | 501.3888889 | 43.3740 |
| 10/31/06 | 10:59:00 | 52.9860 | 0.7220 | -3.1450 | 501.3888889 | 43.1310 |
| 10/31/06 | 11:00:00 | 52.9860 | 0.7210 | -3.1450 | 500.6944444 | 43.1310 |
| 10/31/06 | 11:01:00 | 53.1250 | 0.7220 | -3.1450 | 501.3888889 | 43.2700 |
| 10/31/06 | 11:02:00 | 53.1250 | 0.7220 | -3.1450 | 501.3888889 | 43.2700 |
| 10/31/06 | 11:03:00 | 53.0560 | 0.7220 | -3.1450 | 501.3888889 | 43.2010 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/31/06 | 11:04:00 | 53.0560 | 0.7220 | -3.1450 | 501.3888889 | 43.2010 |
| 10/31/06 | 11:05:00 | 53.1250 | 0.7220 | -3.1450 | 501.3888889 | 43.2700 |
| 10/31/06 | 11:06:00 | 53.1250 | 0.7220 | -3.1450 | 501.3888889 | 43.2700 |
| 10/31/06 | 11:07:00 | 53.0210 | 0.7220 | -3.1360 | 501.3888889 | 43.1570 |
| 10/31/06 | 11:08:00 | 52.9170 | 0.7210 | -3.1360 | 500.6944444 | 43.0530 |
| 10/31/06 | 11:09:00 | 52.9170 | 0.7210 | -3.1360 | 500.6944444 | 43.0530 |
| 10/31/06 | 11:10:00 | 52.8820 | 0.7210 | -3.1360 | 500.6944444 | 43.0180 |
| 10/31/06 | 11:11:00 | 52.8820 | 0.7210 | -3.1360 | 500.6944444 | 43.0180 |
| 10/31/06 | 11:12:00 | 52.9170 | 0.7220 | -3.1360 | 501.3888889 | 43.0530 |
| 10/31/06 | 11:13:00 | 52.9170 | 0.7230 | -3.1360 | 502.0833333 | 43.0530 |
| 10/31/06 | 11:14:00 | 52.9170 | 0.7230 | -3.1360 | 502.0833333 | 43.0530 |
| 10/31/06 | 11:15:00 | 52.8470 | 0.7220 | -3.1360 | 501.3888889 | 42.9830 |
| 10/31/06 | 11:16:00 | 52.8470 | 0.7220 | -3.1360 | 501.3888889 | 42.9830 |
| 10/31/06 | 11:17:00 | 52.9170 | 0.7240 | -3.1360 | 502.7777778 | 43.0530 |
| 10/31/06 | 11:18:00 | 52.7430 | 0.7250 | -3.1360 | 503.4722222 | 42.8790 |
| 10/31/06 | 11:19:00 | 52.7430 | 0.7250 | -3.1360 | 503.4722222 | 42.8790 |
| 10/31/06 | 11:20:00 | 52.6040 | 0.7250 | -3.1360 | 503.4722222 | 42.7400 |
| 10/31/06 | 11:21:00 | 52.6040 | 0.7250 | -3.1360 | 503.4722222 | 42.7400 |
| 10/31/06 | 11:22:00 | 52.8470 | 0.7250 | -3.1360 | 503.4722222 | 42.9830 |
| 10/31/06 | 11:23:00 | 52.8470 | 0.7250 | -3.1360 | 503.4722222 | 42.9830 |
| 10/31/06 | 11:24:00 | 52.7090 | 0.7250 | -3.1180 | 503.4722222 | 42.8270 |
| 10/31/06 | 11:25:00 | 52.8130 | 0.7260 | -3.1180 | 504.1666667 | 42.9310 |
| 10/31/06 | 11:26:00 | 52.8130 | 0.7260 | -3.1180 | 504.1666667 | 42.9310 |
| 10/31/06 | 11:27:00 | 53.0560 | 0.7250 | -3.1180 | 503.4722222 | 43.1740 |
| 10/31/06 | 11:28:00 | 53.0560 | 0.7250 | -3.1180 | 503.4722222 | 43.1740 |
| 10/31/06 | 11:29:00 | 52.9170 | 0.7280 | -3.1180 | 505.5555556 | 43.0350 |
| 10/31/06 | 11:30:00 | 52.9170 | 0.7260 | -3.1270 | 504.1666667 | 43.0440 |
| 10/31/06 | 11:31:00 | 52.9170 | 0.7260 | -3.1270 | 504.1666667 | 43.0440 |
| 10/31/06 | 11:32:00 | 52.9520 | 0.7260 | -3.1180 | 504.1666667 | 43.0700 |
| 10/31/06 | 11:33:00 | 52.8470 | 0.7270 | -3.1180 | 504.8611111 | 42.9650 |
| 10/31/06 | 11:34:00 | 52.8470 | 0.7270 | -3.1180 | 504.8611111 | 42.9650 |
| 10/31/06 | 11:35:00 | 52.7090 | 0.7280 | -3.1180 | 505.5555556 | 42.8270 |
| 10/31/06 | 11:36:00 | 52.7090 | 0.7280 | -3.1180 | 505.5555556 | 42.8270 |
| 10/31/06 | 11:37:00 | 52.8820 | 0.7280 | -3.1180 | 505.5555556 | 43.0000 |
| 10/31/06 | 11:38:00 | 52.8820 | 0.7280 | -3.1180 | 505.5555556 | 43.0000 |
| 10/31/06 | 11:39:00 | 52.8470 | 0.7270 | -3.1180 | 504.8611111 | 42.9650 |
| 10/31/06 | 11:40:00 | 52.8470 | 0.7270 | -3.1180 | 504.8611111 | 42.9650 |
| 10/31/06 | 11:41:00 | 52.9170 | 0.7270 | -3.1180 | 504.8611111 | 43.0350 |
| 10/31/06 | 11:42:00 | 52.9860 | 0.7280 | -3.1180 | 505.5555556 | 43.1040 |
| 10/31/06 | 11:43:00 | 52.9860 | 0.7280 | -3.1180 | 505.5555556 | 43.1040 |
| 10/31/06 | 11:44:00 | 52.8130 | 0.7280 | -3.1180 | 505.5555556 | 42.9310 |
| 10/31/06 | 11:45:00 | 53.0910 | 0.7280 | -3.1180 | 505.5555556 | 43.2090 |
| 10/31/06 | 11:46:00 | 53.0910 | 0.7280 | -3.1180 | 505.5555556 | 43.2090 |
| 10/31/06 | 11:47:00 | 53.0210 | 0.7270 | -3.1180 | 504.8611111 | 43.1390 |
| 10/31/06 | 11:48:00 | 52.9860 | 0.7280 | -3.1180 | 505.5555556 | 43.1040 |
| 10/31/06 | 11:49:00 | 52.9860 | 0.7280 | -3.1180 | 505.5555556 | 43.1040 |
| 10/31/06 | 11:50:00 | 52.9170 | 0.7290 | -3.1180 | 506.25 | 43.0350 |
| 10/31/06 | 11:51:00 | 52.9170 | 0.7290 | -3.1180 | 506.25 | 43.0350 |
| 10/31/06 | 11:52:00 | 53.0210 | 0.7300 | -3.1180 | 506.9444444 | 43.1390 |
| 10/31/06 | 11:53:00 | 53.0210 | 0.7300 | -3.1180 | 506.9444444 | 43.1390 |
| 10/31/06 | 11:54:00 | 52.9860 | 0.7320 | -3.1180 | 508.3333333 | 43.1040 |
| 10/31/06 | 11:55:00 | 52.8130 | 0.7300 | -3.1180 | 506.9444444 | 42.9310 |
| 10/31/06 | 11:56:00 | 52.8130 | 0.7300 | -3.1180 | 506.9444444 | 42.9310 |
| 10/31/06 | 11:57:00 | 52.8470 | 0.7300 | -3.1180 | 506.9444444 | 42.9650 |
| 10/31/06 | 11:58:00 | 52.8470 | 0.7300 | -3.1180 | 506.9444444 | 42.9650 |
| 10/31/06 | 11:59:00 | 52.9860 | 0.7300 | -3.1180 | 506.9444444 | 43.1040 |
| 10/31/06 | 12:00:00 | 52.9860 | 0.7300 | -3.1180 | 506.9444444 | 43.1040 |
| 10/31/06 | 12:01:00 | 52.9860 | 0.7310 | -3.1180 | 507.6388889 | 43.1040 |
| 10/31/06 | 12:02:00 | 52.9860 | 0.7310 | -3.1180 | 507.6388889 | 43.1040 |
| 10/31/06 | 12:03:00 | 53.0910 | 0.7300 | -3.1180 | 506.9444444 | 43.2090 |
| 10/31/06 | 12:04:00 | 53.0910 | 0.7300 | -3.1180 | 506.9444444 | 43.2090 |
| 10/31/06 | 12:05:00 | 52.8470 | 0.7310 | -3.1180 | 507.6388889 | 42.9650 |
| 10/31/06 | 12:06:00 | 52.8470 | 0.7310 | -3.1180 | 507.6388889 | 42.9650 |
| 10/31/06 | 12:07:00 | 53.1250 | 0.7320 | -3.1180 | 508.3333333 | 43.2430 |
| 10/31/06 | 12:08:00 | 53.1250 | 0.7330 | -3.1180 | 509.0277778 | 43.2430 |
| 10/31/06 | 12:09:00 | 53.1250 | 0.7330 | -3.1180 | 509.0277778 | 43.2430 |
| 10/31/06 | 12:10:00 | 52.9520 | 0.7310 | -3.1180 | 507.6388889 | 43.0700 |
| 10/31/06 | 12:11:00 | 52.8820 | 0.7320 | -3.1180 | 508.3333333 | 43.0000 |
| 10/31/06 | 12:12:00 | 52.8820 | 0.7320 | -3.1180 | 508.3333333 | 43.0000 |
| 10/31/06 | 12:13:00 | 52.7780 | 0.7330 | -3.1180 | 509.0277778 | 42.8960 |
| 10/31/06 | 12:14:00 | 53.0560 | 0.7340 | -3.1180 | 509.7222222 | 43.1740 |
| 10/31/06 | 12:15:00 | 53.0560 | 0.7340 | -3.1180 | 509.7222222 | 43.1740 |
| 10/31/06 | 12:16:00 | 53.0560 | 0.7320 | -3.1180 | 508.3333333 | 43.1740 |
| 10/31/06 | 12:17:00 | 53.0560 | 0.7320 | -3.1180 | 508.3333333 | 43.1740 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/31/06 | 12:18:00 | 53.0210 | 0.7320 | -3.1180 | 508.3333333 | 43.1390 |
| 10/31/06 | 12:19:00 | 53.0210 | 0.7320 | -3.1180 | 508.3333333 | 43.1390 |
| 10/31/06 | 12:20:00 | 52.8820 | 0.7320 | -3.1180 | 508.3333333 | 43.0000 |
| 10/31/06 | 12:21:00 | 52.8820 | 0.7320 | -3.1180 | 508.3333333 | 43.0000 |
| 10/31/06 | 12:22:00 | 52.9170 | 0.7320 | -3.1180 | 508.3333333 | 43.0350 |
| 10/31/06 | 12:23:00 | 52.9170 | 0.7320 | -3.1180 | 508.3333333 | 43.0350 |
| 10/31/06 | 12:24:00 | 52.9520 | 0.7310 | -3.1180 | 507.6388889 | 43.0700 |
| 10/31/06 | 12:25:00 | 52.5000 | 0.7320 | -3.1180 | 508.3333333 | 42.6180 |
| 10/31/06 | 12:26:00 | 52.5000 | 0.7320 | -3.1180 | 508.3333333 | 42.6180 |
| 10/31/06 | 12:27:00 | 52.6740 | 0.7340 | -3.1180 | 509.7222222 | 42.7920 |
| 10/31/06 | 12:28:00 | 52.6740 | 0.7340 | -3.1180 | 509.7222222 | 42.7920 |
| 10/31/06 | 12:29:00 | 52.8820 | 0.7340 | -3.1180 | 509.7222222 | 43.0000 |
| 10/31/06 | 12:30:00 | 52.8130 | 0.7340 | -3.1180 | 509.7222222 | 42.9310 |
| 10/31/06 | 12:31:00 | 52.8130 | 0.7340 | -3.1180 | 509.7222222 | 42.9310 |
| 10/31/06 | 12:32:00 | 52.6040 | 0.7340 | -3.1180 | 509.7222222 | 42.7220 |
| 10/31/06 | 12:33:00 | 52.8130 | 0.7340 | -3.1270 | 509.7222222 | 42.9400 |
| 10/31/06 | 12:34:00 | 52.8130 | 0.7340 | -3.1270 | 509.7222222 | 42.9400 |
| 10/31/06 | 12:35:00 | 52.7090 | 0.7350 | -3.1360 | 510.4166667 | 42.8450 |
| 10/31/06 | 12:36:00 | 52.7090 | 0.7350 | -3.1360 | 510.4166667 | 42.8450 |
| 10/31/06 | 12:37:00 | 52.7430 | 0.7350 | -3.1450 | 510.4166667 | 42.8880 |
| 10/31/06 | 12:38:00 | 52.7430 | 0.7350 | -3.1450 | 510.4166667 | 42.8880 |
| 10/31/06 | 12:39:00 | 52.6740 | 0.7330 | -3.1450 | 509.0277778 | 42.8190 |
| 10/31/06 | 12:40:00 | 52.8820 | 0.7360 | -3.1450 | 511.1111111 | 43.0270 |
| 10/31/06 | 12:41:00 | 52.8820 | 0.7360 | -3.1450 | 511.1111111 | 43.0270 |
| 10/31/06 | 12:42:00 | 52.4660 | 0.7350 | -3.1450 | 510.4166667 | 42.6110 |
| 10/31/06 | 12:43:00 | 52.4660 | 0.7350 | -3.1450 | 510.4166667 | 42.6110 |
| 10/31/06 | 12:44:00 | 52.4660 | 0.7340 | -3.1450 | 509.7222222 | 42.6110 |
| 10/31/06 | 12:45:00 | 52.7430 | 0.7360 | -3.1450 | 511.1111111 | 42.8880 |
| 10/31/06 | 12:46:00 | 52.9860 | 0.7360 | -3.1450 | 511.1111111 | 43.1310 |
| 10/31/06 | 12:47:00 | 52.9860 | 0.7360 | -3.1450 | 511.1111111 | 43.1310 |
| 10/31/06 | 12:48:00 | 53.0210 | 0.7370 | -3.1450 | 511.8055556 | 43.1660 |
| 10/31/06 | 12:49:00 | 53.0210 | 0.7370 | -3.1450 | 511.8055556 | 43.1660 |
| 10/31/06 | 12:50:00 | 52.5700 | 0.7350 | -3.1450 | 510.4166667 | 42.7150 |
| 10/31/06 | 12:51:00 | 52.5700 | 0.7350 | -3.1450 | 510.4166667 | 42.7150 |
| 10/31/06 | 12:52:00 | 52.6040 | 0.7340 | -3.1450 | 509.7222222 | 42.7490 |
| 10/31/06 | 12:53:00 | 52.6040 | 0.7370 | -3.1450 | 511.8055556 | 42.7490 |
| 10/31/06 | 12:54:00 | 52.6040 | 0.7370 | -3.1450 | 511.8055556 | 42.7490 |
| 10/31/06 | 12:55:00 | 52.7780 | 0.7360 | -3.1450 | 511.1111111 | 42.9230 |
| 10/31/06 | 12:56:00 | 52.7780 | 0.7360 | -3.1450 | 511.1111111 | 42.9230 |
| 10/31/06 | 12:57:00 | 52.5000 | 0.7370 | -3.1450 | 511.8055556 | 42.6450 |
| 10/31/06 | 12:58:00 | 52.5350 | 0.7380 | -3.1450 | 512.5 | 42.6800 |
| 10/31/06 | 12:59:00 | 52.5350 | 0.7380 | -3.1450 | 512.5 | 42.6800 |
| 10/31/06 | 13:00:00 | 52.7780 | 0.7370 | -3.1450 | 511.8055556 | 42.9230 |
| 10/31/06 | 13:01:00 | 52.6740 | 0.7380 | -3.1450 | 512.5 | 42.8190 |
| 10/31/06 | 13:02:00 | 52.6740 | 0.7380 | -3.1450 | 512.5 | 42.8190 |
| 10/31/06 | 13:03:00 | 52.5700 | 0.7360 | -3.1450 | 511.1111111 | 42.7150 |
| 10/31/06 | 13:04:00 | 52.5700 | 0.7360 | -3.1450 | 511.1111111 | 42.7150 |
| 10/31/06 | 13:05:00 | 52.6040 | 0.7380 | -3.1450 | 512.5 | 42.7490 |
| 10/31/06 | 13:06:00 | 52.6040 | 0.7380 | -3.1450 | 512.5 | 42.7490 |
| 10/31/06 | 13:07:00 | 52.7090 | 0.7370 | -3.1450 | 511.8055556 | 42.8540 |
| 10/31/06 | 13:08:00 | 52.7090 | 0.7370 | -3.1450 | 511.8055556 | 42.8540 |
| 10/31/06 | 13:09:00 | 52.6740 | 0.7390 | -3.1450 | 513.1944444 | 42.8190 |
| 10/31/06 | 13:10:00 | 52.7780 | 0.7400 | -3.1450 | 513.8888889 | 42.9230 |
| 10/31/06 | 13:11:00 | 52.7780 | 0.7400 | -3.1450 | 513.8888889 | 42.9230 |
| 10/31/06 | 13:12:00 | 52.5350 | 0.7380 | -3.1450 | 512.5 | 42.6800 |
| 10/31/06 | 13:13:00 | 52.7090 | 0.7390 | -3.1450 | 513.1944444 | 42.8540 |
| 10/31/06 | 13:14:00 | 52.7090 | 0.7390 | -3.1450 | 513.1944444 | 42.8540 |
| 10/31/06 | 13:15:00 | 52.5350 | 0.7380 | -3.1450 | 512.5 | 42.6800 |
| 10/31/06 | 13:16:00 | 52.5350 | 0.7380 | -3.1450 | 512.5 | 42.6800 |
| 10/31/06 | 13:17:00 | 52.6740 | 0.7400 | -3.1450 | 513.8888889 | 42.8190 |
| 10/31/06 | 13:18:00 | 52.7430 | 0.7400 | -3.1450 | 513.8888889 | 42.8880 |
| 10/31/06 | 13:19:00 | 52.7430 | 0.7400 | -3.1450 | 513.8888889 | 42.8880 |
| 10/31/06 | 13:20:00 | 52.9170 | 0.7410 | -3.0640 | 514.5833333 | 42.9810 |
| 10/31/06 | 13:21:00 | 52.9170 | 0.7410 | -3.0640 | 514.5833333 | 42.9810 |
| 10/31/06 | 13:22:00 | 52.7780 | 0.7420 | -2.9730 | 515.2777778 | 42.7510 |
| 10/31/06 | 13:23:00 | 52.7780 | 0.7420 | -2.9730 | 515.2777778 | 42.7510 |
| 10/31/06 | 13:24:00 | 52.9170 | 0.7420 | -2.9190 | 515.2777778 | 42.8360 |
| 10/31/06 | 13:25:00 | 53.2990 | 0.7440 | -2.9190 | 516.6666667 | 43.2180 |
| 10/31/06 | 13:26:00 | 53.2990 | 0.7440 | -2.9190 | 516.6666667 | 43.2180 |
| 10/31/06 | 13:27:00 | 53.2640 | 0.7430 | -2.8740 | 515.9722222 | 43.1380 |
| 10/31/06 | 13:28:00 | 53.2640 | 0.7430 | -2.8740 | 515.9722222 | 43.1380 |
| 10/31/06 | 13:29:00 | 53.2290 | 0.7450 | -2.8380 | 517.3611111 | 43.0670 |
| 10/31/06 | 13:30:00 | 53.0910 | 0.7440 | -2.8380 | 516.6666667 | 42.9290 |
| 10/31/06 | 13:31:00 | 53.0910 | 0.7440 | -2.8380 | 516.6666667 | 42.9290 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 13:32:00 | 53.0210 | 0.7430 | -2.8290 | 515.9722222 | 42.8500 |
| 10/31/06 | 13:33:00 | 53.1600 | 0.7440 | -2.8200 | 516.6666667 | 42.9800 |
| 10/31/06 | 13:34:00 | 53.1600 | 0.7440 | -2.8200 | 516.6666667 | 42.9800 |
| 10/31/06 | 13:35:00 | 52.9860 | 0.7450 | -2.7840 | 517.3611111 | 42.7700 |
| 10/31/06 | 13:36:00 | 52.9860 | 0.7450 | -2.7840 | 517.3611111 | 42.7700 |
| 10/31/06 | 13:37:00 | 53.1950 | 0.7450 | -2.7840 | 517.3611111 | 42.9790 |
| 10/31/06 | 13:38:00 | 53.1950 | 0.7450 | -2.7840 | 517.3611111 | 42.9790 |
| 10/31/06 | 13:39:00 | 53.1950 | 0.7440 | -2.7840 | 516.6666667 | 42.9790 |
| 10/31/06 | 13:40:00 | 52.9860 | 0.7460 | -2.7840 | 518.0555556 | 42.7700 |
| 10/31/06 | 13:41:00 | 52.9860 | 0.7460 | -2.7840 | 518.0555556 | 42.7700 |
| 10/31/06 | 13:42:00 | 53.0910 | 0.7470 | -2.7840 | 518.75 | 42.8750 |
| 10/31/06 | 13:43:00 | 53.0910 | 0.7470 | -2.7840 | 518.75 | 42.8750 |
| 10/31/06 | 13:44:00 | 52.9170 | 0.7470 | -2.7840 | 518.75 | 42.7010 |
| 10/31/06 | 13:45:00 | 53.2290 | 0.7450 | -2.7840 | 517.3611111 | 43.0130 |
| 10/31/06 | 13:46:00 | 53.0210 | 0.7450 | -2.7840 | 517.3611111 | 42.8050 |
| 10/31/06 | 13:47:00 | 53.0210 | 0.7450 | -2.7840 | 517.3611111 | 42.8050 |
| 10/31/06 | 13:48:00 | 52.8130 | 0.7460 | -2.7840 | 518.0555556 | 42.5970 |
| 10/31/06 | 13:49:00 | 52.8130 | 0.7460 | -2.7840 | 518.0555556 | 42.5970 |
| 10/31/06 | 13:50:00 | 53.0210 | 0.7450 | -2.7840 | 517.3611111 | 42.8050 |
| 10/31/06 | 13:51:00 | 53.0210 | 0.7450 | -2.7840 | 517.3611111 | 42.8050 |
| 10/31/06 | 13:52:00 | 52.9860 | 0.7500 | -2.7840 | 520.8333333 | 42.7700 |
| 10/31/06 | 13:53:00 | 52.9860 | 0.7500 | -2.7840 | 520.8333333 | 42.7700 |
| 10/31/06 | 13:54:00 | 53.0210 | 0.7460 | -2.7840 | 518.0555556 | 42.8050 |
| 10/31/06 | 13:55:00 | 53.0210 | 0.7490 | -2.7840 | 520.1388889 | 42.8050 |
| 10/31/06 | 13:56:00 | 53.0210 | 0.7490 | -2.7840 | 520.1388889 | 42.8050 |
| 10/31/06 | 13:57:00 | 53.0910 | 0.7480 | -2.7840 | 519.4444444 | 42.8750 |
| 10/31/06 | 13:58:00 | 53.0910 | 0.7480 | -2.7840 | 519.4444444 | 42.8750 |
| 10/31/06 | 13:59:00 | 53.1600 | 0.7480 | -2.7480 | 519.4444444 | 42.9080 |
| 10/31/06 | 14:00:00 | 53.0210 | 0.7500 | -2.6940 | 520.8333333 | 42.7150 |
| 10/31/06 | 14:01:00 | 53.0210 | 0.7500 | -2.6940 | 520.8333333 | 42.7150 |
| 10/31/06 | 14:02:00 | 53.3340 | 0.7530 | -2.6120 | 522.9166667 | 42.9460 |
| 10/31/06 | 14:03:00 | 53.3340 | 0.7530 | -2.6120 | 522.9166667 | 42.9460 |
| 10/31/06 | 14:04:00 | 53.4380 | 0.7510 | -2.5310 | 521.5277778 | 42.9690 |
| 10/31/06 | 14:05:00 | 53.4380 | 0.7510 | -2.5310 | 521.5277778 | 42.9690 |
| 10/31/06 | 14:06:00 | 53.5770 | 0.7520 | -2.4770 | 522.2222222 | 43.0540 |
| 10/31/06 | 14:07:00 | 53.4720 | 0.7530 | -2.4230 | 522.9166667 | 42.8950 |
| 10/31/06 | 14:08:00 | 53.4720 | 0.7530 | -2.4230 | 522.9166667 | 42.8950 |
| 10/31/06 | 14:09:00 | 53.7850 | 0.7530 | -2.3870 | 522.9166667 | 43.1720 |
| 10/31/06 | 14:10:00 | 53.7850 | 0.7530 | -2.3870 | 522.9166667 | 43.1720 |
| 10/31/06 | 14:11:00 | 53.7850 | 0.7540 | -2.3600 | 523.6111111 | 43.1450 |
| 10/31/06 | 14:12:00 | 53.6460 | 0.7550 | -2.3600 | 524.3055556 | 43.0060 |
| 10/31/06 | 14:13:00 | 53.6460 | 0.7550 | -2.3600 | 524.3055556 | 43.0060 |
| 10/31/06 | 14:14:00 | 53.8540 | 0.7550 | -2.3320 | 524.3055556 | 43.1860 |
| 10/31/06 | 14:15:00 | 53.8540 | 0.7560 | -2.3140 | 525 | 43.1680 |
| 10/31/06 | 14:16:00 | 53.8540 | 0.7560 | -2.3140 | 525 | 43.1680 |
| 10/31/06 | 14:17:00 | 53.7160 | 0.7540 | -2.3050 | 523.6111111 | 43.0210 |
| 10/31/06 | 14:18:00 | 53.7160 | 0.7540 | -2.3050 | 523.6111111 | 43.0210 |
| 10/31/06 | 14:19:00 | 53.8540 | 0.7550 | -2.2960 | 524.3055556 | 43.1500 |
| 10/31/06 | 14:20:00 | 53.8540 | 0.7550 | -2.2960 | 524.3055556 | 43.1500 |
| 10/31/06 | 14:21:00 | 53.7160 | 0.7550 | -2.2780 | 524.3055556 | 42.9940 |
| 10/31/06 | 14:22:00 | 53.7160 | 0.7550 | -2.2780 | 524.3055556 | 42.9940 |
| 10/31/06 | 14:23:00 | 53.7500 | 0.7550 | -2.2780 | 524.3055556 | 43.0280 |
| 10/31/06 | 14:24:00 | 53.7160 | 0.7560 | -2.2690 | 525 | 42.9850 |
| 10/31/06 | 14:25:00 | 53.7160 | 0.7560 | -2.2690 | 525 | 42.9850 |
| 10/31/06 | 14:26:00 | 53.6110 | 0.7570 | -2.2600 | 525.6944444 | 42.8710 |
| 10/31/06 | 14:27:00 | 53.6110 | 0.7570 | -2.2600 | 525.6944444 | 42.8710 |
| 10/31/06 | 14:28:00 | 53.6110 | 0.7570 | -2.2510 | 525.6944444 | 42.8620 |
| 10/31/06 | 14:29:00 | 53.7500 | 0.7580 | -2.2510 | 526.3888889 | 43.0010 |
| 10/31/06 | 14:30:00 | 53.7500 | 0.7580 | -2.2510 | 526.3888889 | 43.0010 |
| 10/31/06 | 14:31:00 | 53.8540 | 0.7580 | -2.2510 | 526.3888889 | 43.1050 |
| 10/31/06 | 14:32:00 | 53.8540 | 0.7580 | -2.2510 | 526.3888889 | 43.1050 |
| 10/31/06 | 14:33:00 | 53.7500 | 0.7570 | -2.2420 | 525.6944444 | 42.9920 |
| 10/31/06 | 14:34:00 | 53.7500 | 0.7580 | -2.2330 | 526.3888889 | 42.9830 |
| 10/31/06 | 14:35:00 | 53.7500 | 0.7580 | -2.2330 | 526.3888889 | 42.9830 |
| 10/31/06 | 14:36:00 | 53.6810 | 0.7590 | -2.2330 | 527.0833333 | 42.9140 |
| 10/31/06 | 14:37:00 | 53.6810 | 0.7590 | -2.2330 | 527.0833333 | 42.9140 |
| 10/31/06 | 14:38:00 | 53.7850 | 0.7590 | -2.2240 | 527.0833333 | 43.0090 |
| 10/31/06 | 14:39:00 | 53.7850 | 0.7590 | -2.2240 | 527.0833333 | 43.0090 |
| 10/31/06 | 14:40:00 | 53.6460 | 0.7590 | -2.2240 | 527.0833333 | 42.8700 |
| 10/31/06 | 14:41:00 | 53.7850 | 0.7590 | -2.2240 | 527.0833333 | 43.0090 |
| 10/31/06 | 14:42:00 | 53.7850 | 0.7590 | -2.2240 | 527.0833333 | 43.0090 |
| 10/31/06 | 14:43:00 | 53.8200 | 0.7590 | -2.2240 | 527.0833333 | 43.0440 |
| 10/31/06 | 14:44:00 | 53.8200 | 0.7590 | -2.2240 | 527.0833333 | 43.0440 |
| 10/31/06 | 14:45:00 | 53.6110 | 0.7590 | -2.2150 | 527.0833333 | 42.8260 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 14:46:00 | 53.8200 | 0.7590 | -2.2240 | 527.0833333 | 43.0440 |
| 10/31/06 | 14:47:00 | 53.6810 | 0.7590 | -2.2240 | 527.0833333 | 42.9050 |
| 10/31/06 | 14:48:00 | 53.6810 | 0.7590 | -2.2240 | 527.0833333 | 42.9050 |
| 10/31/06 | 14:49:00 | 53.7160 | 0.7590 | -2.2240 | 527.0833333 | 42.9400 |
| 10/31/06 | 14:50:00 | 53.7160 | 0.7590 | -2.2240 | 527.0833333 | 42.9400 |
| 10/31/06 | 14:51:00 | 53.6810 | 0.7590 | -2.2240 | 527.0833333 | 42.9050 |
| 10/31/06 | 14:52:00 | 53.6810 | 0.7590 | -2.2240 | 527.0833333 | 42.9050 |
| 10/31/06 | 14:53:00 | 53.4720 | 0.7590 | -2.2240 | 527.0833333 | 42.6960 |
| 10/31/06 | 14:54:00 | 53.4720 | 0.7590 | -2.2240 | 527.0833333 | 42.6960 |
| 10/31/06 | 14:55:00 | 53.7500 | 0.7610 | -2.2240 | 528.4722222 | 42.9740 |
| 10/31/06 | 14:56:00 | 53.7500 | 0.7610 | -2.2240 | 528.4722222 | 42.9740 |
| 10/31/06 | 14:57:00 | 53.7850 | 0.7610 | -2.2240 | 528.4722222 | 43.0090 |
| 10/31/06 | 14:58:00 | 53.5420 | 0.7590 | -2.2240 | 527.0833333 | 42.7660 |
| 10/31/06 | 14:59:00 | 53.5420 | 0.7590 | -2.2240 | 527.0833333 | 42.7660 |
| 10/31/06 | 15:00:00 | 53.7500 | 0.7610 | -2.2240 | 528.4722222 | 42.9740 |
| 10/31/06 | 15:01:00 | 53.4720 | 0.7610 | -2.2240 | 528.4722222 | 42.6960 |
| 10/31/06 | 15:02:00 | 53.4720 | 0.7610 | -2.2240 | 528.4722222 | 42.6960 |
| 10/31/06 | 15:03:00 | 53.4380 | 0.7610 | -2.2240 | 528.4722222 | 42.6620 |
| 10/31/06 | 15:04:00 | 53.4380 | 0.7610 | -2.2240 | 528.4722222 | 42.6620 |
| 10/31/06 | 15:05:00 | 53.6110 | 0.7610 | -2.2150 | 528.4722222 | 42.8260 |
| 10/31/06 | 15:06:00 | 53.6110 | 0.7610 | -2.2150 | 528.4722222 | 42.8260 |
| 10/31/06 | 15:07:00 | 53.5420 | 0.7610 | -2.2240 | 528.4722222 | 42.7660 |
| 10/31/06 | 15:08:00 | 53.5420 | 0.7610 | -2.2240 | 528.4722222 | 42.7660 |
| 10/31/06 | 15:09:00 | 53.5420 | 0.7620 | -2.2240 | 529.1666667 | 42.7660 |
| 10/31/06 | 15:10:00 | 53.4720 | 0.7620 | -2.2240 | 529.1666667 | 42.6960 |
| 10/31/06 | 15:11:00 | 53.4720 | 0.7620 | -2.2240 | 529.1666667 | 42.6960 |
| 10/31/06 | 15:12:00 | 53.2640 | 0.7620 | -2.2240 | 529.1666667 | 42.4880 |
| 10/31/06 | 15:13:00 | 53.5420 | 0.7610 | -2.2240 | 528.4722222 | 42.7660 |
| 10/31/06 | 15:14:00 | 53.5420 | 0.7610 | -2.2240 | 528.4722222 | 42.7660 |
| 10/31/06 | 15:15:00 | 53.5070 | 0.7620 | -2.2240 | 529.1666667 | 42.7310 |
| 10/31/06 | 15:16:00 | 53.6810 | 0.7600 | -2.2240 | 527.7777778 | 42.9050 |
| 10/31/06 | 15:17:00 | 53.6810 | 0.7600 | -2.2240 | 527.7777778 | 42.9050 |
| 10/31/06 | 15:18:00 | 53.5420 | 0.7630 | -2.2240 | 529.8611111 | 42.7660 |
| 10/31/06 | 15:19:00 | 53.5420 | 0.7630 | -2.2240 | 529.8611111 | 42.7660 |
| 10/31/06 | 15:20:00 | 53.4030 | 0.7630 | -2.2240 | 529.8611111 | 42.6270 |
| 10/31/06 | 15:21:00 | 53.4030 | 0.7630 | -2.2240 | 529.8611111 | 42.6270 |
| 10/31/06 | 15:22:00 | 53.4030 | 0.7610 | -2.2240 | 528.4722222 | 42.6270 |
| 10/31/06 | 15:23:00 | 53.4030 | 0.7610 | -2.2240 | 528.4722222 | 42.6270 |
| 10/31/06 | 15:24:00 | 53.5420 | 0.7640 | -2.2240 | 530.5555556 | 42.7660 |
| 10/31/06 | 15:25:00 | 53.5420 | 0.7640 | -2.2240 | 530.5555556 | 42.7660 |
| 10/31/06 | 15:26:00 | 53.6110 | 0.7640 | -2.2150 | 530.5555556 | 42.8260 |
| 10/31/06 | 15:27:00 | 53.4030 | 0.7630 | -2.2150 | 529.8611111 | 42.6180 |
| 10/31/06 | 15:28:00 | 53.4030 | 0.7630 | -2.2150 | 529.8611111 | 42.6180 |
| 10/31/06 | 15:29:00 | 53.3680 | 0.7630 | -2.2150 | 529.8611111 | 42.5830 |
| 10/31/06 | 15:30:00 | 53.4030 | 0.7640 | -2.2150 | 530.5555556 | 42.6180 |
| 10/31/06 | 15:31:00 | 53.4030 | 0.7640 | -2.2150 | 530.5555556 | 42.6180 |
| 10/31/06 | 15:32:00 | 53.4380 | 0.7630 | -2.2150 | 529.8611111 | 42.6530 |
| 10/31/06 | 15:33:00 | 53.4030 | 0.7630 | -2.2150 | 529.8611111 | 42.6180 |
| 10/31/06 | 15:34:00 | 53.4030 | 0.7630 | -2.2150 | 529.8611111 | 42.6180 |
| 10/31/06 | 15:35:00 | 53.4380 | 0.7610 | -2.2150 | 528.4722222 | 42.6530 |
| 10/31/06 | 15:36:00 | 53.4380 | 0.7610 | -2.2150 | 528.4722222 | 42.6530 |
| 10/31/06 | 15:37:00 | 53.1950 | 0.7620 | -2.2150 | 529.1666667 | 42.4100 |
| 10/31/06 | 15:38:00 | 53.1950 | 0.7620 | -2.2150 | 529.1666667 | 42.4100 |
| 10/31/06 | 15:39:00 | 53.4380 | 0.7610 | -2.2150 | 528.4722222 | 42.6530 |
| 10/31/06 | 15:40:00 | 53.4720 | 0.7610 | -2.2150 | 528.4722222 | 42.6870 |
| 10/31/06 | 15:41:00 | 53.3340 | 0.7620 | -2.2150 | 529.1666667 | 42.5490 |
| 10/31/06 | 15:42:00 | 53.3340 | 0.7620 | -2.2150 | 529.1666667 | 42.5490 |
| 10/31/06 | 15:43:00 | 53.3340 | 0.7620 | -2.2150 | 529.1666667 | 42.5490 |
| 10/31/06 | 15:44:00 | 53.4030 | 0.7640 | -2.2150 | 530.5555556 | 42.6180 |
| 10/31/06 | 15:45:00 | 53.4030 | 0.7620 | -2.2150 | 529.1666667 | 42.6180 |
| 10/31/06 | 15:46:00 | 53.4030 | 0.7620 | -2.2150 | 529.1666667 | 42.6180 |
| 10/31/06 | 15:47:00 | 53.3340 | 0.7630 | -2.2060 | 529.8611111 | 42.5400 |
| 10/31/06 | 15:48:00 | 53.3340 | 0.7630 | -2.2060 | 529.8611111 | 42.5400 |
| 10/31/06 | 15:49:00 | 53.3680 | 0.7630 | -2.1970 | 529.8611111 | 42.5650 |
| 10/31/06 | 15:50:00 | 53.4720 | 0.7650 | -2.1970 | 531.25 | 42.6690 |
| 10/31/06 | 15:51:00 | 53.4720 | 0.7650 | -2.1970 | 531.25 | 42.6690 |
| 10/31/06 | 15:52:00 | 53.4720 | 0.7650 | -2.1970 | 531.25 | 42.6690 |
| 10/31/06 | 15:53:00 | 53.2290 | 0.7630 | -2.1970 | 529.8611111 | 42.4260 |
| 10/31/06 | 15:54:00 | 53.2290 | 0.7630 | -2.1970 | 529.8611111 | 42.4260 |
| 10/31/06 | 15:55:00 | 53.5070 | 0.7640 | -2.1970 | 530.5555556 | 42.7040 |
| 10/31/06 | 15:56:00 | 53.4720 | 0.7640 | -2.1970 | 530.5555556 | 42.6690 |
| 10/31/06 | 15:57:00 | 53.4720 | 0.7640 | -2.1970 | 530.5555556 | 42.6690 |
| 10/31/06 | 15:58:00 | 53.5070 | 0.7640 | -2.1970 | 530.5555556 | 42.7040 |
| 10/31/06 | 15:59:00 | 53.5070 | 0.7640 | -2.1970 | 530.5555556 | 42.7040 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 16:00:00 | 53.3340 | 0.7640 | -2.1970 | 530.5555556 | 42.5310 |
| 10/31/06 | 16:01:00 | 53.4720 | 0.7650 | -2.1970 | 531.25 | 42.6690 |
| 10/31/06 | 16:02:00 | 53.4720 | 0.7650 | -2.1970 | 531.25 | 42.6690 |
| 10/31/06 | 16:03:00 | 53.2290 | 0.7640 | -2.1970 | 530.5555556 | 42.4260 |
| 10/31/06 | 16:04:00 | 53.2290 | 0.7640 | -2.1970 | 530.5555556 | 42.4260 |
| 10/31/06 | 16:05:00 | 53.3680 | 0.7650 | -2.1970 | 531.25 | 42.5650 |
| 10/31/06 | 16:06:00 | 53.3680 | 0.7650 | -2.1970 | 531.25 | 42.5650 |
| 10/31/06 | 16:07:00 | 53.3680 | 0.7640 | -2.1880 | 530.5555556 | 42.5560 |
| 10/31/06 | 16:08:00 | 53.3680 | 0.7640 | -2.1880 | 530.5555556 | 42.5560 |
| 10/31/06 | 16:09:00 | 53.4380 | 0.7650 | -2.1700 | 531.25 | 42.6080 |
| 10/31/06 | 16:10:00 | 53.5070 | 0.7660 | -2.1610 | 531.9444444 | 42.6680 |
| 10/31/06 | 16:11:00 | 37.2220 | 0.5630 | -12.9580 | 390.9722222 | 37.1800 |
| 10/31/06 | 16:12:00 | 53.5070 | 0.7660 | -2.1610 | 531.9444444 | 42.6680 |
| 10/31/06 | 16:13:00 | 53.5070 | 0.7660 | -2.1610 | 531.9444444 | 42.6680 |
| 10/31/06 | 16:14:00 | 53.4380 | 0.7650 | -2.1520 | 531.25 | 42.5900 |
| 10/31/06 | 16:15:00 | 53.4380 | 0.7650 | -2.1520 | 531.25 | 42.5900 |
| 10/31/06 | 16:16:00 | 53.4380 | 0.7650 | -2.1520 | 531.25 | 42.5900 |
| 10/31/06 | 16:17:00 | 53.4380 | 0.7650 | -2.1520 | 531.25 | 42.5900 |
| 10/31/06 | 16:18:00 | 53.5770 | 0.7650 | -2.1610 | 531.25 | 42.7380 |
| 10/31/06 | 16:19:00 | 53.5770 | 0.7650 | -2.1610 | 531.25 | 42.7380 |
| 10/31/06 | 16:20:00 | 53.2990 | 0.7650 | -2.1610 | 531.25 | 42.4600 |
| 10/31/06 | 16:21:00 | 53.2990 | 0.7650 | -2.1610 | 531.25 | 42.4600 |
| 10/31/06 | 16:22:00 | 53.4030 | 0.7650 | -2.1610 | 531.25 | 42.5640 |
| 10/31/06 | 16:23:00 | 53.1950 | 0.7650 | -2.1610 | 531.25 | 42.3560 |
| 10/31/06 | 16:24:00 | 53.1950 | 0.7650 | -2.1610 | 531.25 | 42.3560 |
| 10/31/06 | 16:25:00 | 53.4030 | 0.7650 | -2.1610 | 531.25 | 42.5640 |
| 10/31/06 | 16:26:00 | 53.4030 | 0.7650 | -2.1610 | 531.25 | 42.5640 |
| 10/31/06 | 16:27:00 | 53.2640 | 0.7660 | -2.1610 | 531.9444444 | 42.4250 |
| 10/31/06 | 16:28:00 | 53.1600 | 0.7660 | -2.1610 | 531.9444444 | 42.3210 |
| 10/31/06 | 16:29:00 | 53.1600 | 0.7660 | -2.1610 | 531.9444444 | 42.3210 |
| 10/31/06 | 16:30:00 | 53.2290 | 0.7660 | -2.1610 | 531.9444444 | 42.3900 |
| 10/31/06 | 16:31:00 | 53.2290 | 0.7660 | -2.1610 | 531.9444444 | 42.3900 |
| 10/31/06 | 16:32:00 | 53.2990 | 0.7650 | -2.1610 | 531.25 | 42.4600 |
| 10/31/06 | 16:33:00 | 53.2640 | 0.7660 | -2.1610 | 531.9444444 | 42.4250 |
| 10/31/06 | 16:34:00 | 53.2640 | 0.7660 | -2.1610 | 531.9444444 | 42.4250 |
| 10/31/06 | 16:35:00 | 53.5070 | 0.7660 | -2.1610 | 531.9444444 | 42.6680 |
| 10/31/06 | 16:36:00 | 53.5070 | 0.7660 | -2.1610 | 531.9444444 | 42.6680 |
| 10/31/06 | 16:37:00 | 53.2290 | 0.7660 | -2.1610 | 531.9444444 | 42.3900 |
| 10/31/06 | 16:38:00 | 53.2290 | 0.7660 | -2.1610 | 531.9444444 | 42.3900 |
| 10/31/06 | 16:39:00 | 53.2290 | 0.7660 | -2.1700 | 531.9444444 | 42.3990 |
| 10/31/06 | 16:40:00 | 53.0560 | 0.7650 | -2.1700 | 531.25 | 42.2260 |
| 10/31/06 | 16:41:00 | 53.0560 | 0.7650 | -2.1700 | 531.25 | 42.2260 |
| 10/31/06 | 16:42:00 | 53.0560 | 0.7670 | -2.1610 | 532.6388889 | 42.2170 |
| 10/31/06 | 16:43:00 | 53.0560 | 0.7670 | -2.1610 | 532.6388889 | 42.2170 |
| 10/31/06 | 16:44:00 | 53.1950 | 0.7660 | -2.1700 | 531.9444444 | 42.3650 |
| 10/31/06 | 16:45:00 | 53.2290 | 0.7680 | -2.1700 | 533.3333333 | 42.3990 |
| 10/31/06 | 16:46:00 | 53.2290 | 0.7680 | -2.1700 | 533.3333333 | 42.3990 |
| 10/31/06 | 16:47:00 | 53.1600 | 0.7680 | -2.1610 | 533.3333333 | 42.3210 |
| 10/31/06 | 16:48:00 | 53.1600 | 0.7680 | -2.1610 | 533.3333333 | 42.3210 |
| 10/31/06 | 16:49:00 | 53.1950 | 0.7670 | -2.1610 | 532.6388889 | 42.3560 |
| 10/31/06 | 16:50:00 | 53.0910 | 0.7670 | -2.1610 | 532.6388889 | 42.2520 |
| 10/31/06 | 16:51:00 | 53.0910 | 0.7670 | -2.1610 | 532.6388889 | 42.2520 |
| 10/31/06 | 16:52:00 | 53.0210 | 0.7670 | -2.1700 | 532.6388889 | 42.1910 |
| 10/31/06 | 16:53:00 | 53.0210 | 0.7670 | -2.1700 | 532.6388889 | 42.1910 |
| 10/31/06 | 16:54:00 | 53.0210 | 0.7670 | -2.1700 | 532.6388889 | 42.1910 |
| 10/31/06 | 16:55:00 | 53.0210 | 0.7670 | -2.1700 | 532.6388889 | 42.1910 |
| 10/31/06 | 16:56:00 | 52.9860 | 0.7680 | -2.1700 | 533.3333333 | 42.1560 |
| 10/31/06 | 16:57:00 | 53.0560 | 0.7680 | -2.1700 | 533.3333333 | 42.2260 |
| 10/31/06 | 16:58:00 | 53.0560 | 0.7680 | -2.1700 | 533.3333333 | 42.2260 |
| 10/31/06 | 16:59:00 | 53.1950 | 0.7680 | -2.1700 | 533.3333333 | 42.3650 |
| 10/31/06 | 17:00:00 | 53.1950 | 0.7680 | -2.1700 | 533.3333333 | 42.3650 |
| 10/31/06 | 17:01:00 | 53.2640 | 0.7680 | -2.1700 | 533.3333333 | 42.4340 |
| 10/31/06 | 17:02:00 | 53.2640 | 0.7690 | -2.1700 | 534.0277778 | 42.4340 |
| 10/31/06 | 17:03:00 | 53.2640 | 0.7690 | -2.1700 | 534.0277778 | 42.4340 |
| 10/31/06 | 17:04:00 | 53.0210 | 0.7680 | -2.1700 | 533.3333333 | 42.1910 |
| 10/31/06 | 17:05:00 | 53.0210 | 0.7680 | -2.1700 | 533.3333333 | 42.1910 |
| 10/31/06 | 17:06:00 | 52.9860 | 0.7680 | -2.1700 | 533.3333333 | 42.1560 |
| 10/31/06 | 17:07:00 | 52.9860 | 0.7680 | -2.1700 | 533.3333333 | 42.1560 |
| 10/31/06 | 17:08:00 | 53.0560 | 0.7680 | -2.1700 | 533.3333333 | 42.2260 |
| 10/31/06 | 17:09:00 | 53.0560 | 0.7680 | -2.1700 | 533.3333333 | 42.2260 |
| 10/31/06 | 17:10:00 | 52.8820 | 0.7680 | -2.1700 | 533.3333333 | 42.0520 |
| 10/31/06 | 17:11:00 | 52.7430 | 0.7670 | -2.1700 | 532.6388889 | 41.9130 |
| 10/31/06 | 17:12:00 | 52.7430 | 0.7670 | -2.1700 | 532.6388889 | 41.9130 |
| 10/31/06 | 17:13:00 | 52.7780 | 0.7680 | -2.1700 | 533.3333333 | 41.9480 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 17:14:00 | 52.7780 | 0.7680 | -2.1700 | 533.3333333 | 41.9480 |
| 10/31/06 | 17:15:00 | 53.1250 | 0.7690 | -2.1700 | 534.0277778 | 42.2950 |
| 10/31/06 | 17:16:00 | 52.9860 | 0.7680 | -2.1700 | 533.3333333 | 42.1560 |
| 10/31/06 | 17:17:00 | 52.9860 | 0.7680 | -2.1700 | 533.3333333 | 42.1560 |
| 10/31/06 | 17:18:00 | 52.8470 | 0.7680 | -2.1700 | 533.3333333 | 42.0170 |
| 10/31/06 | 17:19:00 | 52.8470 | 0.7680 | -2.1700 | 533.3333333 | 42.0170 |
| 10/31/06 | 17:20:00 | 52.8470 | 0.7670 | -2.1700 | 532.6388889 | 42.0170 |
| 10/31/06 | 17:21:00 | 52.8470 | 0.7670 | -2.1700 | 532.6388889 | 42.0170 |
| 10/31/06 | 17:22:00 | 52.8130 | 0.7700 | -2.1700 | 534.7222222 | 41.9830 |
| 10/31/06 | 17:23:00 | 52.8130 | 0.7700 | -2.1700 | 534.7222222 | 41.9830 |
| 10/31/06 | 17:24:00 | 52.7780 | 0.7670 | -2.1700 | 532.6388889 | 41.9480 |
| 10/31/06 | 17:25:00 | 52.8130 | 0.7690 | -2.1700 | 534.0277778 | 41.9830 |
| 10/31/06 | 17:26:00 | 52.8130 | 0.7690 | -2.1700 | 534.0277778 | 41.9830 |
| 10/31/06 | 17:27:00 | 52.8130 | 0.7690 | -2.1700 | 534.0277778 | 41.9830 |
| 10/31/06 | 17:28:00 | 52.7430 | 0.7680 | -2.1700 | 533.3333333 | 41.9130 |
| 10/31/06 | 17:29:00 | 52.7430 | 0.7680 | -2.1700 | 533.3333333 | 41.9130 |
| 10/31/06 | 17:30:00 | 52.6390 | 0.7680 | -2.1700 | 533.3333333 | 41.8090 |
| 10/31/06 | 17:31:00 | 52.6390 | 0.7680 | -2.1700 | 533.3333333 | 41.8090 |
| 10/31/06 | 17:32:00 | 52.8130 | 0.7680 | -2.1700 | 533.3333333 | 41.9830 |
| 10/31/06 | 17:33:00 | 52.7090 | 0.7680 | -2.1700 | 533.3333333 | 41.8790 |
| 10/31/06 | 17:34:00 | 52.7090 | 0.7680 | -2.1700 | 533.3333333 | 41.8790 |
| 10/31/06 | 17:35:00 | 52.5350 | 0.7690 | -2.1700 | 534.0277778 | 41.7050 |
| 10/31/06 | 17:36:00 | 52.5350 | 0.7690 | -2.1700 | 534.0277778 | 41.7050 |
| 10/31/06 | 17:37:00 | 52.7780 | 0.7680 | -2.1700 | 533.3333333 | 41.9480 |
| 10/31/06 | 17:38:00 | 52.7780 | 0.7680 | -2.1700 | 533.3333333 | 41.9480 |
| 10/31/06 | 17:39:00 | 52.6740 | 0.7680 | -2.1700 | 533.3333333 | 41.8440 |
| 10/31/06 | 17:40:00 | 52.7090 | 0.7680 | -2.1700 | 533.3333333 | 41.8790 |
| 10/31/06 | 17:41:00 | 52.7090 | 0.7680 | -2.1700 | 533.3333333 | 41.8790 |
| 10/31/06 | 17:42:00 | 52.8130 | 0.7680 | -2.1700 | 533.3333333 | 41.9830 |
| 10/31/06 | 17:43:00 | 52.8130 | 0.7680 | -2.1700 | 533.3333333 | 41.9830 |
| 10/31/06 | 17:44:00 | 52.8470 | 0.7680 | -2.1700 | 533.3333333 | 42.0170 |
| 10/31/06 | 17:45:00 | 52.5350 | 0.7700 | -2.1700 | 534.7222222 | 41.7050 |
| 10/31/06 | 17:46:00 | 52.5350 | 0.7700 | -2.1700 | 534.7222222 | 41.7050 |
| 10/31/06 | 17:47:00 | 52.5700 | 0.7690 | -2.1700 | 534.0277778 | 41.7400 |
| 10/31/06 | 17:48:00 | 52.5700 | 0.7690 | -2.1700 | 534.0277778 | 41.7400 |
| 10/31/06 | 17:49:00 | 52.6040 | 0.7690 | -2.1700 | 534.0277778 | 41.7740 |
| 10/31/06 | 17:50:00 | 52.6040 | 0.7690 | -2.1700 | 534.0277778 | 41.7740 |
| 10/31/06 | 17:51:00 | 52.8130 | 0.7700 | -2.1790 | 534.7222222 | 41.9920 |
| 10/31/06 | 17:52:00 | 52.8130 | 0.7700 | -2.1790 | 534.7222222 | 41.9920 |
| 10/31/06 | 17:53:00 | 52.5700 | 0.7690 | -2.1970 | 534.0277778 | 41.7670 |
| 10/31/06 | 17:54:00 | 52.7090 | 0.7690 | -2.1970 | 534.0277778 | 41.9060 |
| 10/31/06 | 17:55:00 | 52.7090 | 0.7690 | -2.1970 | 534.0277778 | 41.9060 |
| 10/31/06 | 17:56:00 | 52.6390 | 0.7690 | -2.1970 | 534.0277778 | 41.8360 |
| 10/31/06 | 17:57:00 | 52.6390 | 0.7690 | -2.1970 | 534.0277778 | 41.8360 |
| 10/31/06 | 17:58:00 | 52.6040 | 0.7690 | -2.1970 | 534.0277778 | 41.8010 |
| 10/31/06 | 17:59:00 | 52.8130 | 0.7700 | -2.1970 | 534.7222222 | 42.0100 |
| 10/31/06 | 18:00:00 | 52.8130 | 0.7700 | -2.1970 | 534.7222222 | 42.0100 |
| 10/31/06 | 18:01:00 | 52.9170 | 0.7700 | -2.1970 | 534.7222222 | 42.1140 |
| 10/31/06 | 18:02:00 | 52.7780 | 0.7700 | -2.1970 | 534.7222222 | 41.9750 |
| 10/31/06 | 18:03:00 | 52.7780 | 0.7700 | -2.1970 | 534.7222222 | 41.9750 |
| 10/31/06 | 18:04:00 | 52.7780 | 0.7700 | -2.1970 | 534.7222222 | 41.9750 |
| 10/31/06 | 18:05:00 | 52.7430 | 0.7700 | -2.1970 | 534.7222222 | 41.9400 |
| 10/31/06 | 18:06:00 | 52.4660 | 0.7700 | -2.1970 | 534.7222222 | 41.6630 |
| 10/31/06 | 18:07:00 | 52.4660 | 0.7700 | -2.1970 | 534.7222222 | 41.6630 |
| 10/31/06 | 18:08:00 | 52.5350 | 0.7710 | -2.2060 | 535.4166667 | 41.7410 |
| 10/31/06 | 18:09:00 | 52.4660 | 0.7710 | -2.2060 | 535.4166667 | 41.6720 |
| 10/31/06 | 18:10:00 | 52.6390 | 0.7680 | -2.2060 | 533.3333333 | 41.8450 |
| 10/31/06 | 18:11:00 | 52.5700 | 0.7700 | -2.2060 | 534.7222222 | 41.7760 |
| 10/31/06 | 18:12:00 | 52.5700 | 0.7700 | -2.2060 | 534.7222222 | 41.7760 |
| 10/31/06 | 18:13:00 | 52.6740 | 0.7700 | -2.2060 | 534.7222222 | 41.8800 |
| 10/31/06 | 18:14:00 | 52.5000 | 0.7700 | -2.2060 | 534.7222222 | 41.7060 |
| 10/31/06 | 18:15:00 | 52.5000 | 0.7700 | -2.2060 | 534.7222222 | 41.7060 |
| 10/31/06 | 18:16:00 | 52.8470 | 0.7710 | -2.2060 | 535.4166667 | 42.0530 |
| 10/31/06 | 18:17:00 | 52.8470 | 0.7710 | -2.2060 | 535.4166667 | 42.0530 |
| 10/31/06 | 18:18:00 | 52.6740 | 0.7720 | -2.2060 | 536.1111111 | 41.8800 |
| 10/31/06 | 18:19:00 | 52.6740 | 0.7720 | -2.2060 | 536.1111111 | 41.8800 |
| 10/31/06 | 18:20:00 | 52.3270 | 0.7720 | -2.2060 | 536.1111111 | 41.5330 |
| 10/31/06 | 18:21:00 | 52.3270 | 0.7720 | -2.2060 | 536.1111111 | 41.5330 |
| 10/31/06 | 18:22:00 | 52.5350 | 0.7720 | -2.2060 | 536.1111111 | 41.7410 |
| 10/31/06 | 18:23:00 | 52.5700 | 0.7720 | -2.2060 | 536.1111111 | 41.7760 |
| 10/31/06 | 18:24:00 | 52.5700 | 0.7720 | -2.2060 | 536.1111111 | 41.7760 |
| 10/31/06 | 18:25:00 | 52.3960 | 0.7720 | -2.2240 | 536.1111111 | 41.6200 |
| 10/31/06 | 18:26:00 | 52.3960 | 0.7720 | -2.2240 | 536.1111111 | 41.6200 |
| 10/31/06 | 18:27:00 | 52.5000 | 0.7710 | -2.2240 | 535.4166667 | 41.7240 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 18:28:00 | 52.2570 | 0.7720 | -2.2240 | 536.1111111 | 41.4810 |
| 10/31/06 | 18:29:00 | 52.2570 | 0.7720 | -2.2240 | 536.1111111 | 41.4810 |
| 10/31/06 | 18:30:00 | 52.8130 | 0.7720 | -2.2510 | 536.1111111 | 42.0640 |
| 10/31/06 | 18:31:00 | 52.4660 | 0.7730 | -2.2510 | 536.8055556 | 41.7170 |
| 10/31/06 | 18:32:00 | 52.4660 | 0.7730 | -2.2510 | 536.8055556 | 41.7170 |
| 10/31/06 | 18:33:00 | 52.5700 | 0.7710 | -2.2510 | 535.4166667 | 41.8210 |
| 10/31/06 | 18:34:00 | 52.5700 | 0.7710 | -2.2510 | 535.4166667 | 41.8210 |
| 10/31/06 | 18:35:00 | 52.3610 | 0.7700 | -2.2510 | 534.7222222 | 41.6120 |
| 10/31/06 | 18:36:00 | 52.3610 | 0.7700 | -2.2510 | 534.7222222 | 41.6120 |
| 10/31/06 | 18:37:00 | 52.7090 | 0.7710 | -2.2780 | 535.4166667 | 41.9870 |
| 10/31/06 | 18:38:00 | 52.7090 | 0.7710 | -2.2780 | 535.4166667 | 41.9870 |
| 10/31/06 | 18:39:00 | 52.6040 | 0.7710 | -2.2780 | 535.4166667 | 41.8820 |
| 10/31/06 | 18:40:00 | 52.3610 | 0.7700 | -2.2780 | 534.7222222 | 41.6390 |
| 10/31/06 | 18:41:00 | 52.3610 | 0.7700 | -2.2780 | 534.7222222 | 41.6390 |
| 10/31/06 | 18:42:00 | 52.3610 | 0.7740 | -2.2870 | 537.5 | 41.6480 |
| 10/31/06 | 18:43:00 | 52.4310 | 0.7720 | -2.3050 | 536.1111111 | 41.7360 |
| 10/31/06 | 18:44:00 | 52.4310 | 0.7720 | -2.3050 | 536.1111111 | 41.7360 |
| 10/31/06 | 18:45:00 | 52.4310 | 0.7720 | -2.3140 | 536.1111111 | 41.7450 |
| 10/31/06 | 18:46:00 | 52.5000 | 0.7710 | -2.3140 | 535.4166667 | 41.8140 |
| 10/31/06 | 18:47:00 | 52.5000 | 0.7710 | -2.3140 | 535.4166667 | 41.8140 |
| 10/31/06 | 18:48:00 | 52.3960 | 0.7710 | -2.3320 | 535.4166667 | 41.7280 |
| 10/31/06 | 18:49:00 | 52.3960 | 0.7710 | -2.3320 | 535.4166667 | 41.7280 |
| 10/31/06 | 18:50:00 | 52.0490 | 0.7710 | -2.3320 | 535.4166667 | 41.3810 |
| 10/31/06 | 18:51:00 | 52.0490 | 0.7710 | -2.3320 | 535.4166667 | 41.3810 |
| 10/31/06 | 18:52:00 | 52.1530 | 0.7700 | -2.3420 | 534.7222222 | 41.4950 |
| 10/31/06 | 18:53:00 | 52.1530 | 0.7700 | -2.3420 | 534.7222222 | 41.4950 |
| 10/31/06 | 18:54:00 | 52.2570 | 0.7710 | -2.3420 | 535.4166667 | 41.5990 |
| 10/31/06 | 18:55:00 | 52.6390 | 0.7710 | -2.3600 | 535.4166667 | 41.9990 |
| 10/31/06 | 18:56:00 | 52.6390 | 0.7710 | -2.3600 | 535.4166667 | 41.9990 |
| 10/31/06 | 18:57:00 | 52.4310 | 0.7720 | -2.3600 | 536.1111111 | 41.7910 |
| 10/31/06 | 18:58:00 | 52.4310 | 0.7720 | -2.3600 | 536.1111111 | 41.7910 |
| 10/31/06 | 18:59:00 | 52.5700 | 0.7710 | -2.3690 | 535.4166667 | 41.9390 |
| 10/31/06 | 19:00:00 | 52.4310 | 0.7710 | -2.3690 | 535.4166667 | 41.8000 |
| 10/31/06 | 19:01:00 | 52.4310 | 0.7710 | -2.3690 | 535.4166667 | 41.8000 |
| 10/31/06 | 19:02:00 | 52.3270 | 0.7710 | -2.3870 | 535.4166667 | 41.7140 |
| 10/31/06 | 19:03:00 | 52.3270 | 0.7710 | -2.3870 | 535.4166667 | 41.7140 |
| 10/31/06 | 19:04:00 | 52.5350 | 0.7730 | -2.3960 | 536.8055556 | 41.9310 |
| 10/31/06 | 19:05:00 | 52.5350 | 0.7730 | -2.3960 | 536.8055556 | 41.9310 |
| 10/31/06 | 19:06:00 | 52.2570 | 0.7710 | -2.3960 | 535.4166667 | 41.6530 |
| 10/31/06 | 19:07:00 | 52.2570 | 0.7710 | -2.3960 | 535.4166667 | 41.6530 |
| 10/31/06 | 19:08:00 | 52.4660 | 0.7710 | -2.3960 | 535.4166667 | 41.8620 |
| 10/31/06 | 19:09:00 | 52.5700 | 0.7710 | -2.3960 | 535.4166667 | 41.9660 |
| 10/31/06 | 19:10:00 | 52.5700 | 0.7710 | -2.3960 | 535.4166667 | 41.9660 |
| 10/31/06 | 19:11:00 | 52.4310 | 0.7720 | -2.4050 | 536.1111111 | 41.8360 |
| 10/31/06 | 19:12:00 | 52.4310 | 0.7720 | -2.4050 | 536.1111111 | 41.8360 |
| 10/31/06 | 19:13:00 | 52.4660 | 0.7730 | -2.4230 | 536.8055556 | 41.8890 |
| 10/31/06 | 19:14:00 | 52.3270 | 0.7720 | -2.4230 | 536.1111111 | 41.7500 |
| 10/31/06 | 19:15:00 | 52.2920 | 0.7720 | -2.4230 | 536.1111111 | 41.7150 |
| 10/31/06 | 19:16:00 | 52.2920 | 0.7720 | -2.4230 | 536.1111111 | 41.7150 |
| 10/31/06 | 19:17:00 | 52.2920 | 0.7710 | -2.4410 | 535.4166667 | 41.7330 |
| 10/31/06 | 19:18:00 | 52.2920 | 0.7710 | -2.4410 | 535.4166667 | 41.7330 |
| 10/31/06 | 19:19:00 | 52.5000 | 0.7720 | -2.4500 | 536.1111111 | 41.9500 |
| 10/31/06 | 19:20:00 | 52.5000 | 0.7720 | -2.4500 | 536.1111111 | 41.9500 |
| 10/31/06 | 19:21:00 | 52.2570 | 0.7720 | -2.4500 | 536.1111111 | 41.7070 |
| 10/31/06 | 19:22:00 | 52.2570 | 0.7720 | -2.4500 | 536.1111111 | 41.7070 |
| 10/31/06 | 19:23:00 | 52.4310 | 0.7730 | -2.4500 | 536.8055556 | 41.8810 |
| 10/31/06 | 19:24:00 | 52.4310 | 0.7730 | -2.4500 | 536.8055556 | 41.8810 |
| 10/31/06 | 19:25:00 | 52.3270 | 0.7710 | -2.4500 | 535.4166667 | 41.7770 |
| 10/31/06 | 19:26:00 | 52.3270 | 0.7710 | -2.4500 | 535.4166667 | 41.7770 |
| 10/31/06 | 19:27:00 | 52.2570 | 0.7720 | -2.4410 | 536.1111111 | 41.6980 |
| 10/31/06 | 19:28:00 | 52.0140 | 0.7710 | -2.4500 | 535.4166667 | 41.4640 |
| 10/31/06 | 19:29:00 | 52.0140 | 0.7710 | -2.4500 | 535.4166667 | 41.4640 |
| 10/31/06 | 19:30:00 | 51.9790 | 0.7720 | -2.4590 | 536.1111111 | 41.4380 |
| 10/31/06 | 19:31:00 | 51.9790 | 0.7720 | -2.4590 | 536.1111111 | 41.4380 |
| 10/31/06 | 19:32:00 | 52.1530 | 0.7720 | -2.5310 | 536.1111111 | 41.6840 |
| 10/31/06 | 19:33:00 | 51.9450 | 0.7710 | -2.5310 | 535.4166667 | 41.4760 |
| 10/31/06 | 19:34:00 | 51.9450 | 0.7710 | -2.5310 | 535.4166667 | 41.4760 |
| 10/31/06 | 19:35:00 | 52.2220 | 0.7720 | -2.5310 | 536.1111111 | 41.7530 |
| 10/31/06 | 19:36:00 | 52.2220 | 0.7720 | -2.5310 | 536.1111111 | 41.7530 |
| 10/31/06 | 19:37:00 | 52.3270 | 0.7740 | -2.5310 | 537.5 | 41.8580 |
| 10/31/06 | 19:38:00 | 52.3270 | 0.7740 | -2.5310 | 537.5 | 41.8580 |
| 10/31/06 | 19:39:00 | 52.2570 | 0.7710 | -2.5310 | 535.4166667 | 41.7880 |
| 10/31/06 | 19:40:00 | 52.2570 | 0.7710 | -2.5310 | 535.4166667 | 41.7880 |
| 10/31/06 | 19:41:00 | 52.1880 | 0.7730 | -2.5310 | 536.8055556 | 41.7190 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 19:42:00 | 52.2570 | 0.7710 | -2.5310 | 535.4166667 | 41.7880 |
| 10/31/06 | 19:43:00 | 52.2570 | 0.7710 | -2.5310 | 535.4166667 | 41.7880 |
| 10/31/06 | 19:44:00 | 52.0840 | 0.7720 | -2.5310 | 536.1111111 | 41.6150 |
| 10/31/06 | 19:45:00 | 52.1880 | 0.7730 | -2.5310 | 536.8055556 | 41.7190 |
| 10/31/06 | 19:46:00 | 52.1880 | 0.7730 | -2.5310 | 536.8055556 | 41.7190 |
| 10/31/06 | 19:47:00 | 52.3610 | 0.7720 | -2.5310 | 536.1111111 | 41.8920 |
| 10/31/06 | 19:48:00 | 52.3610 | 0.7720 | -2.5310 | 536.1111111 | 41.8920 |
| 10/31/06 | 19:49:00 | 52.1880 | 0.7720 | -2.5310 | 536.1111111 | 41.7190 |
| 10/31/06 | 19:50:00 | 52.1880 | 0.7720 | -2.5310 | 536.1111111 | 41.7190 |
| 10/31/06 | 19:51:00 | 52.2570 | 0.7720 | -2.5310 | 536.1111111 | 41.7880 |
| 10/31/06 | 19:52:00 | 52.2570 | 0.7720 | -2.5310 | 536.1111111 | 41.7880 |
| 10/31/06 | 19:53:00 | 52.3610 | 0.7710 | -2.5310 | 535.4166667 | 41.8920 |
| 10/31/06 | 19:54:00 | 52.2920 | 0.7720 | -2.5310 | 536.1111111 | 41.8230 |
| 10/31/06 | 19:55:00 | 52.2920 | 0.7720 | -2.5310 | 536.1111111 | 41.8230 |
| 10/31/06 | 19:56:00 | 52.2220 | 0.7720 | -2.5310 | 536.1111111 | 41.7530 |
| 10/31/06 | 19:57:00 | 52.2220 | 0.7720 | -2.5310 | 536.1111111 | 41.7530 |
| 10/31/06 | 19:58:00 | 52.2570 | 0.7730 | -2.5310 | 536.8055556 | 41.7880 |
| 10/31/06 | 19:59:00 | 52.2570 | 0.7730 | -2.5310 | 536.8055556 | 41.7880 |
| 10/31/06 | 20:00:00 | 52.2920 | 0.7720 | -2.5400 | 536.1111111 | 41.8320 |
| 10/31/06 | 20:01:00 | 52.2920 | 0.7740 | -2.5580 | 537.5 | 41.8500 |
| 10/31/06 | 20:02:00 | 52.2920 | 0.7740 | -2.5580 | 537.5 | 41.8500 |
| 10/31/06 | 20:03:00 | 52.3610 | 0.7720 | -2.5760 | 536.1111111 | 41.9370 |
| 10/31/06 | 20:04:00 | 52.3610 | 0.7720 | -2.5760 | 536.1111111 | 41.9370 |
| 10/31/06 | 20:05:00 | 52.3270 | 0.7720 | -2.5850 | 536.1111111 | 41.9120 |
| 10/31/06 | 20:06:00 | 52.3270 | 0.7720 | -2.5850 | 536.1111111 | 41.9120 |
| 10/31/06 | 20:07:00 | 52.2570 | 0.7720 | -2.5940 | 536.1111111 | 41.8510 |
| 10/31/06 | 20:08:00 | 52.0140 | 0.7710 | -2.6120 | 535.4166667 | 41.6260 |
| 10/31/06 | 20:09:00 | 52.0140 | 0.7710 | -2.6120 | 535.4166667 | 41.6260 |
| 10/31/06 | 20:10:00 | 52.0490 | 0.7700 | -2.6210 | 534.7222222 | 41.6700 |
| 10/31/06 | 20:11:00 | 52.1530 | 0.7720 | -2.6120 | 536.1111111 | 41.7650 |
| 10/31/06 | 20:12:00 | 52.1530 | 0.7720 | -2.6120 | 536.1111111 | 41.7650 |
| 10/31/06 | 20:13:00 | 52.2570 | 0.7720 | -2.6210 | 536.1111111 | 41.8780 |
| 10/31/06 | 20:14:00 | 51.9450 | 0.7710 | -2.6390 | 535.4166667 | 41.5840 |
| 10/31/06 | 20:15:00 | 51.9450 | 0.7710 | -2.6390 | 535.4166667 | 41.5840 |
| 10/31/06 | 20:16:00 | 52.0490 | 0.7720 | -2.6390 | 536.1111111 | 41.6880 |
| 10/31/06 | 20:17:00 | 51.9790 | 0.7720 | -2.6390 | 536.1111111 | 41.6180 |
| 10/31/06 | 20:18:00 | 51.9790 | 0.7720 | -2.6480 | 536.1111111 | 41.6270 |
| 10/31/06 | 20:19:00 | 51.9790 | 0.7720 | -2.6480 | 536.1111111 | 41.6270 |
| 10/31/06 | 20:20:00 | 51.9790 | 0.7730 | -2.6390 | 536.8055556 | 41.6180 |
| 10/31/06 | 20:21:00 | 51.9790 | 0.7730 | -2.6390 | 536.8055556 | 41.6180 |
| 10/31/06 | 20:22:00 | 52.0490 | 0.7740 | -2.6480 | 537.5 | 41.6970 |
| 10/31/06 | 20:23:00 | 52.1180 | 0.7730 | -2.6760 | 536.8055556 | 41.7940 |
| 10/31/06 | 20:24:00 | 52.1180 | 0.7730 | -2.6760 | 536.8055556 | 41.7940 |
| 10/31/06 | 20:25:00 | 52.1880 | 0.7720 | -2.6670 | 536.1111111 | 41.8550 |
| 10/31/06 | 20:26:00 | 52.1880 | 0.7720 | -2.6670 | 536.1111111 | 41.8550 |
| 10/31/06 | 20:27:00 | 52.0140 | 0.7720 | -2.6760 | 536.1111111 | 41.6900 |
| 10/31/06 | 20:28:00 | 52.0140 | 0.7720 | -2.6760 | 536.1111111 | 41.6900 |
| 10/31/06 | 20:29:00 | 52.1180 | 0.7720 | -2.7030 | 536.1111111 | 41.8210 |
| 10/31/06 | 20:30:00 | 52.1530 | 0.7720 | -2.7030 | 536.1111111 | 41.8560 |
| 10/31/06 | 20:31:00 | 52.1180 | 0.7740 | -2.7030 | 537.5 | 41.8210 |
| 10/31/06 | 20:32:00 | 52.1180 | 0.7740 | -2.7030 | 537.5 | 41.8210 |
| 10/31/06 | 20:33:00 | 52.1880 | 0.7730 | -2.7210 | 536.8055556 | 41.9090 |
| 10/31/06 | 20:34:00 | 52.1880 | 0.7730 | -2.7210 | 536.8055556 | 41.9090 |
| 10/31/06 | 20:35:00 | 52.1180 | 0.7720 | -2.7300 | 536.1111111 | 41.8480 |
| 10/31/06 | 20:36:00 | 52.1180 | 0.7720 | -2.7300 | 536.1111111 | 41.8480 |
| 10/31/06 | 20:37:00 | 51.9790 | 0.7740 | -2.7300 | 537.5 | 41.7090 |
| 10/31/06 | 20:38:00 | 51.9790 | 0.7740 | -2.7300 | 537.5 | 41.7090 |
| 10/31/06 | 20:39:00 | 51.8750 | 0.7700 | -2.7300 | 534.7222222 | 41.6050 |
| 10/31/06 | 20:40:00 | 52.0490 | 0.7710 | -2.7300 | 535.4166667 | 41.7790 |
| 10/31/06 | 20:41:00 | 52.0490 | 0.7710 | -2.7300 | 535.4166667 | 41.7790 |
| 10/31/06 | 20:42:00 | 52.2570 | 0.7720 | -2.7390 | 536.1111111 | 41.9960 |
| 10/31/06 | 20:43:00 | 52.2570 | 0.7720 | -2.7390 | 536.1111111 | 41.9960 |
| 10/31/06 | 20:44:00 | 52.3610 | 0.7720 | -2.7390 | 536.1111111 | 42.1000 |
| 10/31/06 | 20:45:00 | 52.3610 | 0.7720 | -2.7300 | 536.1111111 | 42.0910 |
| 10/31/06 | 20:46:00 | 52.3610 | 0.7720 | -2.7300 | 536.1111111 | 42.0910 |
| 10/31/06 | 20:47:00 | 52.3270 | 0.7750 | -2.7300 | 538.1944444 | 42.0570 |
| 10/31/06 | 20:48:00 | 52.4660 | 0.7730 | -2.7300 | 536.8055556 | 42.1960 |
| 10/31/06 | 20:49:00 | 52.4660 | 0.7730 | -2.7300 | 536.8055556 | 42.1960 |
| 10/31/06 | 20:50:00 | 52.0840 | 0.7710 | -2.7300 | 535.4166667 | 41.8140 |
| 10/31/06 | 20:51:00 | 52.0840 | 0.7710 | -2.7300 | 535.4166667 | 41.8140 |
| 10/31/06 | 20:52:00 | 52.2920 | 0.7730 | -2.7390 | 536.8055556 | 42.0310 |
| 10/31/06 | 20:53:00 | 52.2920 | 0.7730 | -2.7390 | 536.8055556 | 42.0310 |
| 10/31/06 | 20:54:00 | 52.1880 | 0.7720 | -2.7480 | 536.1111111 | 41.9360 |
| 10/31/06 | 20:55:00 | 52.0840 | 0.7730 | -2.7570 | 536.8055556 | 41.8410 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 20:56:00 | 52.0840 | 0.7730 | -2.7570 | 536.8055556 | 41.8410 |
| 10/31/06 | 20:57:00 | 52.0840 | 0.7720 | -2.7570 | 536.1111111 | 41.8410 |
| 10/31/06 | 20:58:00 | 52.0840 | 0.7720 | -2.7570 | 536.1111111 | 41.8410 |
| 10/31/06 | 20:59:00 | 52.1180 | 0.7760 | -2.7750 | 538.8888889 | 41.8930 |
| 10/31/06 | 21:00:00 | 52.2220 | 0.7750 | -2.7750 | 538.1944444 | 41.9970 |
| 10/31/06 | 21:01:00 | 52.2220 | 0.7750 | -2.7840 | 538.1944444 | 42.0060 |
| 10/31/06 | 21:02:00 | 52.0840 | 0.7720 | -2.7840 | 536.1111111 | 41.8680 |
| 10/31/06 | 21:03:00 | 52.0840 | 0.7720 | -2.7840 | 536.1111111 | 41.8680 |
| 10/31/06 | 21:04:00 | 52.0840 | 0.7720 | -2.7840 | 536.1111111 | 41.8680 |
| 10/31/06 | 21:05:00 | 52.0840 | 0.7720 | -2.7840 | 536.1111111 | 41.8680 |
| 10/31/06 | 21:06:00 | 52.0840 | 0.7720 | -2.7840 | 536.1111111 | 41.8680 |
| 10/31/06 | 21:07:00 | 51.9790 | 0.7720 | -2.7840 | 536.1111111 | 41.7630 |
| 10/31/06 | 21:08:00 | 52.0490 | 0.7710 | -2.7840 | 535.4166667 | 41.8330 |
| 10/31/06 | 21:09:00 | 52.0490 | 0.7710 | -2.7840 | 535.4166667 | 41.8330 |
| 10/31/06 | 21:10:00 | 52.0140 | 0.7740 | -2.7840 | 537.5 | 41.7980 |
| 10/31/06 | 21:11:00 | 52.0140 | 0.7740 | -2.7840 | 537.5 | 41.7980 |
| 10/31/06 | 21:12:00 | 52.2570 | 0.7720 | -2.7930 | 536.1111111 | 42.0500 |
| 10/31/06 | 21:13:00 | 52.1180 | 0.7710 | -2.8110 | 535.4166667 | 41.9290 |
| 10/31/06 | 21:14:00 | 52.1180 | 0.7710 | -2.8110 | 535.4166667 | 41.9290 |
| 10/31/06 | 21:15:00 | 52.0140 | 0.7750 | -2.8110 | 538.1944444 | 41.8250 |
| 10/31/06 | 21:16:00 | 52.0140 | 0.7750 | -2.8110 | 538.1944444 | 41.8250 |
| 10/31/06 | 21:17:00 | 52.2920 | 0.7740 | -2.8110 | 537.5 | 42.1030 |
| 10/31/06 | 21:18:00 | 52.0490 | 0.7740 | -2.8200 | 537.5 | 41.8690 |
| 10/31/06 | 21:19:00 | 52.0490 | 0.7740 | -2.8200 | 537.5 | 41.8690 |
| 10/31/06 | 21:20:00 | 52.1180 | 0.7730 | -2.8380 | 536.8055556 | 41.9560 |
| 10/31/06 | 21:21:00 | 52.1180 | 0.7730 | -2.8380 | 536.8055556 | 41.9560 |
| 10/31/06 | 21:22:00 | 52.1180 | 0.7740 | -2.8380 | 537.5 | 41.9560 |
| 10/31/06 | 21:23:00 | 52.0840 | 0.7740 | -2.8380 | 537.5 | 41.9220 |
| 10/31/06 | 21:24:00 | 52.0840 | 0.7740 | -2.8380 | 537.5 | 41.9220 |
| 10/31/06 | 21:25:00 | 52.0490 | 0.7730 | -2.8560 | 536.8055556 | 41.9050 |
| 10/31/06 | 21:26:00 | 52.0490 | 0.7730 | -2.8560 | 536.8055556 | 41.9050 |
| 10/31/06 | 21:27:00 | 52.0140 | 0.7740 | -2.8650 | 537.5 | 41.8790 |
| 10/31/06 | 21:28:00 | 52.0140 | 0.7730 | -2.8650 | 536.8055556 | 41.8790 |
| 10/31/06 | 21:29:00 | 52.0140 | 0.7730 | -2.8650 | 536.8055556 | 41.8790 |
| 10/31/06 | 21:30:00 | 51.9790 | 0.7740 | -2.8650 | 537.5 | 41.8440 |
| 10/31/06 | 21:31:00 | 52.1880 | 0.7730 | -2.8650 | 536.8055556 | 42.0530 |
| 10/31/06 | 21:32:00 | 52.1880 | 0.7730 | -2.8650 | 536.8055556 | 42.0530 |
| 10/31/06 | 21:33:00 | 51.9450 | 0.7750 | -2.8740 | 538.1944444 | 41.8190 |
| 10/31/06 | 21:34:00 | 51.9450 | 0.7750 | -2.8740 | 538.1944444 | 41.8190 |
| 10/31/06 | 21:35:00 | 52.0490 | 0.7740 | -2.8740 | 537.5 | 41.9230 |
| 10/31/06 | 21:36:00 | 52.0490 | 0.7740 | -2.8740 | 537.5 | 41.9230 |
| 10/31/06 | 21:37:00 | 52.1530 | 0.7750 | -2.8740 | 538.1944444 | 42.0270 |
| 10/31/06 | 21:38:00 | 52.1530 | 0.7750 | -2.8740 | 538.1944444 | 42.0270 |
| 10/31/06 | 21:39:00 | 52.2220 | 0.7740 | -2.8830 | 537.5 | 42.1050 |
| 10/31/06 | 21:40:00 | 52.2220 | 0.7740 | -2.8830 | 537.5 | 42.1050 |
| 10/31/06 | 21:41:00 | 52.1180 | 0.7730 | -2.8920 | 536.8055556 | 42.0100 |
| 10/31/06 | 21:42:00 | 51.9790 | 0.7730 | -2.8920 | 536.8055556 | 41.8710 |
| 10/31/06 | 21:43:00 | 51.9790 | 0.7730 | -2.8920 | 536.8055556 | 41.8710 |
| 10/31/06 | 21:44:00 | 52.1180 | 0.7740 | -2.9010 | 537.5 | 42.0190 |
| 10/31/06 | 21:45:00 | 51.8750 | 0.7720 | -2.8920 | 536.1111111 | 41.7670 |
| 10/31/06 | 21:46:00 | 51.8750 | 0.7720 | -2.8920 | 536.1111111 | 41.7670 |
| 10/31/06 | 21:47:00 | 51.9790 | 0.7740 | -2.8920 | 537.5 | 41.8710 |
| 10/31/06 | 21:48:00 | 51.9790 | 0.7740 | -2.8920 | 537.5 | 41.8710 |
| 10/31/06 | 21:49:00 | 52.0490 | 0.7740 | -2.9100 | 537.5 | 41.9590 |
| 10/31/06 | 21:50:00 | 51.9790 | 0.7740 | -2.9190 | 537.5 | 41.8980 |
| 10/31/06 | 21:51:00 | 51.9790 | 0.7740 | -2.9190 | 537.5 | 41.8980 |
| 10/31/06 | 21:52:00 | 52.1180 | 0.7740 | -2.9190 | 537.5 | 42.0370 |
| 10/31/06 | 21:53:00 | 52.1180 | 0.7740 | -2.9190 | 537.5 | 42.0370 |
| 10/31/06 | 21:54:00 | 51.9100 | 0.7760 | -2.9280 | 538.8888889 | 41.8380 |
| 10/31/06 | 21:55:00 | 51.9100 | 0.7760 | -2.9280 | 538.8888889 | 41.8380 |
| 10/31/06 | 21:56:00 | 51.9450 | 0.7750 | -2.9190 | 538.1944444 | 41.8640 |
| 10/31/06 | 21:57:00 | 51.9450 | 0.7750 | -2.9190 | 538.1944444 | 41.8640 |
| 10/31/06 | 21:58:00 | 51.8410 | 0.7730 | -2.9190 | 536.8055556 | 41.7600 |
| 10/31/06 | 21:59:00 | 51.9100 | 0.7730 | -2.9190 | 536.8055556 | 41.8290 |
| 10/31/06 | 22:00:00 | 51.9100 | 0.7730 | -2.9190 | 536.8055556 | 41.8290 |
| 10/31/06 | 22:01:00 | 51.8750 | 0.7740 | -2.9190 | 537.5 | 41.7940 |
| 10/31/06 | 22:02:00 | 52.1880 | 0.7780 | -2.9190 | 540.2777778 | 42.1070 |
| 10/31/06 | 22:03:00 | 52.1880 | 0.7780 | -2.9190 | 540.2777778 | 42.1070 |
| 10/31/06 | 22:04:00 | 52.1880 | 0.7780 | -2.9190 | 540.2777778 | 42.1070 |
| 10/31/06 | 22:05:00 | 52.0840 | 0.7780 | -2.9280 | 540.2777778 | 42.0120 |
| 10/31/06 | 22:06:00 | 52.2920 | 0.7790 | -2.9190 | 540.9722222 | 42.2110 |
| 10/31/06 | 22:07:00 | 52.2920 | 0.7790 | -2.9190 | 540.9722222 | 42.2110 |
| 10/31/06 | 22:08:00 | 52.2220 | 0.7760 | -2.9190 | 538.8888889 | 42.1410 |
| 10/31/06 | 22:09:00 | 52.2220 | 0.7760 | -2.9190 | 538.8888889 | 42.1410 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 10/31/06 | 22:10:00 | 52.0140 | 0.7750 | -2.9190 | 538.1944444 | 41.9330 |
| 10/31/06 | 22:11:00 | 52.0140 | 0.7750 | -2.9190 | 538.1944444 | 41.9330 |
| 10/31/06 | 22:12:00 | 51.8750 | 0.7750 | -2.9190 | 538.1944444 | 41.7940 |
| 10/31/06 | 22:13:00 | 51.7020 | 0.7740 | -2.9280 | 537.5 | 41.6300 |
| 10/31/06 | 22:14:00 | 51.7020 | 0.7740 | -2.9280 | 537.5 | 41.6300 |
| 10/31/06 | 22:15:00 | 51.9100 | 0.7750 | -2.9550 | 538.1944444 | 41.8650 |
| 10/31/06 | 22:16:00 | 52.0140 | 0.7740 | -2.9460 | 537.5 | 41.9600 |
| 10/31/06 | 22:17:00 | 52.0140 | 0.7740 | -2.9460 | 537.5 | 41.9600 |
| 10/31/06 | 22:18:00 | 51.8750 | 0.7730 | -2.9460 | 536.8055556 | 41.8210 |
| 10/31/06 | 22:19:00 | 51.8750 | 0.7730 | -2.9460 | 536.8055556 | 41.8210 |
| 10/31/06 | 22:20:00 | 51.5970 | 0.7710 | -2.9460 | 535.4166667 | 41.5430 |
| 10/31/06 | 22:21:00 | 51.5970 | 0.7710 | -2.9460 | 535.4166667 | 41.5430 |
| 10/31/06 | 22:22:00 | 51.9100 | 0.7740 | -2.9550 | 537.5 | 41.8650 |
| 10/31/06 | 22:23:00 | 51.9100 | 0.7740 | -2.9550 | 537.5 | 41.8650 |
| 10/31/06 | 22:24:00 | 51.5970 | 0.7720 | -2.9820 | 536.1111111 | 41.5790 |
| 10/31/06 | 22:25:00 | 51.5280 | 0.7700 | -2.9730 | 534.7222222 | 41.5010 |
| 10/31/06 | 22:26:00 | 51.5280 | 0.7700 | -2.9730 | 534.7222222 | 41.5010 |
| 10/31/06 | 22:27:00 | 51.5970 | 0.7710 | -2.9820 | 535.4166667 | 41.5790 |
| 10/31/06 | 22:28:00 | 51.5970 | 0.7710 | -2.9820 | 535.4166667 | 41.5790 |
| 10/31/06 | 22:29:00 | 51.5630 | 0.7700 | -2.9820 | 534.7222222 | 41.5450 |
| 10/31/06 | 22:30:00 | 51.4240 | 0.7710 | -2.9820 | 535.4166667 | 41.4060 |
| 10/31/06 | 22:31:00 | 51.4240 | 0.7710 | -2.9820 | 535.4166667 | 41.4060 |
| 10/31/06 | 22:32:00 | 51.4240 | 0.7730 | -2.9920 | 536.8055556 | 41.4160 |
| 10/31/06 | 22:33:00 | 51.5280 | 0.7720 | -3.0100 | 536.1111111 | 41.5380 |
| 10/31/06 | 22:34:00 | 51.5280 | 0.7720 | -3.0100 | 536.1111111 | 41.5380 |
| 10/31/06 | 22:35:00 | 51.6670 | 0.7740 | -3.0010 | 537.5 | 41.6680 |
| 10/31/06 | 22:36:00 | 51.6670 | 0.7740 | -3.0010 | 537.5 | 41.6680 |
| 10/31/06 | 22:37:00 | 51.4590 | 0.7720 | -3.0100 | 536.1111111 | 41.4690 |
| 10/31/06 | 22:38:00 | 51.4590 | 0.7720 | -3.0100 | 536.1111111 | 41.4690 |
| 10/31/06 | 22:39:00 | 51.4240 | 0.7730 | -3.0100 | 536.8055556 | 41.4340 |
| 10/31/06 | 22:40:00 | 51.4240 | 0.7730 | -3.0100 | 536.8055556 | 41.4340 |
| 10/31/06 | 22:41:00 | 51.3890 | 0.7720 | -3.0280 | 536.1111111 | 41.4170 |
| 10/31/06 | 22:42:00 | 51.4240 | 0.7730 | -3.0370 | 536.8055556 | 41.4610 |
| 10/31/06 | 22:43:00 | 51.4240 | 0.7730 | -3.0370 | 536.8055556 | 41.4610 |
| 10/31/06 | 22:44:00 | 51.6320 | 0.7740 | -3.0370 | 537.5 | 41.6690 |
| 10/31/06 | 22:45:00 | 51.7360 | 0.7730 | -3.0550 | 536.8055556 | 41.7910 |
| 10/31/06 | 22:46:00 | 51.7360 | 0.7730 | -3.0550 | 536.8055556 | 41.7910 |
| 10/31/06 | 22:47:00 | 51.7360 | 0.7740 | -3.0640 | 537.5 | 41.8000 |
| 10/31/06 | 22:48:00 | 51.7360 | 0.7740 | -3.0640 | 537.5 | 41.8000 |
| 10/31/06 | 22:49:00 | 51.4930 | 0.7720 | -3.0640 | 536.1111111 | 41.5570 |
| 10/31/06 | 22:50:00 | 51.3890 | 0.7700 | -3.0640 | 534.7222222 | 41.4530 |
| 10/31/06 | 22:51:00 | 51.3890 | 0.7700 | -3.0640 | 534.7222222 | 41.4530 |
| 10/31/06 | 22:52:00 | 51.5280 | 0.7710 | -3.0910 | 535.4166667 | 41.6190 |
| 10/31/06 | 22:53:00 | 51.5280 | 0.7710 | -3.0910 | 535.4166667 | 41.6190 |
| 10/31/06 | 22:54:00 | 51.5970 | 0.7720 | -3.0910 | 536.1111111 | 41.6880 |
| 10/31/06 | 22:55:00 | 51.5970 | 0.7720 | -3.0910 | 536.1111111 | 41.6880 |
| 10/31/06 | 22:56:00 | 51.7360 | 0.7730 | -3.0910 | 536.8055556 | 41.8270 |
| 10/31/06 | 22:57:00 | 51.7360 | 0.7730 | -3.0910 | 536.8055556 | 41.8270 |
| 10/31/06 | 22:58:00 | 50.3470 | 0.7760 | -3.0910 | 538.8888889 | 40.4380 |
| 10/31/06 | 22:59:00 | 50.5910 | 0.7750 | -3.0910 | 538.1944444 | 40.6820 |
| 10/31/06 | 23:00:00 | 50.5910 | 0.7750 | -3.0910 | 538.1944444 | 40.6820 |
| 10/31/06 | 23:01:00 | 50.3820 | 0.7730 | -3.0910 | 536.8055556 | 40.4730 |
| 10/31/06 | 23:02:00 | 50.3820 | 0.7730 | -3.0910 | 536.8055556 | 40.4730 |
| 10/31/06 | 23:03:00 | 50.4170 | 0.7720 | -3.1180 | 536.1111111 | 40.5350 |
| 10/31/06 | 23:04:00 | 50.4170 | 0.7720 | -3.1180 | 536.1111111 | 40.5350 |
| 10/31/06 | 23:05:00 | 50.6950 | 0.7740 | -3.1180 | 537.5 | 40.8130 |
| 10/31/06 | 23:06:00 | 50.6950 | 0.7740 | -3.1180 | 537.5 | 40.8130 |
| 10/31/06 | 23:07:00 | 50.6250 | 0.7740 | -3.1180 | 537.5 | 40.7430 |
| 10/31/06 | 23:08:00 | 50.7990 | 0.7740 | -3.1180 | 537.5 | 40.9170 |
| 10/31/06 | 23:09:00 | 50.7990 | 0.7740 | -3.1180 | 537.5 | 40.9170 |
| 10/31/06 | 23:10:00 | 50.7990 | 0.7730 | -3.1270 | 536.8055556 | 40.9260 |
| 10/31/06 | 23:11:00 | 50.7990 | 0.7730 | -3.1270 | 536.8055556 | 40.9260 |
| 10/31/06 | 23:12:00 | 50.7990 | 0.7750 | -3.1450 | 538.1944444 | 40.9440 |
| 10/31/06 | 23:13:00 | 50.7290 | 0.7750 | -3.1450 | 538.1944444 | 40.8740 |
| 10/31/06 | 23:14:00 | 50.7290 | 0.7750 | -3.1450 | 538.1944444 | 40.8740 |
| 10/31/06 | 23:15:00 | 50.6250 | 0.7750 | -3.1450 | 538.1944444 | 40.7700 |
| 10/31/06 | 23:16:00 | 50.6250 | 0.7750 | -3.1450 | 538.1944444 | 40.7700 |
| 10/31/06 | 23:17:00 | 50.6250 | 0.7740 | -3.1450 | 537.5 | 40.7700 |
| 10/31/06 | 23:18:00 | 50.9030 | 0.7740 | -3.1450 | 537.5 | 41.0480 |
| 10/31/06 | 23:19:00 | 50.9030 | 0.7740 | -3.1450 | 537.5 | 41.0480 |
| 10/31/06 | 23:20:00 | 50.9030 | 0.7740 | -3.1450 | 537.5 | 41.0480 |
| 10/31/06 | 23:21:00 | 50.7290 | 0.7740 | -3.1450 | 537.5 | 40.8740 |
| 10/31/06 | 23:22:00 | 50.7640 | 0.7740 | -3.1450 | 537.5 | 40.9090 |
| 10/31/06 | 23:23:00 | 50.7640 | 0.7740 | -3.1450 | 537.5 | 40.9090 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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| 10/31/06 | 23:24:00 | 50.9720 | 0.7760 | -3.1450 | 538.8888889 | 41.1170 |
| 10/31/06 | 23:25:00 | 50.9720 | 0.7760 | -3.1450 | 538.8888889 | 41.1170 |
| 10/31/06 | 23:26:00 | 50.7990 | 0.7760 | -3.1450 | 538.8888889 | 40.9440 |
| 10/31/06 | 23:27:00 | 50.8340 | 0.7770 | -3.1450 | 539.5833333 | 40.9790 |
| 10/31/06 | 23:28:00 | 50.8340 | 0.7770 | -3.1450 | 539.5833333 | 40.9790 |
| 10/31/06 | 23:29:00 | 50.7990 | 0.7760 | -3.1540 | 538.8888889 | 40.9530 |
| 10/31/06 | 23:30:00 | 51.0070 | 0.7770 | -3.1720 | 539.5833333 | 41.1790 |
| 10/31/06 | 23:31:00 | 51.0070 | 0.7770 | -3.1720 | 539.5833333 | 41.1790 |
| 10/31/06 | 23:32:00 | 50.7990 | 0.7760 | -3.1720 | 538.8888889 | 40.9710 |
| 10/31/06 | 23:33:00 | 50.7990 | 0.7760 | -3.1720 | 538.8888889 | 40.9710 |
| 10/31/06 | 23:34:00 | 50.7990 | 0.7760 | -3.1720 | 538.8888889 | 40.9710 |
| 10/31/06 | 23:35:00 | 50.7640 | 0.7760 | -3.1720 | 538.8888889 | 40.9360 |
| 10/31/06 | 23:36:00 | 50.7640 | 0.7760 | -3.1720 | 538.8888889 | 40.9360 |
| 10/31/06 | 23:37:00 | 50.6600 | 0.7740 | -3.1810 | 537.5 | 40.8410 |
| 10/31/06 | 23:38:00 | 50.6600 | 0.7740 | -3.1810 | 537.5 | 40.8410 |
| 10/31/06 | 23:39:00 | 50.8340 | 0.7730 | -3.1810 | 536.8055556 | 41.0150 |
| 10/31/06 | 23:40:00 | 50.8340 | 0.7730 | -3.1810 | 536.8055556 | 41.0150 |
| 10/31/06 | 23:41:00 | 50.7290 | 0.7740 | -3.1990 | 537.5 | 40.9280 |
| 10/31/06 | 23:42:00 | 50.6950 | 0.7750 | -3.1990 | 538.1944444 | 40.8940 |
| 10/31/06 | 23:43:00 | 50.6950 | 0.7750 | -3.1990 | 538.1944444 | 40.8940 |
| 10/31/06 | 23:44:00 | 50.8680 | 0.7760 | -3.1990 | 538.8888889 | 41.0670 |
| 10/31/06 | 23:45:00 | 50.8340 | 0.7750 | -3.1990 | 538.1944444 | 41.0330 |
| 10/31/06 | 23:46:00 | 50.8340 | 0.7750 | -3.1990 | 538.1944444 | 41.0330 |
| 10/31/06 | 23:47:00 | 50.7290 | 0.7730 | -3.2170 | 536.8055556 | 40.9460 |
| 10/31/06 | 23:48:00 | 50.7290 | 0.7730 | -3.2170 | 536.8055556 | 40.9460 |
| 10/31/06 | 23:49:00 | 50.6600 | 0.7730 | -3.2260 | 536.8055556 | 40.8860 |
| 10/31/06 | 23:50:00 | 50.7990 | 0.7740 | -3.2260 | 537.5 | 41.0250 |
| 10/31/06 | 23:51:00 | 50.7990 | 0.7740 | -3.2260 | 537.5 | 41.0250 |
| 10/31/06 | 23:52:00 | 50.7990 | 0.7750 | -3.2260 | 538.1944444 | 41.0250 |
| 10/31/06 | 23:53:00 | 50.7990 | 0.7750 | -3.2260 | 538.1944444 | 41.0250 |
| 10/31/06 | 23:54:00 | 50.9030 | 0.7740 | -3.2260 | 537.5 | 41.1290 |
| 10/31/06 | 23:55:00 | 50.9030 | 0.7740 | -3.2260 | 537.5 | 41.1290 |
| 10/31/06 | 23:56:00 | 50.8680 | 0.7750 | -3.2260 | 538.1944444 | 41.0940 |
| 10/31/06 | 23:57:00 | 50.8680 | 0.7750 | -3.2350 | 538.1944444 | 41.1030 |
| 10/31/06 | 23:58:00 | 50.8680 | 0.7750 | -3.2350 | 538.1944444 | 41.1030 |
| 10/31/06 | 23:59:00 | 50.8340 | 0.7750 | -3.2440 | 538.1944444 | 41.0780 |
| 11/01/06 | 00:00:00 | 50.8340 | 0.7750 | -3.2440 | 538.1944444 | 41.0780 |
| 11/01/06 | 00:01:00 | 50.8340 | 0.7750 | -3.2530 | 538.1944444 | 41.0870 |
| 11/01/06 | 00:02:00 | 50.7290 | 0.7750 | -3.2620 | 538.1944444 | 40.9910 |
| 11/01/06 | 00:03:00 | 50.7290 | 0.7750 | -3.2620 | 538.1944444 | 40.9910 |
| 11/01/06 | 00:04:00 | 50.9030 | 0.7760 | -3.2530 | 538.8888889 | 41.1560 |
| 11/01/06 | 00:05:00 | 50.9030 | 0.7760 | -3.2530 | 538.8888889 | 41.1560 |
| 11/01/06 | 00:06:00 | 50.8340 | 0.7750 | -3.2530 | 538.1944444 | 41.0870 |
| 11/01/06 | 00:07:00 | 50.8340 | 0.7750 | -3.2530 | 538.1944444 | 41.0870 |
| 11/01/06 | 00:08:00 | 50.9720 | 0.7760 | -3.2530 | 538.8888889 | 41.2250 |
| 11/01/06 | 00:09:00 | 50.9380 | 0.7750 | -3.2620 | 538.1944444 | 41.2000 |
| 11/01/06 | 00:10:00 | 50.9380 | 0.7750 | -3.2620 | 538.1944444 | 41.2000 |
| 11/01/06 | 00:11:00 | 33.1950 | 0.5390 | -12.9670 | 374.3055556 | 33.1620 |
| 11/01/06 | 00:12:00 | 50.9380 | 0.7750 | -3.2620 | 538.1944444 | 41.2000 |
| 11/01/06 | 00:13:00 | 50.9380 | 0.7750 | -3.2620 | 538.1944444 | 41.2000 |
| 11/01/06 | 00:14:00 | 50.9030 | 0.7760 | -3.2890 | 538.8888889 | 41.1920 |
| 11/01/06 | 00:15:00 | 50.9030 | 0.7750 | -3.2890 | 538.1944444 | 41.1920 |
| 11/01/06 | 00:16:00 | 50.9030 | 0.7750 | -3.2890 | 538.1944444 | 41.1920 |
| 11/01/06 | 00:17:00 | 50.9030 | 0.7750 | -3.2890 | 538.1944444 | 41.1920 |
| 11/01/06 | 00:18:00 | 50.9030 | 0.7750 | -3.2890 | 538.1944444 | 41.1920 |
| 11/01/06 | 00:19:00 | 50.9380 | 0.7760 | -3.2980 | 538.8888889 | 41.2360 |
| 11/01/06 | 00:20:00 | 50.9380 | 0.7760 | -3.2980 | 538.8888889 | 41.2360 |
| 11/01/06 | 00:21:00 | 50.9030 | 0.7750 | -3.3070 | 538.1944444 | 41.2100 |
| 11/01/06 | 00:22:00 | 50.9720 | 0.7760 | -3.3070 | 538.8888889 | 41.2790 |
| 11/01/06 | 00:23:00 | 50.9720 | 0.7760 | -3.3070 | 538.8888889 | 41.2790 |
| 11/01/06 | 00:24:00 | 51.0420 | 0.7770 | -3.3070 | 539.5833333 | 41.3490 |
| 11/01/06 | 00:25:00 | 51.0420 | 0.7770 | -3.3070 | 539.5833333 | 41.3490 |
| 11/01/06 | 00:26:00 | 50.7990 | 0.7760 | -3.3170 | 538.8888889 | 41.1160 |
| 11/01/06 | 00:27:00 | 50.9380 | 0.7770 | -3.3170 | 539.5833333 | 41.2550 |
| 11/01/06 | 00:28:00 | 50.9380 | 0.7770 | -3.3170 | 539.5833333 | 41.2550 |
| 11/01/06 | 00:29:00 | 50.9380 | 0.7760 | -3.3260 | 538.8888889 | 41.2640 |
| 11/01/06 | 00:30:00 | 50.8340 | 0.7760 | -3.3440 | 538.8888889 | 41.1780 |
| 11/01/06 | 00:31:00 | 50.8340 | 0.7760 | -3.3440 | 538.8888889 | 41.1780 |
| 11/01/06 | 00:32:00 | 50.7290 | 0.7760 | -3.3440 | 538.8888889 | 41.0730 |
| 11/01/06 | 00:33:00 | 50.9030 | 0.7750 | -3.3440 | 538.1944444 | 41.2470 |
| 11/01/06 | 00:34:00 | 50.9030 | 0.7750 | -3.3440 | 538.1944444 | 41.2470 |
| 11/01/06 | 00:35:00 | 50.9380 | 0.7770 | -3.3440 | 539.5833333 | 41.2820 |
| 11/01/06 | 00:36:00 | 50.9380 | 0.7770 | -3.3440 | 539.5833333 | 41.2820 |
| 11/01/06 | 00:37:00 | 50.7990 | 0.7750 | -3.3440 | 538.1944444 | 41.1430 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 00:38:00 | 50.7990 | 0.7750 | -3.3440 | 538.1944444 | 41.1430 |
| 11/01/06 | 00:39:00 | 50.7990 | 0.7740 | -3.3620 | 537.5 | 41.1610 |
| 11/01/06 | 00:40:00 | 50.9380 | 0.7770 | -3.3710 | 539.5833333 | 41.3090 |
| 11/01/06 | 00:41:00 | 50.9380 | 0.7770 | -3.3710 | 539.5833333 | 41.3090 |
| 11/01/06 | 00:42:00 | 50.7290 | 0.7770 | -3.3710 | 539.5833333 | 41.1000 |
| 11/01/06 | 00:43:00 | 50.7290 | 0.7770 | -3.3710 | 539.5833333 | 41.1000 |
| 11/01/06 | 00:44:00 | 50.7990 | 0.7750 | -3.3710 | 538.1944444 | 41.1700 |
| 11/01/06 | 00:45:00 | 50.9720 | 0.7750 | -3.3710 | 538.1944444 | 41.3430 |
| 11/01/06 | 00:46:00 | 50.9720 | 0.7750 | -3.3710 | 538.1944444 | 41.3430 |
| 11/01/06 | 00:47:00 | 50.6950 | 0.7770 | -3.3800 | 539.5833333 | 41.0750 |
| 11/01/06 | 00:48:00 | 50.7990 | 0.7760 | -3.3980 | 538.8888889 | 41.1970 |
| 11/01/06 | 00:49:00 | 50.7990 | 0.7760 | -3.3980 | 538.8888889 | 41.1970 |
| 11/01/06 | 00:50:00 | 50.7640 | 0.7760 | -3.3980 | 538.8888889 | 41.1620 |
| 11/01/06 | 00:51:00 | 50.7640 | 0.7760 | -3.3980 | 538.8888889 | 41.1620 |
| 11/01/06 | 00:52:00 | 50.8340 | 0.7770 | -3.3980 | 539.5833333 | 41.2320 |
| 11/01/06 | 00:53:00 | 50.8340 | 0.7770 | -3.3980 | 539.5833333 | 41.2320 |
| 11/01/06 | 00:54:00 | 50.7640 | 0.7760 | -3.3980 | 538.8888889 | 41.1620 |
| 11/01/06 | 00:55:00 | 50.7640 | 0.7760 | -3.3980 | 538.8888889 | 41.1620 |
| 11/01/06 | 00:56:00 | 51.0070 | 0.7770 | -3.3980 | 539.5833333 | 41.4050 |
| 11/01/06 | 00:57:00 | 50.5910 | 0.7760 | -3.4070 | 538.8888889 | 40.9980 |
| 11/01/06 | 00:58:00 | 50.5910 | 0.7760 | -3.4070 | 538.8888889 | 40.9980 |
| 11/01/06 | 00:59:00 | 50.6950 | 0.7770 | -3.4160 | 539.5833333 | 41.1110 |
| 11/01/06 | 01:00:00 | 50.7640 | 0.7770 | -3.4250 | 539.5833333 | 41.1890 |
| 11/01/06 | 01:01:00 | 50.7640 | 0.7770 | -3.4250 | 539.5833333 | 41.1890 |
| 11/01/06 | 01:02:00 | 50.5560 | 0.7770 | -3.4250 | 539.5833333 | 40.9810 |
| 11/01/06 | 01:03:00 | 50.5560 | 0.7770 | -3.4250 | 539.5833333 | 40.9810 |
| 11/01/06 | 01:04:00 | 50.7290 | 0.7770 | -3.4250 | 539.5833333 | 41.1540 |
| 11/01/06 | 01:05:00 | 50.7290 | 0.7770 | -3.4250 | 539.5833333 | 41.1540 |
| 11/01/06 | 01:06:00 | 50.7640 | 0.7770 | -3.4250 | 539.5833333 | 41.1890 |
| 11/01/06 | 01:07:00 | 50.7640 | 0.7770 | -3.4250 | 539.5833333 | 41.1890 |
| 11/01/06 | 01:08:00 | 50.9030 | 0.7760 | -3.4250 | 538.8888889 | 41.3280 |
| 11/01/06 | 01:09:00 | 50.7990 | 0.7780 | -3.4250 | 540.2777778 | 41.2240 |
| 11/01/06 | 01:10:00 | 50.7990 | 0.7780 | -3.4250 | 540.2777778 | 41.2240 |
| 11/01/06 | 01:11:00 | 50.6950 | 0.7760 | -3.4340 | 538.8888889 | 41.1290 |
| 11/01/06 | 01:12:00 | 50.9380 | 0.7780 | -3.4340 | 540.2777778 | 41.3720 |
| 11/01/06 | 01:13:00 | 50.9380 | 0.7780 | -3.4340 | 540.2777778 | 41.3720 |
| 11/01/06 | 01:14:00 | 50.9380 | 0.7760 | -3.4520 | 538.8888889 | 41.3900 |
| 11/01/06 | 01:15:00 | 50.8680 | 0.7770 | -3.4520 | 539.5833333 | 41.3200 |
| 11/01/06 | 01:16:00 | 50.8680 | 0.7770 | -3.4520 | 539.5833333 | 41.3200 |
| 11/01/06 | 01:17:00 | 50.7640 | 0.7760 | -3.4520 | 538.8888889 | 41.2160 |
| 11/01/06 | 01:18:00 | 50.7640 | 0.7760 | -3.4520 | 538.8888889 | 41.2160 |
| 11/01/06 | 01:19:00 | 50.8340 | 0.7760 | -3.4520 | 538.8888889 | 41.2860 |
| 11/01/06 | 01:20:00 | 50.8340 | 0.7760 | -3.4520 | 538.8888889 | 41.2860 |
| 11/01/06 | 01:21:00 | 51.0070 | 0.7760 | -3.4520 | 538.8888889 | 41.4590 |
| 11/01/06 | 01:22:00 | 51.0070 | 0.7760 | -3.4520 | 538.8888889 | 41.4590 |
| 11/01/06 | 01:23:00 | 50.7990 | 0.7770 | -3.4520 | 539.5833333 | 41.2510 |
| 11/01/06 | 01:24:00 | 50.7990 | 0.7770 | -3.4520 | 539.5833333 | 41.2510 |
| 11/01/06 | 01:25:00 | 50.7640 | 0.7760 | -3.4520 | 538.8888889 | 41.2160 |
| 11/01/06 | 01:26:00 | 50.7290 | 0.7770 | -3.4700 | 539.5833333 | 41.1990 |
| 11/01/06 | 01:27:00 | 50.7290 | 0.7770 | -3.4700 | 539.5833333 | 41.1990 |
| 11/01/06 | 01:28:00 | 50.7640 | 0.7770 | -3.4790 | 539.5833333 | 41.2430 |
| 11/01/06 | 01:29:00 | 50.6950 | 0.7750 | -3.4790 | 538.1944444 | 41.1740 |
| 11/01/06 | 01:30:00 | 50.6950 | 0.7750 | -3.4790 | 538.1944444 | 41.1740 |
| 11/01/06 | 01:31:00 | 50.7640 | 0.7760 | -3.4790 | 538.8888889 | 41.2430 |
| 11/01/06 | 01:32:00 | 50.7640 | 0.7760 | -3.4790 | 538.8888889 | 41.2430 |
| 11/01/06 | 01:33:00 | 50.7290 | 0.7770 | -3.4790 | 539.5833333 | 41.2080 |
| 11/01/06 | 01:34:00 | 50.6600 | 0.7770 | -3.4790 | 539.5833333 | 41.1390 |
| 11/01/06 | 01:35:00 | 50.6600 | 0.7770 | -3.4790 | 539.5833333 | 41.1390 |
| 11/01/06 | 01:36:00 | 50.6600 | 0.7780 | -3.4790 | 540.2777778 | 41.1390 |
| 11/01/06 | 01:37:00 | 50.6600 | 0.7780 | -3.4790 | 540.2777778 | 41.1390 |
| 11/01/06 | 01:38:00 | 50.7990 | 0.7770 | -3.4970 | 539.5833333 | 41.2960 |
| 11/01/06 | 01:39:00 | 50.7990 | 0.7770 | -3.4970 | 539.5833333 | 41.2960 |
| 11/01/06 | 01:40:00 | 50.8340 | 0.7770 | -3.5060 | 539.5833333 | 41.3400 |
| 11/01/06 | 01:41:00 | 50.8680 | 0.7770 | -3.5060 | 539.5833333 | 41.3740 |
| 11/01/06 | 01:42:00 | 50.8680 | 0.7770 | -3.5060 | 539.5833333 | 41.3740 |
| 11/01/06 | 01:43:00 | 50.7290 | 0.7760 | -3.5150 | 538.8888889 | 41.2440 |
| 11/01/06 | 01:44:00 | 50.7640 | 0.7760 | -3.5150 | 538.8888889 | 41.2790 |
| 11/01/06 | 01:45:00 | 50.7640 | 0.7760 | -3.5150 | 538.8888889 | 41.2790 |
| 11/01/06 | 01:46:00 | 50.8680 | 0.7760 | -3.5240 | 538.8888889 | 41.3920 |
| 11/01/06 | 01:47:00 | 50.7640 | 0.7770 | -3.5330 | 539.5833333 | 41.2970 |
| 11/01/06 | 01:48:00 | 50.7640 | 0.7770 | -3.5330 | 539.5833333 | 41.2970 |
| 11/01/06 | 01:49:00 | 50.5210 | 0.7760 | -3.5330 | 538.8888889 | 41.0540 |
| 11/01/06 | 01:50:00 | 50.5210 | 0.7760 | -3.5330 | 538.8888889 | 41.0540 |
| 11/01/06 | 01:51:00 | 50.7290 | 0.7780 | -3.5330 | 540.2777778 | 41.2620 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 01:52:00 | 50.7290 | 0.7780 | -3.5330 | 540.2777778 | 41.2620 |
| 11/01/06 | 01:53:00 | 50.6600 | 0.7770 | -3.5510 | 539.5833333 | 41.2110 |
| 11/01/06 | 01:54:00 | 50.6600 | 0.7770 | -3.5510 | 539.5833333 | 41.2110 |
| 11/01/06 | 01:55:00 | 50.6600 | 0.7770 | -3.5600 | 539.5833333 | 41.2200 |
| 11/01/06 | 01:56:00 | 50.7640 | 0.7770 | -3.5600 | 539.5833333 | 41.3240 |
| 11/01/06 | 01:57:00 | 50.7640 | 0.7770 | -3.5600 | 539.5833333 | 41.3240 |
| 11/01/06 | 01:58:00 | 50.6250 | 0.7780 | -3.5690 | 540.2777778 | 41.1940 |
| 11/01/06 | 01:59:00 | 50.4170 | 0.7750 | -3.5690 | 538.1944444 | 40.9860 |
| 11/01/06 | 02:00:00 | 50.4170 | 0.7750 | -3.5690 | 538.1944444 | 40.9860 |
| 11/01/06 | 02:01:00 | 50.6950 | 0.7770 | -3.5780 | 539.5833333 | 41.2730 |
| 11/01/06 | 02:02:00 | 50.6950 | 0.7770 | -3.5780 | 539.5833333 | 41.2730 |
| 11/01/06 | 02:03:00 | 50.8340 | 0.7770 | -3.5870 | 539.5833333 | 41.4210 |
| 11/01/06 | 02:04:00 | 50.8340 | 0.7770 | -3.5870 | 539.5833333 | 41.4210 |
| 11/01/06 | 02:05:00 | 50.6250 | 0.7750 | -3.5870 | 538.1944444 | 41.2120 |
| 11/01/06 | 02:06:00 | 50.7640 | 0.7760 | -3.5960 | 538.8888889 | 41.3600 |
| 11/01/06 | 02:07:00 | 50.7640 | 0.7760 | -3.5960 | 538.8888889 | 41.3600 |
| 11/01/06 | 02:08:00 | 50.5560 | 0.7770 | -3.6050 | 539.5833333 | 41.1610 |
| 11/01/06 | 02:09:00 | 50.5560 | 0.7770 | -3.6050 | 539.5833333 | 41.1610 |
| 11/01/06 | 02:10:00 | 50.6600 | 0.7760 | -3.6140 | 538.8888889 | 41.2740 |
| 11/01/06 | 02:11:00 | 50.5910 | 0.7760 | -3.6230 | 538.8888889 | 41.2140 |
| 11/01/06 | 02:12:00 | 50.5910 | 0.7760 | -3.6230 | 538.8888889 | 41.2140 |
| 11/01/06 | 02:13:00 | 50.5560 | 0.7740 | -3.6140 | 537.5 | 41.1700 |
| 11/01/06 | 02:14:00 | 50.6600 | 0.7760 | -3.6140 | 538.8888889 | 41.2740 |
| 11/01/06 | 02:15:00 | 50.6600 | 0.7760 | -3.6140 | 538.8888889 | 41.2740 |
| 11/01/06 | 02:16:00 | 50.6250 | 0.7750 | -3.6140 | 538.1944444 | 41.2390 |
| 11/01/06 | 02:17:00 | 50.5910 | 0.7750 | -3.6230 | 538.1944444 | 41.2140 |
| 11/01/06 | 02:18:00 | 50.5910 | 0.7750 | -3.6230 | 538.1944444 | 41.2140 |
| 11/01/06 | 02:19:00 | 50.5560 | 0.7770 | -3.6420 | 539.5833333 | 41.1980 |
| 11/01/06 | 02:20:00 | 50.5560 | 0.7770 | -3.6420 | 539.5833333 | 41.1980 |
| 11/01/06 | 02:21:00 | 50.6250 | 0.7750 | -3.6510 | 538.1944444 | 41.2760 |
| 11/01/06 | 02:22:00 | 50.6250 | 0.7750 | -3.6510 | 538.1944444 | 41.2760 |
| 11/01/06 | 02:23:00 | 50.5560 | 0.7750 | -3.6510 | 538.1944444 | 41.2070 |
| 11/01/06 | 02:24:00 | 50.5560 | 0.7750 | -3.6510 | 538.1944444 | 41.2070 |
| 11/01/06 | 02:25:00 | 50.5560 | 0.7750 | -3.6510 | 538.1944444 | 41.2070 |
| 11/01/06 | 02:26:00 | 50.6600 | 0.7740 | -3.6690 | 537.5 | 41.3290 |
| 11/01/06 | 02:27:00 | 50.6600 | 0.7740 | -3.6690 | 537.5 | 41.3290 |
| 11/01/06 | 02:28:00 | 50.5910 | 0.7750 | -3.6780 | 538.1944444 | 41.2690 |
| 11/01/06 | 02:29:00 | 50.5910 | 0.7750 | -3.6780 | 538.1944444 | 41.2690 |
| 11/01/06 | 02:30:00 | 50.6250 | 0.7760 | -3.6780 | 538.8888889 | 41.3030 |
| 11/01/06 | 02:31:00 | 50.5560 | 0.7750 | -3.6780 | 538.1944444 | 41.2340 |
| 11/01/06 | 02:32:00 | 50.5560 | 0.7750 | -3.6780 | 538.1944444 | 41.2340 |
| 11/01/06 | 02:33:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:34:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:35:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:36:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:37:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:38:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:39:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:40:00 | 50.6950 | 0.7750 | -3.6780 | 538.1944444 | 41.3730 |
| 11/01/06 | 02:41:00 | 50.3130 | 0.7750 | -3.7050 | 538.1944444 | 41.0180 |
| 11/01/06 | 02:42:00 | 50.3130 | 0.7750 | -3.7050 | 538.1944444 | 41.0180 |
| 11/01/06 | 02:43:00 | 50.3470 | 0.7740 | -3.7050 | 537.5 | 41.0520 |
| 11/01/06 | 02:44:00 | 50.3470 | 0.7740 | -3.7050 | 537.5 | 41.0520 |
| 11/01/06 | 02:45:00 | 50.3470 | 0.7750 | -3.7050 | 538.1944444 | 41.0520 |
| 11/01/06 | 02:46:00 | 50.2090 | 0.7720 | -3.7140 | 536.1111111 | 40.9230 |
| 11/01/06 | 02:47:00 | 50.2090 | 0.7720 | -3.7140 | 536.1111111 | 40.9230 |
| 11/01/06 | 02:48:00 | 50.3820 | 0.7740 | -3.7140 | 537.5 | 41.0960 |
| 11/01/06 | 02:49:00 | 50.5910 | 0.7750 | -3.7140 | 538.1944444 | 41.3050 |
| 11/01/06 | 02:50:00 | 50.5910 | 0.7750 | -3.7140 | 538.1944444 | 41.3050 |
| 11/01/06 | 02:51:00 | 50.3470 | 0.7750 | -3.7320 | 538.1944444 | 41.0790 |
| 11/01/06 | 02:52:00 | 50.3470 | 0.7750 | -3.7320 | 538.1944444 | 41.0790 |
| 11/01/06 | 02:53:00 | 50.2780 | 0.7740 | -3.7230 | 537.5 | 41.0010 |
| 11/01/06 | 02:54:00 | 50.2780 | 0.7740 | -3.7230 | 537.5 | 41.0010 |
| 11/01/06 | 02:55:00 | 50.3820 | 0.7740 | -3.7320 | 537.5 | 41.1140 |
| 11/01/06 | 02:56:00 | 50.4520 | 0.7740 | -3.7410 | 537.5 | 41.1930 |
| 11/01/06 | 02:57:00 | 50.4520 | 0.7740 | -3.7410 | 537.5 | 41.1930 |
| 11/01/06 | 02:58:00 | 50.4170 | 0.7720 | -3.7590 | 536.1111111 | 41.1760 |
| 11/01/06 | 02:59:00 | 50.4170 | 0.7720 | -3.7590 | 536.1111111 | 41.1760 |
| 11/01/06 | 03:00:00 | 50.2430 | 0.7730 | -3.7590 | 536.8055556 | 41.0020 |
| 11/01/06 | 03:01:00 | 50.3820 | 0.7750 | -3.7590 | 538.1944444 | 41.1410 |
| 11/01/06 | 03:02:00 | 50.3820 | 0.7750 | -3.7590 | 538.1944444 | 41.1410 |
| 11/01/06 | 03:03:00 | 50.5560 | 0.7750 | -3.7680 | 538.1944444 | 41.3240 |
| 11/01/06 | 03:04:00 | 50.5560 | 0.7750 | -3.7680 | 538.1944444 | 41.3240 |
| 11/01/06 | 03:05:00 | 50.3820 | 0.7740 | -3.7680 | 537.5 | 41.1500 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 03:06:00 | 50.3820 | 0.7740 | -3.7680 | 537.5 | 41.1500 |
| 11/01/06 | 03:07:00 | 50.3130 | 0.7750 | -3.7860 | 538.1944444 | 41.0990 |
| 11/01/06 | 03:08:00 | 50.3470 | 0.7750 | -3.7860 | 538.1944444 | 41.1330 |
| 11/01/06 | 03:09:00 | 50.3470 | 0.7750 | -3.7860 | 538.1944444 | 41.1330 |
| 11/01/06 | 03:10:00 | 50.2430 | 0.7750 | -3.7860 | 538.1944444 | 41.0290 |
| 11/01/06 | 03:11:00 | 50.2430 | 0.7750 | -3.7860 | 538.1944444 | 41.0290 |
| 11/01/06 | 03:12:00 | 50.2090 | 0.7740 | -3.7860 | 537.5 | 40.9950 |
| 11/01/06 | 03:13:00 | 50.4170 | 0.7750 | -3.7860 | 538.1944444 | 41.2030 |
| 11/01/06 | 03:14:00 | 50.4170 | 0.7750 | -3.7860 | 538.1944444 | 41.2030 |
| 11/01/06 | 03:15:00 | 50.4170 | 0.7750 | -3.7860 | 538.1944444 | 41.2030 |
| 11/01/06 | 03:16:00 | 50.5210 | 0.7740 | -3.7950 | 537.5 | 41.3160 |
| 11/01/06 | 03:17:00 | 50.5210 | 0.7740 | -3.7950 | 537.5 | 41.3160 |
| 11/01/06 | 03:18:00 | 50.2430 | 0.7770 | -3.8130 | 539.5833333 | 41.0560 |
| 11/01/06 | 03:19:00 | 50.2430 | 0.7770 | -3.8130 | 539.5833333 | 41.0560 |
| 11/01/06 | 03:20:00 | 50.3820 | 0.7750 | -3.8130 | 538.1944444 | 41.1950 |
| 11/01/06 | 03:21:00 | 50.3820 | 0.7750 | -3.8130 | 538.1944444 | 41.1950 |
| 11/01/06 | 03:22:00 | 50.4520 | 0.7740 | -3.8130 | 537.5 | 41.2650 |
| 11/01/06 | 03:23:00 | 50.4170 | 0.7760 | -3.8130 | 538.8888889 | 41.2300 |
| 11/01/06 | 03:24:00 | 50.4170 | 0.7760 | -3.8130 | 538.8888889 | 41.2300 |
| 11/01/06 | 03:25:00 | 50.2430 | 0.7730 | -3.8130 | 536.8055556 | 41.0560 |
| 11/01/06 | 03:26:00 | 50.2430 | 0.7730 | -3.8130 | 536.8055556 | 41.0560 |
| 11/01/06 | 03:27:00 | 50.3470 | 0.7740 | -3.8220 | 537.5 | 41.1690 |
| 11/01/06 | 03:28:00 | 50.2780 | 0.7740 | -3.8220 | 537.5 | 41.1000 |
| 11/01/06 | 03:29:00 | 50.2780 | 0.7740 | -3.8220 | 537.5 | 41.1000 |
| 11/01/06 | 03:30:00 | 50.2090 | 0.7740 | -3.8130 | 537.5 | 41.0220 |
| 11/01/06 | 03:31:00 | 50.2430 | 0.7760 | -3.8130 | 538.8888889 | 41.0560 |
| 11/01/06 | 03:32:00 | 50.2430 | 0.7760 | -3.8130 | 538.8888889 | 41.0560 |
| 11/01/06 | 03:33:00 | 50.2090 | 0.7740 | -3.8220 | 537.5 | 41.0310 |
| 11/01/06 | 03:34:00 | 50.2090 | 0.7740 | -3.8220 | 537.5 | 41.0310 |
| 11/01/06 | 03:35:00 | 50.2430 | 0.7740 | -3.8400 | 537.5 | 41.0830 |
| 11/01/06 | 03:36:00 | 50.2430 | 0.7740 | -3.8400 | 537.5 | 41.0830 |
| 11/01/06 | 03:37:00 | 50.2780 | 0.7730 | -3.8400 | 536.8055556 | 41.1180 |
| 11/01/06 | 03:38:00 | 50.2430 | 0.7740 | -3.8490 | 537.5 | 41.0920 |
| 11/01/06 | 03:39:00 | 50.2430 | 0.7740 | -3.8490 | 537.5 | 41.0920 |
| 11/01/06 | 03:40:00 | 50.1740 | 0.7740 | -3.8670 | 537.5 | 41.0410 |
| 11/01/06 | 03:41:00 | 50.1740 | 0.7740 | -3.8670 | 537.5 | 41.0410 |
| 11/01/06 | 03:42:00 | 50.1390 | 0.7740 | -3.8670 | 537.5 | 41.0060 |
| 11/01/06 | 03:43:00 | 50.1740 | 0.7740 | -3.8670 | 537.5 | 41.0410 |
| 11/01/06 | 03:44:00 | 50.1740 | 0.7740 | -3.8670 | 537.5 | 41.0410 |
| 11/01/06 | 03:45:00 | 50.1390 | 0.7760 | -3.8760 | 538.8888889 | 41.0150 |
| 11/01/06 | 03:46:00 | 50.1040 | 0.7740 | -3.8850 | 537.5 | 40.9890 |
| 11/01/06 | 03:47:00 | 50.1040 | 0.7740 | -3.8850 | 537.5 | 40.9890 |
| 11/01/06 | 03:48:00 | 50.3130 | 0.7750 | -3.8850 | 538.1944444 | 41.1980 |
| 11/01/06 | 03:49:00 | 50.2090 | 0.7740 | -3.9030 | 537.5 | 41.1120 |
| 11/01/06 | 03:50:00 | 50.2090 | 0.7740 | -3.9030 | 537.5 | 41.1120 |
| 11/01/06 | 03:51:00 | 50.2430 | 0.7750 | -3.9120 | 538.1944444 | 41.1550 |
| 11/01/06 | 03:52:00 | 50.2430 | 0.7750 | -3.9120 | 538.1944444 | 41.1550 |
| 11/01/06 | 03:53:00 | 50.2430 | 0.7740 | -3.9120 | 537.5 | 41.1550 |
| 11/01/06 | 03:54:00 | 50.2430 | 0.7740 | -3.9120 | 537.5 | 41.1550 |
| 11/01/06 | 03:55:00 | 50.1040 | 0.7740 | -3.9300 | 537.5 | 41.0340 |
| 11/01/06 | 03:56:00 | 50.0700 | 0.7720 | -3.9300 | 536.1111111 | 41.0000 |
| 11/01/06 | 03:57:00 | 50.0700 | 0.7720 | -3.9300 | 536.1111111 | 41.0000 |
| 11/01/06 | 03:58:00 | 49.9310 | 0.7740 | -3.9300 | 537.5 | 40.8610 |
| 11/01/06 | 03:59:00 | 49.9310 | 0.7740 | -3.9300 | 537.5 | 40.8610 |
| 11/01/06 | 04:00:00 | 50.1040 | 0.7730 | -3.9300 | 536.8055556 | 41.0340 |
| 11/01/06 | 04:01:00 | 49.9660 | 0.7740 | -3.9390 | 537.5 | 40.9050 |
| 11/01/06 | 04:02:00 | 49.9660 | 0.7740 | -3.9390 | 537.5 | 40.9050 |
| 11/01/06 | 04:03:00 | 49.8270 | 0.7710 | -3.9390 | 535.4166667 | 40.7660 |
| 11/01/06 | 04:04:00 | 49.8270 | 0.7710 | -3.9390 | 535.4166667 | 40.7660 |
| 11/01/06 | 04:05:00 | 50.0350 | 0.7720 | -3.9390 | 536.1111111 | 40.9740 |
| 11/01/06 | 04:06:00 | 50.0350 | 0.7720 | -3.9390 | 536.1111111 | 40.9740 |
| 11/01/06 | 04:07:00 | 49.9660 | 0.7720 | -3.9570 | 536.1111111 | 40.9230 |
| 11/01/06 | 04:08:00 | 49.9660 | 0.7720 | -3.9570 | 536.1111111 | 40.9230 |
| 11/01/06 | 04:09:00 | 49.9660 | 0.7720 | -3.9570 | 536.1111111 | 40.9230 |
| 11/01/06 | 04:10:00 | 50.1390 | 0.7720 | -3.9570 | 536.1111111 | 41.0960 |
| 11/01/06 | 04:11:00 | 50.1390 | 0.7720 | -3.9570 | 536.1111111 | 41.0960 |
| 11/01/06 | 04:12:00 | 50.1390 | 0.7750 | -3.9570 | 538.1944444 | 41.0960 |
| 11/01/06 | 04:13:00 | 50.0700 | 0.7740 | -3.9670 | 537.5 | 41.0370 |
| 11/01/06 | 04:14:00 | 50.0700 | 0.7740 | -3.9670 | 537.5 | 41.0370 |
| 11/01/06 | 04:15:00 | 49.9660 | 0.7710 | -3.9760 | 535.4166667 | 40.9420 |
| 11/01/06 | 04:16:00 | 49.8610 | 0.7710 | -3.9850 | 535.4166667 | 40.8460 |
| 11/01/06 | 04:17:00 | 49.8610 | 0.7710 | -3.9850 | 535.4166667 | 40.8460 |
| 11/01/06 | 04:18:00 | 49.9310 | 0.7740 | -3.9850 | 537.5 | 40.9160 |
| 11/01/06 | 04:19:00 | 49.9310 | 0.7740 | -3.9850 | 537.5 | 40.9160 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 04:20:00 | 49.9660 | 0.7730 | -3.9850 | 536.8055556 | 40.9510 |
| 11/01/06 | 04:21:00 | 49.9660 | 0.7730 | -3.9850 | 536.8055556 | 40.9510 |
| 11/01/06 | 04:22:00 | 50.0350 | 0.7720 | -3.9850 | 536.1111111 | 41.0200 |
| 11/01/06 | 04:23:00 | 50.0350 | 0.7720 | -3.9850 | 536.1111111 | 41.0200 |
| 11/01/06 | 04:24:00 | 49.8610 | 0.7720 | -3.9850 | 536.1111111 | 40.8460 |
| 11/01/06 | 04:25:00 | 50.0350 | 0.7720 | -3.9850 | 536.1111111 | 41.0200 |
| 11/01/06 | 04:26:00 | 50.0350 | 0.7720 | -3.9850 | 536.1111111 | 41.0200 |
| 11/01/06 | 04:27:00 | 49.8960 | 0.7720 | -3.9850 | 536.1111111 | 40.8810 |
| 11/01/06 | 04:28:00 | 49.8960 | 0.7720 | -3.9850 | 536.1111111 | 40.8810 |
| 11/01/06 | 04:29:00 | 49.7920 | 0.7720 | -3.9850 | 536.1111111 | 40.7770 |
| 11/01/06 | 04:30:00 | 49.9310 | 0.7720 | -3.9850 | 536.1111111 | 40.9160 |
| 11/01/06 | 04:31:00 | 49.9310 | 0.7720 | -3.9850 | 536.1111111 | 40.9160 |
| 11/01/06 | 04:32:00 | 49.8960 | 0.7740 | -3.9940 | 537.5 | 40.8900 |
| 11/01/06 | 04:33:00 | 50.0350 | 0.7720 | -4.0030 | 536.1111111 | 41.0380 |
| 11/01/06 | 04:34:00 | 50.0350 | 0.7720 | -4.0030 | 536.1111111 | 41.0380 |
| 11/01/06 | 04:35:00 | 49.9660 | 0.7740 | -4.0120 | 537.5 | 40.9780 |
| 11/01/06 | 04:36:00 | 49.9660 | 0.7740 | -4.0120 | 537.5 | 40.9780 |
| 11/01/06 | 04:37:00 | 49.9310 | 0.7730 | -4.0120 | 536.8055556 | 40.9430 |
| 11/01/06 | 04:38:00 | 49.9310 | 0.7730 | -4.0120 | 536.8055556 | 40.9430 |
| 11/01/06 | 04:39:00 | 49.8610 | 0.7720 | -4.0120 | 536.1111111 | 40.8730 |
| 11/01/06 | 04:40:00 | 49.8610 | 0.7720 | -4.0120 | 536.1111111 | 40.8730 |
| 11/01/06 | 04:41:00 | 49.9660 | 0.7710 | -4.0120 | 535.4166667 | 40.9780 |
| 11/01/06 | 04:42:00 | 49.9310 | 0.7720 | -4.0120 | 536.1111111 | 40.9430 |
| 11/01/06 | 04:43:00 | 49.9310 | 0.7720 | -4.0120 | 536.1111111 | 40.9430 |
| 11/01/06 | 04:44:00 | 49.8270 | 0.7710 | -4.0210 | 535.4166667 | 40.8480 |
| 11/01/06 | 04:45:00 | 49.7920 | 0.7710 | -4.0210 | 535.4166667 | 40.8130 |
| 11/01/06 | 04:46:00 | 49.7920 | 0.7710 | -4.0210 | 535.4166667 | 40.8130 |
| 11/01/06 | 04:47:00 | 49.7920 | 0.7730 | -4.0300 | 536.8055556 | 40.8220 |
| 11/01/06 | 04:48:00 | 50.0000 | 0.7740 | -4.0390 | 537.5 | 41.0390 |
| 11/01/06 | 04:49:00 | 50.0000 | 0.7740 | -4.0390 | 537.5 | 41.0390 |
| 11/01/06 | 04:50:00 | 49.8960 | 0.7740 | -4.0390 | 537.5 | 40.9350 |
| 11/01/06 | 04:51:00 | 49.8960 | 0.7740 | -4.0390 | 537.5 | 40.9350 |
| 11/01/06 | 04:52:00 | 49.8960 | 0.7720 | -4.0390 | 536.1111111 | 40.9350 |
| 11/01/06 | 04:53:00 | 49.8960 | 0.7720 | -4.0390 | 536.1111111 | 40.9350 |
| 11/01/06 | 04:54:00 | 49.7920 | 0.7720 | -4.0480 | 536.1111111 | 40.8400 |
| 11/01/06 | 04:55:00 | 49.7920 | 0.7720 | -4.0480 | 536.1111111 | 40.8400 |
| 11/01/06 | 04:56:00 | 49.7570 | 0.7720 | -4.0480 | 536.1111111 | 40.8050 |
| 11/01/06 | 04:57:00 | 49.8270 | 0.7730 | -4.0660 | 536.8055556 | 40.8930 |
| 11/01/06 | 04:58:00 | 49.8270 | 0.7730 | -4.0660 | 536.8055556 | 40.8930 |
| 11/01/06 | 04:59:00 | 49.7220 | 0.7710 | -4.0660 | 535.4166667 | 40.7880 |
| 11/01/06 | 05:00:00 | 49.8270 | 0.7730 | -4.0660 | 536.8055556 | 40.8930 |
| 11/01/06 | 05:01:00 | 49.8270 | 0.7730 | -4.0660 | 536.8055556 | 40.8930 |
| 11/01/06 | 05:02:00 | 49.6880 | 0.7710 | -4.0660 | 535.4166667 | 40.7540 |
| 11/01/06 | 05:03:00 | 49.6880 | 0.7710 | -4.0660 | 535.4166667 | 40.7540 |
| 11/01/06 | 05:04:00 | 50.1390 | 0.7740 | -4.0750 | 537.5 | 41.2140 |
| 11/01/06 | 05:05:00 | 50.1390 | 0.7740 | -4.0750 | 537.5 | 41.2140 |
| 11/01/06 | 05:06:00 | 49.8960 | 0.7710 | -4.0840 | 535.4166667 | 40.9800 |
| 11/01/06 | 05:07:00 | 49.9310 | 0.7720 | -4.0840 | 536.1111111 | 41.0150 |
| 11/01/06 | 05:08:00 | 49.9310 | 0.7720 | -4.0840 | 536.1111111 | 41.0150 |
| 11/01/06 | 05:09:00 | 49.8270 | 0.7730 | -4.0930 | 536.8055556 | 40.9200 |
| 11/01/06 | 05:10:00 | 49.8270 | 0.7730 | -4.0930 | 536.8055556 | 40.9200 |
| 11/01/06 | 05:11:00 | 49.8270 | 0.7710 | -4.0930 | 535.4166667 | 40.9200 |
| 11/01/06 | 05:12:00 | 50.0700 | 0.7720 | -4.0930 | 536.1111111 | 41.1630 |
| 11/01/06 | 05:13:00 | 50.0700 | 0.7720 | -4.0930 | 536.1111111 | 41.1630 |
| 11/01/06 | 05:14:00 | 49.9310 | 0.7720 | -4.0930 | 536.1111111 | 41.0240 |
| 11/01/06 | 05:15:00 | 49.8960 | 0.7710 | -4.1020 | 535.4166667 | 40.9980 |
| 11/01/06 | 05:16:00 | 49.8960 | 0.7710 | -4.1020 | 535.4166667 | 40.9980 |
| 11/01/06 | 05:17:00 | 49.6880 | 0.7710 | -4.1020 | 535.4166667 | 40.7900 |
| 11/01/06 | 05:18:00 | 49.6880 | 0.7710 | -4.1020 | 535.4166667 | 40.7900 |
| 11/01/06 | 05:19:00 | 49.9310 | 0.7710 | -4.1110 | 535.4166667 | 41.0420 |
| 11/01/06 | 05:20:00 | 49.9310 | 0.7710 | -4.1110 | 535.4166667 | 41.0420 |
| 11/01/06 | 05:21:00 | 49.6880 | 0.7710 | -4.1110 | 535.4166667 | 40.7990 |
| 11/01/06 | 05:22:00 | 49.8960 | 0.7720 | -4.1110 | 536.1111111 | 41.0070 |
| 11/01/06 | 05:23:00 | 49.8960 | 0.7720 | -4.1110 | 536.1111111 | 41.0070 |
| 11/01/06 | 05:24:00 | 49.9660 | 0.7730 | -4.1200 | 536.8055556 | 41.0860 |
| 11/01/06 | 05:25:00 | 49.9660 | 0.7730 | -4.1200 | 536.8055556 | 41.0860 |
| 11/01/06 | 05:26:00 | 49.9660 | 0.7720 | -4.1200 | 536.1111111 | 41.0860 |
| 11/01/06 | 05:27:00 | 49.9310 | 0.7720 | -4.1200 | 536.1111111 | 41.0510 |
| 11/01/06 | 05:28:00 | 49.9310 | 0.7720 | -4.1200 | 536.1111111 | 41.0510 |
| 11/01/06 | 05:29:00 | 49.7920 | 0.7730 | -4.1200 | 536.8055556 | 40.9120 |
| 11/01/06 | 05:30:00 | 49.9310 | 0.7710 | -4.1290 | 535.4166667 | 41.0600 |
| 11/01/06 | 05:31:00 | 49.9310 | 0.7710 | -4.1290 | 535.4166667 | 41.0600 |
| 11/01/06 | 05:32:00 | 49.8270 | 0.7700 | -4.1380 | 534.7222222 | 40.9650 |
| 11/01/06 | 05:33:00 | 49.9660 | 0.7720 | -4.1470 | 536.1111111 | 41.1130 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 05:34:00 | 49.9660 | 0.7720 | -4.1470 | 536.1111111 | 41.1130 |
| 11/01/06 | 05:35:00 | 49.9310 | 0.7720 | -4.1470 | 536.1111111 | 41.0780 |
| 11/01/06 | 05:36:00 | 49.9310 | 0.7720 | -4.1470 | 536.1111111 | 41.0780 |
| 11/01/06 | 05:37:00 | 49.6880 | 0.7720 | -4.1470 | 536.1111111 | 40.8350 |
| 11/01/06 | 05:38:00 | 49.6880 | 0.7720 | -4.1470 | 536.1111111 | 40.8350 |
| 11/01/06 | 05:39:00 | 49.9660 | 0.7710 | -4.1470 | 535.4166667 | 41.1130 |
| 11/01/06 | 05:40:00 | 49.9310 | 0.7710 | -4.1470 | 535.4166667 | 41.0780 |
| 11/01/06 | 05:41:00 | 49.9310 | 0.7710 | -4.1470 | 535.4166667 | 41.0780 |
| 11/01/06 | 05:42:00 | 49.7570 | 0.7710 | -4.1560 | 535.4166667 | 40.9130 |
| 11/01/06 | 05:43:00 | 49.7570 | 0.7710 | -4.1560 | 535.4166667 | 40.9130 |
| 11/01/06 | 05:44:00 | 49.7220 | 0.7740 | -4.1560 | 537.5 | 40.8780 |
| 11/01/06 | 05:45:00 | 49.8270 | 0.7710 | -4.1740 | 535.4166667 | 41.0010 |
| 11/01/06 | 05:46:00 | 49.8270 | 0.7710 | -4.1740 | 535.4166667 | 41.0010 |
| 11/01/06 | 05:47:00 | 49.8610 | 0.7710 | -4.1740 | 535.4166667 | 41.0350 |
| 11/01/06 | 05:48:00 | 49.8270 | 0.7690 | -4.1830 | 534.0277778 | 41.0100 |
| 11/01/06 | 05:49:00 | 49.8270 | 0.7690 | -4.1830 | 534.0277778 | 41.0100 |
| 11/01/06 | 05:50:00 | 49.7570 | 0.7700 | -4.1830 | 534.7222222 | 40.9400 |
| 11/01/06 | 05:51:00 | 49.7570 | 0.7700 | -4.1830 | 534.7222222 | 40.9400 |
| 11/01/06 | 05:52:00 | 49.7570 | 0.7710 | -4.1920 | 535.4166667 | 40.9490 |
| 11/01/06 | 05:53:00 | 49.7570 | 0.7710 | -4.1920 | 535.4166667 | 40.9490 |
| 11/01/06 | 05:54:00 | 49.8960 | 0.7720 | -4.1830 | 536.1111111 | 41.0790 |
| 11/01/06 | 05:55:00 | 49.8960 | 0.7720 | -4.1830 | 536.1111111 | 41.0790 |
| 11/01/06 | 05:56:00 | 49.7570 | 0.7710 | -4.1920 | 535.4166667 | 40.9490 |
| 11/01/06 | 05:57:00 | 49.7570 | 0.7710 | -4.1920 | 535.4166667 | 40.9490 |
| 11/01/06 | 05:58:00 | 49.7220 | 0.7720 | -4.2010 | 536.1111111 | 40.9230 |
| 11/01/06 | 05:59:00 | 49.7220 | 0.7720 | -4.2100 | 536.1111111 | 40.9320 |
| 11/01/06 | 06:00:00 | 49.7220 | 0.7720 | -4.2100 | 536.1111111 | 40.9320 |
| 11/01/06 | 06:01:00 | 49.6880 | 0.7700 | -4.2100 | 534.7222222 | 40.8980 |
| 11/01/06 | 06:02:00 | 49.6530 | 0.7710 | -4.2190 | 535.4166667 | 40.8720 |
| 11/01/06 | 06:03:00 | 49.6530 | 0.7710 | -4.2190 | 535.4166667 | 40.8720 |
| 11/01/06 | 06:04:00 | 49.7570 | 0.7710 | -4.2100 | 535.4166667 | 40.9670 |
| 11/01/06 | 06:05:00 | 49.7570 | 0.7710 | -4.2100 | 535.4166667 | 40.9670 |
| 11/01/06 | 06:06:00 | 49.6880 | 0.7700 | -4.2190 | 534.7222222 | 40.9070 |
| 11/01/06 | 06:07:00 | 49.6880 | 0.7700 | -4.2190 | 534.7222222 | 40.9070 |
| 11/01/06 | 06:08:00 | 49.8270 | 0.7710 | -4.2100 | 535.4166667 | 41.0370 |
| 11/01/06 | 06:09:00 | 49.8610 | 0.7710 | -4.2100 | 535.4166667 | 41.0710 |
| 11/01/06 | 06:10:00 | 49.8610 | 0.7710 | -4.2100 | 535.4166667 | 41.0710 |
| 11/01/06 | 06:11:00 | 49.7570 | 0.7720 | -4.2100 | 536.1111111 | 40.9670 |
| 11/01/06 | 06:12:00 | 49.7570 | 0.7720 | -4.2100 | 536.1111111 | 40.9670 |
| 11/01/06 | 06:13:00 | 49.9310 | 0.7700 | -4.2190 | 534.7222222 | 41.1500 |
| 11/01/06 | 06:14:00 | 49.7920 | 0.7710 | -4.2010 | 535.4166667 | 40.9930 |
| 11/01/06 | 06:15:00 | 49.7570 | 0.7720 | -4.2010 | 536.1111111 | 40.9580 |
| 11/01/06 | 06:16:00 | 49.7570 | 0.7720 | -4.2010 | 536.1111111 | 40.9580 |
| 11/01/06 | 06:17:00 | 49.8270 | 0.7710 | -4.2010 | 535.4166667 | 41.0280 |
| 11/01/06 | 06:18:00 | 49.8270 | 0.7710 | -4.2010 | 535.4166667 | 41.0280 |
| 11/01/06 | 06:19:00 | 49.8960 | 0.7720 | -4.1920 | 536.1111111 | 41.0880 |
| 11/01/06 | 06:20:00 | 49.8960 | 0.7720 | -4.1920 | 536.1111111 | 41.0880 |
| 11/01/06 | 06:21:00 | 49.8610 | 0.7700 | -4.1920 | 534.7222222 | 41.0530 |
| 11/01/06 | 06:22:00 | 49.8610 | 0.7700 | -4.1920 | 534.7222222 | 41.0530 |
| 11/01/06 | 06:23:00 | 49.8610 | 0.7720 | -4.1740 | 536.1111111 | 41.0350 |
| 11/01/06 | 06:24:00 | 49.8270 | 0.7720 | -4.1470 | 536.1111111 | 40.9740 |
| 11/01/06 | 06:25:00 | 49.8270 | 0.7720 | -4.1470 | 536.1111111 | 40.9740 |
| 11/01/06 | 06:26:00 | 49.8270 | 0.7720 | -4.1470 | 536.1111111 | 40.9740 |
| 11/01/06 | 06:27:00 | 50.3820 | 0.7750 | -4.1200 | 538.1944444 | 41.5020 |
| 11/01/06 | 06:28:00 | 50.3820 | 0.7750 | -4.1200 | 538.1944444 | 41.5020 |
| 11/01/06 | 06:29:00 | 50.4170 | 0.7750 | -4.0930 | 538.1944444 | 41.5100 |
| 11/01/06 | 06:30:00 | 50.1390 | 0.7750 | -4.0750 | 538.1944444 | 41.2140 |
| 11/01/06 | 06:31:00 | 50.1390 | 0.7750 | -4.0750 | 538.1944444 | 41.2140 |
| 11/01/06 | 06:32:00 | 50.2430 | 0.7730 | -4.0750 | 536.8055556 | 41.3180 |
| 11/01/06 | 06:33:00 | 50.0700 | 0.7720 | -4.0660 | 536.1111111 | 41.1360 |
| 11/01/06 | 06:34:00 | 50.0700 | 0.7720 | -4.0660 | 536.1111111 | 41.1360 |
| 11/01/06 | 06:35:00 | 50.1390 | 0.7740 | -4.0660 | 537.5 | 41.2050 |
| 11/01/06 | 06:36:00 | 50.1390 | 0.7740 | -4.0660 | 537.5 | 41.2050 |
| 11/01/06 | 06:37:00 | 50.0000 | 0.7720 | -4.0570 | 536.1111111 | 41.0570 |
| 11/01/06 | 06:38:00 | 50.0000 | 0.7720 | -4.0570 | 536.1111111 | 41.0570 |
| 11/01/06 | 06:39:00 | 50.2430 | 0.7730 | -4.0750 | 536.8055556 | 41.3180 |
| 11/01/06 | 06:40:00 | 50.1740 | 0.7710 | -4.0750 | 535.4166667 | 41.2490 |
| 11/01/06 | 06:41:00 | 50.1740 | 0.7710 | -4.0750 | 535.4166667 | 41.2490 |
| 11/01/06 | 06:42:00 | 50.2430 | 0.7720 | -4.0750 | 536.1111111 | 41.3180 |
| 11/01/06 | 06:43:00 | 50.2430 | 0.7720 | -4.0750 | 536.1111111 | 41.3180 |
| 11/01/06 | 06:44:00 | 50.1740 | 0.7710 | -4.0840 | 535.4166667 | 41.2580 |
| 11/01/06 | 06:45:00 | 50.1040 | 0.7710 | -4.0930 | 535.4166667 | 41.1970 |
| 11/01/06 | 06:46:00 | 50.1040 | 0.7710 | -4.0930 | 535.4166667 | 41.1970 |
| 11/01/06 | 06:47:00 | 50.1740 | 0.7710 | -4.1110 | 535.4166667 | 41.2850 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 06:48:00 | 50.1740 | 0.7710 | -4.1110 | 535.4166667 | 41.2850 |
| 11/01/06 | 06:49:00 | 50.2090 | 0.7730 | -4.1290 | 536.8055556 | 41.3380 |
| 11/01/06 | 06:50:00 | 50.2090 | 0.7730 | -4.1290 | 536.8055556 | 41.3380 |
| 11/01/06 | 06:51:00 | 50.3130 | 0.7740 | -4.1380 | 537.5 | 41.4510 |
| 11/01/06 | 06:52:00 | 50.3130 | 0.7740 | -4.1380 | 537.5 | 41.4510 |
| 11/01/06 | 06:53:00 | 50.0700 | 0.7700 | -4.1470 | 534.7222222 | 41.2170 |
| 11/01/06 | 06:54:00 | 50.1740 | 0.7720 | -4.1560 | 536.1111111 | 41.3300 |
| 11/01/06 | 06:55:00 | 50.1740 | 0.7720 | -4.1560 | 536.1111111 | 41.3300 |
| 11/01/06 | 06:56:00 | 50.1740 | 0.7720 | -4.1650 | 536.1111111 | 41.3390 |
| 11/01/06 | 06:57:00 | 50.1740 | 0.7720 | -4.1650 | 536.1111111 | 41.3390 |
| 11/01/06 | 06:58:00 | 50.2430 | 0.7700 | -4.1650 | 534.7222222 | 41.4080 |
| 11/01/06 | 06:59:00 | 50.2430 | 0.7700 | -4.1740 | 534.7222222 | 41.4170 |
| 11/01/06 | 07:00:00 | 50.2430 | 0.7700 | -4.1740 | 534.7222222 | 41.4170 |
| 11/01/06 | 07:01:00 | 50.2090 | 0.7720 | -4.1740 | 536.1111111 | 41.3830 |
| 11/01/06 | 07:02:00 | 50.2430 | 0.7730 | -4.1470 | 536.8055556 | 41.3900 |
| 11/01/06 | 07:03:00 | 50.2430 | 0.7730 | -4.1470 | 536.8055556 | 41.3900 |
| 11/01/06 | 07:04:00 | 50.1040 | 0.7720 | -4.1380 | 536.1111111 | 41.2420 |
| 11/01/06 | 07:05:00 | 50.1040 | 0.7720 | -4.1380 | 536.1111111 | 41.2420 |
| 11/01/06 | 07:06:00 | 50.2090 | 0.7710 | -4.1110 | 535.4166667 | 41.3200 |
| 11/01/06 | 07:07:00 | 50.2090 | 0.7710 | -4.1110 | 535.4166667 | 41.3200 |
| 11/01/06 | 07:08:00 | 50.3820 | 0.7740 | -4.1020 | 537.5 | 41.4840 |
| 11/01/06 | 07:09:00 | 50.3820 | 0.7740 | -4.1020 | 537.5 | 41.4840 |
| 11/01/06 | 07:10:00 | 50.3470 | 0.7740 | -4.0750 | 537.5 | 41.4220 |
| 11/01/06 | 07:11:00 | 50.2090 | 0.7730 | -4.0660 | 536.8055556 | 41.2750 |
| 11/01/06 | 07:12:00 | 50.2090 | 0.7730 | -4.0660 | 536.8055556 | 41.2750 |
| 11/01/06 | 07:13:00 | 50.2430 | 0.7720 | -4.0480 | 536.1111111 | 41.2910 |
| 11/01/06 | 07:14:00 | 50.2090 | 0.7740 | -4.0390 | 537.5 | 41.2480 |
| 11/01/06 | 07:15:00 | 50.2090 | 0.7740 | -4.0390 | 537.5 | 41.2480 |
| 11/01/06 | 07:16:00 | 50.2430 | 0.7740 | -4.0300 | 537.5 | 41.2730 |
| 11/01/06 | 07:17:00 | 50.3470 | 0.7740 | -4.0300 | 537.5 | 41.3770 |
| 11/01/06 | 07:18:00 | 50.3470 | 0.7740 | -4.0300 | 537.5 | 41.3770 |
| 11/01/06 | 07:19:00 | 50.3470 | 0.7740 | -4.0300 | 537.5 | 41.3770 |
| 11/01/06 | 07:20:00 | 50.1740 | 0.7750 | -4.0300 | 538.1944444 | 41.2040 |
| 11/01/06 | 07:21:00 | 50.1740 | 0.7750 | -4.0300 | 538.1944444 | 41.2040 |
| 11/01/06 | 07:22:00 | 50.5210 | 0.7760 | -4.0300 | 538.8888889 | 41.5510 |
| 11/01/06 | 07:23:00 | 50.3820 | 0.7750 | -4.0300 | 538.1944444 | 41.4120 |
| 11/01/06 | 07:24:00 | 50.3820 | 0.7750 | -4.0300 | 538.1944444 | 41.4120 |
| 11/01/06 | 07:25:00 | 50.5910 | 0.7760 | -4.0210 | 538.8888889 | 41.6120 |
| 11/01/06 | 07:26:00 | 50.4520 | 0.7740 | -4.0300 | 537.5 | 41.4820 |
| 11/01/06 | 07:27:00 | 50.4520 | 0.7740 | -4.0300 | 537.5 | 41.4820 |
| 11/01/06 | 07:28:00 | 50.2090 | 0.7750 | -4.0300 | 538.1944444 | 41.2390 |
| 11/01/06 | 07:29:00 | 50.2780 | 0.7740 | -4.0210 | 537.5 | 41.2990 |
| 11/01/06 | 07:30:00 | 50.2780 | 0.7740 | -4.0210 | 537.5 | 41.2990 |
| 11/01/06 | 07:31:00 | 50.3470 | 0.7750 | -3.9850 | 538.1944444 | 41.3320 |
| 11/01/06 | 07:32:00 | 50.3470 | 0.7750 | -3.9850 | 538.1944444 | 41.3320 |
| 11/01/06 | 07:33:00 | 50.4860 | 0.7760 | -3.9760 | 538.8888889 | 41.4620 |
| 11/01/06 | 07:34:00 | 50.4860 | 0.7760 | -3.9760 | 538.8888889 | 41.4620 |
| 11/01/06 | 07:35:00 | 50.3820 | 0.7750 | -3.9670 | 538.1944444 | 41.3490 |
| 11/01/06 | 07:36:00 | 50.3820 | 0.7750 | -3.9670 | 538.1944444 | 41.3490 |
| 11/01/06 | 07:37:00 | 50.3820 | 0.7760 | -3.9760 | 538.8888889 | 41.3580 |
| 11/01/06 | 07:38:00 | 50.2430 | 0.7750 | -3.9570 | 538.1944444 | 41.2000 |
| 11/01/06 | 07:39:00 | 50.2430 | 0.7750 | -3.9570 | 538.1944444 | 41.2000 |
| 11/01/06 | 07:40:00 | 50.3820 | 0.7760 | -3.9570 | 538.8888889 | 41.3390 |
| 11/01/06 | 07:41:00 | 50.3820 | 0.7760 | -3.9570 | 538.8888889 | 41.3390 |
| 11/01/06 | 07:42:00 | 50.4520 | 0.7770 | -3.9570 | 539.5833333 | 41.4090 |
| 11/01/06 | 07:43:00 | 50.4860 | 0.7770 | -3.9390 | 539.5833333 | 41.4250 |
| 11/01/06 | 07:44:00 | 50.4860 | 0.7770 | -3.9390 | 539.5833333 | 41.4250 |
| 11/01/06 | 07:45:00 | 50.3470 | 0.7770 | -3.9390 | 539.5833333 | 41.2860 |
| 11/01/06 | 07:46:00 | 50.3820 | 0.7760 | -3.9300 | 538.8888889 | 41.3120 |
| 11/01/06 | 07:47:00 | 50.3820 | 0.7760 | -3.9300 | 538.8888889 | 41.3120 |
| 11/01/06 | 07:48:00 | 50.5210 | 0.7760 | -3.8670 | 538.8888889 | 41.3880 |
| 11/01/06 | 07:49:00 | 50.5210 | 0.7760 | -3.8670 | 538.8888889 | 41.3880 |
| 11/01/06 | 07:50:00 | 50.4860 | 0.7770 | -3.8220 | 539.5833333 | 41.3080 |
| 11/01/06 | 07:51:00 | 50.4860 | 0.7770 | -3.8220 | 539.5833333 | 41.3080 |
| 11/01/06 | 07:52:00 | 50.4520 | 0.7770 | -3.8130 | 539.5833333 | 41.2650 |
| 11/01/06 | 07:53:00 | 50.4520 | 0.7770 | -3.8130 | 539.5833333 | 41.2650 |
| 11/01/06 | 07:54:00 | 50.6950 | 0.7780 | -3.7860 | 540.2777778 | 41.4810 |
| 11/01/06 | 07:55:00 | 50.3130 | 0.7760 | -3.7680 | 538.8888889 | 41.0810 |
| 11/01/06 | 07:56:00 | 50.3130 | 0.7760 | -3.7680 | 538.8888889 | 41.0810 |
| 11/01/06 | 07:57:00 | 50.4860 | 0.7780 | -3.7590 | 540.2777778 | 41.2450 |
| 11/01/06 | 07:58:00 | 50.4860 | 0.7780 | -3.7590 | 540.2777778 | 41.2450 |
| 11/01/06 | 07:59:00 | 50.4520 | 0.7770 | -3.7590 | 539.5833333 | 41.2110 |
| 11/01/06 | 08:00:00 | 50.7290 | 0.7780 | -3.6960 | 540.2777778 | 41.4250 |
| 11/01/06 | 08:01:00 | 50.7290 | 0.7780 | -3.6960 | 540.2777778 | 41.4250 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 08:02:00 | 50.7990 | 0.7790 | -3.6230 | 540.9722222 | 41.4220 |
| 11/01/06 | 08:03:00 | 50.7990 | 0.7790 | -3.6230 | 540.9722222 | 41.4220 |
| 11/01/06 | 08:04:00 | 50.7990 | 0.7790 | -3.6230 | 540.9722222 | 41.4220 |
| 11/01/06 | 08:05:00 | 50.7290 | 0.7800 | -3.5060 | 541.6666667 | 41.2350 |
| 11/01/06 | 08:06:00 | 51.0070 | 0.7800 | -3.4250 | 541.6666667 | 41.4320 |
| 11/01/06 | 08:07:00 | 51.0070 | 0.7800 | -3.4250 | 541.6666667 | 41.4320 |
| 11/01/06 | 08:08:00 | 50.7990 | 0.7800 | -3.3980 | 541.6666667 | 41.1970 |
| 11/01/06 | 08:09:00 | 50.7990 | 0.7800 | -3.3980 | 541.6666667 | 41.1970 |
| 11/01/06 | 08:10:00 | 50.8680 | 0.7810 | -3.3710 | 542.3611111 | 41.2390 |
| 11/01/06 | 08:11:00 | 50.9380 | 0.7810 | -3.3710 | 542.3611111 | 41.3090 |
| 11/01/06 | 08:12:00 | 50.9380 | 0.7810 | -3.3710 | 542.3611111 | 41.3090 |
| 11/01/06 | 08:13:00 | 51.2160 | 0.7830 | -3.3440 | 543.75 | 41.5600 |
| 11/01/06 | 08:14:00 | 51.0770 | 0.7830 | -3.3170 | 543.75 | 41.3940 |
| 11/01/06 | 08:15:00 | 51.0770 | 0.7830 | -3.3170 | 543.75 | 41.3940 |
| 11/01/06 | 08:16:00 | 51.2160 | 0.7840 | -3.2890 | 544.4444444 | 41.5050 |
| 11/01/06 | 08:17:00 | 51.1460 | 0.7840 | -3.2890 | 544.4444444 | 41.4350 |
| 11/01/06 | 08:18:00 | 51.1460 | 0.7840 | -3.2890 | 544.4444444 | 41.4350 |
| 11/01/06 | 08:19:00 | 51.1460 | 0.7840 | -3.2800 | 544.4444444 | 41.4260 |
| 11/01/06 | 08:20:00 | 51.1460 | 0.7840 | -3.2800 | 544.4444444 | 41.4260 |
| 11/01/06 | 08:21:00 | 50.9720 | 0.7810 | -3.2800 | 542.3611111 | 41.2520 |
| 11/01/06 | 08:22:00 | 50.9720 | 0.7810 | -3.2800 | 542.3611111 | 41.2520 |
| 11/01/06 | 08:23:00 | 51.2500 | 0.7860 | -3.2620 | 545.8333333 | 41.5120 |
| 11/01/06 | 08:24:00 | 51.3540 | 0.7860 | -3.2530 | 545.8333333 | 41.6070 |
| 11/01/06 | 08:25:00 | 51.3540 | 0.7860 | -3.2530 | 545.8333333 | 41.6070 |
| 11/01/06 | 08:26:00 | 51.2160 | 0.7840 | -3.2530 | 544.4444444 | 41.4690 |
| 11/01/06 | 08:27:00 | 51.2160 | 0.7840 | -3.2530 | 544.4444444 | 41.4690 |
| 11/01/06 | 08:28:00 | 51.1110 | 0.7840 | -3.2530 | 544.4444444 | 41.3640 |
| 11/01/06 | 08:29:00 | 51.3540 | 0.7830 | -3.2620 | 543.75 | 41.6160 |
| 11/01/06 | 08:30:00 | 51.2160 | 0.7830 | -3.2620 | 543.75 | 41.4780 |
| 11/01/06 | 08:31:00 | 51.2160 | 0.7830 | -3.2620 | 543.75 | 41.4780 |
| 11/01/06 | 08:32:00 | 51.3200 | 0.7840 | -3.2350 | 544.4444444 | 41.5550 |
| 11/01/06 | 08:33:00 | 51.3200 | 0.7840 | -3.2350 | 544.4444444 | 41.5550 |
| 11/01/06 | 08:34:00 | 51.4240 | 0.7860 | -3.2260 | 545.8333333 | 41.6500 |
| 11/01/06 | 08:35:00 | 51.4240 | 0.7860 | -3.2260 | 545.8333333 | 41.6500 |
| 11/01/06 | 08:36:00 | 51.2850 | 0.7820 | -3.2260 | 543.0555556 | 41.5110 |
| 11/01/06 | 08:37:00 | 51.2160 | 0.7850 | -3.1990 | 545.1388889 | 41.4150 |
| 11/01/06 | 08:38:00 | 51.2160 | 0.7850 | -3.1990 | 545.1388889 | 41.4150 |
| 11/01/06 | 08:39:00 | 51.2160 | 0.7840 | -3.1720 | 544.4444444 | 41.3880 |
| 11/01/06 | 08:40:00 | 51.2160 | 0.7840 | -3.1720 | 544.4444444 | 41.3880 |
| 11/01/06 | 08:41:00 | 51.3890 | 0.7850 | -3.1450 | 545.1388889 | 41.5340 |
| 11/01/06 | 08:42:00 | 51.2160 | 0.7860 | -3.1270 | 545.8333333 | 41.3430 |
| 11/01/06 | 08:43:00 | 51.2160 | 0.7860 | -3.1270 | 545.8333333 | 41.3430 |
| 11/01/06 | 08:44:00 | 51.3540 | 0.7860 | -3.1270 | 545.8333333 | 41.4810 |
| 11/01/06 | 08:45:00 | 51.3540 | 0.7860 | -3.1270 | 545.8333333 | 41.4810 |
| 11/01/06 | 08:46:00 | 51.3200 | 0.7860 | -3.1270 | 545.8333333 | 41.4470 |
| 11/01/06 | 08:47:00 | 51.3200 | 0.7860 | -3.1270 | 545.8333333 | 41.4470 |
| 11/01/06 | 08:48:00 | 51.3540 | 0.7870 | -3.1180 | 546.5277778 | 41.4720 |
| 11/01/06 | 08:49:00 | 51.3540 | 0.7870 | -3.1180 | 546.5277778 | 41.4720 |
| 11/01/06 | 08:50:00 | 51.1460 | 0.7860 | -3.1180 | 545.8333333 | 41.2640 |
| 11/01/06 | 08:51:00 | 51.1460 | 0.7860 | -3.1180 | 545.8333333 | 41.2640 |
| 11/01/06 | 08:52:00 | 51.1460 | 0.7870 | -3.0910 | 546.5277778 | 41.2370 |
| 11/01/06 | 08:53:00 | 51.1460 | 0.7870 | -3.0910 | 546.5277778 | 41.2370 |
| 11/01/06 | 08:54:00 | 51.0770 | 0.7850 | -3.0820 | 545.1388889 | 41.1590 |
| 11/01/06 | 08:55:00 | 50.9380 | 0.7850 | -3.0640 | 545.1388889 | 41.0020 |
| 11/01/06 | 08:56:00 | 50.9380 | 0.7850 | -3.0640 | 545.1388889 | 41.0020 |
| 11/01/06 | 08:57:00 | 50.9720 | 0.7870 | -3.0640 | 546.5277778 | 41.0360 |
| 11/01/06 | 08:58:00 | 51.1110 | 0.7860 | -3.0370 | 545.8333333 | 41.1480 |
| 11/01/06 | 08:59:00 | 51.1110 | 0.7860 | -3.0370 | 545.8333333 | 41.1480 |
| 11/01/06 | 09:00:00 | 51.3200 | 0.7850 | -3.0190 | 545.1388889 | 41.3390 |
| 11/01/06 | 09:01:00 | 51.3540 | 0.7870 | -3.0010 | 546.5277778 | 41.3550 |
| 11/01/06 | 09:02:00 | 51.3540 | 0.7870 | -3.0010 | 546.5277778 | 41.3550 |
| 11/01/06 | 09:03:00 | 51.3540 | 0.7870 | -2.9730 | 546.5277778 | 41.3270 |
| 11/01/06 | 09:04:00 | 51.3540 | 0.7870 | -2.9730 | 546.5277778 | 41.3270 |
| 11/01/06 | 09:05:00 | 51.2160 | 0.7860 | -2.9820 | 545.8333333 | 41.1980 |
| 11/01/06 | 09:06:00 | 51.2160 | 0.7860 | -2.9820 | 545.8333333 | 41.1980 |
| 11/01/06 | 09:07:00 | 51.2160 | 0.7840 | -2.9820 | 544.4444444 | 41.1980 |
| 11/01/06 | 09:08:00 | 51.2160 | 0.7840 | -2.9820 | 544.4444444 | 41.1980 |
| 11/01/06 | 09:09:00 | 51.2500 | 0.7870 | -2.9820 | 546.5277778 | 41.2320 |
| 11/01/06 | 09:10:00 | 51.2500 | 0.7870 | -2.9820 | 546.5277778 | 41.2320 |
| 11/01/06 | 09:11:00 | 51.3890 | 0.7860 | -2.9730 | 545.8333333 | 41.3620 |
| 11/01/06 | 09:12:00 | 51.4590 | 0.7860 | -2.9460 | 545.8333333 | 41.4050 |
| 11/01/06 | 09:13:00 | 51.4590 | 0.7860 | -2.9460 | 545.8333333 | 41.4050 |
| 11/01/06 | 09:14:00 | 51.4240 | 0.7860 | -2.9460 | 545.8333333 | 41.3700 |
| 11/01/06 | 09:15:00 | 51.4590 | 0.7860 | -2.9190 | 545.8333333 | 41.3780 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 09:16:00 | 51.4590 | 0.7860 | -2.9190 | 545.8333333 | 41.3780 |
| 11/01/06 | 09:17:00 | 51.5280 | 0.7870 | -2.8920 | 546.5277778 | 41.4200 |
| 11/01/06 | 09:18:00 | 51.5280 | 0.7870 | -2.8920 | 546.5277778 | 41.4200 |
| 11/01/06 | 09:19:00 | 51.4930 | 0.7870 | -2.8920 | 546.5277778 | 41.3850 |
| 11/01/06 | 09:20:00 | 51.4930 | 0.7870 | -2.8920 | 546.5277778 | 41.3850 |
| 11/01/06 | 09:21:00 | 51.4930 | 0.7870 | -2.9010 | 546.5277778 | 41.3940 |
| 11/01/06 | 09:22:00 | 51.4930 | 0.7870 | -2.9010 | 546.5277778 | 41.3940 |
| 11/01/06 | 09:23:00 | 51.3890 | 0.7880 | -2.8920 | 547.2222222 | 41.2810 |
| 11/01/06 | 09:24:00 | 51.3890 | 0.7880 | -2.8920 | 547.2222222 | 41.2810 |
| 11/01/06 | 09:25:00 | 51.5630 | 0.7870 | -2.8740 | 546.5277778 | 41.4370 |
| 11/01/06 | 09:26:00 | 51.4930 | 0.7880 | -2.8650 | 547.2222222 | 41.3580 |
| 11/01/06 | 09:27:00 | 51.4930 | 0.7880 | -2.8650 | 547.2222222 | 41.3580 |
| 11/01/06 | 09:28:00 | 51.5630 | 0.7880 | -2.8650 | 547.2222222 | 41.4280 |
| 11/01/06 | 09:29:00 | 51.5630 | 0.7880 | -2.8650 | 547.2222222 | 41.4280 |
| 11/01/06 | 09:30:00 | 51.4930 | 0.7870 | -2.8650 | 546.5277778 | 41.3580 |
| 11/01/06 | 09:31:00 | 51.4240 | 0.7890 | -2.8650 | 547.9166667 | 41.2890 |
| 11/01/06 | 09:32:00 | 51.4240 | 0.7890 | -2.8650 | 547.9166667 | 41.2890 |
| 11/01/06 | 09:33:00 | 51.3200 | 0.7870 | -2.8470 | 546.5277778 | 41.1670 |
| 11/01/06 | 09:34:00 | 51.3200 | 0.7870 | -2.8470 | 546.5277778 | 41.1670 |
| 11/01/06 | 09:35:00 | 51.4590 | 0.7880 | -2.8380 | 547.2222222 | 41.2970 |
| 11/01/06 | 09:36:00 | 51.4590 | 0.7880 | -2.8380 | 547.2222222 | 41.2970 |
| 11/01/06 | 09:37:00 | 51.4590 | 0.7890 | -2.8290 | 547.9166667 | 41.2880 |
| 11/01/06 | 09:38:00 | 51.4590 | 0.7890 | -2.8290 | 547.9166667 | 41.2880 |
| 11/01/06 | 09:39:00 | 51.4240 | 0.7890 | -2.8200 | 547.9166667 | 41.2440 |
| 11/01/06 | 09:40:00 | 51.4930 | 0.7880 | -2.8110 | 547.2222222 | 41.3040 |
| 11/01/06 | 09:41:00 | 51.4930 | 0.7880 | -2.8110 | 547.2222222 | 41.3040 |
| 11/01/06 | 09:42:00 | 51.4930 | 0.7900 | -2.8110 | 548.6111111 | 41.3040 |
| 11/01/06 | 09:43:00 | 51.4930 | 0.7900 | -2.8110 | 548.6111111 | 41.3040 |
| 11/01/06 | 09:44:00 | 51.4590 | 0.7890 | -2.8110 | 547.9166667 | 41.2700 |
| 11/01/06 | 09:45:00 | 51.5630 | 0.7890 | -2.8110 | 547.9166667 | 41.3740 |
| 11/01/06 | 09:46:00 | 51.5630 | 0.7890 | -2.8110 | 547.9166667 | 41.3740 |
| 11/01/06 | 09:47:00 | 51.3890 | 0.7890 | -2.8110 | 547.9166667 | 41.2000 |
| 11/01/06 | 09:48:00 | 51.5280 | 0.7880 | -2.7840 | 547.2222222 | 41.3120 |
| 11/01/06 | 09:49:00 | 51.5280 | 0.7880 | -2.7840 | 547.2222222 | 41.3120 |
| 11/01/06 | 09:50:00 | 51.4590 | 0.7880 | -2.7840 | 547.2222222 | 41.2430 |
| 11/01/06 | 09:51:00 | 51.4590 | 0.7880 | -2.7840 | 547.2222222 | 41.2430 |
| 11/01/06 | 09:52:00 | 51.5970 | 0.7860 | -2.7840 | 545.8333333 | 41.3810 |
| 11/01/06 | 09:53:00 | 51.5970 | 0.7860 | -2.7840 | 545.8333333 | 41.3810 |
| 11/01/06 | 09:54:00 | 51.5280 | 0.7870 | -2.7840 | 546.5277778 | 41.3120 |
| 11/01/06 | 09:55:00 | 51.5630 | 0.7870 | -2.7840 | 546.5277778 | 41.3470 |
| 11/01/06 | 09:56:00 | 51.5630 | 0.7870 | -2.7840 | 546.5277778 | 41.3470 |
| 11/01/06 | 09:57:00 | 51.5630 | 0.7870 | -2.7840 | 546.5277778 | 41.3470 |
| 11/01/06 | 09:58:00 | 51.5630 | 0.7870 | -2.7840 | 546.5277778 | 41.3470 |
| 11/01/06 | 09:59:00 | 51.5970 | 0.7880 | -2.7840 | 547.2222222 | 41.3810 |
| 11/01/06 | 10:00:00 | 51.6670 | 0.7880 | -2.7840 | 547.2222222 | 41.4510 |
| 11/01/06 | 10:01:00 | 51.4930 | 0.7880 | -2.7840 | 547.2222222 | 41.2770 |
| 11/01/06 | 10:02:00 | 51.4930 | 0.7880 | -2.7660 | 547.2222222 | 41.2590 |
| 11/01/06 | 10:03:00 | 51.4930 | 0.7880 | -2.7660 | 547.2222222 | 41.2590 |
| 11/01/06 | 10:04:00 | 51.5970 | 0.7880 | -2.7570 | 547.2222222 | 41.3540 |
| 11/01/06 | 10:05:00 | 51.5970 | 0.7880 | -2.7570 | 547.2222222 | 41.3540 |
| 11/01/06 | 10:06:00 | 51.6320 | 0.7860 | -2.7300 | 545.8333333 | 41.3620 |
| 11/01/06 | 10:07:00 | 51.6320 | 0.7860 | -2.7300 | 545.8333333 | 41.3620 |
| 11/01/06 | 10:08:00 | 51.5280 | 0.7890 | -2.7300 | 547.9166667 | 41.2580 |
| 11/01/06 | 10:09:00 | 51.6320 | 0.7870 | -2.7300 | 546.5277778 | 41.3620 |
| 11/01/06 | 10:10:00 | 51.6320 | 0.7870 | -2.7300 | 546.5277778 | 41.3620 |
| 11/01/06 | 10:11:00 | 51.8060 | 0.7870 | -2.7300 | 546.5277778 | 41.5360 |
| 11/01/06 | 10:12:00 | 51.8060 | 0.7870 | -2.7300 | 546.5277778 | 41.5360 |
| 11/01/06 | 10:13:00 | 51.7020 | 0.7870 | -2.7300 | 546.5277778 | 41.4320 |
| 11/01/06 | 10:14:00 | 51.5970 | 0.7880 | -2.7210 | 547.2222222 | 41.3180 |
| 11/01/06 | 10:15:00 | 51.6320 | 0.7880 | -2.7210 | 547.2222222 | 41.3530 |
| 11/01/06 | 10:16:00 | 51.6320 | 0.7880 | -2.7300 | 547.2222222 | 41.3620 |
| 11/01/06 | 10:17:00 | 51.7020 | 0.7890 | -2.7300 | 547.9166667 | 41.4320 |
| 11/01/06 | 10:18:00 | 51.7020 | 0.7890 | -2.7300 | 547.9166667 | 41.4320 |
| 11/01/06 | 10:19:00 | 51.7020 | 0.7870 | -2.7300 | 546.5277778 | 41.4320 |
| 11/01/06 | 10:20:00 | 51.7020 | 0.7870 | -2.7300 | 546.5277778 | 41.4320 |
| 11/01/06 | 10:21:00 | 51.8410 | 0.7890 | -2.7300 | 547.9166667 | 41.5710 |
| 11/01/06 | 10:22:00 | 51.8410 | 0.7890 | -2.7300 | 547.9166667 | 41.5710 |
| 11/01/06 | 10:23:00 | 51.5970 | 0.7900 | -2.7210 | 548.6111111 | 41.3180 |
| 11/01/06 | 10:24:00 | 51.5970 | 0.7900 | -2.7210 | 548.6111111 | 41.3180 |
| 11/01/06 | 10:25:00 | 51.5970 | 0.7890 | -2.7120 | 547.9166667 | 41.3090 |
| 11/01/06 | 10:26:00 | 51.6670 | 0.7900 | -2.6940 | 548.6111111 | 41.3610 |
| 11/01/06 | 10:27:00 | 51.6670 | 0.7900 | -2.6940 | 548.6111111 | 41.3610 |
| 11/01/06 | 10:28:00 | 51.7020 | 0.7900 | -2.6480 | 548.6111111 | 41.3500 |
| 11/01/06 | 10:29:00 | 51.7360 | 0.7900 | -2.5940 | 548.6111111 | 41.3300 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/01/06 | 10:30:00 | 51.7360 | 0.7890 | -2.5940 | 547.9166667 | 41.3300 |
| 11/01/06 | 10:31:00 | 51.8750 | 0.7910 | -2.5310 | 549.3055556 | 41.4060 |
| 11/01/06 | 10:32:00 | 51.8750 | 0.7910 | -2.5310 | 549.3055556 | 41.4060 |
| 11/01/06 | 10:33:00 | 51.8750 | 0.7920 | -2.4320 | 550 | 41.3070 |
| 11/01/06 | 10:34:00 | 51.8750 | 0.7920 | -2.4320 | 550 | 41.3070 |
| 11/01/06 | 10:35:00 | 52.1880 | 0.7930 | -2.3960 | 550.6944444 | 41.5840 |
| 11/01/06 | 10:36:00 | 52.1880 | 0.7930 | -2.3960 | 550.6944444 | 41.5840 |
| 11/01/06 | 10:37:00 | 52.0840 | 0.7910 | -2.3690 | 549.3055556 | 41.4530 |
| 11/01/06 | 10:38:00 | 52.0840 | 0.7910 | -2.3690 | 549.3055556 | 41.4530 |
| 11/01/06 | 10:39:00 | 52.0840 | 0.7910 | -2.3690 | 549.3055556 | 41.4530 |
| 11/01/06 | 10:40:00 | 52.1880 | 0.7910 | -2.3870 | 549.3055556 | 41.5750 |
| 11/01/06 | 10:41:00 | 52.1880 | 0.7910 | -2.3870 | 549.3055556 | 41.5750 |
| 11/01/06 | 10:42:00 | 52.1180 | 0.7910 | -2.3870 | 549.3055556 | 41.5050 |
| 11/01/06 | 10:43:00 | 51.9790 | 0.7900 | -2.3870 | 548.6111111 | 41.3660 |
| 11/01/06 | 10:44:00 | 51.9790 | 0.7900 | -2.3870 | 548.6111111 | 41.3660 |
| 11/01/06 | 10:45:00 | 51.9790 | 0.7900 | -2.3870 | 548.6111111 | 41.3660 |
| 11/01/06 | 10:46:00 | 52.0140 | 0.7900 | -2.3870 | 548.6111111 | 41.4010 |
| 11/01/06 | 10:47:00 | 52.0140 | 0.7900 | -2.3870 | 548.6111111 | 41.4010 |
| 11/01/06 | 10:48:00 | 52.0140 | 0.7910 | -2.3870 | 549.3055556 | 41.4010 |
| 11/01/06 | 10:49:00 | 52.0140 | 0.7910 | -2.3870 | 549.3055556 | 41.4010 |
| 11/01/06 | 10:50:00 | 52.0840 | 0.7910 | -2.3870 | 549.3055556 | 41.4710 |
| 11/01/06 | 10:51:00 | 52.0840 | 0.7910 | -2.3870 | 549.3055556 | 41.4710 |
| 11/01/06 | 10:52:00 | 52.0840 | 0.7910 | -2.3870 | 549.3055556 | 41.4710 |
| 11/01/06 | 10:53:00 | 52.0840 | 0.7910 | -2.3870 | 549.3055556 | 41.4710 |
| 11/01/06 | 10:54:00 | 51.7710 | 0.7890 | -2.3870 | 547.9166667 | 41.1580 |
| 11/01/06 | 10:55:00 | 51.7710 | 0.7890 | -2.3870 | 547.9166667 | 41.1580 |
| 11/01/06 | 10:56:00 | 52.0140 | 0.7900 | -2.3870 | 548.6111111 | 41.4010 |
| 11/01/06 | 10:57:00 | 52.0140 | 0.7900 | -2.3870 | 548.6111111 | 41.4010 |
| 11/01/06 | 10:58:00 | 52.0490 | 0.7900 | -2.3870 | 548.6111111 | 41.4360 |
| 11/01/06 | 10:59:00 | 51.9790 | 0.7910 | -2.3870 | 549.3055556 | 41.3660 |
| 11/01/06 | 11:00:00 | 51.9790 | 0.7910 | -2.3870 | 549.3055556 | 41.3660 |
| 11/01/06 | 11:01:00 | 52.0140 | 0.7900 | -2.3870 | 548.6111111 | 41.4010 |
| 11/01/06 | 11:02:00 | 52.0140 | 0.7900 | -2.3870 | 548.6111111 | 41.4010 |
| 11/01/06 | 11:03:00 | 52.2220 | 0.7910 | -2.3870 | 549.3055556 | 41.6090 |
| 11/01/06 | 11:04:00 | 52.2220 | 0.7910 | -2.3870 | 549.3055556 | 41.6090 |
| 11/01/06 | 11:05:00 | 52.0840 | 0.7910 | -2.3600 | 549.3055556 | 41.4440 |
| 11/01/06 | 11:06:00 | 52.0840 | 0.7910 | -2.3600 | 549.3055556 | 41.4440 |
| 11/01/06 | 11:07:00 | 52.2220 | 0.7920 | -2.3600 | 550 | 41.5820 |
| 11/01/06 | 11:08:00 | 52.2220 | 0.7920 | -2.3600 | 550 | 41.5820 |
| 11/01/06 | 11:09:00 | 52.1880 | 0.7910 | -2.3320 | 549.3055556 | 41.5200 |
| 11/01/06 | 11:10:00 | 51.9450 | 0.7890 | -2.3320 | 547.9166667 | 41.2770 |
| 11/01/06 | 11:11:00 | 51.9450 | 0.7890 | -2.3320 | 547.9166667 | 41.2770 |
| 11/01/06 | 11:12:00 | 51.9100 | 0.7900 | -2.3230 | 548.6111111 | 41.2330 |
| 11/01/06 | 11:13:00 | 52.0840 | 0.7900 | -2.3050 | 548.6111111 | 41.3890 |
| 11/01/06 | 11:14:00 | 52.0840 | 0.7900 | -2.3050 | 548.6111111 | 41.3890 |
| 11/01/06 | 11:15:00 | 52.0490 | 0.7910 | -2.3050 | 549.3055556 | 41.3540 |
| 11/01/06 | 11:16:00 | 52.0840 | 0.7900 | -2.3050 | 548.6111111 | 41.3890 |
| 11/01/06 | 11:17:00 | 52.0840 | 0.7900 | -2.3050 | 548.6111111 | 41.3890 |
| 11/01/06 | 11:18:00 | 52.1880 | 0.7920 | -2.3050 | 550 | 41.4930 |
| 11/01/06 | 11:19:00 | 52.1880 | 0.7920 | -2.3050 | 550 | 41.4930 |
| 11/01/06 | 11:20:00 | 52.2570 | 0.7910 | -2.2780 | 549.3055556 | 41.5350 |
| 11/01/06 | 11:21:00 | 52.2570 | 0.7910 | -2.2780 | 549.3055556 | 41.5350 |
| 11/01/06 | 11:22:00 | 52.1530 | 0.7900 | -2.2780 | 548.6111111 | 41.4310 |
| 11/01/06 | 11:23:00 | 52.1880 | 0.7910 | -2.2510 | 549.3055556 | 41.4390 |
| 11/01/06 | 11:24:00 | 52.1880 | 0.7910 | -2.2510 | 549.3055556 | 41.4390 |
| 11/01/06 | 11:25:00 | 52.2220 | 0.7920 | -2.2420 | 550 | 41.4640 |
| 11/01/06 | 11:26:00 | 52.2220 | 0.7920 | -2.2420 | 550 | 41.4640 |
| 11/01/06 | 11:27:00 | 52.1180 | 0.7910 | -2.2330 | 549.3055556 | 41.3510 |
| 11/01/06 | 11:28:00 | 52.1880 | 0.7910 | -2.2240 | 549.3055556 | 41.4120 |
| 11/01/06 | 11:29:00 | 52.1880 | 0.7910 | -2.2240 | 549.3055556 | 41.4120 |
| 11/01/06 | 11:30:00 | 52.2920 | 0.7900 | -2.2240 | 548.6111111 | 41.5160 |
| 11/01/06 | 11:31:00 | 52.2570 | 0.7900 | -2.2240 | 548.6111111 | 41.4810 |
| 11/01/06 | 11:32:00 | 52.2570 | 0.7900 | -2.2240 | 548.6111111 | 41.4810 |
| 11/01/06 | 11:33:00 | 52.1530 | 0.7910 | -2.2240 | 549.3055556 | 41.3770 |
| 11/01/06 | 11:34:00 | 52.1530 | 0.7910 | -2.2240 | 549.3055556 | 41.3770 |
| 11/01/06 | 11:35:00 | 52.1880 | 0.7910 | -2.2240 | 549.3055556 | 41.4120 |
| 11/01/06 | 11:36:00 | 52.1880 | 0.7910 | -2.2240 | 549.3055556 | 41.4120 |
| 11/01/06 | 11:37:00 | 52.1880 | 0.7910 | -2.2240 | 549.3055556 | 41.4120 |
| 11/01/06 | 11:38:00 | 52.1880 | 0.7910 | -2.2240 | 549.3055556 | 41.4120 |
| 11/01/06 | 11:39:00 | 52.1880 | 0.7920 | -2.2150 | 550 | 41.4030 |
| 11/01/06 | 11:40:00 | 52.1880 | 0.7920 | -2.2150 | 550 | 41.4030 |
| 11/01/06 | 11:41:00 | 52.1880 | 0.7920 | -2.2060 | 550 | 41.3940 |
| 11/01/06 | 11:42:00 | 52.2220 | 0.7910 | -2.1970 | 549.3055556 | 41.4190 |
| 11/01/06 | 11:43:00 | 52.2220 | 0.7910 | -2.1970 | 549.3055556 | 41.4190 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/01/06 | 11:44:00 | 52.1180 | 0.7920 | -2.1970 | 550 | 41.3150 |
| 11/01/06 | 11:45:00 | 52.1180 | 0.7920 | -2.1970 | 550 | 41.3150 |
| 11/01/06 | 11:46:00 | 52.1530 | 0.7910 | -2.1970 | 549.3055556 | 41.3500 |
| 11/01/06 | 11:47:00 | 52.3270 | 0.7910 | -2.1970 | 549.3055556 | 41.5240 |
| 11/01/06 | 11:48:00 | 52.3270 | 0.7910 | -2.1970 | 549.3055556 | 41.5240 |
| 11/01/06 | 11:49:00 | 52.2570 | 0.7920 | -2.1970 | 550 | 41.4540 |
| 11/01/06 | 11:50:00 | 52.2570 | 0.7920 | -2.1970 | 550 | 41.4540 |
| 11/01/06 | 11:51:00 | 52.3610 | 0.7930 | -2.1880 | 550.6944444 | 41.5490 |
| 11/01/06 | 11:52:00 | 52.3610 | 0.7930 | -2.1880 | 550.6944444 | 41.5490 |
| 11/01/06 | 11:53:00 | 52.3610 | 0.7920 | -2.1790 | 550 | 41.5400 |
| 11/01/06 | 11:54:00 | 52.3610 | 0.7920 | -2.1790 | 550 | 41.5400 |
| 11/01/06 | 11:55:00 | 52.2220 | 0.7920 | -2.1700 | 550 | 41.3920 |
| 11/01/06 | 11:56:00 | 52.3270 | 0.7920 | -2.1700 | 550 | 41.4970 |
| 11/01/06 | 11:57:00 | 52.3270 | 0.7920 | -2.1700 | 550 | 41.4970 |
| 11/01/06 | 11:58:00 | 52.2920 | 0.7920 | -2.1610 | 550 | 41.4530 |
| 11/01/06 | 11:59:00 | 52.3270 | 0.7920 | -2.1520 | 550 | 41.4790 |
| 11/01/06 | 12:00:00 | 52.3270 | 0.7920 | -2.1520 | 550 | 41.4790 |
| 11/01/06 | 12:01:00 | 52.3610 | 0.7920 | -2.1340 | 550 | 41.4950 |
| 11/01/06 | 12:02:00 | 52.3610 | 0.7920 | -2.1340 | 550 | 41.4950 |
| 11/01/06 | 12:03:00 | 52.3270 | 0.7920 | -2.1430 | 550 | 41.4700 |
| 11/01/06 | 12:04:00 | 52.3270 | 0.7920 | -2.1430 | 550 | 41.4700 |
| 11/01/06 | 12:05:00 | 52.2570 | 0.7900 | -2.1430 | 548.6111111 | 41.4000 |
| 11/01/06 | 12:06:00 | 52.2570 | 0.7900 | -2.1430 | 548.6111111 | 41.4000 |
| 11/01/06 | 12:07:00 | 52.3270 | 0.7910 | -2.1430 | 549.3055556 | 41.4700 |
| 11/01/06 | 12:08:00 | 52.2220 | 0.7940 | -2.1430 | 551.3888889 | 41.3650 |
| 11/01/06 | 12:09:00 | 52.2220 | 0.7940 | -2.1430 | 551.3888889 | 41.3650 |
| 11/01/06 | 12:10:00 | 52.3610 | 0.7920 | -2.1430 | 550 | 41.5040 |
| 11/01/06 | 12:11:00 | 52.3270 | 0.7920 | -2.1430 | 550 | 41.4700 |
| 11/01/06 | 12:12:00 | 52.3270 | 0.7920 | -2.1430 | 550 | 41.4700 |
| 11/01/06 | 12:13:00 | 52.3270 | 0.7930 | -2.1430 | 550.6944444 | 41.4700 |
| 11/01/06 | 12:14:00 | 52.3960 | 0.7910 | -2.1430 | 549.3055556 | 41.5390 |
| 11/01/06 | 12:15:00 | 52.3960 | 0.7910 | -2.1430 | 549.3055556 | 41.5390 |
| 11/01/06 | 12:16:00 | 52.2220 | 0.7920 | -2.1430 | 550 | 41.3650 |
| 11/01/06 | 12:17:00 | 52.4310 | 0.7920 | -2.1340 | 550 | 41.5650 |
| 11/01/06 | 12:18:00 | 52.4310 | 0.7920 | -2.1340 | 550 | 41.5650 |
| 11/01/06 | 12:19:00 | 52.2920 | 0.7920 | -2.1430 | 550 | 41.4350 |
| 11/01/06 | 12:20:00 | 52.2920 | 0.7920 | -2.1430 | 550 | 41.4350 |
| 11/01/06 | 12:21:00 | 52.2570 | 0.7920 | -2.1340 | 550 | 41.3910 |
| 11/01/06 | 12:22:00 | 52.2570 | 0.7920 | -2.1340 | 550 | 41.3910 |
| 11/01/06 | 12:23:00 | 52.3270 | 0.7910 | -2.1340 | 549.3055556 | 41.4610 |
| 11/01/06 | 12:24:00 | 52.3270 | 0.7910 | -2.1340 | 549.3055556 | 41.4610 |
| 11/01/06 | 12:25:00 | 52.3270 | 0.7930 | -2.1340 | 550.6944444 | 41.4610 |
| 11/01/06 | 12:26:00 | 52.2570 | 0.7910 | -2.1340 | 549.3055556 | 41.3910 |
| 11/01/06 | 12:27:00 | 52.2570 | 0.7910 | -2.1340 | 549.3055556 | 41.3910 |
| 11/01/06 | 12:28:00 | 52.2570 | 0.7940 | -2.1250 | 551.3888889 | 41.3820 |
| 11/01/06 | 12:29:00 | 52.3610 | 0.7920 | -2.1070 | 550 | 41.4680 |
| 11/01/06 | 12:30:00 | 52.3610 | 0.7920 | -2.1070 | 550 | 41.4680 |
| 11/01/06 | 12:31:00 | 52.4660 | 0.7920 | -2.0890 | 550 | 41.5550 |
| 11/01/06 | 12:32:00 | 52.5000 | 0.7920 | -2.0620 | 550 | 41.5620 |
| 11/01/06 | 12:33:00 | 52.5000 | 0.7920 | -2.0620 | 550 | 41.5620 |
| 11/01/06 | 12:34:00 | 52.5350 | 0.7930 | -2.0440 | 550.6944444 | 41.5790 |
| 11/01/06 | 12:35:00 | 52.5350 | 0.7930 | -2.0440 | 550.6944444 | 41.5790 |
| 11/01/06 | 12:36:00 | 52.4660 | 0.7930 | -2.0260 | 550.6944444 | 41.4920 |
| 11/01/06 | 12:37:00 | 52.4660 | 0.7930 | -2.0260 | 550.6944444 | 41.4920 |
| 11/01/06 | 12:38:00 | 52.5000 | 0.7940 | -1.9980 | 551.3888889 | 41.4980 |
| 11/01/06 | 12:39:00 | 52.5350 | 0.7940 | -1.9710 | 551.3888889 | 41.5060 |
| 11/01/06 | 12:40:00 | 52.5350 | 0.7940 | -1.9710 | 551.3888889 | 41.5060 |
| 11/01/06 | 12:41:00 | 52.5350 | 0.7940 | -1.9440 | 551.3888889 | 41.4790 |
| 11/01/06 | 12:42:00 | 52.5350 | 0.7940 | -1.9440 | 551.3888889 | 41.4790 |
| 11/01/06 | 12:43:00 | 52.5700 | 0.7950 | -1.9170 | 552.0833333 | 41.4870 |
| 11/01/06 | 12:44:00 | 52.5350 | 0.7950 | -1.8900 | 552.0833333 | 41.4250 |
| 11/01/06 | 12:45:00 | 52.5350 | 0.7950 | -1.8900 | 552.0833333 | 41.4250 |
| 11/01/06 | 12:46:00 | 52.6040 | 0.7930 | -1.8900 | 550.6944444 | 41.4940 |
| 11/01/06 | 12:47:00 | 52.4310 | 0.7940 | -1.8720 | 551.3888889 | 41.3030 |
| 11/01/06 | 12:48:00 | 52.4310 | 0.7940 | -1.8720 | 551.3888889 | 41.3030 |
| 11/01/06 | 12:49:00 | 52.5700 | 0.7950 | -1.8630 | 552.0833333 | 41.4330 |
| 11/01/06 | 12:50:00 | 52.5700 | 0.7950 | -1.8630 | 552.0833333 | 41.4330 |
| 11/01/06 | 12:51:00 | 52.5350 | 0.7940 | -1.8630 | 551.3888889 | 41.3980 |
| 11/01/06 | 12:52:00 | 52.5350 | 0.7940 | -1.8630 | 551.3888889 | 41.3980 |
| 11/01/06 | 12:53:00 | 52.7430 | 0.7950 | -1.8360 | 552.0833333 | 41.5790 |
| 11/01/06 | 12:54:00 | 52.7430 | 0.7950 | -1.8090 | 552.0833333 | 41.5520 |
| 11/01/06 | 12:55:00 | 52.7430 | 0.7950 | -1.8090 | 552.0833333 | 41.5520 |
| 11/01/06 | 12:56:00 | 52.7780 | 0.7940 | -1.7820 | 551.3888889 | 41.5600 |
| 11/01/06 | 12:57:00 | 52.7780 | 0.7940 | -1.7820 | 551.3888889 | 41.5600 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/01/06 | 12:58:00 | 52.8130 | 0.7970 | -1.7550 | 553.4722222 | 41.5680 |
| 11/01/06 | 12:59:00 | 52.7430 | 0.7950 | -1.7190 | 552.0833333 | 41.4620 |
| 11/01/06 | 13:00:00 | 52.7430 | 0.7950 | -1.7190 | 552.0833333 | 41.4620 |
| 11/01/06 | 13:01:00 | 53.0210 | 0.7970 | -1.6640 | 553.4722222 | 41.6850 |
| 11/01/06 | 13:02:00 | 53.0210 | 0.7970 | -1.6640 | 553.4722222 | 41.6850 |
| 11/01/06 | 13:03:00 | 52.9520 | 0.7980 | -1.6100 | 554.1666667 | 41.5620 |
| 11/01/06 | 13:04:00 | 52.9520 | 0.7980 | -1.6100 | 554.1666667 | 41.5620 |
| 11/01/06 | 13:05:00 | 53.0560 | 0.7980 | -1.5830 | 554.1666667 | 41.6390 |
| 11/01/06 | 13:06:00 | 53.0210 | 0.7990 | -1.5830 | 554.8611111 | 41.6040 |
| 11/01/06 | 13:07:00 | 53.0210 | 0.7990 | -1.5830 | 554.8611111 | 41.6040 |
| 11/01/06 | 13:08:00 | 52.9520 | 0.7980 | -1.5560 | 554.1666667 | 41.5080 |
| 11/01/06 | 13:09:00 | 52.9520 | 0.7980 | -1.5560 | 554.1666667 | 41.5080 |
| 11/01/06 | 13:10:00 | 53.0910 | 0.8000 | -1.5020 | 555.5555556 | 41.5930 |
| 11/01/06 | 13:11:00 | 53.0210 | 0.7980 | -1.5020 | 554.1666667 | 41.5230 |
| 11/01/06 | 13:12:00 | 53.0210 | 0.7980 | -1.5020 | 554.1666667 | 41.5230 |
| 11/01/06 | 13:13:00 | 52.8470 | 0.7990 | -1.5020 | 554.8611111 | 41.3490 |
| 11/01/06 | 13:14:00 | 52.8470 | 0.7990 | -1.5020 | 554.8611111 | 41.3490 |
| 11/01/06 | 13:15:00 | 52.9520 | 0.7990 | -1.4750 | 554.8611111 | 41.4270 |
| 11/01/06 | 13:16:00 | 53.1600 | 0.7990 | -1.4750 | 554.8611111 | 41.6350 |
| 11/01/06 | 13:17:00 | 53.1600 | 0.7990 | -1.4750 | 554.8611111 | 41.6350 |
| 11/01/06 | 13:18:00 | 53.1600 | 0.7990 | -1.4750 | 554.8611111 | 41.6350 |
| 11/01/06 | 13:19:00 | 53.1600 | 0.7990 | -1.4750 | 554.8611111 | 41.6350 |
| 11/01/06 | 13:20:00 | 52.9520 | 0.7960 | -1.4750 | 552.7777778 | 41.4270 |
| 11/01/06 | 13:21:00 | 52.9520 | 0.7960 | -1.4750 | 552.7777778 | 41.4270 |
| 11/01/06 | 13:22:00 | 52.9520 | 0.7960 | -1.4480 | 552.7777778 | 41.4000 |
| 11/01/06 | 13:23:00 | 53.0910 | 0.7980 | -1.4480 | 554.1666667 | 41.5390 |
| 11/01/06 | 13:24:00 | 53.0910 | 0.7980 | -1.4480 | 554.1666667 | 41.5390 |
| 11/01/06 | 13:25:00 | 53.0560 | 0.7990 | -1.4210 | 554.8611111 | 41.4770 |
| 11/01/06 | 13:26:00 | 53.0560 | 0.7990 | -1.4210 | 554.8611111 | 41.4770 |
| 11/01/06 | 13:27:00 | 53.1600 | 0.7990 | -1.4210 | 554.8611111 | 41.5810 |
| 11/01/06 | 13:28:00 | 53.1600 | 0.7990 | -1.4210 | 554.8611111 | 41.5810 |
| 11/01/06 | 13:29:00 | 53.0910 | 0.7990 | -1.4210 | 554.8611111 | 41.5120 |
| 11/01/06 | 13:30:00 | 53.0560 | 0.8020 | -1.4210 | 556.9444444 | 41.4770 |
| 11/01/06 | 13:31:00 | 53.1250 | 0.7990 | -1.4210 | 554.8611111 | 41.5460 |
| 11/01/06 | 13:32:00 | 53.1250 | 0.7990 | -1.4210 | 554.8611111 | 41.5460 |
| 11/01/06 | 13:33:00 | 53.1250 | 0.8000 | -1.4210 | 555.5555556 | 41.5460 |
| 11/01/06 | 13:34:00 | 53.1250 | 0.8000 | -1.4210 | 555.5555556 | 41.5460 |
| 11/01/06 | 13:35:00 | 53.2990 | 0.7990 | -1.4210 | 554.8611111 | 41.7200 |
| 11/01/06 | 13:36:00 | 53.2990 | 0.7990 | -1.4210 | 554.8611111 | 41.7200 |
| 11/01/06 | 13:37:00 | 52.9170 | 0.7990 | -1.4120 | 554.8611111 | 41.3290 |
| 11/01/06 | 13:38:00 | 52.9170 | 0.7990 | -1.4120 | 554.8611111 | 41.3290 |
| 11/01/06 | 13:39:00 | 53.0210 | 0.7990 | -1.4210 | 554.8611111 | 41.4420 |
| 11/01/06 | 13:40:00 | 52.9860 | 0.7990 | -1.4210 | 554.8611111 | 41.4070 |
| 11/01/06 | 13:41:00 | 52.9860 | 0.7990 | -1.4210 | 554.8611111 | 41.4070 |
| 11/01/06 | 13:42:00 | 53.0210 | 0.7980 | -1.4210 | 554.1666667 | 41.4420 |
| 11/01/06 | 13:43:00 | 53.0210 | 0.7980 | -1.4210 | 554.1666667 | 41.4420 |
| 11/01/06 | 13:44:00 | 53.1250 | 0.7980 | -1.3940 | 554.1666667 | 41.5190 |
| 11/01/06 | 13:45:00 | 53.0910 | 0.7990 | -1.3850 | 554.8611111 | 41.4760 |
| 11/01/06 | 13:46:00 | 53.0910 | 0.7990 | -1.3850 | 554.8611111 | 41.4760 |
| 11/01/06 | 13:47:00 | 53.1250 | 0.7980 | -1.3940 | 554.1666667 | 41.5190 |
| 11/01/06 | 13:48:00 | 52.9860 | 0.8000 | -1.3940 | 555.5555556 | 41.3800 |
| 11/01/06 | 13:49:00 | 52.9860 | 0.8000 | -1.3940 | 555.5555556 | 41.3800 |
| 11/01/06 | 13:50:00 | 53.1600 | 0.8000 | -1.3850 | 555.5555556 | 41.5450 |
| 11/01/06 | 13:51:00 | 53.1600 | 0.8000 | -1.3850 | 555.5555556 | 41.5450 |
| 11/01/06 | 13:52:00 | 53.0910 | 0.8010 | -1.3850 | 556.25 | 41.4760 |
| 11/01/06 | 13:53:00 | 53.0910 | 0.8010 | -1.3850 | 556.25 | 41.4760 |
| 11/01/06 | 13:54:00 | 53.3340 | 0.8000 | -1.3850 | 555.5555556 | 41.7190 |
| 11/01/06 | 13:55:00 | 53.3340 | 0.8000 | -1.3850 | 555.5555556 | 41.7190 |
| 11/01/06 | 13:56:00 | 52.9170 | 0.7980 | -1.3940 | 554.1666667 | 41.3110 |
| 11/01/06 | 13:57:00 | 52.9170 | 0.7980 | -1.3940 | 554.1666667 | 41.3110 |
| 11/01/06 | 13:58:00 | 53.2290 | 0.8000 | -1.3940 | 555.5555556 | 41.6230 |
| 11/01/06 | 13:59:00 | 53.2290 | 0.8000 | -1.3940 | 555.5555556 | 41.6230 |
| 11/01/06 | 14:00:00 | 53.1250 | 0.8000 | -1.3850 | 555.5555556 | 41.5100 |
| 11/01/06 | 14:01:00 | 53.2640 | 0.8000 | -1.3940 | 555.5555556 | 41.6580 |
| 11/01/06 | 14:02:00 | 53.2640 | 0.8000 | -1.3940 | 555.5555556 | 41.6580 |
| 11/01/06 | 14:03:00 | 53.3340 | 0.8000 | -1.3940 | 555.5555556 | 41.7280 |
| 11/01/06 | 14:04:00 | 53.3340 | 0.8000 | -1.3940 | 555.5555556 | 41.7280 |
| 11/01/06 | 14:05:00 | 53.1600 | 0.8000 | -1.3660 | 555.5555556 | 41.5260 |
| 11/01/06 | 14:06:00 | 53.1600 | 0.8000 | -1.3660 | 555.5555556 | 41.5260 |
| 11/01/06 | 14:07:00 | 53.2990 | 0.8010 | -1.3570 | 556.25 | 41.6560 |
| 11/01/06 | 14:08:00 | 53.1600 | 0.8000 | -1.3570 | 555.5555556 | 41.5170 |
| 11/01/06 | 14:09:00 | 53.1600 | 0.8000 | -1.3570 | 555.5555556 | 41.5170 |
| 11/01/06 | 14:10:00 | 53.2990 | 0.8010 | -1.3570 | 556.25 | 41.6560 |
| 11/01/06 | 14:11:00 | 53.3340 | 0.8010 | -1.3570 | 556.25 | 41.6910 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 14:12:00 | 53.3340 | 0.8010 | -1.3660 | 556.25 | 41.7000 |
| 11/01/06 | 14:13:00 | 53.1600 | 0.8000 | -1.3570 | 555.5555556 | 41.5170 |
| 11/01/06 | 14:14:00 | 53.2640 | 0.8000 | -1.3570 | 555.5555556 | 41.6210 |
| 11/01/06 | 14:15:00 | 53.2640 | 0.8000 | -1.3570 | 555.5555556 | 41.6210 |
| 11/01/06 | 14:16:00 | 53.2990 | 0.8000 | -1.3570 | 555.5555556 | 41.6560 |
| 11/01/06 | 14:17:00 | 53.2990 | 0.8000 | -1.3570 | 555.5555556 | 41.6560 |
| 11/01/06 | 14:18:00 | 53.2290 | 0.8010 | -1.3660 | 556.25 | 41.5950 |
| 11/01/06 | 14:19:00 | 53.2290 | 0.8010 | -1.3660 | 556.25 | 41.5950 |
| 11/01/06 | 14:20:00 | 53.1600 | 0.8010 | -1.3570 | 556.25 | 41.5170 |
| 11/01/06 | 14:21:00 | 53.1600 | 0.8010 | -1.3570 | 556.25 | 41.5170 |
| 11/01/06 | 14:22:00 | 53.1950 | 0.7990 | -1.3570 | 554.8611111 | 41.5520 |
| 11/01/06 | 14:23:00 | 53.1950 | 0.7990 | -1.3570 | 554.8611111 | 41.5520 |
| 11/01/06 | 14:24:00 | 53.2640 | 0.8000 | -1.3660 | 555.5555556 | 41.6300 |
| 11/01/06 | 14:25:00 | 53.2640 | 0.8000 | -1.3660 | 555.5555556 | 41.6300 |
| 11/01/06 | 14:26:00 | 53.2640 | 0.8000 | -1.3660 | 555.5555556 | 41.6300 |
| 11/01/06 | 14:27:00 | 53.1950 | 0.8020 | -1.3570 | 556.9444444 | 41.5520 |
| 11/01/06 | 14:28:00 | 53.1950 | 0.8020 | -1.3570 | 556.9444444 | 41.5520 |
| 11/01/06 | 14:29:00 | 53.1600 | 0.8010 | -1.3570 | 556.25 | 41.5170 |
| 11/01/06 | 14:30:00 | 53.1600 | 0.7990 | -1.3660 | 554.8611111 | 41.5260 |
| 11/01/06 | 14:31:00 | 53.1250 | 0.7980 | -1.3570 | 554.1666667 | 41.4820 |
| 11/01/06 | 14:32:00 | 53.1250 | 0.7980 | -1.3570 | 554.1666667 | 41.4820 |
| 11/01/06 | 14:33:00 | 53.0910 | 0.8000 | -1.3660 | 555.5555556 | 41.4570 |
| 11/01/06 | 14:34:00 | 53.0910 | 0.8000 | -1.3660 | 555.5555556 | 41.4570 |
| 11/01/06 | 14:35:00 | 53.0910 | 0.8000 | -1.3660 | 555.5555556 | 41.4570 |
| 11/01/06 | 14:36:00 | 53.0910 | 0.8000 | -1.3660 | 555.5555556 | 41.4570 |
| 11/01/06 | 14:37:00 | 53.0910 | 0.7990 | -1.3660 | 554.8611111 | 41.4570 |
| 11/01/06 | 14:38:00 | 53.0910 | 0.7990 | -1.3660 | 554.8611111 | 41.4570 |
| 11/01/06 | 14:39:00 | 53.0560 | 0.8000 | -1.3760 | 555.5555556 | 41.4320 |
| 11/01/06 | 14:40:00 | 53.1600 | 0.7990 | -1.3850 | 554.8611111 | 41.5450 |
| 11/01/06 | 14:41:00 | 53.1600 | 0.7990 | -1.3850 | 554.8611111 | 41.5450 |
| 11/01/06 | 14:42:00 | 53.1950 | 0.8010 | -1.3850 | 556.25 | 41.5800 |
| 11/01/06 | 14:43:00 | 53.1950 | 0.8010 | -1.3850 | 556.25 | 41.5800 |
| 11/01/06 | 14:44:00 | 53.1600 | 0.8000 | -1.3940 | 555.5555556 | 41.5540 |
| 11/01/06 | 14:45:00 | 53.2990 | 0.8000 | -1.3940 | 555.5555556 | 41.6930 |
| 11/01/06 | 14:46:00 | 53.2990 | 0.8000 | -1.3940 | 555.5555556 | 41.6930 |
| 11/01/06 | 14:47:00 | 53.0210 | 0.8010 | -1.3940 | 556.25 | 41.4150 |
| 11/01/06 | 14:48:00 | 52.9860 | 0.8010 | -1.3850 | 556.25 | 41.3710 |
| 11/01/06 | 14:49:00 | 52.9860 | 0.8010 | -1.3850 | 556.25 | 41.3710 |
| 11/01/06 | 14:50:00 | 53.1600 | 0.8000 | -1.3850 | 555.5555556 | 41.5450 |
| 11/01/06 | 14:51:00 | 53.1600 | 0.8000 | -1.3850 | 555.5555556 | 41.5450 |
| 11/01/06 | 14:52:00 | 53.1250 | 0.8010 | -1.3940 | 556.25 | 41.5190 |
| 11/01/06 | 14:53:00 | 53.1250 | 0.8010 | -1.3940 | 556.25 | 41.5190 |
| 11/01/06 | 14:54:00 | 53.2290 | 0.8010 | -1.3850 | 556.25 | 41.6140 |
| 11/01/06 | 14:55:00 | 53.2290 | 0.8010 | -1.3850 | 556.25 | 41.6140 |
| 11/01/06 | 14:56:00 | 53.0910 | 0.7990 | -1.3940 | 554.8611111 | 41.4850 |
| 11/01/06 | 14:57:00 | 53.2290 | 0.8010 | -1.3850 | 556.25 | 41.6140 |
| 11/01/06 | 14:58:00 | 53.2290 | 0.8010 | -1.3850 | 556.25 | 41.6140 |
| 11/01/06 | 14:59:00 | 53.1250 | 0.8010 | -1.3850 | 556.25 | 41.5100 |
| 11/01/06 | 15:00:00 | 53.0910 | 0.7990 | -1.3850 | 554.8611111 | 41.4760 |
| 11/01/06 | 15:01:00 | 53.0910 | 0.7990 | -1.3850 | 554.8611111 | 41.4760 |
| 11/01/06 | 15:02:00 | 53.0560 | 0.7990 | -1.3940 | 554.8611111 | 41.4500 |
| 11/01/06 | 15:03:00 | 53.0560 | 0.7990 | -1.3940 | 554.8611111 | 41.4500 |
| 11/01/06 | 15:04:00 | 53.2290 | 0.8000 | -1.3940 | 555.5555556 | 41.6230 |
| 11/01/06 | 15:05:00 | 53.2290 | 0.8000 | -1.3940 | 555.5555556 | 41.6230 |
| 11/01/06 | 15:06:00 | 53.1600 | 0.8010 | -1.4120 | 556.25 | 41.5720 |
| 11/01/06 | 15:07:00 | 53.0210 | 0.7990 | -1.4210 | 554.8611111 | 41.4420 |
| 11/01/06 | 15:08:00 | 53.0210 | 0.7990 | -1.4210 | 554.8611111 | 41.4420 |
| 11/01/06 | 15:09:00 | 52.8130 | 0.7990 | -1.4210 | 554.8611111 | 41.2340 |
| 11/01/06 | 15:10:00 | 52.8130 | 0.7990 | -1.4210 | 554.8611111 | 41.2340 |
| 11/01/06 | 15:11:00 | 52.8470 | 0.7990 | -1.4120 | 554.8611111 | 41.2590 |
| 11/01/06 | 15:12:00 | 52.8470 | 0.7990 | -1.4120 | 554.8611111 | 41.2590 |
| 11/01/06 | 15:13:00 | 52.8820 | 0.7970 | -1.4210 | 553.4722222 | 41.3030 |
| 11/01/06 | 15:14:00 | 52.8470 | 0.8000 | -1.4210 | 555.5555556 | 41.2680 |
| 11/01/06 | 15:15:00 | 52.8470 | 0.8000 | -1.4210 | 555.5555556 | 41.2680 |
| 11/01/06 | 15:16:00 | 52.8820 | 0.7990 | -1.4120 | 554.8611111 | 41.2940 |
| 11/01/06 | 15:17:00 | 52.7780 | 0.7970 | -1.4210 | 553.4722222 | 41.1990 |
| 11/01/06 | 15:18:00 | 52.7780 | 0.7970 | -1.4210 | 553.4722222 | 41.1990 |
| 11/01/06 | 15:19:00 | 52.8820 | 0.7990 | -1.4210 | 554.8611111 | 41.3030 |
| 11/01/06 | 15:20:00 | 52.8820 | 0.7990 | -1.4210 | 554.8611111 | 41.3030 |
| 11/01/06 | 15:21:00 | 52.7090 | 0.7990 | -1.4210 | 554.8611111 | 41.1300 |
| 11/01/06 | 15:22:00 | 52.7090 | 0.7990 | -1.4210 | 554.8611111 | 41.1300 |
| 11/01/06 | 15:23:00 | 52.7780 | 0.7970 | -1.4120 | 553.4722222 | 41.1900 |
| 11/01/06 | 15:24:00 | 52.8130 | 0.7970 | -1.4210 | 553.4722222 | 41.2340 |
| 11/01/06 | 15:25:00 | 52.8130 | 0.7970 | -1.4210 | 553.4722222 | 41.2340 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 15:26:00 | 52.9520 | 0.7980 | -1.4210 | 554.1666667 | 41.3730 |
| 11/01/06 | 15:27:00 | 52.9520 | 0.7980 | -1.4210 | 554.1666667 | 41.3730 |
| 11/01/06 | 15:28:00 | 52.8470 | 0.7970 | -1.4210 | 553.4722222 | 41.2680 |
| 11/01/06 | 15:29:00 | 52.8470 | 0.7980 | -1.4210 | 554.1666667 | 41.2680 |
| 11/01/06 | 15:30:00 | 52.8470 | 0.7980 | -1.4210 | 554.1666667 | 41.2680 |
| 11/01/06 | 15:31:00 | 52.7430 | 0.7980 | -1.4210 | 554.1666667 | 41.1640 |
| 11/01/06 | 15:32:00 | 52.9170 | 0.8000 | -1.4390 | 555.5555556 | 41.3560 |
| 11/01/06 | 15:33:00 | 52.9170 | 0.8000 | -1.4390 | 555.5555556 | 41.3560 |
| 11/01/06 | 15:34:00 | 52.8820 | 0.7980 | -1.4480 | 554.1666667 | 41.3300 |
| 11/01/06 | 15:35:00 | 52.8820 | 0.7980 | -1.4480 | 554.1666667 | 41.3300 |
| 11/01/06 | 15:36:00 | 52.8820 | 0.7980 | -1.4480 | 554.1666667 | 41.3300 |
| 11/01/06 | 15:37:00 | 52.7780 | 0.7990 | -1.4480 | 554.8611111 | 41.2260 |
| 11/01/06 | 15:38:00 | 52.8130 | 0.7990 | -1.4480 | 554.8611111 | 41.2610 |
| 11/01/06 | 15:39:00 | 52.8130 | 0.7990 | -1.4480 | 554.8611111 | 41.2610 |
| 11/01/06 | 15:40:00 | 52.8470 | 0.7980 | -1.4750 | 554.1666667 | 41.3220 |
| 11/01/06 | 15:41:00 | 52.8470 | 0.7980 | -1.4750 | 554.1666667 | 41.3220 |
| 11/01/06 | 15:42:00 | 52.8130 | 0.7990 | -1.4750 | 554.8611111 | 41.2880 |
| 11/01/06 | 15:43:00 | 52.8820 | 0.8000 | -1.4750 | 555.5555556 | 41.3570 |
| 11/01/06 | 15:44:00 | 52.8820 | 0.8000 | -1.4750 | 555.5555556 | 41.3570 |
| 11/01/06 | 15:45:00 | 52.8470 | 0.7980 | -1.4750 | 554.1666667 | 41.3220 |
| 11/01/06 | 15:46:00 | 52.8820 | 0.7990 | -1.4750 | 554.8611111 | 41.3570 |
| 11/01/06 | 15:47:00 | 52.8820 | 0.7990 | -1.4750 | 554.8611111 | 41.3570 |
| 11/01/06 | 15:48:00 | 52.7430 | 0.7990 | -1.4750 | 554.8611111 | 41.2180 |
| 11/01/06 | 15:49:00 | 52.7430 | 0.7990 | -1.4750 | 554.8611111 | 41.2180 |
| 11/01/06 | 15:50:00 | 52.7430 | 0.7990 | -1.4750 | 554.8611111 | 41.2180 |
| 11/01/06 | 15:51:00 | 52.8820 | 0.8000 | -1.4750 | 555.5555556 | 41.3570 |
| 11/01/06 | 15:52:00 | 52.8820 | 0.8000 | -1.4750 | 555.5555556 | 41.3570 |
| 11/01/06 | 15:53:00 | 52.8470 | 0.7990 | -1.4750 | 554.8611111 | 41.3220 |
| 11/01/06 | 15:54:00 | 52.8470 | 0.7990 | -1.4750 | 554.8611111 | 41.3220 |
| 11/01/06 | 15:55:00 | 52.7430 | 0.7980 | -1.4750 | 554.1666667 | 41.2180 |
| 11/01/06 | 15:56:00 | 52.8820 | 0.8000 | -1.4750 | 555.5555556 | 41.3570 |
| 11/01/06 | 15:57:00 | 52.8820 | 0.8000 | -1.4750 | 555.5555556 | 41.3570 |
| 11/01/06 | 15:58:00 | 52.9860 | 0.7990 | -1.4750 | 554.8611111 | 41.4610 |
| 11/01/06 | 15:59:00 | 52.9860 | 0.7990 | -1.4750 | 554.8611111 | 41.4610 |
| 11/01/06 | 16:00:00 | 52.8820 | 0.7970 | -1.4750 | 553.4722222 | 41.3570 |
| 11/01/06 | 16:01:00 | 52.9170 | 0.7990 | -1.4840 | 554.8611111 | 41.4010 |
| 11/01/06 | 16:02:00 | 52.9170 | 0.7990 | -1.4840 | 554.8611111 | 41.4010 |
| 11/01/06 | 16:03:00 | 52.9860 | 0.7990 | -1.4750 | 554.8611111 | 41.4610 |
| 11/01/06 | 16:04:00 | 52.9860 | 0.7990 | -1.4750 | 554.8611111 | 41.4610 |
| 11/01/06 | 16:05:00 | 52.8820 | 0.7990 | -1.4750 | 554.8611111 | 41.3570 |
| 11/01/06 | 16:06:00 | 52.8820 | 0.7990 | -1.4750 | 554.8611111 | 41.3570 |
| 11/01/06 | 16:07:00 | 52.8820 | 0.8000 | -1.4930 | 555.5555556 | 41.3750 |
| 11/01/06 | 16:08:00 | 52.8820 | 0.8000 | -1.4930 | 555.5555556 | 41.3750 |
| 11/01/06 | 16:09:00 | 52.9170 | 0.7990 | -1.4930 | 554.8611111 | 41.4100 |
| 11/01/06 | 16:10:00 | 52.9170 | 0.7990 | -1.4930 | 554.8611111 | 41.4100 |
| 11/01/06 | 16:11:00 | 52.9520 | 0.8000 | -1.5020 | 555.5555556 | 41.4540 |
| 11/01/06 | 16:12:00 | 52.9520 | 0.8000 | -1.5020 | 555.5555556 | 41.4540 |
| 11/01/06 | 16:13:00 | 52.9170 | 0.7970 | -1.5020 | 553.4722222 | 41.4190 |
| 11/01/06 | 16:14:00 | 52.9520 | 0.7990 | -1.5020 | 554.8611111 | 41.4540 |
| 11/01/06 | 16:15:00 | 52.9520 | 0.7980 | -1.5020 | 554.1666667 | 41.4540 |
| 11/01/06 | 16:16:00 | 52.9520 | 0.7980 | -1.5020 | 554.1666667 | 41.4540 |
| 11/01/06 | 16:17:00 | 52.8470 | 0.7990 | -1.5020 | 554.8611111 | 41.3490 |
| 11/01/06 | 16:18:00 | 52.8470 | 0.7990 | -1.5020 | 554.8611111 | 41.3490 |
| 11/01/06 | 16:19:00 | 52.9170 | 0.7980 | -1.5020 | 554.1666667 | 41.4190 |
| 11/01/06 | 16:20:00 | 52.9170 | 0.7980 | -1.5020 | 554.1666667 | 41.4190 |
| 11/01/06 | 16:21:00 | 53.0560 | 0.7970 | -1.5290 | 553.4722222 | 41.5850 |
| 11/01/06 | 16:22:00 | 53.0560 | 0.7970 | -1.5290 | 553.4722222 | 41.5850 |
| 11/01/06 | 16:23:00 | 52.8130 | 0.7990 | -1.5290 | 554.8611111 | 41.3420 |
| 11/01/06 | 16:24:00 | 52.8130 | 0.7990 | -1.5290 | 554.8611111 | 41.3420 |
| 11/01/06 | 16:25:00 | 52.9860 | 0.7990 | -1.5290 | 554.8611111 | 41.5150 |
| 11/01/06 | 16:26:00 | 52.7780 | 0.7980 | -1.5290 | 554.1666667 | 41.3070 |
| 11/01/06 | 16:27:00 | 52.7780 | 0.7980 | -1.5290 | 554.1666667 | 41.3070 |
| 11/01/06 | 16:28:00 | 52.8130 | 0.7960 | -1.5290 | 552.7777778 | 41.3420 |
| 11/01/06 | 16:29:00 | 52.7430 | 0.7990 | -1.5290 | 554.8611111 | 41.2720 |
| 11/01/06 | 16:30:00 | 52.7430 | 0.7990 | -1.5290 | 554.8611111 | 41.2720 |
| 11/01/06 | 16:31:00 | 52.7430 | 0.7970 | -1.5560 | 553.4722222 | 41.2990 |
| 11/01/06 | 16:32:00 | 52.7430 | 0.7970 | -1.5560 | 553.4722222 | 41.2990 |
| 11/01/06 | 16:33:00 | 53.0210 | 0.7990 | -1.5560 | 554.8611111 | 41.5770 |
| 11/01/06 | 16:34:00 | 52.9170 | 0.7970 | -1.5560 | 553.4722222 | 41.4730 |
| 11/01/06 | 16:35:00 | 52.9170 | 0.7970 | -1.5560 | 553.4722222 | 41.4730 |
| 11/01/06 | 16:36:00 | 52.8820 | 0.7980 | -1.5560 | 554.1666667 | 41.4380 |
| 11/01/06 | 16:37:00 | 52.8820 | 0.7980 | -1.5560 | 554.1666667 | 41.4380 |
| 11/01/06 | 16:38:00 | 52.9170 | 0.7960 | -1.5560 | 552.7777778 | 41.4730 |
| 11/01/06 | 16:39:00 | 52.9170 | 0.7960 | -1.5560 | 552.7777778 | 41.4730 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 16:40:00 | 52.8130 | 0.7970 | -1.5830 | 553.4722222 | 41.3960 |
| 11/01/06 | 16:41:00 | 52.8820 | 0.7980 | -1.5830 | 554.1666667 | 41.4650 |
| 11/01/06 | 16:42:00 | 52.8820 | 0.7980 | -1.5830 | 554.1666667 | 41.4650 |
| 11/01/06 | 16:43:00 | 52.6390 | 0.7950 | -1.6010 | 552.0833333 | 41.2400 |
| 11/01/06 | 16:44:00 | 52.6740 | 0.7960 | -1.6010 | 552.7777778 | 41.2750 |
| 11/01/06 | 16:45:00 | 52.8130 | 0.7960 | -1.6100 | 552.7777778 | 41.4230 |
| 11/01/06 | 16:46:00 | 52.5350 | 0.7970 | -1.6100 | 553.4722222 | 41.1450 |
| 11/01/06 | 16:47:00 | 52.8470 | 0.7970 | -1.6100 | 553.4722222 | 41.4570 |
| 11/01/06 | 16:48:00 | 52.8470 | 0.7970 | -1.6100 | 553.4722222 | 41.4570 |
| 11/01/06 | 16:49:00 | 52.8470 | 0.7970 | -1.6100 | 553.4722222 | 41.4570 |
| 11/01/06 | 16:50:00 | 52.8470 | 0.7970 | -1.6100 | 553.4722222 | 41.4570 |
| 11/01/06 | 16:51:00 | 52.9860 | 0.8010 | -1.5380 | 556.25 | 41.5240 |
| 11/01/06 | 16:52:00 | 52.9860 | 0.8010 | -1.5380 | 556.25 | 41.5240 |
| 11/01/06 | 16:53:00 | 52.8470 | 0.8000 | -1.5020 | 555.5555556 | 41.3490 |
| 11/01/06 | 16:54:00 | 52.8470 | 0.8000 | -1.5020 | 555.5555556 | 41.3490 |
| 11/01/06 | 16:55:00 | 53.0560 | 0.8000 | -1.4660 | 555.5555556 | 41.5220 |
| 11/01/06 | 16:56:00 | 53.0560 | 0.8000 | -1.4660 | 555.5555556 | 41.5220 |
| 11/01/06 | 16:57:00 | 52.6390 | 0.7990 | -1.4750 | 554.8611111 | 41.1140 |
| 11/01/06 | 16:58:00 | 52.9520 | 0.7980 | -1.4480 | 554.1666667 | 41.4000 |
| 11/01/06 | 16:59:00 | 52.9520 | 0.7980 | -1.4480 | 554.1666667 | 41.4000 |
| 11/01/06 | 17:00:00 | 52.9170 | 0.8000 | -1.4480 | 555.5555556 | 41.3650 |
| 11/01/06 | 17:01:00 | 52.9860 | 0.8000 | -1.4480 | 555.5555556 | 41.4340 |
| 11/01/06 | 17:02:00 | 52.9860 | 0.8000 | -1.4480 | 555.5555556 | 41.4340 |
| 11/01/06 | 17:03:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:04:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:05:00 | 52.8820 | 0.7990 | -1.4480 | 554.8611111 | 41.3300 |
| 11/01/06 | 17:06:00 | 52.8820 | 0.7990 | -1.4480 | 554.8611111 | 41.3300 |
| 11/01/06 | 17:07:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:08:00 | 52.9520 | 0.7990 | -1.4480 | 554.8611111 | 41.4000 |
| 11/01/06 | 17:09:00 | 52.9520 | 0.7990 | -1.4480 | 554.8611111 | 41.4000 |
| 11/01/06 | 17:10:00 | 53.0910 | 0.7980 | -1.4480 | 554.1666667 | 41.5390 |
| 11/01/06 | 17:11:00 | 53.0910 | 0.7980 | -1.4480 | 554.1666667 | 41.5390 |
| 11/01/06 | 17:12:00 | 52.8470 | 0.7970 | -1.4390 | 553.4722222 | 41.2860 |
| 11/01/06 | 17:13:00 | 52.7780 | 0.7980 | -1.4480 | 554.1666667 | 41.2260 |
| 11/01/06 | 17:14:00 | 52.8820 | 0.7970 | -1.4480 | 553.4722222 | 41.3300 |
| 11/01/06 | 17:15:00 | 52.8820 | 0.7970 | -1.4480 | 553.4722222 | 41.3300 |
| 11/01/06 | 17:16:00 | 52.8820 | 0.7990 | -1.4390 | 554.8611111 | 41.3210 |
| 11/01/06 | 17:17:00 | 52.8820 | 0.7990 | -1.4390 | 554.8611111 | 41.3210 |
| 11/01/06 | 17:18:00 | 52.7090 | 0.7970 | -1.4390 | 553.4722222 | 41.1480 |
| 11/01/06 | 17:19:00 | 52.7090 | 0.7970 | -1.4390 | 553.4722222 | 41.1480 |
| 11/01/06 | 17:20:00 | 53.0910 | 0.7990 | -1.4390 | 554.8611111 | 41.5300 |
| 11/01/06 | 17:21:00 | 52.8820 | 0.7980 | -1.4480 | 554.1666667 | 41.3300 |
| 11/01/06 | 17:22:00 | 52.8820 | 0.7980 | -1.4480 | 554.1666667 | 41.3300 |
| 11/01/06 | 17:23:00 | 52.8470 | 0.7990 | -1.4480 | 554.8611111 | 41.2950 |
| 11/01/06 | 17:24:00 | 52.8470 | 0.7990 | -1.4480 | 554.8611111 | 41.2950 |
| 11/01/06 | 17:25:00 | 52.8820 | 0.7990 | -1.4480 | 554.8611111 | 41.3300 |
| 11/01/06 | 17:26:00 | 52.8820 | 0.8000 | -1.4480 | 555.5555556 | 41.3300 |
| 11/01/06 | 17:27:00 | 52.8820 | 0.8000 | -1.4480 | 555.5555556 | 41.3300 |
| 11/01/06 | 17:28:00 | 52.6040 | 0.8000 | -1.4480 | 555.5555556 | 41.0520 |
| 11/01/06 | 17:29:00 | 52.6040 | 0.8000 | -1.4480 | 555.5555556 | 41.0520 |
| 11/01/06 | 17:30:00 | 52.9520 | 0.7990 | -1.4480 | 554.8611111 | 41.4000 |
| 11/01/06 | 17:31:00 | 52.8130 | 0.7990 | -1.4480 | 554.8611111 | 41.2610 |
| 11/01/06 | 17:32:00 | 52.8130 | 0.7990 | -1.4480 | 554.8611111 | 41.2610 |
| 11/01/06 | 17:33:00 | 53.0910 | 0.8000 | -1.4480 | 555.5555556 | 41.5390 |
| 11/01/06 | 17:34:00 | 53.0910 | 0.8000 | -1.4480 | 555.5555556 | 41.5390 |
| 11/01/06 | 17:35:00 | 52.8130 | 0.7980 | -1.4480 | 554.1666667 | 41.2610 |
| 11/01/06 | 17:36:00 | 52.8130 | 0.7980 | -1.4480 | 554.1666667 | 41.2610 |
| 11/01/06 | 17:37:00 | 53.0560 | 0.8000 | -1.4480 | 555.5555556 | 41.5040 |
| 11/01/06 | 17:38:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:39:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:40:00 | 53.0560 | 0.8010 | -1.4480 | 556.25 | 41.5040 |
| 11/01/06 | 17:41:00 | 53.0560 | 0.8010 | -1.4480 | 556.25 | 41.5040 |
| 11/01/06 | 17:42:00 | 52.9170 | 0.7990 | -1.4480 | 554.8611111 | 41.3650 |
| 11/01/06 | 17:43:00 | 52.9170 | 0.7990 | -1.4480 | 554.8611111 | 41.3650 |
| 11/01/06 | 17:44:00 | 53.0210 | 0.7970 | -1.4480 | 553.4722222 | 41.4690 |
| 11/01/06 | 17:45:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:46:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:47:00 | 52.8820 | 0.7990 | -1.4480 | 554.8611111 | 41.3300 |
| 11/01/06 | 17:48:00 | 52.8820 | 0.7990 | -1.4480 | 554.8611111 | 41.3300 |
| 11/01/06 | 17:49:00 | 52.8130 | 0.8000 | -1.4480 | 555.5555556 | 41.2610 |
| 11/01/06 | 17:50:00 | 52.7430 | 0.8000 | -1.4480 | 555.5555556 | 41.1910 |
| 11/01/06 | 17:51:00 | 52.7430 | 0.8000 | -1.4480 | 555.5555556 | 41.1910 |
| 11/01/06 | 17:52:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |
| 11/01/06 | 17:53:00 | 53.0210 | 0.7990 | -1.4480 | 554.8611111 | 41.4690 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 17:54:00 | 52.8820 | 0.8000 | -1.4390 | 555.5555556 | 41.3210 |
| 11/01/06 | 17:55:00 | 52.8820 | 0.8000 | -1.4390 | 555.5555556 | 41.3210 |
| 11/01/06 | 17:56:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 17:57:00 | 52.8130 | 0.7990 | -1.4480 | 554.8611111 | 41.2610 |
| 11/01/06 | 17:58:00 | 52.8820 | 0.8010 | -1.4480 | 556.25 | 41.3300 |
| 11/01/06 | 17:59:00 | 52.8820 | 0.7970 | -1.4480 | 553.4722222 | 41.3300 |
| 11/01/06 | 18:00:00 | 52.8820 | 0.7970 | -1.4480 | 553.4722222 | 41.3300 |
| 11/01/06 | 18:01:00 | 53.0560 | 0.7990 | -1.4480 | 554.8611111 | 41.5040 |
| 11/01/06 | 18:02:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:03:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:04:00 | 52.8820 | 0.8000 | -1.4480 | 555.5555556 | 41.3300 |
| 11/01/06 | 18:05:00 | 52.8820 | 0.8000 | -1.4480 | 555.5555556 | 41.3300 |
| 11/01/06 | 18:06:00 | 53.0210 | 0.7980 | -1.4480 | 554.1666667 | 41.4690 |
| 11/01/06 | 18:07:00 | 53.0210 | 0.7980 | -1.4480 | 554.1666667 | 41.4690 |
| 11/01/06 | 18:08:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:09:00 | 53.0210 | 0.8000 | -1.4480 | 555.5555556 | 41.4690 |
| 11/01/06 | 18:10:00 | 53.0210 | 0.8000 | -1.4480 | 555.5555556 | 41.4690 |
| 11/01/06 | 18:11:00 | 53.1250 | 0.7990 | -1.4480 | 554.8611111 | 41.5730 |
| 11/01/06 | 18:12:00 | 53.1250 | 0.7990 | -1.4480 | 554.8611111 | 41.5730 |
| 11/01/06 | 18:13:00 | 52.8820 | 0.7980 | -1.4480 | 554.1666667 | 41.3300 |
| 11/01/06 | 18:14:00 | 52.9520 | 0.8000 | -1.4480 | 555.5555556 | 41.4000 |
| 11/01/06 | 18:15:00 | 52.9170 | 0.8000 | -1.4480 | 555.5555556 | 41.3650 |
| 11/01/06 | 18:16:00 | 52.9170 | 0.8000 | -1.4480 | 555.5555556 | 41.3650 |
| 11/01/06 | 18:17:00 | 53.1600 | 0.7980 | -1.4480 | 554.1666667 | 41.6080 |
| 11/01/06 | 18:18:00 | 53.1600 | 0.7980 | -1.4480 | 554.1666667 | 41.6080 |
| 11/01/06 | 18:19:00 | 52.8470 | 0.8000 | -1.4480 | 555.5555556 | 41.2950 |
| 11/01/06 | 18:20:00 | 52.8470 | 0.8000 | -1.4480 | 555.5555556 | 41.2950 |
| 11/01/06 | 18:21:00 | 53.1250 | 0.8000 | -1.4480 | 555.5555556 | 41.5730 |
| 11/01/06 | 18:22:00 | 53.1250 | 0.8000 | -1.4480 | 555.5555556 | 41.5730 |
| 11/01/06 | 18:23:00 | 53.0210 | 0.7980 | -1.4480 | 554.1666667 | 41.4690 |
| 11/01/06 | 18:24:00 | 52.9520 | 0.8000 | -1.4480 | 555.5555556 | 41.4000 |
| 11/01/06 | 18:25:00 | 52.9520 | 0.8000 | -1.4480 | 555.5555556 | 41.4000 |
| 11/01/06 | 18:26:00 | 53.1950 | 0.7990 | -1.4480 | 554.8611111 | 41.6430 |
| 11/01/06 | 18:27:00 | 53.1950 | 0.7990 | -1.4480 | 554.8611111 | 41.6430 |
| 11/01/06 | 18:28:00 | 53.0910 | 0.8000 | -1.4480 | 555.5555556 | 41.5390 |
| 11/01/06 | 18:29:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:30:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:31:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:32:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:33:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:34:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:35:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:36:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:37:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:38:00 | 52.9860 | 0.7990 | -1.4480 | 554.8611111 | 41.4340 |
| 11/01/06 | 18:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:47:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:48:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:49:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:50:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:51:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:52:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:53:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:54:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:55:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 18:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 18:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 19:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 19:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 19:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 20:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 20:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 20:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 20:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 20:51:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 20:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 20:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 21:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/01/06 | 21:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/01/06 | 21:33:00 | 53.0210 | 0.0000 | 0.0000 | 0 | 40.0210 |
| 11/01/06 | 21:34:00 | 52.7090 | 0.7940 | -1.8360 | 551.3888889 | 41.5450 |
| 11/01/06 | 21:35:00 | 52.7090 | 0.7940 | -1.8360 | 551.3888889 | 41.5450 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 21:36:00 | 52.6390 | 0.7940 | -1.8360 | 551.3888889 | 41.4750 |
| 11/01/06 | 21:37:00 | 52.5000 | 0.7930 | -1.8360 | 550.6944444 | 41.3360 |
| 11/01/06 | 21:38:00 | 52.5000 | 0.7930 | -1.8360 | 550.6944444 | 41.3360 |
| 11/01/06 | 21:39:00 | 52.5000 | 0.7920 | -1.8360 | 550 | 41.3360 |
| 11/01/06 | 21:40:00 | 52.5350 | 0.7920 | -1.8360 | 550 | 41.3710 |
| 11/01/06 | 21:41:00 | 52.7090 | 0.7920 | -1.8360 | 550 | 41.5450 |
| 11/01/06 | 21:42:00 | 52.7090 | 0.7920 | -1.8360 | 550 | 41.5450 |
| 11/01/06 | 21:43:00 | 52.7090 | 0.7920 | -1.8360 | 550 | 41.5450 |
| 11/01/06 | 21:44:00 | 52.7090 | 0.7920 | -1.8360 | 550 | 41.5450 |
| 11/01/06 | 21:45:00 | 52.6390 | 0.7920 | -1.8360 | 550 | 41.4750 |
| 11/01/06 | 21:46:00 | 52.6040 | 0.7930 | -1.8630 | 550.6944444 | 41.4670 |
| 11/01/06 | 21:47:00 | 52.6040 | 0.7930 | -1.8630 | 550.6944444 | 41.4670 |
| 11/01/06 | 21:48:00 | 52.8470 | 0.7950 | -1.8630 | 552.0833333 | 41.7100 |
| 11/01/06 | 21:49:00 | 52.6740 | 0.7940 | -1.8630 | 551.3888889 | 41.5370 |
| 11/01/06 | 21:50:00 | 52.6740 | 0.7940 | -1.8630 | 551.3888889 | 41.5370 |
| 11/01/06 | 21:51:00 | 52.7090 | 0.7960 | -1.8630 | 552.7777778 | 41.5720 |
| 11/01/06 | 21:52:00 | 52.7090 | 0.7960 | -1.8630 | 552.7777778 | 41.5720 |
| 11/01/06 | 21:53:00 | 52.7090 | 0.7960 | -1.8630 | 552.7777778 | 41.5720 |
| 11/01/06 | 21:54:00 | 52.7090 | 0.7960 | -1.8630 | 552.7777778 | 41.5720 |
| 11/01/06 | 21:55:00 | 52.8130 | 0.7930 | -1.8630 | 550.6944444 | 41.6760 |
| 11/01/06 | 21:56:00 | 52.8130 | 0.7930 | -1.8630 | 550.6944444 | 41.6760 |
| 11/01/06 | 21:57:00 | 52.4660 | 0.7930 | -1.8900 | 550.6944444 | 41.3560 |
| 11/01/06 | 21:58:00 | 52.4660 | 0.7930 | -1.8900 | 550.6944444 | 41.3560 |
| 11/01/06 | 21:59:00 | 52.4660 | 0.7910 | -1.9170 | 549.3055556 | 41.3830 |
| 11/01/06 | 22:00:00 | 52.4660 | 0.7910 | -1.9170 | 549.3055556 | 41.3830 |
| 11/01/06 | 22:01:00 | 52.4660 | 0.7910 | -1.9170 | 549.3055556 | 41.3830 |
| 11/01/06 | 22:02:00 | 52.4660 | 0.7910 | -1.9170 | 549.3055556 | 41.3830 |
| 11/01/06 | 22:03:00 | 52.3610 | 0.7910 | -1.9170 | 549.3055556 | 41.2780 |
| 11/01/06 | 22:04:00 | 52.3610 | 0.7910 | -1.9170 | 549.3055556 | 41.2780 |
| 11/01/06 | 22:05:00 | 52.1880 | 0.7900 | -1.9440 | 548.6111111 | 41.1320 |
| 11/01/06 | 22:06:00 | 52.2570 | 0.7890 | -1.9440 | 547.9166667 | 41.2010 |
| 11/01/06 | 22:07:00 | 52.2570 | 0.7890 | -1.9440 | 547.9166667 | 41.2010 |
| 11/01/06 | 22:08:00 | 52.4310 | 0.7910 | -1.9440 | 549.3055556 | 41.3750 |
| 11/01/06 | 22:09:00 | 52.4310 | 0.7910 | -1.9440 | 549.3055556 | 41.3750 |
| 11/01/06 | 22:10:00 | 52.2570 | 0.7910 | -1.9440 | 549.3055556 | 41.2010 |
| 11/01/06 | 22:11:00 | 52.1880 | 0.7890 | -1.9440 | 547.9166667 | 41.1320 |
| 11/01/06 | 22:12:00 | 52.1880 | 0.7890 | -1.9440 | 547.9166667 | 41.1320 |
| 11/01/06 | 22:13:00 | 52.2220 | 0.7890 | -1.9440 | 547.9166667 | 41.1660 |
| 11/01/06 | 22:14:00 | 52.6040 | 0.7900 | -1.9530 | 548.6111111 | 41.5570 |
| 11/01/06 | 22:15:00 | 52.6040 | 0.7900 | -1.9530 | 548.6111111 | 41.5570 |
| 11/01/06 | 22:16:00 | 52.6040 | 0.7900 | -1.9530 | 548.6111111 | 41.5570 |
| 11/01/06 | 22:17:00 | 52.3610 | 0.7920 | -1.9800 | 550 | 41.3410 |
| 11/01/06 | 22:18:00 | 52.3610 | 0.7920 | -1.9800 | 550 | 41.3410 |
| 11/01/06 | 22:19:00 | 52.3610 | 0.7920 | -1.9800 | 550 | 41.3410 |
| 11/01/06 | 22:20:00 | 52.3610 | 0.7920 | -1.9800 | 550 | 41.3410 |
| 11/01/06 | 22:21:00 | 52.3610 | 0.7920 | -1.9800 | 550 | 41.3410 |
| 11/01/06 | 22:22:00 | 52.3610 | 0.7920 | -1.9800 | 550 | 41.3410 |
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| 11/01/06 | 22:27:00 | 52.3610 | 0.7900 | -1.9800 | 548.6111111 | 41.3410 |
| 11/01/06 | 22:28:00 | 52.3610 | 0.7900 | -1.9800 | 548.6111111 | 41.3410 |
| 11/01/06 | 22:29:00 | 52.4660 | 0.7900 | -1.9800 | 548.6111111 | 41.4460 |
| 11/01/06 | 22:30:00 | 52.4660 | 0.7900 | -1.9800 | 548.6111111 | 41.4460 |
| 11/01/06 | 22:31:00 | 52.5000 | 0.7910 | -1.9800 | 549.3055556 | 41.4800 |
| 11/01/06 | 22:32:00 | 52.5000 | 0.7910 | -1.9800 | 549.3055556 | 41.4800 |
| 11/01/06 | 22:33:00 | 52.6390 | 0.7920 | -1.9800 | 550 | 41.6190 |
| 11/01/06 | 22:34:00 | 52.6390 | 0.7920 | -1.9800 | 550 | 41.6190 |
| 11/01/06 | 22:35:00 | 52.6390 | 0.7920 | -1.9800 | 550 | 41.6190 |
| 11/01/06 | 22:36:00 | 52.4660 | 0.7910 | -2.0070 | 549.3055556 | 41.4730 |
| 11/01/06 | 22:37:00 | 52.4660 | 0.7910 | -2.0070 | 549.3055556 | 41.4730 |
| 11/01/06 | 22:38:00 | 52.6040 | 0.7900 | -2.0070 | 548.6111111 | 41.6110 |
| 11/01/06 | 22:39:00 | 52.1880 | 0.7880 | -2.0260 | 547.2222222 | 41.2140 |
| 11/01/06 | 22:40:00 | 52.1880 | 0.7880 | -2.0260 | 547.2222222 | 41.2140 |
| 11/01/06 | 22:41:00 | 52.3960 | 0.7910 | -2.0350 | 549.3055556 | 41.4310 |
| 11/01/06 | 22:42:00 | 52.3960 | 0.7910 | -2.0350 | 549.3055556 | 41.4310 |
| 11/01/06 | 22:43:00 | 52.4660 | 0.7920 | -2.0260 | 550 | 41.4920 |
| 11/01/06 | 22:44:00 | 52.3270 | 0.7910 | -2.0620 | 549.3055556 | 41.3890 |
| 11/01/06 | 22:45:00 | 52.3270 | 0.7910 | -2.0620 | 549.3055556 | 41.3890 |
| 11/01/06 | 22:46:00 | 52.4310 | 0.7920 | -2.0620 | 550 | 41.4930 |
| 11/01/06 | 22:47:00 | 52.3960 | 0.7900 | -2.0620 | 548.6111111 | 41.4580 |
| 11/01/06 | 22:48:00 | 52.3960 | 0.7900 | -2.0620 | 548.6111111 | 41.4580 |
| 11/01/06 | 22:49:00 | 52.2570 | 0.7890 | -2.0710 | 547.9166667 | 41.3280 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/01/06 | 22:50:00 | 52.2570 | 0.7890 | -2.0710 | 547.9166667 | 41.3280 |
| 11/01/06 | 22:51:00 | 52.2220 | 0.7900 | -2.0890 | 548.6111111 | 41.3110 |
| 11/01/06 | 22:52:00 | 52.2220 | 0.7900 | -2.0890 | 548.6111111 | 41.3110 |
| 11/01/06 | 22:53:00 | 52.3270 | 0.7890 | -2.0890 | 547.9166667 | 41.4160 |
| 11/01/06 | 22:54:00 | 52.3270 | 0.7920 | -2.0980 | 550 | 41.4250 |
| 11/01/06 | 22:55:00 | 52.3270 | 0.7920 | -2.0980 | 550 | 41.4250 |
| 11/01/06 | 22:56:00 | 52.3960 | 0.7890 | -2.1160 | 547.9166667 | 41.5120 |
| 11/01/06 | 22:57:00 | 52.3960 | 0.7890 | -2.1160 | 547.9166667 | 41.5120 |
| 11/01/06 | 22:58:00 | 52.4660 | 0.7910 | -2.1160 | 549.3055556 | 41.5820 |
| 11/01/06 | 22:59:00 | 52.4660 | 0.7910 | -2.1160 | 549.3055556 | 41.5820 |
| 11/01/06 | 23:00:00 | 52.4660 | 0.7910 | -2.1160 | 549.3055556 | 41.5820 |
| 11/01/06 | 23:01:00 | 52.4660 | 0.7910 | -2.1160 | 549.3055556 | 41.5820 |
| 11/01/06 | 23:02:00 | 52.4660 | 0.7910 | -2.1160 | 549.3055556 | 41.5820 |
| 11/01/06 | 23:03:00 | 52.2220 | 0.7880 | -2.1430 | 547.2222222 | 41.3650 |
| 11/01/06 | 23:04:00 | 52.2220 | 0.7880 | -2.1430 | 547.2222222 | 41.3650 |
| 11/01/06 | 23:05:00 | 52.4660 | 0.7920 | -2.1430 | 550 | 41.6090 |
| 11/01/06 | 23:06:00 | 52.4660 | 0.7920 | -2.1430 | 550 | 41.6090 |
| 11/01/06 | 23:07:00 | 52.4660 | 0.7920 | -2.1430 | 550 | 41.6090 |
| 11/01/06 | 23:08:00 | 52.2220 | 0.7880 | -2.1430 | 547.2222222 | 41.3650 |
| 11/01/06 | 23:09:00 | 52.2220 | 0.7880 | -2.1430 | 547.2222222 | 41.3650 |
| 11/01/06 | 23:10:00 | 52.1880 | 0.7880 | -2.1520 | 547.2222222 | 41.3400 |
| 11/01/06 | 23:11:00 | 52.1880 | 0.7880 | -2.1520 | 547.2222222 | 41.3400 |
| 11/01/06 | 23:12:00 | 52.4310 | 0.7890 | -2.1700 | 547.9166667 | 41.6010 |
| 11/01/06 | 23:13:00 | 52.4310 | 0.7890 | -2.1700 | 547.9166667 | 41.6010 |
| 11/01/06 | 23:14:00 | 52.2920 | 0.7890 | -2.1700 | 547.9166667 | 41.4620 |
| 11/01/06 | 23:15:00 | 52.4660 | 0.7900 | -2.1700 | 548.6111111 | 41.6360 |
| 11/01/06 | 23:16:00 | 52.4660 | 0.7900 | -2.1700 | 548.6111111 | 41.6360 |
| 11/01/06 | 23:17:00 | 52.3270 | 0.7890 | -2.1700 | 547.9166667 | 41.4970 |
| 11/01/06 | 23:18:00 | 52.3270 | 0.7890 | -2.1700 | 547.9166667 | 41.4970 |
| 11/01/06 | 23:19:00 | 52.4310 | 0.7870 | -2.1790 | 546.5277778 | 41.6100 |
| 11/01/06 | 23:20:00 | 52.4310 | 0.7870 | -2.1790 | 546.5277778 | 41.6100 |
| 11/01/06 | 23:21:00 | 52.4310 | 0.7870 | -2.1790 | 546.5277778 | 41.6100 |
| 11/01/06 | 23:22:00 | 52.3270 | 0.7880 | -2.1790 | 547.2222222 | 41.5060 |
| 11/01/06 | 23:23:00 | 52.3610 | 0.7910 | -2.1790 | 549.3055556 | 41.5400 |
| 11/01/06 | 23:24:00 | 52.3610 | 0.7910 | -2.1790 | 549.3055556 | 41.5400 |
| 11/01/06 | 23:25:00 | 52.7430 | 0.7900 | -2.1790 | 548.6111111 | 41.9220 |
| 11/01/06 | 23:26:00 | 52.7430 | 0.7900 | -2.1790 | 548.6111111 | 41.9220 |
| 11/01/06 | 23:27:00 | 52.6390 | 0.7910 | -2.1790 | 549.3055556 | 41.8180 |
| 11/01/06 | 23:28:00 | 52.4660 | 0.7890 | -2.1970 | 547.9166667 | 41.6630 |
| 11/01/06 | 23:29:00 | 52.4660 | 0.7890 | -2.1970 | 547.9166667 | 41.6630 |
| 11/01/06 | 23:30:00 | 52.5000 | 0.7900 | -2.1970 | 548.6111111 | 41.6970 |
| 11/01/06 | 23:31:00 | 52.5000 | 0.7900 | -2.1970 | 548.6111111 | 41.6970 |
| 11/01/06 | 23:32:00 | 52.5000 | 0.7900 | -2.1970 | 548.6111111 | 41.6970 |
| 11/01/06 | 23:33:00 | 52.3270 | 0.7890 | -2.1970 | 547.9166667 | 41.5240 |
| 11/01/06 | 23:34:00 | 52.3960 | 0.7900 | -2.1970 | 548.6111111 | 41.5930 |
| 11/01/06 | 23:35:00 | 52.3960 | 0.7900 | -2.1970 | 548.6111111 | 41.5930 |
| 11/01/06 | 23:36:00 | 52.2920 | 0.7890 | -2.2060 | 547.9166667 | 41.4980 |
| 11/01/06 | 23:37:00 | 52.2920 | 0.7890 | -2.2060 | 547.9166667 | 41.4980 |
| 11/01/06 | 23:38:00 | 52.2570 | 0.7890 | -2.2240 | 547.9166667 | 41.4810 |
| 11/01/06 | 23:39:00 | 52.2570 | 0.7890 | -2.2240 | 547.9166667 | 41.4810 |
| 11/01/06 | 23:40:00 | 52.6740 | 0.7890 | -2.2240 | 547.9166667 | 41.8980 |
| 11/01/06 | 23:41:00 | 52.6390 | 0.7900 | -2.2240 | 548.6111111 | 41.8630 |
| 11/01/06 | 23:42:00 | 52.6390 | 0.7900 | -2.2240 | 548.6111111 | 41.8630 |
| 11/01/06 | 23:43:00 | 52.2920 | 0.7870 | -2.2240 | 546.5277778 | 41.5160 |
| 11/01/06 | 23:44:00 | 52.2920 | 0.7870 | -2.2240 | 546.5277778 | 41.5160 |
| 11/01/06 | 23:45:00 | 52.2570 | 0.7860 | -2.2240 | 545.8333333 | 41.4810 |
| 11/01/06 | 23:46:00 | 52.4660 | 0.7880 | -2.2240 | 547.2222222 | 41.6900 |
| 11/01/06 | 23:47:00 | 52.4660 | 0.7880 | -2.2240 | 547.2222222 | 41.6900 |
| 11/01/06 | 23:48:00 | 52.2220 | 0.7870 | -2.2240 | 546.5277778 | 41.4460 |
| 11/01/06 | 23:49:00 | 52.1880 | 0.7890 | -2.2240 | 547.9166667 | 41.4120 |
| 11/01/06 | 23:50:00 | 52.1880 | 0.7890 | -2.2240 | 547.9166667 | 41.4120 |
| 11/01/06 | 23:51:00 | 52.2920 | 0.7890 | -2.2510 | 547.9166667 | 41.5430 |
| 11/01/06 | 23:52:00 | 52.2920 | 0.7890 | -2.2510 | 547.9166667 | 41.5430 |
| 11/01/06 | 23:53:00 | 52.2920 | 0.7890 | -2.2510 | 547.9166667 | 41.5430 |
| 11/01/06 | 23:54:00 | 52.6040 | 0.7880 | -2.2510 | 547.2222222 | 41.8550 |
| 11/01/06 | 23:55:00 | 52.1880 | 0.7880 | -2.2510 | 547.2222222 | 41.4390 |
| 11/01/06 | 23:56:00 | 52.1880 | 0.7880 | -2.2510 | 547.2222222 | 41.4390 |
| 11/01/06 | 23:57:00 | 52.2920 | 0.7890 | -2.2780 | 547.9166667 | 41.5700 |
| 11/01/06 | 23:58:00 | 52.2920 | 0.7890 | -2.2780 | 547.9166667 | 41.5700 |
| 11/01/06 | 23:59:00 | 52.1880 | 0.7870 | -2.2780 | 546.5277778 | 41.4660 |
| 11/02/06 | 00:00:00 | 52.1880 | 0.7870 | -2.2780 | 546.5277778 | 41.4660 |
| 11/02/06 | 00:01:00 | 52.1880 | 0.7870 | -2.2780 | 546.5277778 | 41.4660 |
| 11/02/06 | 00:02:00 | 52.1180 | 0.7880 | -2.2780 | 547.2222222 | 41.3960 |
| 11/02/06 | 00:03:00 | 52.1180 | 0.7880 | -2.2780 | 547.2222222 | 41.3960 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/02/06 | 00:04:00 | 52.0840 | 0.7870 | -2.2780 | 546.5277778 | 41.3620 |
| 11/02/06 | 00:05:00 | 52.0840 | 0.7870 | -2.2780 | 546.5277778 | 41.3620 |
| 11/02/06 | 00:06:00 | 52.2920 | 0.7890 | -2.3050 | 547.9166667 | 41.5970 |
| 11/02/06 | 00:07:00 | 52.2920 | 0.7890 | -2.3050 | 547.9166667 | 41.5970 |
| 11/02/06 | 00:08:00 | 52.0840 | 0.7880 | -2.3050 | 547.2222222 | 41.3890 |
| 11/02/06 | 00:09:00 | 52.2220 | 0.7880 | -2.3050 | 547.2222222 | 41.5270 |
| 11/02/06 | 00:10:00 | 52.2220 | 0.7880 | -2.3050 | 547.2222222 | 41.5270 |
| 11/02/06 | 00:11:00 | 52.2570 | 0.7880 | -2.3140 | 547.2222222 | 41.5710 |
| 11/02/06 | 00:12:00 | 52.2570 | 0.7880 | -2.3140 | 547.2222222 | 41.5710 |
| 11/02/06 | 00:13:00 | 52.2220 | 0.7870 | -2.3320 | 546.5277778 | 41.5540 |
| 11/02/06 | 00:14:00 | 52.2920 | 0.7880 | -2.3320 | 547.2222222 | 41.6240 |
| 11/02/06 | 00:15:00 | 52.2920 | 0.7880 | -2.3320 | 547.2222222 | 41.6240 |
| 11/02/06 | 00:16:00 | 52.3610 | 0.7880 | -2.3420 | 547.2222222 | 41.7030 |
| 11/02/06 | 00:17:00 | 52.3610 | 0.7880 | -2.3420 | 547.2222222 | 41.7030 |
| 11/02/06 | 00:18:00 | 52.3960 | 0.7880 | -2.3320 | 547.2222222 | 41.7280 |
| 11/02/06 | 00:19:00 | 52.3960 | 0.7880 | -2.3320 | 547.2222222 | 41.7280 |
| 11/02/06 | 00:20:00 | 52.3610 | 0.7880 | -2.3420 | 547.2222222 | 41.7030 |
| 11/02/06 | 00:21:00 | 52.3610 | 0.7880 | -2.3420 | 547.2222222 | 41.7030 |
| 11/02/06 | 00:22:00 | 52.1180 | 0.7860 | -2.3600 | 545.8333333 | 41.4780 |
| 11/02/06 | 00:23:00 | 52.1180 | 0.7860 | -2.3600 | 545.8333333 | 41.4780 |
| 11/02/06 | 00:24:00 | 52.1180 | 0.7860 | -2.3600 | 545.8333333 | 41.4780 |
| 11/02/06 | 00:25:00 | 52.2570 | 0.7890 | -2.3600 | 547.9166667 | 41.6170 |
| 11/02/06 | 00:26:00 | 52.2570 | 0.7890 | -2.3600 | 547.9166667 | 41.6170 |
| 11/02/06 | 00:27:00 | 52.1180 | 0.7880 | -2.3690 | 547.2222222 | 41.4870 |
| 11/02/06 | 00:28:00 | 52.1180 | 0.7880 | -2.3690 | 547.2222222 | 41.4870 |
| 11/02/06 | 00:29:00 | 52.1180 | 0.7880 | -2.3690 | 547.2222222 | 41.4870 |
| 11/02/06 | 00:30:00 | 52.1180 | 0.7880 | -2.3690 | 547.2222222 | 41.4870 |
| 11/02/06 | 00:31:00 | 52.1880 | 0.7880 | -2.3600 | 547.2222222 | 41.5480 |
| 11/02/06 | 00:32:00 | 52.1880 | 0.7880 | -2.3600 | 547.2222222 | 41.5480 |
| 11/02/06 | 00:33:00 | 51.9790 | 0.7860 | -2.3690 | 545.8333333 | 41.3480 |
| 11/02/06 | 00:34:00 | 51.9790 | 0.7860 | -2.3690 | 545.8333333 | 41.3480 |
| 11/02/06 | 00:35:00 | 51.9790 | 0.7860 | -2.3690 | 545.8333333 | 41.3480 |
| 11/02/06 | 00:36:00 | 52.1530 | 0.7880 | -2.3780 | 547.2222222 | 41.5310 |
| 11/02/06 | 00:37:00 | 52.1530 | 0.7880 | -2.3780 | 547.2222222 | 41.5310 |
| 11/02/06 | 00:38:00 | 52.1530 | 0.7880 | -2.3780 | 547.2222222 | 41.5310 |
| 11/02/06 | 00:39:00 | 52.0140 | 0.7860 | -2.3870 | 545.8333333 | 41.4010 |
| 11/02/06 | 00:40:00 | 52.0140 | 0.7860 | -2.3870 | 545.8333333 | 41.4010 |
| 11/02/06 | 00:41:00 | 52.1530 | 0.7860 | -2.3870 | 545.8333333 | 41.5400 |
| 11/02/06 | 00:42:00 | 52.1530 | 0.7860 | -2.3870 | 545.8333333 | 41.5400 |
| 11/02/06 | 00:43:00 | 52.1530 | 0.7860 | -2.3870 | 545.8333333 | 41.5400 |
| 11/02/06 | 00:44:00 | 52.1180 | 0.7860 | -2.3960 | 545.8333333 | 41.5140 |
| 11/02/06 | 00:45:00 | 52.1180 | 0.7860 | -2.3960 | 545.8333333 | 41.5140 |
| 11/02/06 | 00:46:00 | 51.9100 | 0.7880 | -2.3870 | 547.2222222 | 41.2970 |
| 11/02/06 | 00:47:00 | 51.9100 | 0.7880 | -2.3870 | 547.2222222 | 41.2970 |
| 11/02/06 | 00:48:00 | 51.9100 | 0.7880 | -2.3870 | 547.2222222 | 41.2970 |
| 11/02/06 | 00:49:00 | 52.0840 | 0.7860 | -2.3960 | 545.8333333 | 41.4800 |
| 11/02/06 | 00:50:00 | 52.0840 | 0.7860 | -2.3960 | 545.8333333 | 41.4800 |
| 11/02/06 | 00:51:00 | 52.0840 | 0.7860 | -2.3960 | 545.8333333 | 41.4800 |
| 11/02/06 | 00:52:00 | 52.1880 | 0.7870 | -2.4140 | 546.5277778 | 41.6020 |
| 11/02/06 | 00:53:00 | 52.1880 | 0.7870 | -2.4140 | 546.5277778 | 41.6020 |
| 11/02/06 | 00:54:00 | 52.1880 | 0.7870 | -2.4140 | 546.5277778 | 41.6020 |
| 11/02/06 | 00:55:00 | 52.1880 | 0.7870 | -2.4140 | 546.5277778 | 41.6020 |
| 11/02/06 | 00:56:00 | 52.1880 | 0.7870 | -2.4140 | 546.5277778 | 41.6020 |
| 11/02/06 | 00:57:00 | 52.1180 | 0.7880 | -2.4230 | 547.2222222 | 41.5410 |
| 11/02/06 | 00:58:00 | 52.1180 | 0.7880 | -2.4230 | 547.2222222 | 41.5410 |
| 11/02/06 | 00:59:00 | 52.0140 | 0.7890 | -2.4230 | 547.9166667 | 41.4370 |
| 11/02/06 | 01:00:00 | 52.0140 | 0.7890 | -2.4230 | 547.9166667 | 41.4370 |
| 11/02/06 | 01:01:00 | 52.0840 | 0.7890 | -2.4230 | 547.9166667 | 41.5070 |
| 11/02/06 | 01:02:00 | 52.0840 | 0.7890 | -2.4230 | 547.9166667 | 41.5070 |
| 11/02/06 | 01:03:00 | 52.0840 | 0.7890 | -2.4230 | 547.9166667 | 41.5070 |
| 11/02/06 | 01:04:00 | 52.2220 | 0.7870 | -2.4410 | 546.5277778 | 41.6630 |
| 11/02/06 | 01:05:00 | 52.2220 | 0.7870 | -2.4410 | 546.5277778 | 41.6630 |
| 11/02/06 | 01:06:00 | 52.2220 | 0.7870 | -2.4410 | 546.5277778 | 41.6630 |
| 11/02/06 | 01:07:00 | 51.9450 | 0.7850 | -2.4500 | 545.1388889 | 41.3950 |
| 11/02/06 | 01:08:00 | 51.9450 | 0.7850 | -2.4500 | 545.1388889 | 41.3950 |
| 11/02/06 | 01:09:00 | 51.9450 | 0.7850 | -2.4500 | 545.1388889 | 41.3950 |
| 11/02/06 | 01:10:00 | 52.1530 | 0.7860 | -2.4500 | 545.8333333 | 41.6030 |
| 11/02/06 | 01:11:00 | 52.1530 | 0.7860 | -2.4500 | 545.8333333 | 41.6030 |
| 11/02/06 | 01:12:00 | 52.1530 | 0.7880 | -2.4500 | 547.2222222 | 41.6030 |
| 11/02/06 | 01:13:00 | 52.1530 | 0.7880 | -2.4500 | 547.2222222 | 41.6030 |
| 11/02/06 | 01:14:00 | 52.1180 | 0.7880 | -2.4590 | 547.2222222 | 41.5770 |
| 11/02/06 | 01:15:00 | 52.1180 | 0.7880 | -2.4590 | 547.2222222 | 41.5770 |
| 11/02/06 | 01:16:00 | 52.1180 | 0.7880 | -2.4590 | 547.2222222 | 41.5770 |
| 11/02/06 | 01:17:00 | 51.5970 | 0.7870 | -2.4770 | 546.5277778 | 41.0740 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/02/06 | 01:18:00 | 51.7020 | 0.7840 | -2.4770 | 544.4444444 | 41.1790 |
| 11/02/06 | 01:19:00 | 51.7020 | 0.7840 | -2.4770 | 544.4444444 | 41.1790 |
| 11/02/06 | 01:20:00 | 51.7020 | 0.7840 | -2.4770 | 544.4444444 | 41.1790 |
| 11/02/06 | 01:21:00 | 51.5970 | 0.7810 | -2.4770 | 542.3611111 | 41.0740 |
| 11/02/06 | 01:22:00 | 51.5970 | 0.7810 | -2.4770 | 542.3611111 | 41.0740 |
| 11/02/06 | 01:23:00 | 51.5970 | 0.7810 | -2.4770 | 542.3611111 | 41.0740 |
| 11/02/06 | 01:24:00 | 51.8410 | 0.7840 | -2.4770 | 544.4444444 | 41.3180 |
| 11/02/06 | 01:25:00 | 51.8410 | 0.7840 | -2.4770 | 544.4444444 | 41.3180 |
| 11/02/06 | 01:26:00 | 51.8410 | 0.7840 | -2.4770 | 544.4444444 | 41.3180 |
| 11/02/06 | 01:27:00 | 51.8410 | 0.7840 | -2.4770 | 544.4444444 | 41.3180 |
| 11/02/06 | 01:28:00 | 51.8410 | 0.7840 | -2.4770 | 544.4444444 | 41.3180 |
| 11/02/06 | 01:29:00 | 51.9450 | 0.7850 | -2.4860 | 545.1388889 | 41.4310 |
| 11/02/06 | 01:30:00 | 51.9450 | 0.7850 | -2.4860 | 545.1388889 | 41.4310 |
| 11/02/06 | 01:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 01:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 01:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 01:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 01:35:00 | 51.8750 | 0.7850 | -2.5040 | 545.1388889 | 41.3790 |
| 11/02/06 | 01:36:00 | 51.8750 | 0.7850 | -2.5040 | 545.1388889 | 41.3790 |
| 11/02/06 | 01:37:00 | 51.8750 | 0.7850 | -2.5040 | 545.1388889 | 41.3790 |
| 11/02/06 | 01:38:00 | 51.9450 | 0.7850 | -2.5040 | 545.1388889 | 41.4490 |
| 11/02/06 | 01:39:00 | 51.9450 | 0.7850 | -2.5040 | 545.1388889 | 41.4490 |
| 11/02/06 | 01:40:00 | 51.9450 | 0.7850 | -2.5040 | 545.1388889 | 41.4490 |
| 11/02/06 | 01:41:00 | 51.2500 | 0.7780 | -2.5040 | 540.2777778 | 40.7540 |
| 11/02/06 | 01:42:00 | 51.2500 | 0.7780 | -2.5040 | 540.2777778 | 40.7540 |
| 11/02/06 | 01:43:00 | 51.2500 | 0.7780 | -2.5040 | 540.2777778 | 40.7540 |
| 11/02/06 | 01:44:00 | 51.2500 | 0.7780 | -2.5040 | 540.2777778 | 40.7540 |
| 11/02/06 | 01:45:00 | 51.2500 | 0.7780 | -2.5040 | 540.2777778 | 40.7540 |
| 11/02/06 | 01:46:00 | 51.2500 | 0.7780 | -2.5040 | 540.2777778 | 40.7540 |
| 11/02/06 | 01:47:00 | 51.4590 | 0.7810 | -2.5040 | 542.3611111 | 40.9630 |
| 11/02/06 | 01:48:00 | 51.4590 | 0.7810 | -2.5040 | 542.3611111 | 40.9630 |
| 11/02/06 | 01:49:00 | 51.4240 | 0.7790 | -2.5040 | 540.9722222 | 40.9280 |
| 11/02/06 | 01:50:00 | 51.4240 | 0.7790 | -2.5040 | 540.9722222 | 40.9280 |
| 11/02/06 | 01:51:00 | 51.4240 | 0.7790 | -2.5040 | 540.9722222 | 40.9280 |
| 11/02/06 | 01:52:00 | 51.4930 | 0.7810 | -2.5040 | 542.3611111 | 40.9970 |
| 11/02/06 | 01:53:00 | 51.4930 | 0.7810 | -2.5040 | 542.3611111 | 40.9970 |
| 11/02/06 | 01:54:00 | 51.5280 | 0.7810 | -2.5040 | 542.3611111 | 41.0320 |
| 11/02/06 | 01:55:00 | 51.5280 | 0.7810 | -2.5040 | 542.3611111 | 41.0320 |
| 11/02/06 | 01:56:00 | 51.4930 | 0.7800 | -2.5040 | 541.6666667 | 40.9970 |
| 11/02/06 | 01:57:00 | 51.4930 | 0.7800 | -2.5040 | 541.6666667 | 40.9970 |
| 11/02/06 | 01:58:00 | 51.4930 | 0.7800 | -2.5040 | 541.6666667 | 40.9970 |
| 11/02/06 | 01:59:00 | 51.4930 | 0.7800 | -2.5040 | 541.6666667 | 40.9970 |
| 11/02/06 | 02:00:00 | 51.4930 | 0.7800 | -2.5040 | 541.6666667 | 40.9970 |
| 11/02/06 | 02:01:00 | 51.5280 | 0.7810 | -2.5040 | 542.3611111 | 41.0320 |
| 11/02/06 | 02:02:00 | 51.5280 | 0.7800 | -2.5040 | 541.6666667 | 41.0320 |
| 11/02/06 | 02:03:00 | 51.5280 | 0.7800 | -2.5040 | 541.6666667 | 41.0320 |
| 11/02/06 | 02:04:00 | 51.5280 | 0.7800 | -2.5040 | 541.6666667 | 41.0320 |
| 11/02/06 | 02:05:00 | 51.5280 | 0.7800 | -2.5040 | 541.6666667 | 41.0320 |
| 11/02/06 | 02:06:00 | 51.5280 | 0.7800 | -2.5040 | 541.6666667 | 41.0320 |
| 11/02/06 | 02:07:00 | 51.5630 | 0.7820 | -2.5310 | 543.0555556 | 41.0940 |
| 11/02/06 | 02:08:00 | 51.5630 | 0.7820 | -2.5310 | 543.0555556 | 41.0940 |
| 11/02/06 | 02:09:00 | 51.4590 | 0.7800 | -2.5310 | 541.6666667 | 40.9900 |
| 11/02/06 | 02:10:00 | 51.4590 | 0.7800 | -2.5310 | 541.6666667 | 40.9900 |
| 11/02/06 | 02:11:00 | 51.4590 | 0.7800 | -2.5310 | 541.6666667 | 40.9900 |
| 11/02/06 | 02:12:00 | 51.4930 | 0.7820 | -2.5400 | 543.0555556 | 41.0330 |
| 11/02/06 | 02:13:00 | 51.4930 | 0.7820 | -2.5400 | 543.0555556 | 41.0330 |
| 11/02/06 | 02:14:00 | 51.4240 | 0.7790 | -2.5580 | 540.9722222 | 40.9820 |
| 11/02/06 | 02:15:00 | 51.4240 | 0.7790 | -2.5580 | 540.9722222 | 40.9820 |
| 11/02/06 | 02:16:00 | 51.4240 | 0.7790 | -2.5580 | 540.9722222 | 40.9820 |
| 11/02/06 | 02:17:00 | 51.4240 | 0.7790 | -2.5580 | 540.9722222 | 40.9820 |
| 11/02/06 | 02:18:00 | 51.4240 | 0.7790 | -2.5580 | 540.9722222 | 40.9820 |
| 11/02/06 | 02:19:00 | 51.4240 | 0.7790 | -2.5580 | 540.9722222 | 40.9820 |
| 11/02/06 | 02:20:00 | 51.4930 | 0.7800 | -2.5580 | 541.6666667 | 41.0510 |
| 11/02/06 | 02:21:00 | 51.4930 | 0.7800 | -2.5580 | 541.6666667 | 41.0510 |
| 11/02/06 | 02:22:00 | 51.4240 | 0.7800 | -2.5850 | 541.6666667 | 41.0090 |
| 11/02/06 | 02:23:00 | 51.4930 | 0.7790 | -2.5850 | 540.9722222 | 41.0780 |
| 11/02/06 | 02:24:00 | 51.4930 | 0.7790 | -2.5850 | 540.9722222 | 41.0780 |
| 11/02/06 | 02:25:00 | 51.4930 | 0.7790 | -2.5850 | 540.9722222 | 41.0780 |
| 11/02/06 | 02:26:00 | 51.4930 | 0.7790 | -2.5850 | 540.9722222 | 41.0780 |
| 11/02/06 | 02:27:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:28:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:29:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:30:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:31:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/02/06 | 02:32:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:33:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:34:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:35:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:36:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:37:00 | 51.4590 | 0.7790 | -2.5850 | 540.9722222 | 41.0440 |
| 11/02/06 | 02:38:00 | 51.4590 | 0.7800 | -2.6120 | 541.6666667 | 41.0710 |
| 11/02/06 | 02:39:00 | 51.4590 | 0.7800 | -2.6120 | 541.6666667 | 41.0710 |
| 11/02/06 | 02:40:00 | 51.6320 | 0.7800 | -2.6120 | 541.6666667 | 41.2440 |
| 11/02/06 | 02:41:00 | 51.6320 | 0.7800 | -2.6120 | 541.6666667 | 41.2440 |
| 11/02/06 | 02:42:00 | 51.5970 | 0.7800 | -2.6120 | 541.6666667 | 41.2090 |
| 11/02/06 | 02:43:00 | 51.4590 | 0.7790 | -2.6210 | 540.9722222 | 41.0800 |
| 11/02/06 | 02:44:00 | 51.4590 | 0.7790 | -2.6210 | 540.9722222 | 41.0800 |
| 11/02/06 | 02:45:00 | 51.4590 | 0.7790 | -2.6300 | 540.9722222 | 41.0890 |
| 11/02/06 | 02:46:00 | 51.4590 | 0.7790 | -2.6390 | 540.9722222 | 41.0980 |
| 11/02/06 | 02:47:00 | 51.4590 | 0.7790 | -2.6390 | 540.9722222 | 41.0980 |
| 11/02/06 | 02:48:00 | 51.3890 | 0.7790 | -2.6390 | 540.9722222 | 41.0280 |
| 11/02/06 | 02:49:00 | 51.3540 | 0.7780 | -2.6390 | 540.2777778 | 40.9930 |
| 11/02/06 | 02:50:00 | 51.3540 | 0.7780 | -2.6390 | 540.2777778 | 40.9930 |
| 11/02/06 | 02:51:00 | 51.3540 | 0.7780 | -2.6390 | 540.2777778 | 40.9930 |
| 11/02/06 | 02:52:00 | 51.3200 | 0.7780 | -2.6390 | 540.2777778 | 40.9590 |
| 11/02/06 | 02:53:00 | 51.3540 | 0.7800 | -2.6480 | 541.6666667 | 41.0020 |
| 11/02/06 | 02:54:00 | 51.3540 | 0.7800 | -2.6480 | 541.6666667 | 41.0020 |
| 11/02/06 | 02:55:00 | 51.3540 | 0.7800 | -2.6480 | 541.6666667 | 41.0020 |
| 11/02/06 | 02:56:00 | 51.3200 | 0.7780 | -2.6480 | 540.2777778 | 40.9680 |
| 11/02/06 | 02:57:00 | 51.3200 | 0.7780 | -2.6480 | 540.2777778 | 40.9680 |
| 11/02/06 | 02:58:00 | 51.3200 | 0.7780 | -2.6480 | 540.2777778 | 40.9680 |
| 11/02/06 | 02:59:00 | 51.3200 | 0.7780 | -2.6480 | 540.2777778 | 40.9680 |
| 11/02/06 | 03:00:00 | 51.3200 | 0.7780 | -2.6670 | 540.2777778 | 40.9870 |
| 11/02/06 | 03:01:00 | 51.4240 | 0.7800 | -2.6670 | 541.6666667 | 41.0910 |
| 11/02/06 | 03:02:00 | 51.4240 | 0.7800 | -2.6670 | 541.6666667 | 41.0910 |
| 11/02/06 | 03:03:00 | 51.4240 | 0.7800 | -2.6670 | 541.6666667 | 41.0910 |
| 11/02/06 | 03:04:00 | 51.4240 | 0.7800 | -2.6670 | 541.6666667 | 41.0910 |
| 11/02/06 | 03:05:00 | 51.3200 | 0.7780 | -2.6760 | 540.2777778 | 40.9960 |
| 11/02/06 | 03:06:00 | 51.3200 | 0.7780 | -2.6760 | 540.2777778 | 40.9960 |
| 11/02/06 | 03:07:00 | 51.3890 | 0.7790 | -2.6760 | 540.9722222 | 41.0650 |
| 11/02/06 | 03:08:00 | 51.3890 | 0.7790 | -2.6760 | 540.9722222 | 41.0650 |
| 11/02/06 | 03:09:00 | 51.3890 | 0.7790 | -2.6760 | 540.9722222 | 41.0650 |
| 11/02/06 | 03:10:00 | 51.3890 | 0.7790 | -2.6760 | 540.9722222 | 41.0650 |
| 11/02/06 | 03:11:00 | 51.2850 | 0.7780 | -2.7030 | 540.2777778 | 40.9880 |
| 11/02/06 | 03:12:00 | 51.2850 | 0.7780 | -2.7030 | 540.2777778 | 40.9880 |
| 11/02/06 | 03:13:00 | 51.2850 | 0.7780 | -2.7030 | 540.2777778 | 40.9880 |
| 11/02/06 | 03:14:00 | 51.3540 | 0.7800 | -2.7030 | 541.6666667 | 41.0570 |
| 11/02/06 | 03:15:00 | 51.3540 | 0.7800 | -2.7030 | 541.6666667 | 41.0570 |
| 11/02/06 | 03:16:00 | 51.3540 | 0.7800 | -2.7030 | 541.6666667 | 41.0570 |
| 11/02/06 | 03:17:00 | 51.3540 | 0.7800 | -2.7030 | 541.6666667 | 41.0570 |
| 11/02/06 | 03:18:00 | 51.1810 | 0.7780 | -2.7030 | 540.2777778 | 40.8840 |
| 11/02/06 | 03:19:00 | 51.1810 | 0.7780 | -2.7030 | 540.2777778 | 40.8840 |
| 11/02/06 | 03:20:00 | 51.1810 | 0.7780 | -2.7030 | 540.2777778 | 40.8840 |
| 11/02/06 | 03:21:00 | 51.1110 | 0.7750 | -2.7030 | 538.1944444 | 40.8140 |
| 11/02/06 | 03:22:00 | 51.1110 | 0.7750 | -2.7030 | 538.1944444 | 40.8140 |
| 11/02/06 | 03:23:00 | 51.1110 | 0.7770 | -2.7030 | 539.5833333 | 40.8140 |
| 11/02/06 | 03:24:00 | 51.1110 | 0.7770 | -2.7030 | 539.5833333 | 40.8140 |
| 11/02/06 | 03:25:00 | 51.1110 | 0.7760 | -2.7030 | 538.8888889 | 40.8140 |
| 11/02/06 | 03:26:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:27:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:28:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:29:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:30:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:31:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:32:00 | 51.2160 | 0.7780 | -2.7030 | 540.2777778 | 40.9190 |
| 11/02/06 | 03:33:00 | 51.2160 | 0.7780 | -2.7300 | 540.2777778 | 40.9460 |
| 11/02/06 | 03:34:00 | 51.2160 | 0.7780 | -2.7300 | 540.2777778 | 40.9460 |
| 11/02/06 | 03:35:00 | 51.2160 | 0.7780 | -2.7300 | 540.2777778 | 40.9460 |
| 11/02/06 | 03:36:00 | 51.2500 | 0.7770 | -2.7300 | 539.5833333 | 40.9800 |
| 11/02/06 | 03:37:00 | 51.2500 | 0.7770 | -2.7300 | 539.5833333 | 40.9800 |
| 11/02/06 | 03:38:00 | 51.1460 | 0.7760 | -2.7570 | 538.8888889 | 40.9030 |
| 11/02/06 | 03:39:00 | 51.1460 | 0.7760 | -2.7570 | 538.8888889 | 40.9030 |
| 11/02/06 | 03:40:00 | 51.1460 | 0.7760 | -2.7570 | 538.8888889 | 40.9030 |
| 11/02/06 | 03:41:00 | 51.1460 | 0.7760 | -2.7570 | 538.8888889 | 40.9030 |
| 11/02/06 | 03:42:00 | 51.1460 | 0.7760 | -2.7570 | 538.8888889 | 40.9030 |
| 11/02/06 | 03:43:00 | 51.1460 | 0.7760 | -2.7570 | 538.8888889 | 40.9030 |
| 11/02/06 | 03:44:00 | 51.1810 | 0.7780 | -2.7660 | 540.2777778 | 40.9470 |
| 11/02/06 | 03:45:00 | 51.1810 | 0.7780 | -2.7660 | 540.2777778 | 40.9470 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/02/06 | 03:46:00 | 51.1110 | 0.7770 | -2.7840 | 539.5833333 | 40.8950 |
| 11/02/06 | 03:47:00 | 51.1460 | 0.7750 | -2.7840 | 538.1944444 | 40.9300 |
| 11/02/06 | 03:48:00 | 51.1460 | 0.7750 | -2.7840 | 538.1944444 | 40.9300 |
| 11/02/06 | 03:49:00 | 51.1460 | 0.7760 | -2.7840 | 538.8888889 | 40.9300 |
| 11/02/06 | 03:50:00 | 51.1460 | 0.7760 | -2.7840 | 538.8888889 | 40.9300 |
| 11/02/06 | 03:51:00 | 51.1460 | 0.7760 | -2.7840 | 538.8888889 | 40.9300 |
| 11/02/06 | 03:52:00 | 51.2160 | 0.7770 | -2.7840 | 539.5833333 | 41.0000 |
| 11/02/06 | 03:53:00 | 51.2160 | 0.7770 | -2.7840 | 539.5833333 | 41.0000 |
| 11/02/06 | 03:54:00 | 51.2160 | 0.7760 | -2.7840 | 538.8888889 | 41.0000 |
| 11/02/06 | 03:55:00 | 51.2160 | 0.7760 | -2.7840 | 538.8888889 | 41.0000 |
| 11/02/06 | 03:56:00 | 51.2850 | 0.7770 | -2.7840 | 539.5833333 | 41.0690 |
| 11/02/06 | 03:57:00 | 51.2850 | 0.7770 | -2.7840 | 539.5833333 | 41.0690 |
| 11/02/06 | 03:58:00 | 51.2500 | 0.7780 | -2.7570 | 540.2777778 | 41.0070 |
| 11/02/06 | 03:59:00 | 51.2500 | 0.7780 | -2.7570 | 540.2777778 | 41.0070 |
| 11/02/06 | 04:00:00 | 51.2500 | 0.7780 | -2.7570 | 540.2777778 | 41.0070 |
| 11/02/06 | 04:01:00 | 51.3200 | 0.7780 | -2.7570 | 540.2777778 | 41.0770 |
| 11/02/06 | 04:02:00 | 51.3200 | 0.7780 | -2.7570 | 540.2777778 | 41.0770 |
| 11/02/06 | 04:03:00 | 51.2160 | 0.7770 | -2.7570 | 539.5833333 | 40.9730 |
| 11/02/06 | 04:04:00 | 51.2160 | 0.7770 | -2.7570 | 539.5833333 | 40.9730 |
| 11/02/06 | 04:05:00 | 51.2160 | 0.7770 | -2.7570 | 539.5833333 | 40.9730 |
| 11/02/06 | 04:06:00 | 51.2500 | 0.7780 | -2.7480 | 540.2777778 | 40.9980 |
| 11/02/06 | 04:07:00 | 51.2500 | 0.7780 | -2.7480 | 540.2777778 | 40.9980 |
| 11/02/06 | 04:08:00 | 51.2850 | 0.7770 | -2.7480 | 539.5833333 | 41.0330 |
| 11/02/06 | 04:09:00 | 51.2850 | 0.7770 | -2.7480 | 539.5833333 | 41.0330 |
| 11/02/06 | 04:10:00 | 51.1810 | 0.7770 | -2.7480 | 539.5833333 | 40.9290 |
| 11/02/06 | 04:11:00 | 51.1810 | 0.7770 | -2.7480 | 539.5833333 | 40.9290 |
| 11/02/06 | 04:12:00 | 51.1460 | 0.7760 | -2.7660 | 538.8888889 | 40.9120 |
| 11/02/06 | 04:13:00 | 51.1460 | 0.7760 | -2.7660 | 538.8888889 | 40.9120 |
| 11/02/06 | 04:14:00 | 51.2160 | 0.7760 | -2.7840 | 538.8888889 | 41.0000 |
| 11/02/06 | 04:15:00 | 51.2160 | 0.7780 | -2.7840 | 540.2777778 | 41.0000 |
| 11/02/06 | 04:16:00 | 51.2160 | 0.7780 | -2.7840 | 540.2777778 | 41.0000 |
| 11/02/06 | 04:17:00 | 51.1460 | 0.7760 | -2.7840 | 538.8888889 | 40.9300 |
| 11/02/06 | 04:18:00 | 51.1460 | 0.7760 | -2.7840 | 538.8888889 | 40.9300 |
| 11/02/06 | 04:19:00 | 51.1110 | 0.7760 | -2.7660 | 538.8888889 | 40.8770 |
| 11/02/06 | 04:20:00 | 51.1110 | 0.7760 | -2.7660 | 538.8888889 | 40.8770 |
| 11/02/06 | 04:21:00 | 51.2850 | 0.7770 | -2.7660 | 539.5833333 | 41.0510 |
| 11/02/06 | 04:22:00 | 51.2850 | 0.7770 | -2.7660 | 539.5833333 | 41.0510 |
| 11/02/06 | 04:23:00 | 51.3200 | 0.7770 | -2.7120 | 539.5833333 | 41.0320 |
| 11/02/06 | 04:24:00 | 51.3200 | 0.7770 | -2.7120 | 539.5833333 | 41.0320 |
| 11/02/06 | 04:25:00 | 51.4240 | 0.7760 | -2.6120 | 538.8888889 | 41.0360 |
| 11/02/06 | 04:26:00 | 51.4590 | 0.7780 | -2.5580 | 540.2777778 | 41.0170 |
| 11/02/06 | 04:27:00 | 51.4590 | 0.7780 | -2.5580 | 540.2777778 | 41.0170 |
| 11/02/06 | 04:28:00 | 51.5970 | 0.7790 | -2.5040 | 540.9722222 | 41.1010 |
| 11/02/06 | 04:29:00 | 51.5970 | 0.7790 | -2.5040 | 540.9722222 | 41.1010 |
| 11/02/06 | 04:30:00 | 51.5970 | 0.7800 | -2.4860 | 541.6666667 | 41.0830 |
| 11/02/06 | 04:31:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:32:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:33:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:34:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:35:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:36:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:37:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:38:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:39:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:40:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:41:00 | 51.5970 | 0.7800 | -2.4500 | 541.6666667 | 41.0470 |
| 11/02/06 | 04:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:50:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:51:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 04:55:00 | 51.5630 | 0.7790 | -2.3690 | 540.9722222 | 40.9320 |
| 11/02/06 | 04:56:00 | 51.5630 | 0.7790 | -2.3690 | 540.9722222 | 40.9320 |
| 11/02/06 | 04:57:00 | 51.5630 | 0.7790 | -2.3690 | 540.9722222 | 40.9320 |
| 11/02/06 | 04:58:00 | 51.5630 | 0.7790 | -2.3690 | 540.9722222 | 40.9320 |
| 11/02/06 | 04:59:00 | 51.5630 | 0.7800 | -2.3690 | 541.6666667 | 40.9320 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/02/06 | 05:00:00 | 51.5630 | 0.7800 | -2.3690 | 541.6666667 | 40.9320 |
| 11/02/06 | 05:01:00 | 51.6670 | 0.7790 | -2.3510 | 540.9722222 | 41.0180 |
| 11/02/06 | 05:02:00 | 51.6670 | 0.7790 | -2.3510 | 540.9722222 | 41.0180 |
| 11/02/06 | 05:03:00 | 51.6670 | 0.7790 | -2.3510 | 540.9722222 | 41.0180 |
| 11/02/06 | 05:04:00 | 51.6670 | 0.7790 | -2.3510 | 540.9722222 | 41.0180 |
| 11/02/06 | 05:05:00 | 51.5970 | 0.7800 | -2.3140 | 541.6666667 | 40.9110 |
| 11/02/06 | 05:06:00 | 51.5970 | 0.7800 | -2.3140 | 541.6666667 | 40.9110 |
| 11/02/06 | 05:07:00 | 51.7020 | 0.7800 | -2.3050 | 541.6666667 | 41.0070 |
| 11/02/06 | 05:08:00 | 51.7020 | 0.7800 | -2.3050 | 541.6666667 | 41.0070 |
| 11/02/06 | 05:09:00 | 51.7020 | 0.7800 | -2.3050 | 541.6666667 | 41.0070 |
| 11/02/06 | 05:10:00 | 51.6670 | 0.7800 | -2.2780 | 541.6666667 | 40.9450 |
| 11/02/06 | 05:11:00 | 51.6670 | 0.7800 | -2.2780 | 541.6666667 | 40.9450 |
| 11/02/06 | 05:12:00 | 51.6670 | 0.7800 | -2.2780 | 541.6666667 | 40.9450 |
| 11/02/06 | 05:13:00 | 51.7020 | 0.7810 | -2.2780 | 542.3611111 | 40.9800 |
| 11/02/06 | 05:14:00 | 51.7020 | 0.7790 | -2.2600 | 540.9722222 | 40.9620 |
| 11/02/06 | 05:15:00 | 51.7020 | 0.7790 | -2.2600 | 540.9722222 | 40.9620 |
| 11/02/06 | 05:16:00 | 51.8060 | 0.7810 | -2.2510 | 542.3611111 | 41.0570 |
| 11/02/06 | 05:17:00 | 51.8060 | 0.7810 | -2.2510 | 542.3611111 | 41.0570 |
| 11/02/06 | 05:18:00 | 51.8060 | 0.7810 | -2.2510 | 542.3611111 | 41.0570 |
| 11/02/06 | 05:19:00 | 51.9450 | 0.7810 | -2.2240 | 542.3611111 | 41.1690 |
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| 11/02/06 | 05:21:00 | 51.9450 | 0.7810 | -2.2240 | 542.3611111 | 41.1690 |
| 11/02/06 | 05:22:00 | 51.9450 | 0.7810 | -2.2240 | 542.3611111 | 41.1690 |
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| 11/02/06 | 05:24:00 | 51.8750 | 0.7800 | -2.2150 | 541.6666667 | 41.0900 |
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| 11/02/06 | 05:26:00 | 51.8750 | 0.7800 | -2.2150 | 541.6666667 | 41.0900 |
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| 11/02/06 | 05:28:00 | 51.9100 | 0.7810 | -2.1970 | 542.3611111 | 41.1070 |
| 11/02/06 | 05:29:00 | 51.9100 | 0.7810 | -2.1970 | 542.3611111 | 41.1070 |
| 11/02/06 | 05:30:00 | 51.9100 | 0.7810 | -2.1970 | 542.3611111 | 41.1070 |
| 11/02/06 | 05:31:00 | 51.9100 | 0.7810 | -2.1970 | 542.3611111 | 41.1070 |
| 11/02/06 | 05:32:00 | 51.9100 | 0.7810 | -2.1970 | 542.3611111 | 41.1070 |
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| 11/02/06 | 05:34:00 | 51.9100 | 0.7810 | -2.1970 | 542.3611111 | 41.1070 |
| 11/02/06 | 05:35:00 | 51.9100 | 0.7830 | -2.1700 | 543.75 | 41.0800 |
| 11/02/06 | 05:36:00 | 51.9100 | 0.7830 | -2.1700 | 543.75 | 41.0800 |
| 11/02/06 | 05:37:00 | 51.9100 | 0.7830 | -2.1700 | 543.75 | 41.0800 |
| 11/02/06 | 05:38:00 | 51.7710 | 0.7810 | -2.1700 | 542.3611111 | 40.9410 |
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| 11/02/06 | 05:40:00 | 51.7710 | 0.7810 | -2.1700 | 542.3611111 | 40.9410 |
| 11/02/06 | 05:41:00 | 51.7710 | 0.7810 | -2.1700 | 542.3611111 | 40.9410 |
| 11/02/06 | 05:42:00 | 51.7710 | 0.7810 | -2.1700 | 542.3611111 | 40.9410 |
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| 11/02/06 | 06:04:00 | 52.0140 | 0.7870 | -2.0350 | 546.5277778 | 41.0490 |
| 11/02/06 | 06:05:00 | 52.0140 | 0.7870 | -2.0350 | 546.5277778 | 41.0490 |
| 11/02/06 | 06:06:00 | 52.0140 | 0.7870 | -2.0350 | 546.5277778 | 41.0490 |
| 11/02/06 | 06:07:00 | 52.0140 | 0.7830 | -2.0350 | 543.75 | 41.0490 |
| 11/02/06 | 06:08:00 | 52.0140 | 0.7830 | -2.0350 | 543.75 | 41.0490 |
| 11/02/06 | 06:09:00 | 52.0140 | 0.7840 | -2.0070 | 544.4444444 | 41.0210 |
| 11/02/06 | 06:10:00 | 52.0140 | 0.7840 | -2.0070 | 544.4444444 | 41.0210 |
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| 11/02/06 | 06:12:00 | 52.0490 | 0.7830 | -1.9980 | 543.75 | 41.0470 |
| 11/02/06 | 06:13:00 | 52.1530 | 0.7840 | -1.9980 | 544.4444444 | 41.1510 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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| 11/02/06 | 06:16:00 | 52.1180 | 0.7820 | -1.9800 | 543.0555556 | 41.0980 |
| 11/02/06 | 06:17:00 | 52.1180 | 0.7820 | -1.9800 | 543.0555556 | 41.0980 |
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| 11/02/06 | 06:22:00 | 52.0840 | 0.7850 | -1.9710 | 545.1388889 | 41.0550 |
| 11/02/06 | 06:23:00 | 52.0840 | 0.7850 | -1.9710 | 545.1388889 | 41.0550 |
| 11/02/06 | 06:24:00 | 52.0840 | 0.7850 | -1.9710 | 545.1388889 | 41.0550 |
| 11/02/06 | 06:25:00 | 52.0840 | 0.7850 | -1.9710 | 545.1388889 | 41.0550 |
| 11/02/06 | 06:26:00 | 52.0840 | 0.7850 | -1.9710 | 545.1388889 | 41.0550 |
| 11/02/06 | 06:27:00 | 52.1880 | 0.7830 | -1.9440 | 543.75 | 41.1320 |
| 11/02/06 | 06:28:00 | 52.1880 | 0.7830 | -1.9440 | 543.75 | 41.1320 |
| 11/02/06 | 06:29:00 | 52.1880 | 0.7830 | -1.9440 | 543.75 | 41.1320 |
| 11/02/06 | 06:30:00 | 52.0840 | 0.7840 | -1.9530 | 544.4444444 | 41.0370 |
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| 11/02/06 | 06:32:00 | 52.0840 | 0.7840 | -1.9530 | 544.4444444 | 41.0370 |
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| 11/02/06 | 06:42:00 | 52.1530 | 0.7860 | -1.9440 | 545.8333333 | 41.0970 |
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| 11/02/06 | 07:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 08:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 08:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 08:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 08:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 08:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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| 11/02/06 | 10:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 10:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 10:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 10:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 10:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 10:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 10:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 10:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 11:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 11:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 11:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
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| 11/02/06 | 11:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 11:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 11:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 11:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 11:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 11:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 11:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 11:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 11:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 11:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 12:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 12:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 12:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 12:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 12:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
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| 11/02/06 | 12:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 12:32:00 | 53.1950 | 0.7930 | -1.3030 | 550.6944444 | 41.4980 |
| 11/02/06 | 12:33:00 | 53.1950 | 0.7930 | -1.3030 | 550.6944444 | 41.4980 |
| 11/02/06 | 12:34:00 | 53.1950 | 0.7930 | -1.3030 | 550.6944444 | 41.4980 |
| 11/02/06 | 12:35:00 | 53.1600 | 0.7930 | -1.3120 | 550.6944444 | 41.4720 |
| 11/02/06 | 12:36:00 | 53.1600 | 0.7930 | -1.3120 | 550.6944444 | 41.4720 |
| 11/02/06 | 12:37:00 | 53.1600 | 0.7930 | -1.3120 | 550.6944444 | 41.4720 |
| 11/02/06 | 12:38:00 | 53.1250 | 0.7930 | -1.2850 | 550.6944444 | 41.4100 |
| 11/02/06 | 12:39:00 | 53.1250 | 0.7930 | -1.2850 | 550.6944444 | 41.4100 |
| 11/02/06 | 12:40:00 | 53.1600 | 0.7940 | -1.2850 | 551.3888889 | 41.4450 |
| 11/02/06 | 12:41:00 | 53.1600 | 0.7940 | -1.2850 | 551.3888889 | 41.4450 |
| 11/02/06 | 12:42:00 | 53.1250 | 0.7940 | -1.2760 | 551.3888889 | 41.4010 |
| 11/02/06 | 12:43:00 | 53.1600 | 0.7930 | -1.2760 | 550.6944444 | 41.4360 |
| 11/02/06 | 12:44:00 | 53.1600 | 0.7930 | -1.2760 | 550.6944444 | 41.4360 |
| 11/02/06 | 12:45:00 | 53.1950 | 0.7940 | -1.2850 | 551.3888889 | 41.4800 |
| 11/02/06 | 12:46:00 | 53.1950 | 0.7940 | -1.2760 | 551.3888889 | 41.4710 |
| 11/02/06 | 12:47:00 | 53.1950 | 0.7940 | -1.2760 | 551.3888889 | 41.4710 |
| 11/02/06 | 12:48:00 | 53.1950 | 0.7940 | -1.2760 | 551.3888889 | 41.4710 |
| 11/02/06 | 12:49:00 | 53.1950 | 0.7940 | -1.2760 | 551.3888889 | 41.4710 |
| 11/02/06 | 12:50:00 | 53.1950 | 0.7940 | -1.2760 | 551.3888889 | 41.4710 |
| 11/02/06 | 12:51:00 | 53.1950 | 0.7940 | -1.2760 | 551.3888889 | 41.4710 |
| 11/02/06 | 12:52:00 | 53.2290 | 0.7930 | -1.2490 | 550.6944444 | 41.4780 |
| 11/02/06 | 12:53:00 | 53.2290 | 0.7930 | -1.2490 | 550.6944444 | 41.4780 |
| 11/02/06 | 12:54:00 | 53.2290 | 0.7930 | -1.2490 | 550.6944444 | 41.4780 |
| 11/02/06 | 12:55:00 | 53.1950 | 0.7930 | -1.2490 | 550.6944444 | 41.4440 |
| 11/02/06 | 12:56:00 | 53.1250 | 0.7910 | -1.2490 | 549.3055556 | 41.3740 |
| 11/02/06 | 12:57:00 | 53.1250 | 0.7910 | -1.2490 | 549.3055556 | 41.3740 |
| 11/02/06 | 12:58:00 | 53.2640 | 0.7930 | -1.2490 | 550.6944444 | 41.5130 |
| 11/02/06 | 12:59:00 | 53.2640 | 0.7930 | -1.2490 | 550.6944444 | 41.5130 |
| 11/02/06 | 13:00:00 | 53.1250 | 0.7950 | -1.2490 | 552.0833333 | 41.3740 |
| 11/02/06 | 13:01:00 | 53.1250 | 0.7930 | -1.2490 | 550.6944444 | 41.3740 |
| 11/02/06 | 13:02:00 | 53.1250 | 0.7930 | -1.2490 | 550.6944444 | 41.3740 |
| 11/02/06 | 13:03:00 | 53.1250 | 0.7930 | -1.2490 | 550.6944444 | 41.3740 |
| 11/02/06 | 13:04:00 | 53.1600 | 0.7930 | -1.2490 | 550.6944444 | 41.4090 |
| 11/02/06 | 13:05:00 | 53.1600 | 0.7930 | -1.2490 | 550.6944444 | 41.4090 |
| 11/02/06 | 13:06:00 | 53.1950 | 0.7940 | -1.2490 | 551.3888889 | 41.4440 |
| 11/02/06 | 13:07:00 | 53.1950 | 0.7940 | -1.2490 | 551.3888889 | 41.4440 |
| 11/02/06 | 13:08:00 | 53.0910 | 0.7930 | -1.2490 | 550.6944444 | 41.3400 |
| 11/02/06 | 13:09:00 | 53.1250 | 0.7940 | -1.2490 | 551.3888889 | 41.3740 |
| 11/02/06 | 13:10:00 | 53.1250 | 0.7940 | -1.2490 | 551.3888889 | 41.3740 |
| 11/02/06 | 13:11:00 | 53.0910 | 0.7910 | -1.2490 | 549.3055556 | 41.3400 |
| 11/02/06 | 13:12:00 | 53.0910 | 0.7910 | -1.2490 | 549.3055556 | 41.3400 |
| 11/02/06 | 13:13:00 | 53.1250 | 0.7930 | -1.2490 | 550.6944444 | 41.3740 |
| 11/02/06 | 13:14:00 | 53.0910 | 0.7920 | -1.2490 | 550 | 41.3400 |
| 11/02/06 | 13:15:00 | 53.0910 | 0.7920 | -1.2490 | 550 | 41.3400 |
| 11/02/06 | 13:16:00 | 53.1600 | 0.7940 | -1.2490 | 551.3888889 | 41.4090 |
| 11/02/06 | 13:17:00 | 53.1600 | 0.7940 | -1.2490 | 551.3888889 | 41.4090 |
| 11/02/06 | 13:18:00 | 53.1950 | 0.7950 | -1.2490 | 552.0833333 | 41.4440 |
| 11/02/06 | 13:19:00 | 53.1950 | 0.7950 | -1.2490 | 552.0833333 | 41.4440 |
| 11/02/06 | 13:20:00 | 53.1600 | 0.7940 | -1.2490 | 551.3888889 | 41.4090 |
| 11/02/06 | 13:21:00 | 53.1600 | 0.7940 | -1.2490 | 551.3888889 | 41.4090 |
| 11/02/06 | 13:22:00 | 53.1950 | 0.7960 | -1.2490 | 552.7777778 | 41.4440 |
| 11/02/06 | 13:23:00 | 53.1950 | 0.7960 | -1.2490 | 552.7777778 | 41.4440 |
| 11/02/06 | 13:24:00 | 53.1950 | 0.7960 | -1.2490 | 552.7777778 | 41.4440 |
| 11/02/06 | 13:25:00 | 53.1600 | 0.7940 | -1.2490 | 551.3888889 | 41.4090 |
| 11/02/06 | 13:26:00 | 53.1250 | 0.7930 | -1.2760 | 550.6944444 | 41.4010 |
| 11/02/06 | 13:27:00 | 53.1250 | 0.7930 | -1.2760 | 550.6944444 | 41.4010 |
| 11/02/06 | 13:28:00 | 53.0910 | 0.7950 | -1.2850 | 552.0833333 | 41.3760 |
| 11/02/06 | 13:29:00 | 53.0910 | 0.7950 | -1.2850 | 552.0833333 | 41.3760 |
| 11/02/06 | 13:30:00 | 53.1250 | 0.7950 | -1.2850 | 552.0833333 | 41.4100 |
| 11/02/06 | 13:31:00 | 53.1250 | 0.7950 | -1.2940 | 552.0833333 | 41.4190 |
| 11/02/06 | 13:32:00 | 53.1250 | 0.7950 | -1.2940 | 552.0833333 | 41.4190 |
| 11/02/06 | 13:33:00 | 53.0910 | 0.7930 | -1.3030 | 550.6944444 | 41.3940 |
| 11/02/06 | 13:34:00 | 53.0910 | 0.7930 | -1.3030 | 550.6944444 | 41.3940 |
| 11/02/06 | 13:35:00 | 53.0560 | 0.7950 | -1.3030 | 552.0833333 | 41.3590 |
| 11/02/06 | 13:36:00 | 53.0560 | 0.7950 | -1.3030 | 552.0833333 | 41.3590 |
| 11/02/06 | 13:37:00 | 53.0210 | 0.7950 | -1.3120 | 552.0833333 | 41.3330 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/02/06 | 13:38:00 | 53.0210 | 0.7950 | -1.3120 | 552.0833333 | 41.3330 |
| 11/02/06 | 13:39:00 | 53.0210 | 0.7930 | -1.3120 | 550.6944444 | 41.3330 |
| 11/02/06 | 13:40:00 | 53.0210 | 0.7930 | -1.3120 | 550.6944444 | 41.3330 |
| 11/02/06 | 13:41:00 | 53.0210 | 0.7940 | -1.3120 | 551.3888889 | 41.3330 |
| 11/02/06 | 13:42:00 | 53.0210 | 0.7940 | -1.3120 | 551.3888889 | 41.3330 |
| 11/02/06 | 13:43:00 | 52.9860 | 0.7930 | -1.3120 | 550.6944444 | 41.2980 |
| 11/02/06 | 13:44:00 | 52.9860 | 0.7930 | -1.3120 | 550.6944444 | 41.2980 |
| 11/02/06 | 13:45:00 | 53.0910 | 0.7940 | -1.3120 | 551.3888889 | 41.4030 |
| 11/02/06 | 13:46:00 | 53.0910 | 0.7940 | -1.3120 | 551.3888889 | 41.4030 |
| 11/02/06 | 13:47:00 | 53.0910 | 0.7930 | -1.3030 | 550.6944444 | 41.3940 |
| 11/02/06 | 13:48:00 | 52.6390 | 0.7910 | -1.3120 | 549.3055556 | 40.9510 |
| 11/02/06 | 13:49:00 | 52.6390 | 0.7910 | -1.3120 | 549.3055556 | 40.9510 |
| 11/02/06 | 13:50:00 | 52.7090 | 0.7910 | -1.3120 | 549.3055556 | 41.0210 |
| 11/02/06 | 13:51:00 | 52.7090 | 0.7910 | -1.3120 | 549.3055556 | 41.0210 |
| 11/02/06 | 13:52:00 | 52.6740 | 0.7920 | -1.3120 | 550 | 40.9860 |
| 11/02/06 | 13:53:00 | 52.6740 | 0.7920 | -1.3120 | 550 | 40.9860 |
| 11/02/06 | 13:54:00 | 52.6740 | 0.7920 | -1.3120 | 550 | 40.9860 |
| 11/02/06 | 13:55:00 | 52.6390 | 0.7920 | -1.3120 | 550 | 40.9510 |
| 11/02/06 | 13:56:00 | 52.6390 | 0.7910 | -1.3030 | 549.3055556 | 40.9420 |
| 11/02/06 | 13:57:00 | 52.6390 | 0.7910 | -1.3030 | 549.3055556 | 40.9420 |
| 11/02/06 | 13:58:00 | 52.7430 | 0.7930 | -1.3120 | 550.6944444 | 41.0550 |
| 11/02/06 | 13:59:00 | 52.7430 | 0.7930 | -1.3120 | 550.6944444 | 41.0550 |
| 11/02/06 | 14:00:00 | 52.7780 | 0.7920 | -1.3120 | 550 | 41.0900 |
| 11/02/06 | 14:01:00 | 52.7430 | 0.7940 | -1.3300 | 551.3888889 | 41.0730 |
| 11/02/06 | 14:02:00 | 52.7430 | 0.7940 | -1.3300 | 551.3888889 | 41.0730 |
| 11/02/06 | 14:03:00 | 52.6740 | 0.7910 | -1.3480 | 549.3055556 | 41.0220 |
| 11/02/06 | 14:04:00 | 52.6740 | 0.7910 | -1.3480 | 549.3055556 | 41.0220 |
| 11/02/06 | 14:05:00 | 52.6740 | 0.7910 | -1.3480 | 549.3055556 | 41.0220 |
| 11/02/06 | 14:06:00 | 52.6740 | 0.7920 | -1.3660 | 550 | 41.0400 |
| 11/02/06 | 14:07:00 | 52.6740 | 0.7920 | -1.3660 | 550 | 41.0400 |
| 11/02/06 | 14:08:00 | 52.6390 | 0.7920 | -1.3940 | 550 | 41.0330 |
| 11/02/06 | 14:09:00 | 52.6740 | 0.7930 | -1.3940 | 550.6944444 | 41.0680 |
| 11/02/06 | 14:10:00 | 52.6740 | 0.7930 | -1.3940 | 550.6944444 | 41.0680 |
| 11/02/06 | 14:11:00 | 52.6740 | 0.7930 | -1.3940 | 550.6944444 | 41.0680 |
| 11/02/06 | 14:12:00 | 52.6740 | 0.7930 | -1.3940 | 550.6944444 | 41.0680 |
| 11/02/06 | 14:13:00 | 52.6390 | 0.7930 | -1.3940 | 550.6944444 | 41.0330 |
| 11/02/06 | 14:14:00 | 52.7090 | 0.7910 | -1.3940 | 549.3055556 | 41.1030 |
| 11/02/06 | 14:15:00 | 52.7090 | 0.7910 | -1.3940 | 549.3055556 | 41.1030 |
| 11/02/06 | 14:16:00 | 52.6390 | 0.7920 | -1.3940 | 550 | 41.0330 |
| 11/02/06 | 14:17:00 | 52.6390 | 0.7920 | -1.3940 | 550 | 41.0330 |
| 11/02/06 | 14:18:00 | 52.7090 | 0.7920 | -1.3940 | 550 | 41.1030 |
| 11/02/06 | 14:19:00 | 52.7090 | 0.7920 | -1.3940 | 550 | 41.1030 |
| 11/02/06 | 14:20:00 | 52.6390 | 0.7930 | -1.3940 | 550.6944444 | 41.0330 |
| 11/02/06 | 14:21:00 | 52.6390 | 0.7930 | -1.3940 | 550.6944444 | 41.0330 |
| 11/02/06 | 14:22:00 | 52.7430 | 0.7940 | -1.3850 | 551.3888889 | 41.1280 |
| 11/02/06 | 14:23:00 | 52.7430 | 0.7940 | -1.3850 | 551.3888889 | 41.1280 |
| 11/02/06 | 14:24:00 | 52.7090 | 0.7930 | -1.3940 | 550.6944444 | 41.1030 |
| 11/02/06 | 14:25:00 | 52.7090 | 0.7930 | -1.3940 | 550.6944444 | 41.1030 |
| 11/02/06 | 14:26:00 | 52.7430 | 0.7940 | -1.3940 | 551.3888889 | 41.1370 |
| 11/02/06 | 14:27:00 | 52.7430 | 0.7940 | -1.3940 | 551.3888889 | 41.1370 |
| 11/02/06 | 14:28:00 | 52.7430 | 0.7940 | -1.3940 | 551.3888889 | 41.1370 |
| 11/02/06 | 14:29:00 | 52.7090 | 0.7940 | -1.3940 | 551.3888889 | 41.1030 |
| 11/02/06 | 14:30:00 | 52.7090 | 0.7940 | -1.4210 | 551.3888889 | 41.1300 |
| 11/02/06 | 14:31:00 | 52.7090 | 0.7940 | -1.4210 | 551.3888889 | 41.1300 |
| 11/02/06 | 14:32:00 | 52.6040 | 0.7930 | -1.4750 | 550.6944444 | 41.0790 |
| 11/02/06 | 14:33:00 | 52.6040 | 0.7930 | -1.4750 | 550.6944444 | 41.0790 |
| 11/02/06 | 14:34:00 | 52.5700 | 0.7910 | -1.4750 | 549.3055556 | 41.0450 |
| 11/02/06 | 14:35:00 | 52.5700 | 0.7910 | -1.4750 | 549.3055556 | 41.0450 |
| 11/02/06 | 14:36:00 | 52.6040 | 0.7940 | -1.5020 | 551.3888889 | 41.1060 |
| 11/02/06 | 14:37:00 | 52.6040 | 0.7940 | -1.5020 | 551.3888889 | 41.1060 |
| 11/02/06 | 14:38:00 | 52.6040 | 0.7920 | -1.5020 | 550 | 41.1060 |
| 11/02/06 | 14:39:00 | 52.6390 | 0.7930 | -1.5020 | 550.6944444 | 41.1410 |
| 11/02/06 | 14:40:00 | 52.6390 | 0.7930 | -1.5020 | 550.6944444 | 41.1410 |
| 11/02/06 | 14:41:00 | 52.5700 | 0.7900 | -1.5290 | 548.6111111 | 41.0990 |
| 11/02/06 | 14:42:00 | 52.5700 | 0.7900 | -1.5290 | 548.6111111 | 41.0990 |
| 11/02/06 | 14:43:00 | 52.5000 | 0.7920 | -1.5560 | 550 | 41.0560 |
| 11/02/06 | 14:44:00 | 52.5000 | 0.7920 | -1.5560 | 550 | 41.0560 |
| 11/02/06 | 14:45:00 | 52.5000 | 0.7910 | -1.5830 | 549.3055556 | 41.0830 |
| 11/02/06 | 14:46:00 | 52.5000 | 0.7910 | -1.5830 | 549.3055556 | 41.0830 |
| 11/02/06 | 14:47:00 | 52.5000 | 0.7920 | -1.5830 | 550 | 41.0830 |
| 11/02/06 | 14:48:00 | 52.5000 | 0.7920 | -1.5830 | 550 | 41.0830 |
| 11/02/06 | 14:49:00 | 52.5350 | 0.7930 | -1.5830 | 550.6944444 | 41.1180 |
| 11/02/06 | 14:50:00 | 52.5000 | 0.7930 | -1.5830 | 550.6944444 | 41.0830 |
| 11/02/06 | 14:51:00 | 52.5000 | 0.7930 | -1.5830 | 550.6944444 | 41.0830 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

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|---|---|---|---|---|---|---|
| 11/02/06 | 14:52:00 | 52.5000 | 0.7930 | -1.5830 | 550.6944444 | 41.0830 |
| 11/02/06 | 14:53:00 | 52.5350 | 0.7920 | -1.5830 | 550 | 41.1180 |
| 11/02/06 | 14:54:00 | 52.5350 | 0.7920 | -1.5830 | 550 | 41.1180 |
| 11/02/06 | 14:55:00 | 52.5350 | 0.7920 | -1.5830 | 550 | 41.1180 |
| 11/02/06 | 14:56:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 14:57:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 14:58:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 14:59:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 15:00:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 15:01:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 15:02:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 15:03:00 | 52.5000 | 0.7940 | -1.5650 | 551.3888889 | 41.0650 |
| 11/02/06 | 15:04:00 | 52.2570 | 0.7890 | -1.5560 | 547.9166667 | 40.8130 |
| 11/02/06 | 15:05:00 | 52.2570 | 0.7890 | -1.5560 | 547.9166667 | 40.8130 |
| 11/02/06 | 15:06:00 | 52.2220 | 0.7900 | -1.5560 | 548.6111111 | 40.7780 |
| 11/02/06 | 15:07:00 | 52.1880 | 0.7900 | -1.5560 | 548.6111111 | 40.7440 |
| 11/02/06 | 15:08:00 | 52.1880 | 0.7900 | -1.5560 | 548.6111111 | 40.7440 |
| 11/02/06 | 15:09:00 | 52.1880 | 0.7900 | -1.5560 | 548.6111111 | 40.7440 |
| 11/02/06 | 15:10:00 | 52.1880 | 0.7900 | -1.5560 | 548.6111111 | 40.7440 |
| 11/02/06 | 15:11:00 | 52.2220 | 0.7890 | -1.5830 | 547.9166667 | 40.8050 |
| 11/02/06 | 15:12:00 | 52.2220 | 0.7890 | -1.5830 | 547.9166667 | 40.8050 |
| 11/02/06 | 15:13:00 | 52.1180 | 0.7890 | -1.6190 | 547.9166667 | 40.7370 |
| 11/02/06 | 15:14:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:15:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:16:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:17:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:18:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:19:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:20:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:21:00 | 52.0490 | 0.7880 | -1.6640 | 547.2222222 | 40.7130 |
| 11/02/06 | 15:22:00 | 51.9450 | 0.7890 | -1.7550 | 547.9166667 | 40.7000 |
| 11/02/06 | 15:23:00 | 51.9450 | 0.7890 | -1.7550 | 547.9166667 | 40.7000 |
| 11/02/06 | 15:24:00 | 51.9790 | 0.7880 | -1.7550 | 547.2222222 | 40.7340 |
| 11/02/06 | 15:25:00 | 51.9790 | 0.7880 | -1.7550 | 547.2222222 | 40.7340 |
| 11/02/06 | 15:26:00 | 51.9790 | 0.7880 | -1.7550 | 547.2222222 | 40.7340 |
| 11/02/06 | 15:27:00 | 51.8750 | 0.7880 | -1.7550 | 547.2222222 | 40.6300 |
| 11/02/06 | 15:28:00 | 51.8750 | 0.7880 | -1.7550 | 547.2222222 | 40.6300 |
| 11/02/06 | 15:29:00 | 51.8750 | 0.7880 | -1.7550 | 547.2222222 | 40.6300 |
| 11/02/06 | 15:30:00 | 51.8750 | 0.7880 | -1.7550 | 547.2222222 | 40.6300 |
| 11/02/06 | 15:31:00 | 51.5630 | 0.7840 | -1.7550 | 544.4444444 | 40.3180 |
| 11/02/06 | 15:32:00 | 51.7360 | 0.7880 | -1.7280 | 547.2222222 | 40.4640 |
| 11/02/06 | 15:33:00 | 51.7360 | 0.7880 | -1.7280 | 547.2222222 | 40.4640 |
| 11/02/06 | 15:34:00 | 51.7360 | 0.7880 | -1.7280 | 547.2222222 | 40.4640 |
| 11/02/06 | 15:35:00 | 51.7020 | 0.7870 | -1.7280 | 546.5277778 | 40.4300 |
| 11/02/06 | 15:36:00 | 51.7020 | 0.7870 | -1.7280 | 546.5277778 | 40.4300 |
| 11/02/06 | 15:37:00 | 51.7020 | 0.7870 | -1.7280 | 546.5277778 | 40.4300 |
| 11/02/06 | 15:38:00 | 51.7710 | 0.7870 | -1.7280 | 546.5277778 | 40.4990 |
| 11/02/06 | 15:39:00 | 51.7360 | 0.7860 | -1.7190 | 545.8333333 | 40.4550 |
| 11/02/06 | 15:40:00 | 51.7360 | 0.7860 | -1.7190 | 545.8333333 | 40.4550 |
| 11/02/06 | 15:41:00 | 51.7020 | 0.7870 | -1.7280 | 546.5277778 | 40.4300 |
| 11/02/06 | 15:42:00 | 51.7020 | 0.7870 | -1.7280 | 546.5277778 | 40.4300 |
| 11/02/06 | 15:43:00 | 51.8750 | 0.7870 | -1.7280 | 546.5277778 | 40.6030 |
| 11/02/06 | 15:44:00 | 51.8750 | 0.7870 | -1.7280 | 546.5277778 | 40.6030 |
| 11/02/06 | 15:45:00 | 51.8750 | 0.7870 | -1.7280 | 546.5277778 | 40.6030 |
| 11/02/06 | 15:46:00 | 51.8750 | 0.7870 | -1.7280 | 546.5277778 | 40.6030 |
| 11/02/06 | 15:47:00 | 51.8750 | 0.7870 | -1.7280 | 546.5277778 | 40.6030 |
| 11/02/06 | 15:48:00 | 51.8750 | 0.7870 | -1.7280 | 546.5277778 | 40.6030 |
| 11/02/06 | 15:49:00 | 51.7020 | 0.7860 | -1.8090 | 545.8333333 | 40.5110 |
| 11/02/06 | 15:50:00 | 51.7020 | 0.7860 | -1.8090 | 545.8333333 | 40.5110 |
| 11/02/06 | 15:51:00 | 51.7360 | 0.7870 | -1.8090 | 546.5277778 | 40.5450 |
| 11/02/06 | 15:52:00 | 51.7360 | 0.7870 | -1.8090 | 546.5277778 | 40.5450 |
| 11/02/06 | 15:53:00 | 51.7020 | 0.7860 | -1.8360 | 545.8333333 | 40.5380 |
| 11/02/06 | 15:54:00 | 51.7020 | 0.7860 | -1.8360 | 545.8333333 | 40.5380 |
| 11/02/06 | 15:55:00 | 51.7360 | 0.7850 | -1.8360 | 545.1388889 | 40.5720 |
| 11/02/06 | 15:56:00 | 51.7360 | 0.7850 | -1.8360 | 545.1388889 | 40.5720 |
| 11/02/06 | 15:57:00 | 51.7020 | 0.7850 | -1.8360 | 545.1388889 | 40.5380 |
| 11/02/06 | 15:58:00 | 51.7020 | 0.7850 | -1.8360 | 545.1388889 | 40.5380 |
| 11/02/06 | 15:59:00 | 51.7710 | 0.7870 | -1.8360 | 546.5277778 | 40.6070 |
| 11/02/06 | 16:00:00 | 51.7710 | 0.7870 | -1.8360 | 546.5277778 | 40.6070 |
| 11/02/06 | 16:01:00 | 51.8410 | 0.7890 | -1.8360 | 547.9166667 | 40.6770 |
| 11/02/06 | 16:02:00 | 51.8410 | 0.7890 | -1.8360 | 547.9166667 | 40.6770 |
| 11/02/06 | 16:03:00 | 52.0490 | 0.7900 | -1.8360 | 548.6111111 | 40.8850 |
| 11/02/06 | 16:04:00 | 52.0490 | 0.7900 | -1.8360 | 548.6111111 | 40.8850 |
| 11/02/06 | 16:05:00 | 52.0490 | 0.7900 | -1.8360 | 548.6111111 | 40.8850 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
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| 11/02/06 | 16:06:00 | 52.0490 | 0.7900 | -1.8360 | 548.6111111 | 40.8850 |
| 11/02/06 | 16:07:00 | 51.9450 | 0.7880 | -1.8630 | 547.2222222 | 40.8080 |
| 11/02/06 | 16:08:00 | 51.9450 | 0.7880 | -1.8630 | 547.2222222 | 40.8080 |
| 11/02/06 | 16:09:00 | 51.9450 | 0.7880 | -1.8630 | 547.2222222 | 40.8080 |
| 11/02/06 | 16:10:00 | 51.9790 | 0.7910 | -1.8630 | 549.3055556 | 40.8420 |
| 11/02/06 | 16:11:00 | 51.9790 | 0.7910 | -1.8630 | 549.3055556 | 40.8420 |
| 11/02/06 | 16:12:00 | 51.9790 | 0.7910 | -1.8630 | 549.3055556 | 40.8420 |
| 11/02/06 | 16:13:00 | 51.9790 | 0.7910 | -1.8630 | 549.3055556 | 40.8420 |
| 11/02/06 | 16:14:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:15:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:16:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:17:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:18:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:19:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:20:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:21:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:22:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:23:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:24:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:25:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:26:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 16:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 16:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 16:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:50:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 16:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 16:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 16:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/02/06 | 17:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 17:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 17:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
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| 11/02/06 | 18:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 18:50:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:51:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:55:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 18:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 19:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 19:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 19:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

# KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/02/06 | 19:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:50:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:51:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:55:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 19:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 20:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 20:51:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:55:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 20:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

# KAHANAHOU WWPS SCADA DATA
# OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/02/06 | 21:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 21:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:50:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 21:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:55:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 21:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:10:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

## KAHANAHOU WWPS SCADA DATA
## OCT. 31, 2006 ~ NOV. 2 2006

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/02/06 | 22:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:35:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:38:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:39:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:40:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:41:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:42:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:43:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:44:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:45:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:46:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:47:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:48:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:49:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:50:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:51:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:52:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:53:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:54:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:55:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 22:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:00:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:01:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:02:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:03:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:04:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:05:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:06:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:07:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:08:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:09:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 23:11:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:12:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:13:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:14:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:15:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:16:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:17:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:18:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:19:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:20:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:21:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:22:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:23:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:24:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:25:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:26:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:27:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:28:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:29:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

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|---|---|---|---|---|---|---|
| 11/02/06 | 23:30:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:31:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:32:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:33:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:34:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
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| 11/02/06 | 23:36:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:37:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:38:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 23:39:00 | 51.8750 | 0.7870 | -1.9170 | 546.5277778 | 40.7920 |
| 11/02/06 | 23:40:00 | 50.8680 | 0.7840 | -3.1000 | 544.4444444 | 40.9680 |
| 11/02/06 | 23:41:00 | 50.8680 | 0.7840 | -3.1000 | 544.4444444 | 40.9680 |
| 11/02/06 | 23:42:00 | 50.8680 | 0.7860 | -3.1000 | 545.8333333 | 40.9680 |
| 11/02/06 | 23:43:00 | 50.8680 | 0.7860 | -3.1000 | 545.8333333 | 40.9680 |
| 11/02/06 | 23:44:00 | 50.8680 | 0.7860 | -3.1000 | 545.8333333 | 40.9680 |
| 11/02/06 | 23:45:00 | 50.9030 | 0.7850 | -3.0910 | 545.1388889 | 40.9940 |
| 11/02/06 | 23:46:00 | 50.9030 | 0.7850 | -3.0910 | 545.1388889 | 40.9940 |
| 11/02/06 | 23:47:00 | 50.7990 | 0.7860 | -3.0910 | 545.8333333 | 40.8900 |
| 11/02/06 | 23:48:00 | 50.7990 | 0.7860 | -3.0910 | 545.8333333 | 40.8900 |
| 11/02/06 | 23:49:00 | 50.7990 | 0.7860 | -3.0910 | 545.8333333 | 40.8900 |
| 11/02/06 | 23:50:00 | 50.7990 | 0.7860 | -3.0910 | 545.8333333 | 40.8900 |
| 11/02/06 | 23:51:00 | 50.7990 | 0.7860 | -3.0910 | 545.8333333 | 40.8900 |
| 11/02/06 | 23:52:00 | 50.7990 | 0.7860 | -3.0910 | 545.8333333 | 40.8900 |
| 11/02/06 | 23:53:00 | 50.7640 | 0.7840 | -3.0910 | 544.4444444 | 40.8550 |
| 11/02/06 | 23:54:00 | 50.7640 | 0.7840 | -3.0910 | 544.4444444 | 40.8550 |
| 11/02/06 | 23:55:00 | 50.7640 | 0.7840 | -3.0910 | 544.4444444 | 40.8550 |
| 11/02/06 | 23:56:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:57:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:58:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |
| 11/02/06 | 23:59:00 | 0.0000 | 0.0000 | 0.0000 | 0 | -13.0000 |

# APPENDIX C
# INFIX PUMP STATION REPORT

PUMP STATION FLOW REPORT - EXISTING FLOW - BABBIT'S FLOW FACTOR

AREA : KANEOHE BASIN

PREPARED BY : CITY & COUNTY OF HONOLULU



Date : 01/06/11

| PLANT/ STATION | TRIBUTARY AREA (ACRES) | TRIBUTARY EQUIVALENT POPULATION RES. | OTHER | TOTAL | WASTEWATER FLOW COMPUTATION AVE. Q (MGD) | MAX FF | MAX Q (MGD) | DRY I/I (MGD) | DESIGN AVE (MGD) | DESIGN Q MAX (MGD) | WET I/I (MGD) | DESIGN Q PEAK (MGD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KK 20 | 619.7 | 8267 | 3006 | 11273 | 0.9018 | 3.08 | 2.7777 | 0.0695 | 0.9713 | 2.8472 | 0.8198 | 3.6670 |
| KK 21 | 16.2 | 373 | 12 | 385 | 0.0308 | 5.00 | 0.1541 | 0.0019 | 0.0327 | 0.1560 | 0.0202 | 0.1762 |
| KK 22 | 195.2 | 2040 | 135 | 2176 | 0.1740 | 4.28 | 0.7449 | 0.0240 | 0.1981 | 0.7690 | 0.2891 | 1.0581 |
| KK 23 | 171.6 | 1900 | 62 | 1963 | 0.1570 | 4.37 | 0.6860 | 0.0221 | 0.1791 | 0.7080 | 0.2554 | 0.9634 |
| KK 24 | 103.6 | 1154 | 17 | 1171 | 0.0936 | 4.84 | 0.4537 | 0.0128 | 0.1064 | 0.4665 | 0.1493 | 0.6158 |
| KK 30 | 4151.8 | 51276 | 40850 | 92126 | 7.3700 | 2.02 | 14.9129 | 0.6261 | 7.9960 | 15.5389 | 6.1627 | 21.7016 |
| KK 31 | 9.0 | 88 | 24 | 112 | 0.0090 | 5.00 | 0.0449 | 0.0006 | 0.0095 | 0.0454 | 0.0113 | 0.0567 |
| KK 32 | 68.6 | 832 | 22 | 854 | 0.0684 | 5.00 | 0.3418 | 0.0149 | 0.0832 | 0.3567 | 0.1218 | 0.4784 |
| KK 33 | 42.4 | 674 | 226 | 900 | 0.0720 | 5.00 | 0.3598 | 0.0095 | 0.0815 | 0.3694 | 0.0731 | 0.4424 |
| KK 34 | 142.5 | 2364 | 0 | 2364 | 0.1891 | 4.21 | 0.7961 | 0.0118 | 0.2009 | 0.8079 | 0.1781 | 0.9861 |
| KK 35 | 425.5 | 743 | 931 | 1674 | 0.1339 | 4.51 | 0.6041 | 0.0084 | 0.1423 | 0.6124 | 1.1111 | 1.7235 |
| KK 36 | 165.5 | 2354 | 2105 | 4459 | 0.3567 | 3.71 | 1.3226 | 0.0329 | 0.3896 | 1.3555 | 0.2251 | 1.5806 |
| KK 37 | 181.1 | 2695 | 277 | 2972 | 0.2377 | 4.02 | 0.9560 | 0.0459 | 0.2837 | 1.0019 | 0.3231 | 1.3251 |
| KK 45 | 27.7 | 442 | 61 | 503 | 0.0402 | 5.00 | 0.2012 | 0.0025 | 0.0428 | 0.2037 | 0.0346 | 0.2383 |
| KK 48 | 4.2 | 68 | 0 | 68 | 0.0054 | 5.00 | 0.0272 | 0.0003 | 0.0058 | 0.0275 | 0.0053 | 0.0328 |
| KK 50 | 464.4 | 4724 | 1078 | 5802 | 0.4642 | 3.52 | 1.6328 | 0.0869 | 0.5511 | 1.7197 | 0.7669 | 2.4866 |
| KK 51 | 280.9 | 2658 | 797 | 3455 | 0.2764 | 3.90 | 1.0784 | 0.0610 | 0.3374 | 1.1394 | 0.4651 | 1.6045 |
| KK 52 | 175.7 | 1763 | 776 | 2538 | 0.2031 | 4.15 | 0.8428 | 0.0536 | 0.2567 | 0.8964 | 0.3193 | 1.2157 |
| KK 53 | 42.0 | 392 | 19 | 411 | 0.0329 | 5.00 | 0.1645 | 0.0061 | 0.0390 | 0.1706 | 0.0815 | 0.2521 |

PUMP STATION FLOW REPORT - FUTURE FLOW - BABBIT'S FLOW FACTOR
AREA : KANEOHE BASIN
PREPARED BY : CITY & COUNTY OF HONOLULU



Date : 01/06/11

| PLANT/ STATION | TRIBUTARY AREA (ACRES) | TRIBUTARY EQUIVALENT POPULATION RES. | OTHER | TOTAL | WASTEWATER FLOW COMPUTATION AVE. Q (MGD) | MAX FF | MAX Q (MGD) | DRY I/I (MGD) | DESIGN AVE (MGD) | DESIGN Q MAX (MGD) | WET I/I (MGD) | DESIGN Q PEAK (MGD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KK 20 | 892.7 | 18101 | 4398 | 22500 | 1.8001 | 2.68 | 4.8286 | 0.2966 | 2.0967 | 5.1252 | 1.5703 | 6.6955 |
| KK 21 | 162.4 | 2780 | 12 | 2792 | 0.2234 | 4.07 | 0.9095 | 0.0858 | 0.3091 | 0.9953 | 0.4223 | 1.4176 |
| KK 22 | 313.0 | 4721 | 1314 | 6035 | 0.4829 | 3.49 | 1.6853 | 0.1343 | 0.6172 | 1.8196 | 0.6130 | 2.4326 |
| KK 23 | 178.2 | 2943 | 56 | 2999 | 0.2400 | 4.01 | 0.9631 | 0.0363 | 0.2762 | 0.9994 | 0.2736 | 1.2730 |
| KK 24 | 110.3 | 1747 | 17 | 1763 | 0.1411 | 4.46 | 0.6298 | 0.0202 | 0.1613 | 0.6500 | 0.1675 | 0.8176 |
| KK 30 | 4470.7 | 83082 | 46631 | 129713 | 10.3771 | 1.89 | 19.6087 | 1.0568 | 11.4339 | 20.6655 | 7.0392 | 27.7047 |
| KK 31 | 9.0 | 88 | 97 | 185 | 0.0148 | 5.00 | 0.0739 | 0.0009 | 0.0157 | 0.0748 | 0.0113 | 0.0861 |
| KK 32 | 76.0 | 1123 | 18 | 1141 | 0.0913 | 4.87 | 0.4447 | 0.0206 | 0.1120 | 0.4653 | 0.1422 | 0.6075 |
| KK 33 | 42.4 | 757 | 261 | 1018 | 0.0814 | 4.98 | 0.4055 | 0.0113 | 0.0927 | 0.4168 | 0.0731 | 0.4899 |
| KK 34 | 142.5 | 2643 | 0 | 2643 | 0.2115 | 4.12 | 0.8705 | 0.0132 | 0.2247 | 0.8837 | 0.1781 | 1.0618 |
| KK 35 | 425.5 | 811 | 931 | 1742 | 0.1394 | 4.47 | 0.6236 | 0.0087 | 0.1481 | 0.6323 | 1.1111 | 1.7434 |
| KK 36 | 170.9 | 3850 | 2177 | 6027 | 0.4822 | 3.49 | 1.6833 | 0.0440 | 0.5262 | 1.7274 | 0.2398 | 1.9671 |
| KK 37 | 188.5 | 3260 | 405 | 3665 | 0.2932 | 3.86 | 1.1306 | 0.0567 | 0.3499 | 1.1874 | 0.3436 | 1.5310 |
| KK 45 | 27.7 | 530 | 61 | 591 | 0.0473 | 5.00 | 0.2365 | 0.0030 | 0.0503 | 0.2395 | 0.0346 | 0.2740 |
| KK 48 | 4.2 | 92 | 0 | 92 | 0.0074 | 5.00 | 0.0369 | 0.0005 | 0.0078 | 0.0373 | 0.0053 | 0.0426 |
| KK 50 | 464.4 | 7198 | 1145 | 8343 | 0.6675 | 3.27 | 2.1834 | 0.1114 | 0.7788 | 2.2947 | 0.7669 | 3.0616 |
| KK 51 | 280.9 | 4637 | 831 | 5468 | 0.4375 | 3.56 | 1.5572 | 0.0824 | 0.5198 | 1.6395 | 0.4651 | 2.1046 |
| KK 52 | 175.7 | 2983 | 776 | 3759 | 0.3007 | 3.84 | 1.1536 | 0.0692 | 0.3699 | 1.2228 | 0.3193 | 1.5421 |
| KK 53 | 42.0 | 643 | 19 | 662 | 0.0529 | 5.00 | 0.2647 | 0.0122 | 0.0651 | 0.2769 | 0.0815 | 0.3584 |

# APPENDIX D
# HISTORICAL FLOW RATES AND POWER USE

# TABLE D-1: KAHANAHOU WWPS
# HISTORICAL FLOW RATES AND POWER USE

(Sheet 1 of 3)

| Month | Total Flow[a] (MGM) | Daily Flow Rate[a] (MGD) Monthly Maximum | Monthly Average | Monthly Minimum | Total Energy[a] (1,000 KWH/Month) | Flow/KWH[a] (1,000 gal/KWH) | Monthly Precipitation[b] (Inches) |
|---|---|---|---|---|---|---|---|
| Jan-00 | 9.0750 | 0.4400 | 0.2927 | 0.2150 | 3.3970 | 2.6715 | 4.49 |
| Feb-00 | 7.1250 | 0.3000 | 0.2457 | 0.1950 | 2.6730 | 2.6655 | 0.39 |
| Mar-00 | 7.6600 | 0.3050 | 0.2471 | 0.2150 | 2.9620 | 2.5861 | 2.11 |
| Apr-00 | 7.7000 | 0.3300 | 0.2567 | 0.2050 | 3.0540 | 2.5213 | 3.40 |
| May-00 | 8.2450 | 0.3600 | 0.2660 | 0.1900 | 3.2030 | 2.5741 | 1.48 |
| Jun-00 | 8.4500 | 0.3400 | 0.2817 | 0.2100 | 3.1830 | 2.6547 | 1.28 |
| Jul-00 | 9.1300 | 0.4150 | 0.2945 | 0.2350 | 3.4380 | 2.6556 | 1.81 |
| Aug-00 | 8.5600 | 0.3400 | 0.2761 | 0.2150 | 3.3390 | 2.5636 | 3.01 |
| Sep-00 | 8.5000 | 0.3400 | 0.2833 | 0.2350 | 3.3020 | 2.5742 | 5.56 |
| Oct-00 | 8.5100 | 0.4200 | 0.2745 | 0.2250 | 3.3090 | 2.5718 | 2.93 |
| Nov-00 | 8.4650 | 0.3550 | 0.2822 | 0.2200 | 3.2870 | 2.5753 | 3.42 |
| Dec-00 | 9.1250 | 0.3850 | 0.2944 | 0.2250 | 3.5340 | 2.5821 | 1.22 |
| Jan-01 | 8.9300 | 0.3650 | 0.2881 | 0.2250 | 3.4860 | 2.5617 | 0.63 |
| Feb-01 | 10.1200 | 0.5000 | 0.3614 | 0.2600 | 3.6270 | 2.7902 | 5.73 |
| Mar-01 | 9.5850 | 0.4000 | 0.3092 | 0.2200 | 3.3010 | 2.9037 | 2.63 |
| Apr-01 | 7.6150 | 0.2850 | 0.2538 | 0.2000 | 3.1520 | 2.4159 | 2.19 |
| May-01 | 8.5300 | 0.3350 | 0.2752 | 0.2300 | 3.4320 | 2.4854 | 3.36 |
| Jun-01 | 8.9300 | 0.3600 | 0.2977 | 0.2400 | 3.3760 | 2.6451 | 2.88 |
| Jul-01 | 10.2500 | 0.4100 | 0.3306 | 0.2600 | 3.9460 | 2.5976 | 0.98 |
| Aug-01 | 9.6700 | 0.4200 | 0.3119 | 0.2400 | 3.7000 | 2.6135 | 2.61 |
| Sep-01 | 9.8700 | 0.3900 | 0.3290 | 0.2450 | 3.6940 | 2.6719 | 1.17 |
| Oct-01 | 8.5300 | 0.3200 | 0.2752 | 0.2200 | 3.3920 | 2.5147 | 3.38 |
| Nov-01 | 9.5300 | 0.6000 | 0.3177 | 0.2300 | 3.6140 | 2.6370 | 6.66 |
| Dec-01 | 9.1600 | 0.4500 | 0.2955 | 0.1900 | 3.6540 | 2.5068 | 4.10 |
| Jan-02 | 11.2250 | 0.6650 | 0.3621 | 0.2550 | 3.8740 | 2.8975 | 7.17 |
| Feb-02 | 9.4750 | 0.5900 | 0.3384 | 0.2400 | 3.0650 | 3.0914 | 3.63 |
| Mar-02 | 8.9800 | 0.3600 | 0.2897 | 0.2300 | 3.0670 | 2.9279 | 7.95 |
| Apr-02 | 9.1100 | 0.3700 | 0.3037 | 0.2400 | 3.0790 | 2.9588 | 2.93 |
| May-02 | 11.0400 | 0.6200 | 0.3561 | 0.2600 | 3.5550 | 3.1055 | 7.05 |
| Jun-02 | 8.9100 | 0.3600 | 0.2970 | 0.2350 | 2.9260 | 3.0451 | 0.99 |
| Jul-02 | 9.3100 | 0.4000 | 0.3003 | 0.2394 | 2.9600 | 3.1453 | 3.62 |
| Aug-02 | 8.1400 | 0.3100 | 0.2626 | 0.2100 | 2.8340 | 2.8723 | 1.72 |
| Sep-02 | 10.4200 | 0.4500 | 0.3473 | 0.2600 | 3.4230 | 3.0441 | 1.05 |
| Oct-02 | 12.5900 | 0.4800 | 0.4061 | 0.3250 | 4.0020 | 3.1459 | 4.17 |
| Nov-02 | 10.3800 | 0.4500 | 0.3460 | 0.2200 | 3.5610 | 2.9149 | 2.70 |
| Dec-02 | 9.6500 | 0.4200 | 0.3113 | 0.2350 | 3.5410 | 2.7252 | 1.18 |
| Jan-03 | 10.4900 | 0.5000 | 0.3384 | 0.2700 | 3.8120 | 2.7518 | 4.13 |
| Feb-03 | 8.8600 | 0.5650 | 0.3164 | 0.2300 | 3.0790 | 2.8776 | 5.94 |
| Mar-03 | 10.2800 | 0.4050 | 0.3316 | 0.2700 | 3.4980 | 2.9388 | 4.93 |
| Apr-03 | 9.5200 | 0.3900 | 0.3173 | 0.2400 | 3.3790 | 2.8174 | 2.52 |
| May-03 | 10.9800 | 0.4300 | 0.3542 | 0.2700 | 3.7770 | 2.9071 | 0.94 |
| Jun-03 | 12.7700 | 0.5200 | 0.4257 | 0.3500 | 4.8160 | 2.6516 | 2.52 |
| Jul-03 | 12.2300 | 0.5000 | 0.3945 | 0.3200 | 4.1680 | 2.9343 | 2.86 |
| Aug-03 | 13.3250 | 0.5250 | 0.4298 | 0.3200 | 4.5160 | 2.9506 | 1.55 |
| Sep-03 | 16.2550 | 0.6200 | 0.5418 | 0.4600 | 5.7290 | 2.8373 | 2.95 |
| Oct-03 | 15.6200 | 0.6000 | 0.5039 | 0.4100 | 5.2260 | 2.9889 | 1.62 |
| Nov-03 | 12.0100 | 0.6000 | 0.4003 | 0.2900 | 4.1700 | 2.8801 | 9.09 |

# TABLE D-1: KAHANAHOU WWPS
# HISTORICAL FLOW RATES AND POWER USE
(Sheet 2 of 3)

| Month | Total Flow[a] (MGM) | Daily Flow Rate[a] (MGD) | | | Total Energy[a] (1,000 KWH/Month) | Flow/KWH[a] (1,000 gal/KWH) | Monthly Precipitation[b] (Inches) |
|---|---|---|---|---|---|---|---|
| | | Monthly Maximum | Monthly Average | Monthly Minimum | | | |
| Dec-03 | 12.9100 | 0.7200 | 0.4165 | 0.2800 | 4.5140 | 2.8600 | 11.70 |
| Jan-04 | 14.6200 | 0.6700 | 0.4716 | 0.3300 | 5.0070 | 2.9199 | 12.86 |
| Feb-04 | 12.8100 | 0.7700 | 0.4417 | 0.3700 | 4.3890 | 2.9187 | 13.89 |
| Mar-04 | 15.0000 | 0.7700 | 0.4839 | 0.3700 | 5.1750 | 2.8986 | 8.42 |
| Apr-04 | 10.8400 | 0.4200 | 0.3613 | 0.2900 | 3.5950 | 3.0153 | 2.91 |
| May-04 | 15.0000 | 0.6900 | 0.4839 | 0.3200 | 5.4980 | 2.7283 | 6.71 |
| Jun-04 | 12.3400 | 0.5000 | 0.4113 | 0.2700 | 4.4460 | 2.7755 | 3.08 |
| Jul-04 | 11.0400 | 0.5500 | 0.3561 | 0.2500 | 3.7400 | 2.9519 | 1.98 |
| Aug-04 | 12.7200 | 0.7100 | 0.4103 | 0.2100 | 4.3160 | 2.9472 | 7.59 |
| Sep-04 | 12.1000 | 0.6700 | 0.4033 | 0.2100 | 4.0350 | 2.9988 | 2.87 |
| Oct-04 | 13.3800 | 0.7900 | 0.4316 | 0.1900 | 4.5830 | 2.9195 | 6.59 |
| Nov-04 | 16.3600 | 1.0000 | 0.5453 | 0.2300 | 5.8570 | 2.7932 | 9.60 |
| Dec-04 | 14.0500 | 0.7300 | 0.4532 | 0.2700 | 5.0360 | 2.7899 | 4.76 |
| Jan-05 | 14.0600 | 0.8300 | 0.4535 | 0.2200 | 4.9870 | 2.8193 | 7.99 |
| Feb-05 | 12.9900 | 1.0700 | 0.4639 | 0.2000 | 4.7490 | 2.7353 | 8.42 |
| Mar-05 | 12.4200 | 0.7100 | 0.4006 | 0.1800 | 4.4640 | 2.7823 | 6.44 |
| Apr-05 | 9.7200 | 0.6100 | 0.3240 | 0.1100 | 3.5740 | 2.7196 | 1.14 |
| May-05 | 10.8200 | 0.4600 | 0.3490 | 0.2800 | 3.7840 | 2.8594 | 2.83 |
| Jun-05 | 10.5700 | 0.4900 | 0.3523 | 0.2900 | 3.4630 | 3.0523 | 1.54 |
| Jul-05 | 9.9300 | 0.4700 | 0.3203 | 0.1900 | 3.4400 | 2.8866 | 2.22 |
| Aug-05 | 10.7000 | 0.5100 | 0.3452 | 0.2100 | 3.4880 | 3.0677 | 0.85 |
| Sep-05 | 11.9500 | 0.7500 | 0.3983 | 0.2700 | 4.0060 | 2.9830 | 10.36 |
| Oct-05 | 11.4700 | 0.6300 | 0.3700 | 0.1500 | 3.8410 | 2.9862 | 10.02 |
| Nov-05 | 11.8600 | 0.8300 | 0.3953 | 0.2300 | 3.9820 | 2.9784 | 3.61 |
| Dec-05 | 12.8400 | 0.6100 | 0.4142 | 0.2400 | 4.4610 | 2.8783 | 2.82 |
| Jan-06 | 12.4900 | 0.7000 | 0.4029 | 0.1300 | 4.4840 | 2.7855 | 4.32 |
| Feb-06 | 13.5000 | 0.9500 | 0.4821 | 0.2200 | 4.7710 | 2.8296 | 18.70 |
| Mar-06 | 18.6200 | 0.8600 | 0.6006 | 0.3300 | 7.2010 | 2.5858 | 26.40 |
| Apr-06 | 14.1200 | 0.8700 | 0.4707 | 0.2300 | 4.9640 | 2.8445 | 4.85 |
| May-06 | 11.2500 | 0.5100 | 0.3629 | 0.2300 | 3.7420 | 3.0064 | 3.26 |
| Jun-06 | 11.9700 | 0.6000 | 0.3990 | 0.2200 | 4.0360 | 2.9658 | 0.83 |
| Jul-06 | 15.8700 | 0.9300 | 0.5119 | 0.2200 | 4.9290 | 3.2197 | 0.65 |
| Aug-06 | 16.0300 | 0.7800 | 0.5171 | 0.2400 | 5.7540 | 2.7859 | 1.67 |
| Sep-06 | 13.3100 | 0.6500 | 0.4437 | 0.2500 | 4.6140 | 2.8847 | 2.50 |
| Oct-06 | 14.7100 | 0.7500 | 0.4745 | 0.2500 | 5.3310 | 2.7593 | 5.13 |
| Nov-06 | 18.4300 | 1.0700 | 0.6143 | 0.2500 | 7.5430 | 2.4433 | 11.19 |
| Dec-06 | 13.5700 | 0.7200 | 0.4377 | 0.2300 | 4.3290 | 3.1347 | 1.78 |
| Jan-07 | 13.2300 | 0.6500 | 0.4268 | 0.2200 | 4.3930 | 3.0116 | 3.64 |
| Feb-07 | 10.8500 | 0.5900 | 0.3875 | 0.2100 | 3.6780 | 2.9500 | 2.16 |
| Mar-07 | 10.7300 | 0.5900 | 0.3461 | 0.1700 | 3.8180 | 2.8104 | 5.10 |
| Apr-07 | 9.2800 | 0.4800 | 0.3093 | 0.1400 | 3.1650 | 2.9321 | 1.22 |
| May-07 | 10.1500 | 0.4700 | 0.3274 | 0.1700 | 3.3190 | 3.0582 | 1.18 |
| Jun-07 | 10.0200 | 0.5300 | 0.3340 | 0.1800 | 3.1480 | 3.1830 | 1.15 |
| Jul-07 | 11.2200 | 0.5300 | 0.3619 | 0.2200 | 3.7440 | 2.9968 | 2.12 |
| Aug-07 | 11.8200 | 0.5500 | 0.3813 | 0.2200 | 4.1470 | 2.8503 | 1.56 |
| Sep-07 | 10.6700 | 0.5200 | 0.3557 | 0.1900 | 3.5140 | 3.0364 | 1.56 |
| Oct-07 | 10.1500 | 0.5500 | 0.3274 | 0.1800 | 3.3610 | 3.0199 | 1.40 |

# TABLE D-1: KAHANAHOU WWPS
# HISTORICAL FLOW RATES AND POWER USE

(Sheet 3 of 3)

| Month | Total Flow[a] (MGM) | Daily Flow Rate[a] (MGD) Monthly Maximum | Monthly Average | Monthly Minimum | Total Energy[a] (1,000 KWH/Month) | Flow/KWH[a] (1,000 gal/KWH) | Monthly Precipitation[b] (Inches) |
|---|---|---|---|---|---|---|---|
| Nov-07 | 13.8200 | 0.8000 | 0.4607 | 0.1800 | 5.4560 | 2.5330 | 10.83 |
| Dec-07 | 16.1200 | 0.7600 | 0.5200 | 0.2500 | 6.6730 | 2.4157 | 13.27 |
| Jan-08 | 13.3200 | 0.6900 | 0.4297 | 0.2000 | 5.1670 | 2.5779 | 3.26 |
| Feb-08 | 9.8100 | 0.5300 | 0.3383 | 0.1900 | 3.8570 | 2.5434 | 2.00 |
| Mar-08 | 9.5600 | 0.4400 | 0.3084 | 0.1700 | 3.7510 | 2.5487 | 0.30 |
| Apr-08 | 8.7700 | 0.4500 | 0.2923 | 0.1500 | 3.5400 | 2.4774 | 2.39 |
| May-08 | 9.7000 | 0.4500 | 0.3129 | 0.1500 | 3.8570 | 2.5149 | 1.84 |
| Jun-08 | 11.5300 | 0.6200 | 0.3843 | 0.1800 | 4.4190 | 2.6092 | 7.80 |
| Jul-08 | 9.9300 | 0.5800 | 0.3203 | 0.1500 | 3.7690 | 2.6347 | 2.67 |
| Aug-08 | 7.3700 | 0.4400 | 0.2377 | 0.9000 | 2.8110 | 2.6218 | 2.35 |
| Sep-08 | 6.2200 | 0.3100 | 0.2073 | 0.1100 | 2.2790 | 2.7293 | 3.01 |
| Oct-08 | 6.3200 | 0.3100 | 0.2039 | 0.1000 | 2.2740 | 2.7792 | 3.38 |
| Nov-08 | 6.4300 | 0.4500 | 0.2143 | 0.1200 | 2.4570 | 2.6170 | 6.65 |
| Dec-08 | 8.7700 | 0.7900 | 0.2829 | 0.1300 | 3.4940 | 2.5100 | 12.41 |
| Jan-09 | 6.2600 | 0.3300 | 0.2019 | 0.1400 | 2.3850 | 2.6247 | 3.20 |
| Feb-09 | 4.8200 | 0.2900 | 0.1721 | 0.1100 | 1.8950 | 2.5435 | 1.98 |
| Mar-09 | 6.6500 | 0.5900 | 0.2145 | 0.0900 | 2.6740 | 2.4869 | 9.05 |
| Apr-09 | 6.3900 | 0.4700 | 0.2130 | 0.0900 | 2.5350 | 2.5207 | 8.15 |
| May-09 | 5.3300 | 0.2700 | 0.1719 | 0.1000 | 1.9410 | 2.7460 | 2.58 |
| Jun-09 | 4.9400 | 0.2500 | 0.1647 | 0.1000 | 1.8750 | 2.6347 | 1.17 |
| Jul-09 | 5.8000 | 0.2900 | 0.1871 | 0.1000 | 2.1440 | 2.7052 | 1.58 |
| Aug-09 | 6.7200 | 0.4000 | 0.2168 | 0.1100 | 2.5020 | 2.6859 | 7.26 |
| Sep-09 | 5.3800 | 0.2400 | 0.1793 | 0.0900 | 2.0200 | 2.6634 | 1.25 |
| Oct-09 | 6.9000 | 0.5300 | 0.2226 | 0.0900 | 2.5950 | 2.6590 | 9.86 |
| Nov-09 | 5.2300 | 0.2800 | 0.1743 | 0.0800 | 1.8930 | 2.7628 | 4.29 |
| Dec-09 | 5.5400 | 0.2700 | 0.1787 | 0.1200 | 1.9620 | 2.8236 | 2.13 |
| Jan-10 | 5.2600 | 0.2600 | 0.1697 | 0.1200 | 1.8960 | 2.7743 | 3.25 |

[a]Flow and Power Data based on City records.
[b]Precipitation Data based on U.S. Department of Commerce, National Oceanic & Atmospheric Administration Annual Climatological records for Station 513117/99999, Kaneohe 838.1, Hawaii.

# APPENDIX E
# HISTORICAL RAINFALL DATA

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2000)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| **2000** Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 77.2X | 66.9X | 72.1X | | 0B | 225B | 81 | 4 | 62 | 26 | 0 | 0 | 0 | 0 | 4.49 | | 1.74 | 20 | 0.0 | 0 | | 11 | 2 | 1 |
| 2 | 81.1 | 67.4 | 74.3 | | 0 | 275 | 84 | 7 | 64 | 8 | 0 | 0 | 0 | 0 | 0.39 | | 0.17 | 1 | 0.0 | 0 | | 1 | 0 | 0 |
| 3 | 82.0X | 69.3X | 75.7X | | 0B | 338B | 87 | 11 | 65 | 9 | 0 | 0 | 0 | 0 | 2.11 | | 0.48 | 27 | 0.0 | 0 | | 6 | 0 | 0 |
| 4 | 79.1X | 68.7X | 73.9X | | 0B | 278B | 83 | 26 | 63 | 9 | 0 | 0 | 0 | 0 | 3.40 | | 1.31 | 1 | 0.0 | 0 | | 6 | 2 | 1 |
| 5 | 83.3 | 71.4 | 77.4 | | 0 | 394 | 85 | 28 | 69 | 16 | 0 | 0 | 0 | 0 | 1.48 | | 0.61 | 17 | 0.0 | 0 | | 2 | 1 | 0 |
| 6 | 86.0 | 73.6 | 79.8 | | 0 | 450 | 89 | 21 | 71 | 8 | 0 | 0 | 0 | 0 | 1.28 | | 0.20 | 7 | 0.0 | 0 | | 3 | 0 | 0 |
| 7 | 84.8 | 74.3 | 79.6 | | 0 | 461 | 87 | 31 | 72 | 4 | 0 | 0 | 0 | 0 | 1.81 | | 0.38 | 21 | 0.0 | 0 | | 6 | 0 | 0 |
| 8 | 85.8 | 74.9 | 80.4 | | 0 | 484 | 89 | 2 | 72 | 21 | 0 | 0 | 0 | 0 | 3.01 | | 1.50 | 21 | 0.0 | 0 | | 10 | 1 | 1 |
| 9 | 84.7 | 73.7 | 79.2 | | 0 | 434 | 87 | 30 | 70 | 28 | 0 | 0 | 0 | 0 | 5.56 | | 2.07 | 28 | 0.0 | 0 | | 10 | 2 | 2 |
| 10 | 84.4 | 74.2 | 79.3 | | 0 | 451 | 87 | 5 | 70 | 30 | 0 | 0 | 0 | 0 | 2.93 | | 1.33 | 30 | 0.0 | 0 | | 5 | 1 | 1 |
| 11 | 81.4 | 72.1 | 76.8 | | 0 | 362 | 85 | 5 | 69 | 30 | 0 | 0 | 0 | 0 | 3.42 | | 0.75 | 3 | 0.0 | 0 | | 13 | 1 | 0 |
| 12 | 81.5 | 68.4 | 75.0 | | 0 | 316 | 84 | 5 | 65 | 31 | 0 | 0 | 0 | 0 | 1.22 | | 0.24 | 9 | 0.0 | 0 | | 4 | 0 | 0 |
| Annual | 82.6X | 71.2X | 77.0X | | 0 | 4468 | 89 | Aug | 62 | Jan | 0 | 0 | 0 | 0 | 31.10 | | 2.07 | Sep | 0.0 | 0 | | 77 | 10 | 6 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:16:22 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2001)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2001 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 83.3X | 70.1X | 76.7X | | 0B | 368B | 91 | 20 | 65 | 1 | 1 | 0 | 0 | 0 | 0.63 | | 0.14 | 14 | 0.0 | 0 | | 2 | 0 | 0 |
| 2 | 81.2 | 68.7 | 75.0 | | 0 | 288 | 86 | 27 | 62 | 8 | 0 | 0 | 0 | 0 | 5.73 | | 2.51 | 9 | 0.0 | 0 | | 7 | 2 | 2 |
| 3 | 81.1 | 68.4 | 74.8 | | 0 | 309 | 86 | 26 | 61 | 21 | 0 | 0 | 0 | 0 | 2.63 | | 0.85 | 18 | 0.0 | 0 | | 7 | 2 | 0 |
| 4 | 81.2 | 70.0 | 75.6 | | 0 | 325 | 84 | 23 | 66 | 17 | 0 | 0 | 0 | 0 | 2.19 | | 0.42 | 29 | 0.0 | 0 | | 7 | 0 | 0 |
| 5 | 82.6 | 71.1 | 76.9 | | 0 | 374 | 88 | 31 | 68 | 6 | 0 | 0 | 0 | 0 | 3.36 | | 1.49 | 19 | 0.0 | 0 | | 8 | 1 | 1 |
| 6 | 83.5X | 72.7X | 78.1X | | 0B | 398B | 85 | 30 | 69 | 5 | 0 | 0 | 0 | 0 | 2.88 | | 0.68 | 5 | 0.0 | 0 | | 8 | 1 | 0 |
| 7 | 86.2 | 74.5 | 80.4 | | 0 | 484 | 87 | 31 | 72 | 18 | 0 | 0 | 0 | 0 | 0.98 | | 0.17 | 31 | 0.0 | 0 | | 4 | 0 | 0 |
| 8 | 85.9X | 74.7 | 80.3X | | 0B | 482B | 91 | 28 | 71 | 26 | 1 | 0 | 0 | 0 | 2.61 | | 0.61 | 27 | 0.0 | 0 | | 9 | 1 | 0 |
| 9 | 86.8 | 75.2 | 81.0 | | 0 | 490 | 89 | 12 | 73 | 30 | 0 | 0 | 0 | 0 | 1.17 | | 0.39 | 30 | 0.0 | 0 | | 3 | 0 | 0 |
| 10 | 83.5 | 73.0 | 78.3 | | 0 | 419 | 87 | 5 | 68 | 24 | 0 | 0 | 0 | 0 | 3.38 | | 0.45 | 28 | 0.0 | 0 | | 10 | 0 | 0 |
| 11 | 83.3X | 70.9X | 77.1X | | 0B | 370B | 90 | 27 | 67 | 18 | 1 | 0 | 0 | 0 | 6.66 | | 3.68 | 27 | 0.0 | 0 | | 8 | 2 | 2 |
| 12 | 80.2X | 71.0 | 75.6X | | 0B | 336B | 85 | 29 | 65 | 27 | 0 | 0 | 0 | 0 | 4.10 | | 1.42 | 24 | 0.0 | 0 | | 9 | 2 | 1 |
| Annual | 83.2X | 71.7X | 77.5X | | 0 | 4643 | 91 | Aug | 61 | Mar | 3 | 0 | 0 | 0 | 36.32 | | 3.68 | Nov | 0.0 | 0 | | 82 | 11 | 6 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:16:06 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2002)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2002 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 79.5X | 68.2 | 73.9X | | 0B | 283B | 86 | 9 | 63 | 2 | 0 | 0 | 0 | 0 | 7.17 | 1.40 | 2.27 | 27 | 0.0 | 0 | | 9 | 4 | 3 |
| 2 | 77.6 | 67.4 | 72.5 | | 0 | 217 | 82 | 20 | 62 | 9 | 0 | 0 | 0 | 0 | 3.63 | -0.98 | 1.92 | 9 | 0.0 | 0 | | 8 | 2 | 1 |
| 3 | 79.5 | 67.8 | 73.7 | | 0 | 277 | 84 | 24 | 63 | 4 | 0 | 0 | 0 | 0 | 7.95 | 2.56 | 2.16 | 17 | 0.0 | 0 | | 9 | 4 | 3 |
| 4 | 83.3 | 69.6 | 76.5 | | 0 | 349 | 92 | 11 | 63 | 3 | 1 | 0 | 0 | 0 | 2.93 | -1.21 | 0.99 | 21 | 0.0 | 0 | | 5 | 2 | 0 |
| 5 | 83.3 | 72.0X | 77.7X | | 0B | 405B | 87 | 31 | 69 | 22 | 0 | 0 | 0 | 0 | 7.05 | 3.82 | 4.92 | 7 | 0.0 | 0 | | 7 | 3 | 1 |
| 6 | 85.0X | 73.4 | 79.2X | | 0B | 434B | 87 | 5 | 69 | 15 | 0 | 0 | 0 | 0 | 0.99 | -1.52 | 0.18 | 22 | 0.0 | 0 | | 4 | 0 | 0 |
| 7 | 84.6 | 72.8 | 78.7 | | 0 | 435 | 88 | 31 | 65 | 26 | 0 | 0 | 0 | 0 | 3.62 | 0.92 | 1.45 | 30 | 0.0 | 0 | | 8 | 1 | 1 |
| 8 | 85.0 | 74.8X | 79.9X | | 0B | 469B | 88 | 26 | 72 | 20 | 0 | 0 | 0 | 0 | 1.72 | -1.14 | 0.25 | 30 | 0.0 | 0 | | 5 | 0 | 0 |
| 9 | 86.6X | 72.9X | 79.8X | | 0B | 452B | 89 | 27 | 70 | 24 | 0 | 0 | 0 | 0 | 1.05 | -2.46 | 0.20 | 12 | 0.0 | 0 | | 3 | 0 | 0 |
| 10 | 85.5 | 73.7 | 79.6 | | 0 | 463 | 90 | 16 | 70 | 28 | 3 | 0 | 0 | 0 | 4.17 | -0.25 | 2.45 | 15 | 0.0 | 0 | | 6 | 2 | 1 |
| 11 | 82.6X | 70.5 | 76.6X | | 0B | 354B | 89 | 10 | 69 | 30 | 0 | 0 | 0 | 0 | 2.70 | -3.65 | 0.46 | 13 | 0.0 | 0 | | 9 | 0 | 0 |
| 12 | 80.9X | 68.1X | 74.5X | | 0B | 300B | 84 | 20 | 65 | 31 | 0 | 0 | 0 | 0 | 1.18 | -4.26 | 0.31 | 28 | 0.0 | 0 | | 4 | 0 | 0 |
| Annual | 82.8X | 70.9X | 76.9X | | 0 | 4438 | 92 | Apr | 62 | Feb | 4 | 0 | 0 | 0 | 44.16 | -6.77 | 4.92 | May | 0.0 | 0 | | 77 | 18 | 10 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:15:48 EDT 2010 via [http://hurricane/ancsum/ACS](http://hurricane/ancsum/ACS)*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at [http://cdo.ncdc.noaa.gov/cdo/3220doc.txt](http://cdo.ncdc.noaa.gov/cdo/3220doc.txt)*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2003)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| **2003** Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 80.5X | 65.3 | 72.9X | | 0B | 254B | 86 | 2 | 58 | 18 | 0 | 0 | 0 | 0 | 4.13 | -1.64 | 0.94 | 20 | 0.0 | 0 | | 8 | 4 | 0 |
| 2 | 78.6 | 67.1 | 72.9 | | 0 | 227 | 85 | 6 | 62 | 14 | 0 | 0 | 0 | 0 | 5.94 | 1.33 | 3.48 | 14 | 0.0 | 0 | | 9 | 2 | 1 |
| 3 | 82.5X | 68.0 | 75.3X | | 0B | 327B | 87 | 27 | 65 | 11 | 0 | 0 | 0 | 0 | 4.93 | -0.46 | 1.35 | 8 | 0.0 | 0 | | 7 | 4 | 2 |
| 4 | 81.6 | 69.5 | 75.6 | | 0 | 324 | 85 | 4 | 67 | 30 | 0 | 0 | 0 | 0 | 2.52 | -1.62 | 0.38 | 11 | 0.0 | 0 | | 9 | 0 | 0 |
| 5 | 83.8 | 72.2 | 78.0 | | 0 | 412 | 86 | 30 | 68 | 1 | 0 | 0 | 0 | 0 | 0.94 | -2.29 | 0.70 | 1 | 0.0 | 0 | | 1 | 1 | 0 |
| 6 | 84.9X | 72.6 | 78.8X | | 0B | 421B | 87 | 9 | 70 | 5 | 0 | 0 | 0 | 0 | 2.52 | 0.01 | 0.54 | 5 | 0.0 | 0 | | 11 | 1 | 0 |
| 7 | 85.3X | 74.6 | 80.0X | | 0B | 470B | 88 | 29 | 71 | 9 | 0 | 0 | 0 | 0 | 2.86 | 0.16 | 0.73 | 27 | 0.0 | 0 | | 6 | 3 | 0 |
| 8 | 85.7X | 74.4 | 80.1X | | 0B | 475B | 88 | 31 | 71 | 6 | 0 | 0 | 0 | 0 | 1.55 | -1.31 | 0.34 | 6 | 0.0 | 0 | | 5 | 0 | 0 |
| 9 | 86.9 | 73.5 | 80.2 | | 0 | 464 | 93 | 25 | 71 | 28 | 3 | 0 | 0 | 0 | 2.95 | -0.56 | 0.96 | 11 | 0.0 | 0 | | 6 | 1 | 0 |
| 10 | 87.5 | 73.4 | 80.5 | | 0 | 489 | 92 | 26 | 70 | 20 | 7 | 0 | 0 | 0 | 1.62 | -2.80 | 0.33 | 7 | 0.0 | 0 | | 6 | 0 | 0 |
| 11 | 82.6X | 71.7X | 77.2X | | 0B | 371B | 88 | 27 | 67 | 28 | 0 | 0 | 0 | 0 | 9.09 | 2.74 | 7.82 | 30 | 0.0 | 0 | | 6 | 1 | 1 |
| 12 | 79.4 | 68.9 | 74.2 | | 0 | 291 | 85 | 31 | 64 | 28 | 0 | 0 | 0 | 0 | 11.70 | 6.26 | 4.33 | 2 | 0.0 | 0 | | 12 | 6 | 3 |
| Annual | 83.3X | 70.9X | 77.1X | | 0 | 4525 | 93 | Sep | 58 | Jan | 10 | 0 | 0 | 0 | 50.75 | -0.18 | 7.82 | Nov | 0.0 | 0 | | 86 | 23 | 7 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:15:34 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
**(2004)**

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2004 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 80.3X | 66.7 | 73.5X | | 0B | 272B | 83 | 20 | 63 | 8 | 0 | 0 | 0 | 0 | 12.86 | 7.09 | 4.89 | 3 | 0.0 | 0 | | 14 | 6 | 5 |
| 2 | 80.6X | 69.1 | 74.9X | | 0B | 294B | 85 | 16 | 62 | 28 | 0 | 0 | 0 | 0 | 13.89 | 9.28 | 7.61 | 28 | 0.0 | 0 | | 8 | 5 | 2 |
| 3 | 77.8 | 67.2 | 72.5 | | 0 | 238 | 84 | 28 | 61 | 19 | 0 | 0 | 0 | 0 | 8.42 | 3.03 | 1.85 | 2 | 0.0 | 0 | | 19 | 5 | 2 |
| 4 | 79.9X | 69.1 | 74.5X | | 0B | 289B | 83 | 26 | 63 | 29 | 0 | 0 | 0 | 0 | 2.91 | -1.23 | 0.85 | 21 | 0.0 | 0 | | 8 | 1 | 0 |
| 5 | 82.3 | 71.0 | 76.7 | | 0 | 368 | 89 | 21 | 66 | 17 | 0 | 0 | 0 | 0 | 6.71 | 3.48 | 1.96 | 16 | 0.0 | 0 | | 7 | 4 | 3 |
| 6 | 83.6 | 73.2X | 78.4X | | 0B | 410B | 87 | 27 | 71 | 15 | 0 | 0 | 0 | 0 | 3.08 | 0.57 | 0.31 | 24 | 0.0 | 0 | | 12 | 0 | 0 |
| 7 | 87.3 | 75.1 | 81.2 | | 0 | 511 | 89 | 24 | 73 | 27 | 0 | 0 | 0 | 0 | 1.98 | -0.72 | 0.43 | 26 | 0.0 | 0 | | 6 | 0 | 0 |
| 8 | 86.5 | 74.9 | 80.7 | | 0 | 492 | 89 | 19 | 71 | 5 | 0 | 0 | 0 | 0 | 7.59 | 4.73 | 3.32 | 4 | 0.0 | 0 | | 11 | 3 | 2 |
| 9 | 87.7X | 74.9 | 81.3X | | 0B | 497B | 90 | 9 | 72 | 27 | 2 | 0 | 0 | 0 | 2.87 | -0.64 | 0.33 | 25 | 0.0 | 0 | | 11 | 0 | 0 |
| 10 | 86.3 | 73.7 | 80.0 | | 0 | 473 | 89 | 15 | 71 | 26 | 0 | 0 | 0 | 0 | 6.59 | 2.17 | 3.14 | 31 | 0.0 | 0 | | 12 | 3 | 1 |
| 11 | 84.0 | 70.9 | 77.5 | | 0 | 381 | 88 | 14 | 67 | 22 | 0 | 0 | 0 | 0 | 9.60 | 3.25 | 2.45 | 10 | 0.0 | 0 | | 13 | 5 | 4 |
| 12 | 81.3X | 69.3 | 75.3X | | 0B | 326B | 86 | 17 | 65 | 15 | 0 | 0 | 0 | 0 | 4.76 | -0.68 | 2.21 | 23 | 0.0 | 0 | | 4 | 3 | 2 |
| Annual | 83.1X | 71.3X | 77.2X | | 0 | 4551 | 90 | Sep | 61 | Mar | 2 | 0 | 0 | 0 | 81.26 | 30.33 | 7.61 | Feb | 0.0 | 0 | | 125 | 35 | 21 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:15:22 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
**(2005)**

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2005 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 80.9 | 67.8X | 74.4X | | 0B | 299B | 86 | 24 | 63 | 13 | 0 | 0 | 0 | 0 | 7.99 | 2.22 | 2.86 | 2 | 0.0 | 0 | | 8 | 5 | 4 |
| 2 | 79.1 | 67.9 | 73.5 | | 0 | 244 | 83 | 7 | 62 | 12 | 0 | 0 | 0 | 0 | 8.42 | 3.81 | 2.64 | 12 | 0.0 | 0 | | 10 | 5 | 4 |
| 3 | 79.7 | 66.6 | 73.2 | | 0 | 263 | 87 | 10 | 61 | 16 | 0 | 0 | 0 | 0 | 6.44 | 1.05 | 1.89 | 9 | 0.0 | 0 | | 11 | 4 | 2 |
| 4 | 81.6 | 71.0 | 76.3 | | 0 | 344 | 88 | 28 | 66 | 29 | 0 | 0 | 0 | 0 | 1.14 | -3.00 | 0.18 | 1 | 0.0 | 0 | | 4 | 0 | 0 |
| 5 | 84.9 | 72.5 | 78.7 | | 0 | 432 | 87 | 11 | 65 | 2 | 0 | 0 | 0 | 0 | 2.83 | -0.40 | 1.10 | 21 | 0.0 | 0 | | 6 | 2 | 1 |
| 6 | 85.0 | 74.2 | 79.6 | | 0 | 444 | 87 | 14 | 72 | 11 | 0 | 0 | 0 | 0 | 1.54 | -0.97 | 0.24 | 29 | 0.0 | 0 | | 7 | 0 | 0 |
| 7 | 84.9 | 74.8 | 79.9 | | 0 | 469 | 87 | 17 | 72 | 23 | 0 | 0 | 0 | 0 | 2.22 | -0.48 | 0.44 | 23 | 0.0 | 0 | | 7 | 0 | 0 |
| 8 | 87.5 | 74.8 | 81.2 | | 0 | 508 | 90 | 28 | 71 | 12 | 2 | 0 | 0 | 0 | 0.85 | -2.01 | 0.17 | 9 | 0.0 | 0 | | 2 | 0 | 0 |
| 9 | 85.9 | 74.8 | 80.4 | | 0 | 467 | 89 | 26 | 72 | 20 | 0 | 0 | 0 | 0 | 10.36 | 6.85 | 5.85 | 24 | 0.0 | 0 | | 15 | 2 | 1 |
| 10 | 83.8 | 73.6 | 78.7 | | 0 | 435 | 86 | 21 | 71 | 25 | 0 | 0 | 0 | 0 | 10.02 | 5.60 | 3.90 | 31 | 0.0 | 0 | | 12 | 4 | 2 |
| 11 | 81.9X | 72.0X | 77.0X | | 0B | 363B | 85 | 26 | 68 | 14 | 0 | 0 | 0 | 0 | 3.61 | -2.74 | 0.86 | 27 | 0.0 | 0 | | 12 | 1 | 0 |
| 12 | 82.3 | 68.2 | 75.3 | | 0 | 328 | 88 | 30 | 64 | 17 | 0 | 0 | 0 | 0 | 2.82 | -2.62 | 2.76 | 5 | 0.0 | 0 | | 1 | 1 | 1 |
| Annual | 83.1X | 71.5X | 77.4X | | 0 | 4596 | 90 | Aug | 61 | Mar | 2 | 0 | 0 | 0 | 58.24 | 7.31 | 5.85 | Sep | 0.0 | 0 | | 95 | 24 | 15 |

## Notes

(blank) Not reported.

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A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:15:05 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2006)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| **2006** Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 79.5 | 69.9 | 74.7 | | 0 | 310 | 87 | 4 | 66 | 6 | 0 | 0 | 0 | 0 | 4.32 | -1.45 | 1.19 | 23 | 0.0 | 0 | | 8 | 3 | 1 |
| 2 | 77.3 | 66.7 | 72.0 | | 0 | 200 | 85 | 3 | 61 | 12 | 0 | 0 | 0 | 0 | 18.70 | 14.09 | 5.75 | 19 | 0.0 | 0 | | 13 | 7 | 5 |
| 3 | 79.4 | 69.3 | 74.4 | | 0 | 296 | 87 | 25 | 65 | 31 | 0 | 0 | 0 | 0 | 26.40 | 21.01 | 6.53 | 3 | 0.0 | 0 | | 19 | 13 | 6 |
| 4 | 79.1 | 69.6 | 74.4 | | 0 | 288 | 83 | 29 | 67 | 22 | 0 | 0 | 0 | 0 | 4.85 | 0.71 | 2.18 | 1 | 0.0 | 0 | | 9 | 2 | 1 |
| 5 | 81.1 | 69.2 | 75.2 | | 0 | 322 | 87 | 26 | 63 | 16 | 0 | 0 | 0 | 0 | 3.26 | 0.03 | 0.75 | 5 | 0.0 | 0 | | 9 | 2 | 0 |
| 6 | 85.5 | 73.4 | 79.5 | | 0 | 440 | 88 | 9 | 71 | 25 | 0 | 0 | 0 | 0 | 0.83 | -1.68 | 0.24 | 26 | 0.0 | 0 | | 2 | 0 | 0 |
| 7 | 85.9X | 74.5 | 80.2X | | 0B | 481B | 90 | 31 | 72 | 15 | 1 | 0 | 0 | 0 | 0.65 | -2.05 | 0.16 | 15 | 0.0 | 0 | | 1 | 0 | 0 |
| 8 | 87.4X | 74.2X | 80.8X | | 0B | 498B | 95 | 28 | 71 | 26 | 3 | 0 | 0 | 0 | 1.67 | -1.19 | 0.57 | 1 | 0.0 | 0 | | 3 | 1 | 0 |
| 9 | 86.6X | 74.1X | 80.4X | | 0B | 465B | 89 | 14 | 71 | 24 | 0 | 0 | 0 | 0 | 2.50 | -1.01 | 0.45 | 16 | 0.0 | 0 | | 8 | 0 | 0 |
| 10 | 85.1 | 73.3X | 79.2X | | 0B | 448B | 93 | 10 | 71 | 18 | 2 | 0 | 0 | 0 | 5.13 | 0.71 | 1.91 | 31 | 0.0 | 0 | | 8 | 3 | 2 |
| 11 | 84.0 | 71.5 | 77.8 | | 0 | 388 | 91 | 6 | 68 | 30 | 2 | 0 | 0 | 0 | 11.19 | 4.84 | 3.73 | 1 | 0.0 | 0 | | 12 | 3 | 3 |
| 12 | 80.7 | 70.5X | 75.6X | | 0B | 338B | 83 | 28 | 66 | 24 | 0 | 0 | 0 | 0 | 1.78 | -3.66 | 0.39 | 29 | 0.0 | 0 | | 5 | 0 | 0 |
| Annual | 82.6X | 71.4X | 77.0X | | 0 | 4474 | 95 | Aug | 61 | Feb | 8 | 0 | 0 | 0 | 81.28 | 30.35 | 6.53 | Mar | 0.0 | 0 | | 97 | 34 | 18 |

## Notes

(blank) Not reported.

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A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

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X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:14:48 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY

**(2007)**

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2007 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 80.0X | 69.3X | 74.7X | | 0B | 303B | 82 | 29 | 64 | 28 | 0 | 0 | 0 | 0 | 3.64 | -2.13 | 0.65 | 30 | 0.0 | 0 | | 11 | 1 | 0 |
| 2 | 79.5 | 67.1 | 73.3 | | 0 | 239 | 84 | 6 | 61 | 5 | 0 | 0 | 0 | 0 | 2.16 | -2.45 | 0.71 | 2 | 0.0 | 0 | | 6 | 1 | 0 |
| 3 | 81.8 | 68.5 | 75.2 | | 0 | 324 | 87 | 9 | 64 | 31 | 0 | 0 | 0 | 0 | 5.10 | -0.29 | 1.41 | 27 | 0.0 | 0 | | 12 | 2 | 1 |
| 4 | 82.1 | 69.1 | 75.6 | | 0 | 323 | 85 | 11 | 63 | 1 | 0 | 0 | 0 | 0 | 1.22 | -2.92 | 0.19 | 27 | 0.0 | 0 | | 5 | 0 | 0 |
| 5 | 84.8X | 71.4X | 78.1X | | 0B | 413B | 89 | 22 | 68 | 11 | 0 | 0 | 0 | 0 | 1.18 | -2.05 | 0.27 | 25 | 0.0 | 0 | | 3 | 0 | 0 |
| 6 | 85.1 | 73.4 | 79.3 | | 0 | 434 | 88 | 4 | 71 | 8 | 0 | 0 | 0 | 0 | 1.15 | -1.36 | 0.32 | 5 | 0.0 | 0 | | 4 | 0 | 0 |
| 7 | 85.5 | 73.5 | 79.5 | | 0 | 458 | 88 | 31 | 71 | 28 | 0 | 0 | 0 | 0 | 2.12 | -0.58 | 0.31 | 17 | 0.0 | 0 | | 6 | 0 | 0 |
| 8 | 87.1 | 74.6 | 80.9 | | 0 | 502 | 91 | 30 | 71 | 21 | 2 | 0 | 0 | 0 | 1.56 | -1.30 | 0.26 | 25 | 0.0 | 0 | | 6 | 0 | 0 |
| 9 | 86.8 | 74.5 | 80.7 | | 0 | 479 | 91 | 8 | 73 | 27 | 1 | 0 | 0 | 0 | 1.56 | -1.95 | 0.23 | 1 | 0.0 | 0 | | 5 | 0 | 0 |
| 10 | 85.2 | 73.5 | 79.4 | | 0 | 454 | 91 | 22 | 69 | 22 | 1 | 0 | 0 | 0 | 1.40 | -3.02 | 0.27 | 31 | 0.0 | 0 | | 5 | 0 | 0 |
| 11 | 83.1 | 70.9 | 77.0 | | 0 | 366 | 90 | 3 | 67 | 21 | 1 | 0 | 0 | 0 | 10.83 | 4.48 | 3.95 | 4 | 0.0 | 0 | | 11 | 5 | 2 |
| 12 | 79.5 | 70.3 | 74.9 | | 0 | 314 | 86 | 3 | 67 | 5 | 0 | 0 | 0 | 0 | 13.27 | 7.83 | 2.85 | 7 | 0.0 | 0 | | 17 | 7 | 5 |
| Annual | 83.4X | 71.3X | 77.4X | | 0 | 4609 | 91 | Oct | 61 | Feb | 5 | 0 | 0 | 0 | 45.19 | -5.74 | 3.95 | Nov | 0.0 | 0 | | 91 | 16 | 8 |

## Notes

(blank) Not reported.

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A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

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M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:14:26 EDT 2010 via [http://hurricane/ancsum/ACS](http://hurricane/ancsum/ACS)*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at [http://cdo.ncdc.noaa.gov/cdo/3220doc.txt](http://cdo.ncdc.noaa.gov/cdo/3220doc.txt)*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
**(2008)**

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 60 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2008 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 77.5 | 67.1 | 72.3 | | 0 | 236 | 82 | 8 | 64 | 19 | 0 | 0 | 0 | 0 | 3.26 | -2.51 | 0.92 | 12 | 0.0 | 0 | | 11 | 1 | 0 |
| 2 | 80.1X | 67.6X | 73.9X | | 0B | 262B | 86 | 19 | 63 | 28 | 0 | 0 | 0 | 0 | 2.00 | -2.61 | M | | 0.0 | 0 | | 8 | 0 | 0 |
| 3 | 82.2X | 70.4X | 76.3X | | 0B | 357B | 85 | 8 | 66 | 10 | 0 | 0 | 0 | 0 | 0.30 | -5.09 | 0.09 | 23 | 0.0 | 0 | | 0 | 0 | 0 |
| 4 | 82.2 | 69.6 | 75.9 | | 0 | 335 | 86 | 26 | 67 | 26 | 0 | 0 | 0 | 0 | 2.39 | -1.75 | 0.96 | 26 | 0.0 | 0 | | 6 | 1 | 0 |
| 5 | 84.6 | 72.2 | 78.4 | | 0 | 424 | 90 | 16 | 68 | 14 | 1 | 0 | 0 | 0 | 1.84 | -1.39 | 1.45 | 22 | 0.0 | 0 | | 1 | 1 | 1 |
| 6 | 84.4 | 72.9 | 78.7 | | 0 | 416 | 88 | 29 | 70 | 12 | 0 | 0 | 0 | 0 | 7.80 | 5.29 | 6.62 | 12 | 0.0 | 0 | | 4 | 1 | 1 |
| 7 | 85.7 | 73.4 | 79.6 | | 0 | 461 | 88 | 18 | 71 | 20 | 0 | 0 | 0 | 0 | 2.67 | -0.03 | 0.51 | 1 | 0.0 | 0 | | 11 | 1 | 0 |
| 8 | 85.9 | 73.9 | 79.9 | | 0 | 471 | 88 | 27 | 71 | 30 | 0 | 0 | 0 | 0 | 2.35 | -0.51 | 0.40 | 30 | 0.0 | 0 | | 8 | 0 | 0 |
| 9 | 85.6 | 72.6 | 79.1 | | 0 | 431 | 88 | 6 | 69 | 14 | 0 | 0 | 0 | 0 | 3.01 | -0.50 | 0.31 | 30 | 0.0 | 0 | | 14 | 0 | 0 |
| 10 | 83.8X | 72.6 | 78.2X | | 0B | 417B | 89 | 9 | 69 | 28 | 0 | 0 | 0 | 0 | 3.38 | -1.04 | 0.95 | 26 | 0.0 | 0 | | 9 | 1 | 0 |
| 11 | 82.2 | 71.3 | 76.8 | | 0 | 358 | 87 | 14 | 67 | 23 | 0 | 0 | 0 | 0 | 6.65 | 0.30 | 3.11 | 23 | 0.0 | 0 | | 6 | 2 | 2 |
| 12 | 80.2X | 70.3 | 75.3X | | 0B | 323B | 86 | 13 | 69 | 18 | 0 | 0 | 0 | 0 | 12.41 | 6.97 | 4.57 | 12 | 0.0 | 0 | | 13 | 4 | 3 |
| Annual | 82.9X | 71.2X | 77.0X | | 0 | 4491 | 90 | May | 63 | Feb | 1 | 0 | 0 | 0 | 48.06 | -2.87 | M | Jun | 0.0 | 0 | | 91 | 12 | 7 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

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E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:14:09 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2009)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 48 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| **2009** Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 79.0X | 66.5 | 72.8X | | 0B | 249B | 85 | 11 | 61 | 19 | 0 | 0 | 0 | 0 | 3.20 | -2.57 | 1.02 | 11 | 0.0 | 0 | | 9 | 1 | 1 |
| 2 | 77.8 | 67.1 | 72.5 | | 0 | 217 | 83 | 12 | 61 | 24 | 0 | 0 | 0 | 0 | 1.98 | -2.63 | 0.88 | 10 | 0.0 | 0 | | 4 | 1 | 0 |
| 3 | 77.7X | 66.6 | 72.2X | | 0B | 234B | 82 | 16 | 58 | 14 | 0 | 0 | 0 | 0 | 9.05 | 3.66 | 4.14 | 15 | 0.0 | 0 | | 9 | 3 | 3 |
| 4 | 78.2X | 67.1 | 72.7X | | 0B | 238B | 87 | 20 | 63 | 28 | 0 | 0 | 0 | 0 | 8.15 | 4.01 | 4.25 | 21 | 0.0 | 0 | | 5 | 3 | 3 |
| 5 | 84.0 | 69.9 | 77.0 | | 0 | 379 | 86 | 31 | 66 | 23 | 0 | 0 | 0 | 0 | 2.58 | -0.65 | 0.80 | 18 | 0.0 | 0 | | 7 | 2 | 0 |
| 6 | 85.3 | 73.2 | 79.3 | | 0 | 434 | 88 | 2 | 70 | 30 | 0 | 0 | 0 | 0 | 1.17 | -1.34 | 0.20 | 19 | 0.0 | 0 | | 3 | 0 | 0 |
| 7 | 85.2X | 74.3 | 79.8X | | 0B | 462B | 87 | 27 | 70 | 1 | 0 | 0 | 0 | 0 | 1.58 | -1.12 | 0.26 | 28 | 0.0 | 0 | | 6 | 0 | 0 |
| 8 | 85.4 | 75.2 | 80.3 | | 0 | 480 | 88 | 9 | 73 | 28 | 0 | 0 | 0 | 0 | 7.26 | 4.40 | 3.11 | 13 | 0.0 | 0 | | 5 | 3 | 3 |
| 9 | 86.0 | 74.6 | 80.3 | | 0 | 465 | 88 | 25 | 71 | 23 | 0 | 0 | 0 | 0 | 1.25 | -2.26 | 0.23 | 25 | 0.0 | 0 | | 6 | 0 | 0 |
| 10 | 85.7 | 73.6 | 79.7 | | 0 | 462 | 89 | 29 | 70 | 16 | 0 | 0 | 0 | 0 | 9.86 | 5.44 | 5.61 | 5 | 0.0 | 0 | | 9 | 4 | 2 |
| 11 | 81.7 | 72.9 | 77.3 | | 0 | 377 | 85 | 13 | 68 | 13 | 0 | 0 | 0 | 0 | 4.29 | -2.06 | 0.86 | 3 | 0.0 | 0 | | 10 | 4 | 0 |
| 12 | 80.3 | 66.9 | 73.6 | | 0 | 274 | 85 | 30 | 63 | 25 | 0 | 0 | 0 | 0 | 2.13 | -3.31 | 0.92 | 4 | 0.0 | 0 | | 5 | 1 | 0 |
| Annual | 82.2X | 70.7 | 76.5X | | 0 | 4271 | 89 | Oct | 58 | Mar | 0 | 0 | 0 | 0 | 52.50 | 1.57 | 5.61 | Oct | 0.0 | 0 | | 78 | 22 | 12 |

## Notes

(blank) Not reported.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence. Used through December 1983 only.

A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

M Used to indicate data element missing.

T Trace of precipitation, snowfall, or snowdepth. The precipitation data value will = zero.

Elem-> Element Types are included to provide cross-reference for users of the NCDC CDO System.

Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:11:18 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

# ANNUAL CLIMATOLOGICAL SUMMARY
## (2010)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

Station: **513117/99999, KANEOHE 838.1, Hawaii** Elev. 48 ft. above sea level Lat. 21°25'N, Lon. 157°48'W

| Date | Temperature (° F) | | | | | | | | | | | | | | Precipitation (inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elem-> | MMXT | MMNT | MNTM | DPNT | HTDD | CLDD | EMXT | | EMNP | | DT90 | DX32 | DT32 | DT00 | TPCP | DPNP | EMXP | | TSNW | MXSD | | DP01 | DP05 | DP10 |
| | | | | | | | | | | | Number of Days | | | | | | Greatest Observed | | Snow, Sleet | | | Number of Days | | |
| 2010 Month | Mean Max. | Mean Min. | Mean | Depart. from Normal | Heating Degree Days | Cooling Degree Days | Highest | High Date | Lowest | Low Date | Max >=90° | Max <=32° | Min <=32° | Min <=0° | Total | Depart. from Normal | Day | Date | Total Fall | Max Depth | Max Date | >=.10 | >=.50 | >=1.0 |
| 1 | 80.8X | 68.0 | 74.4X | | 0B | 299B | 87 | 26 | 63 | 15 | 0 | 0 | 0 | 0 | 3.25 | -2.52 | 1.70 | 30 | 0.0 | 0 | | 7 | 1 | 1 |
| 2 | 80.0X | 66.0X | 73.0X | | 0B | 232B | 84 | 25 | 63 | 20 | 0 | 0 | 0 | 0 | 1.78 | -2.83 | 0.87 | 22 | 0.0 | 0 | | 3 | 1 | 0 |
| 3 | 79.5 | 68.3 | 73.9 | | 0 | 281 | 84 | 18 | 65 | 19 | 0 | 0 | 0 | 0 | 2.59 | -2.80 | 0.44 | 18 | 0.0 | 0 | | 7 | 0 | 0 |
| 4 | 79.9 | 69.4 | 74.7 | | 0 | 297 | 83 | 26 | 64 | 16 | 0 | 0 | 0 | 0 | 1.91 | -2.23 | 0.51 | 7 | 0.0 | 0 | | 6 | 1 | 0 |
| 5 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 6 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 7 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 8 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 9 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 10 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 11 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| 12 | M | M | M | | M | M | M | | M | | M | M | M | M | M | M | M | | M | M | | M | M | M |
| Annual | M | M | M | | M | M | M | Jan | M | Feb | M | M | M | M | M | M | M | Jan | M | M | | M | M | M |

## Notes

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A Accumulated amount. This value is a total that may include data from a previous month or months or year (for annual value).

B Adjusted Total. Monthly value totals based on proportional available data across the entire month.

E An estimated monthly or annual total.

X Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

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Station Station is identified by: CoopID/WBAN, Station Name, State.

S Precipitation amount is continuing to be accumulated. Total will be included in a subsequent monthly or yearly value. Example: Days 1-20 had 1.35 inches of precipitation, then a period of accumulation began. The element TPCP would then be 00135S and the total accumulated amount value appears in a subsequent monthly value. If TPCP = "M" there was no precipitation measured during the month. Flag is set to "S" and the total accumulated amount appears in a subsequent monthly value.

*Dynamically generated Tue Sep 14 21:10:15 EDT 2010 via http://hurricane/ancsum/ACS*
*Data provided from the NCDC CDO System*
*Additional documentation can be found at http://cdo.ncdc.noaa.gov/cdo/3220doc.txt*

# APPENDIX F
# MECHANICAL CATALOG CUTS


# The ABS EffeX range

## The world's first premium-efficiency submersible sewage pumps!

abs

We know how water works

www.absgroup.com

# A completely new approach

At ABS we make it our business to understand wastewater, whether it is our ongoing investigation into causes of blockage, the reduction of water consumption, changing personal hygiene habits or public opinion on environmental issues.

We also closely follow changes to legislation at the global level that set higher levels of wastewater treatment, and legislation at the equipment level that sets minimum efficiency levels for all energy-using equipment. Thus we make sure we recognise the impacts on our equipment and your business.


In response to numerous global, business and social drivers, ABS is the first to launch a series of premium-efficiency submersible sewage pumps – the new ABS EffeX range.

### A time for change

The pressures on the wastewater business have increased regardless of whether you are a publicly funded municipality, privately owned water company or a private operator of a wastewater collection system.

Now we clearly see an increased focus on energy use with regard to cost and $CO_2$ footprint, and requirements for fewer blockages and the associated reduced risk of overflows and pressure to keep operator costs under control. Moreover, we must not forget the constant battle to improve service levels for your customers and the quality of treated water.

ABS firmly believes that the time is now right for advancing the design of submersible wastewater pumping equipment. What was acceptable even five years ago no longer comes close to meeting the ever-changing market needs.

### Setting new standards

The new ABS EffeX range is not a modification to an existing design but a completely fresh concept in submersible wastewater pumping equipment. Our new range pushes available technology to the limit to achieve a design that not only satisfies today's stringent requirements, but also exceeds planned legislation*. It focuses on delivering the utmost in reliable operation, including advanced designs with greater safety margins, and market-leading blockage resistance offering the best rag handling available on the market today with a minimum free solids passage of 75 mm.

Our ABS EffeX range also sets new standards when it comes to optimum energy efficiency. As it incorporates the first premium-efficiency IE3 motor designed and tested in accordance with IEC60034-30 together with optimised hydraulics, the new ABS EffeX range gives the best total efficiency available on the market today.

### The right choice if you want to be first

The ABS EffeX range of submersible sewage pumps offers you a complete solution for your pumping needs. It does this by a combination of much improved reliability, greater energy saving, the highest level of blockage resistance, future-proof designs and a clear commitment to achieving the highest sustainability in both manufacturing and operation.

Simply put: We now give you greater peace of mind in running your wastewater business.

The ABS EffeX range complies fully with IE3

* Contact your local ABS Sales Office for more details.

Six families of ABS EffeX range models will eventually cover virtually all submersible sewage pump applications in the segments Domestic and Commercial Wastewater, Wastewater Collection Networks and Wastewater Treatment.

Now you can make the right choice if you want to be first,
or more importantly,
the first choice if you want to be right!

# Premium efficiency and a lot more

A premium-efficiency motor is just one of many benefits you get with the ABS EffeX range. After analysing market needs and the design of our submersible sewage pumps, we have built in a number of new features that makes our ABS EffeX range the best pumps available. The five major features we now offer you are summarised below along with their corresponding benefits. A detailed description of the features is presented when you fold out the middle spread.

**Long-term reliability**

- Reduced risk of pollution from overflows
- Reduced risk of interruption to services to customers
- Reduced breakdown costs
- Reduced tankering costs
- Reduced maintenance costs

**Greater energy saving**

- Reduced energy costs
- Smaller $CO_2$ footprint
- Qualification for capital allowance schemes

**Excellent rag handling**

- Lowest blockage on the market
- Reduced risk of pollution from overflows
- Reduced risk of interruption to services to customers
- Reduced breakdown costs
- Reduced tankering costs

**Future-proof design**

- Compliance with planned EU, US and other legislation for conventional motors
- Impeller designs based on future wastewater content
- High reliability to ensure compliance with overflow reduction targets

**Sustainable in manufacturing and operation**

- Reduced $CO_2$ emissions in pump manufacturing and operation
- Prolonged pump lifecycle
- Reduced maintenance costs by adjustment rather than repair

**Optimal lifecycle operation**

The sum total of these five major benefits is optimal lifecycle operation. That is, when you install an ABS EffeX range premium-efficiency pump, you know that no other similar type of pump on the market can match its benefits. ABS EffeX range pumps are designed to reduce energy costs and $CO_2$ emissions, and to ensure a prolonged lifecycle compared with competitive pumps. Moreover, they comply with forthcoming equipment motor legislation in relevant countries and contribute to sustainable development.

Our ABS Effex range has several built-in features that make them the best submersible sewage pumps available.

# Details make the best pump

When it comes to pumping wastewater you have to look at the complete picture. Simply focusing on producing a pump with the best hydraulic efficiency will not result in trouble-free operation. High hydraulic efficiency without excellent blockage resistance, rag handling and free solids passage will only result in more blockage, overflows and increased operator costs.

Similarly, products that focus merely on using low-efficiency impellers that are good for rag handling result in unacceptable much higher energy costs and a bigger $CO_2$ footprint.

Conversely, our ABS EffeX range is a complete concept that ensures that all aspects of handling wastewater are considered to provide you with several major benefits. These are discussed in detail below.

## Long-term reliability

Long-term reliability starts with understanding the application. When we discuss wastewater handling it is clear that it is not the same as pumping a clear liquid. Wastewater pumping is like handling abrasive liquids with a high content of rag and other solids in an application where regular stopping and starting are required. This subjects equipment bearings and motors to high loads, high wear and poor cooling.

Reliability of the ABS EffeX range starts with built-in IE3 premium-efficiency motors. These give the major advantage of lower operating temperatures (NEMA Class A) along with reducing the need for cooling, considerably improving the bearing environment and reducing load on the stator.

It is also possible to operate smaller motors (PE1 & PE2 pumps) without any cooling. Add to this an increased bearing design life, reduced shaft deflection and increased shaft fatigue safety factors, and you have a highly robust and reliable submersible motor design.

**Optimum operating conditions**

When it comes to hydraulic reliability, the key is blockage and wear resistance coupled with easy adjustment to maintain optimum operating conditions. The ABS EffeX range makes use of our new Contrablock Plus impeller design with adjustable bottom plate to ensure efficiency and reliability throughout the pump lifetime. Larger pumps also use optimised closed impeller designs to give the best balance between reliability and energy consumption.


**Our long-term reliability gives you:**

- Reduced risk of pollution from overflows
- Reduced risk of interruption to services to customers
- Reduced breakdown costs
- Reduced tankering costs
- Reduced maintenance costs

## Greater energy saving

The impact of good energy management is twofold. Firstly, from a purely operational point of view, good energy management results in lower energy costs, particularly important with ever-increasing energy prices. Secondly, and equally important, is the impact on $CO_2$ production. Reduced energy used in pumping equipment has a direct impact on the $CO_2$ footprint of your organisation.

When we consider the energy consumption of pumping equipment, calculations must always be based on the total efficiency of the pump; that is, the sum of the efficiency of the hydraulics and the motor. To achieve the best result one must optimise both efficiencies. It is no good saying we have the best hydraulic efficiency and then fit the hydraulics to a sub-standard efficiency submersible motor.

**Highest efficiency available**

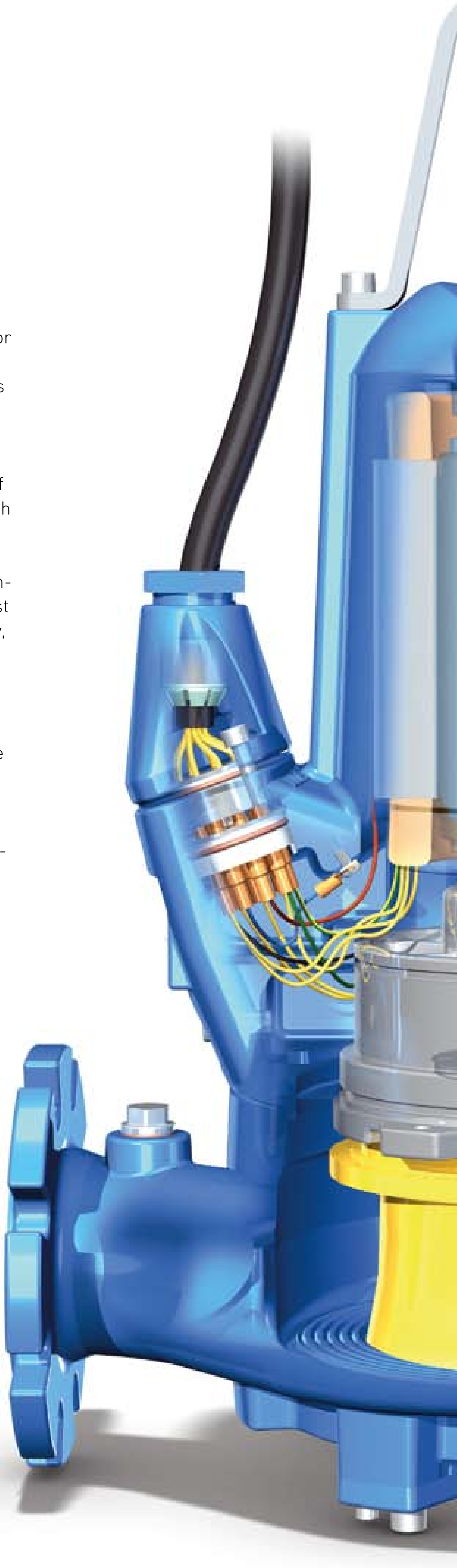
The ABS EffeX range has built-in IE3 premium-efficiency motors in accordance with IEC60034-30 to optimise motor efficiency. And we are the first company in the world to offer submersible motors with such a high standard. The main benefit of using this type of motor is the highest efficiency available on the market without any impact on the risk of increased blockage often associated with hydraulic efficiency.

When we come to hydraulic efficiency, traditional thinking when designing impellers has dictated that you must always compromise between efficiency, rag handling and free solid passage. However, the ABS EffeX range boosts impeller design to the next level and achieves some of the highest hydraulic efficiencies in the market, providing the best resistance to blockage while still maintaining a minimum 75 mm free solid passage.

This is achieved by optimising impellers for efficiency using the latest CFD technology and then completing extensive testing to measure the blockage resistance of the impeller.

**Our greater energy saving gives you:**

- Reduced energy costs
- Smaller $CO_2$ footprint
- Qualification for capital allowance schemes

## Excellent rag handling

On average, over 60% of the breakdown calls from a typical wastewater pumping station are a direct result of a pump problem. This is probably not surprising as pumps are the only piece of rotating equipment installed in many wastewater pumping stations. But what is most alarming is that when we look at these breakdown figures in more detail, we see that over 60% of the pump-related breakdowns are a direct result of blockage.

This situation has not improved in recent years, and even with all the improvements made to impeller design, reduced water consumption and changing personal hygiene habits still continue to increase blockage problems.

**New impeller concept**

Our ABS EffeX range makes use of a completely new impeller concept called Contrablock Plus. This solution takes the best of the tried and tested Contrablock designs and adds new functionality to enhance the levels of blockage resistance above that of any other supplier on the market. In addition, we ensure that the free solids passage is never reduced below 75 mm to give a further level of protection against blockage.

How can we be so sure of our designs? Because ABS has invested in over 5,000 man-hours in blockage testing, understanding the content of wastewater, benchmarking available designs and optimising the impellers used in the ABS EffeX range.

**Our excellent rag handling gives you:**

- Lowest blockage on the market
- Reduced risk of pollution from overflows
- Reduced risk of interruption to services to customers
- Reduced breakdown costs
- Reduced tankering costs

## Future-proof design

Earlier we talked about anticipating the future, trying to understand the trends and forthcoming requirements of the wastewater market. What do we see?

Firstly we can observe the changing characteristics of wastewater, driven mainly by the reduction in water consumption and changes to personal hygiene habits. Have we seen the end of this change? No, the general feeling is that water consumption will continue to reduce with the consequent increase in rag content.

We can also see legislation and other incentives push all users of energy-using products (EuP) to install higher-efficiency and explosion-proof units. There is already legislation in place controlling circulator pumps with others to follow, including submersible pumps.


Our guiding principle when looking at the manufacturing phase is to minimise the consumption of resources. This means designing products that have a long design life and which can be kept running at their optimum performance for a long period of time.

The key benefit achieved here is the optimisation of $CO_2$ used in the operating phase while significantly reducing the overall $CO_2$ footprint of the product during its lifetime.

When it comes to the operating phase, we keep the energy consumed to a minimum with the equipment running most efficiently throughout its design life.

**Already way ahead**

The ABS EffeX range looks to the future; it already more than complies with any legislation under discussion with regard to motor efficiency, hydraulic or total efficiency. With regard to rag handling, the new optimised impeller designs take into account reduced water consumption and increased rag content. The levels of reliability are again in excess of the requirements of global legislation controlling the standard of wastewater collection networks. All models have Ex-configuration as standard.

**Our future-proof design gives you:**

- Compliance with planned EU, US and other legislation for conventional motors
- Impeller designs based on future wastewater content
- High reliability to ensure compliance with overflow reduction targets

## Sustainable in manufacturing and operation

ABS believes in long-term relationships with our customers. To achieve this we must ensure that our business and that of our customers are sustainable in the long term. We also believe in looking far ahead when designing products to make sure that we minimise our impact on the environment with regard to both the manufacturing and operational phases of a product lifetime.

**Long product lifetime**

The ABS EffeX range scores highly on both counts. The models are designed with easily adjustable features that prolong the life of components while maintaining optimal performance.

Moreover, the long life of all components and the highest total efficiency available on the market ensure that the environmental impact of our premium-efficiency submersible sewage pumps is minimised without compromising operational reliability

**Our sustainability in manufacturing and operation gives you:**

- Reduced $CO_2$ emissions in pump manufacturing and operation
- Prolonged pump lifecycle
- Reduced maintenance costs by adjustment rather than repair

# A total solution supplier

It's not surprising that ABS is the first worldwide to introduce premium-efficiency submersible sewage pumps. Our long history of innovation includes being first with high-efficiency pumps, introducing our new Contrablock Plus impeller design that offers the highest available resistance to blockage on the market today, and our AquaWeb advanced alarm management system for wastewater.

**Your long-term partner**
Our strength lies in the unique ability to combine products, services and application know-how into diverse solutions that satisfy a variety of application needs. When you choose us as your solution provider you get:

- A long-term partner from design to operation
- Application expertise and process know-how
- Reliable solutions that enhance process efficiency
- Strong relations through support and after-sales service
- The most complete range of products on the market

ABS solutions not only increase process efficiency, but also enhance overall process performance. Combined with our control and monitoring equipment and services, they provide peace of mind in any wastewater application.

**A wealth of expertise**
Advanced R&D, backed by an engineering heritage going back over 100 years, forms the backbone of our competence and expertise in the design and installation of centrifugal pumps. This, combined with our know-how in wastewater applications, enables us to offer integrated pump solutions that are designed and sized to perfectly match the conditions of your wastewater system. We also provide installation, operational optimisation and training of a customer's own maintenance personnel.

**Service, spares and asset management**
Our comprehensive range of services tailored to your needs includes:

- Planned maintenance, workshop repair, spares and spare parts kits, replacement and upgrading
- Installation, operational support, telemetry and diagnostics, equipment optimisation, asset management.

**Flexible and responsive**
ABS uses high-quality materials and manufacturing techniques with all its product ranges. We have a very modern manufacturing machine park, including our own production equipment operated by highly skilled personnel.

In our efforts to offer high-performance products, we work in close cooperation with our customers to receive important feedback for continuous product improvement.

Make the right choice and choose
ABS as your partner
in wastewater handling.

# At the forefront of wastewater technology

ABS has a long tradition in the wastewater industry with more than 100 years of application experience and manufacturing of customer-oriented solutions based on the latest technology.

We develop and supply individual products and integrated solutions for use in the wastewater segments: Domestic and Commercial Wastewater, Wastewater Collection Networks and Wastewater Treatment. ABS is the main brand of Wastewater Technology, which is one of four divisions of the Cardo Group. Cardo is listed on NASDAQ OMX Stockholm and has its headquarters in Malmö, Sweden.

ABS Group
Phone +46 40 35 04 70 | Fax +46 40 30 50 45
info@absgroup.com | www.absgroup.com

2009PB001en1 – www.pyramid.se

We know how water works

# TECHNICAL DATA

4” ABS XFP PUMP

XFP 100E-CB1
4 Pole, 3 Phase, PE2

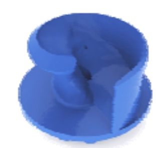
| Date: | 10/10 | | |
|---|---|---|---|
| Dwg: | DS-E01-024 | Rev: | 4 |

## Submersible Motor Specifications, PE2 Frame

| | | |
|---|---|---|
| **Motor Design** | | NEMA design B, squirrel cage induction |
| **Motor Type** | | Fully enclosed Premium Efficiency submersible, IP68 protection rating |
| **Motor Efficiency Standard and Rating** | | IEC 60034-30, IE3 rating |
| **Motor Efficiency Test Protocol** | | IEC 60034-2-1 |
| **Insulation Materials** | | Class H, 180ºC (356ºF), copper windings |
| **Motor Filling Medium** | | Air for wet pit installation, environmentally safe, non-toxic oil for dry pit installation, no cooling jacket required |
| **Temperature Rise** | | Class A for wet pit installation, Class B for dry pit installation |
| **Maximum Fluid Temperature** | | 40ºC (104ºF) continuous, 50ºC (122ºF) intermittent |
| **Motor Protection** | **Thermal** | Normally closed bimetallic switch in each phase, connected in series, 140ºC (284ºF), +/- 5 ºC opening temperature |
| | **Leakage** | ABS Sealminder moisture detection probe in seal sensing chamber |
| **Sensing Chamber Filling Medium** | | Environmentally safe, non-toxic oil |
| **Bearing Type** | **Upper** | Single row ball permanently lubricated |
| | **Lower** | Double row angular contact permanently lubricated |
| **Motor Starter Types** | | Suitable for use with across the line, electronic soft starters, and PWM type Variable Frequency Drives* |
| **Maximum Starts per Hour** | | 15, evenly spaced |
| **Inverter Duty Rating** | | Motors meet NEMA MG1, part 31 requirements |
| **Maximum Submergence** | | 20 meters (65 feet) |
| **Available Voltages** | | 208, 230, 460, 600 |
| **Voltage Tolerance from Rated** | | +/-10% |
| **Agency Approvals** | | Factory Mutual, CSA |
| **Explosion Proof Rating** | | NEC 500 Class 1, Division 1, Group C & D, Class T3C max surface temp |

*Output filters may be required on VFDs. See document **DS-E00-001** for details.

ABS submersible sewage pump XFP
Part of the ABS EffeX range



Premium Efficiency
without Compromise

## Motor Ratings, PE2 Frame

| Motor Model | Input Power (P1) | Rated Power Output (P2) | Nominal RPM | Rated Voltage | Full Load Amps | Locked Rotor Amps | NEMA Code Letter | NEMA Service Factor | Motor Efficiency at % Load | | | Power Factor at % Load | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 100 | 75 | 50 | 100 | 75 | 50 |
| PE 75/4 | 8.2 kW | 7.5 kW<br>10 HP | 1760 | 208<br>230<br>460<br>600 | 30.6<br>27.7<br>13.8<br>10.6 | 177.8<br>160.8<br>80.4<br>61.6 | H | 1.3** | 91.7 | 91.9 | 91.6 | .742 | .654 | .534 |
| PE 90/4 | 9.8kW | 9 kW<br>12 HP | 1760 | 208<br>230<br>460<br>600 | 34.9<br>31.5<br>15.8<br>12.1 | 232<br>210<br>105<br>80.5 | H | 1.3** | 91.7 | 91.5 | 88.8 | .78 | .7 | .56 |
| PE 105/4 | 11.4 kW | 10.5 kW<br>14.1 HP | 1755 | 208<br>230<br>460<br>600 | 39.1<br>35.4<br>17.7<br>13.6 | 232<br>210<br>105<br>80.5 | G | 1.3** | 92.4 | 92.6 | 90.9 | .806 | .754 | .632 |

** For wet pit installation. Service factor is 1.15 for dry pit installation.

Specifications subject to change without notice

## Cable Data, PE2 Frame

| | Motor | Motor Voltage | Cable Type | Cable Nominal Dia. +/- .5mm (.02”) |
|---|---|---|---|---|
| **Power Cable** | PE 75/4 | 208 volt | SOOW 8/4+16/3 | 25.4mm (1.0”) diameter |
| | | 230 volt | SOOW 8/4+16/3 | 25.4mm (1.0”) diameter |
| | | 460 volt | SOOW 12/7* | 18.8mm (0.74”) diameter |
| | | 600 volt | SOOW 14/7 | 18.3mm (0.72”) diameter |
| **Control Cable** | | All | Included in Power Cable | |
| **Power Cable** | PE 90/4 | 208 volt | SOOW 8/4+16/3 | 25.4mm (1.0”) diameter |
| | | 230 volt | SOOW 8/4+16/3 | 25.4mm (1.0”) diameter |
| | | 460 volt | SOOW 12/7* | 18.8mm (0.74”) diameter |
| | | 600 volt | SOOW 14/7 | 18.3mm (0.72”) diameter |
| **Control Cable** | | All | Included in Power Cable | |
| **Power Cable** | PE 105/4 | 208 volt | SOOW 8/4+16/3 | 25.4mm (1.0”) diameter |
| | | 230 volt | SOOW 8/4+16/3 | 25.4mm (1.0”) diameter |
| | | 460 volt | SOOW 10/7* | 20.7mm (0.82”) diameter |
| | | 600 volt | SOOW 12/7 | 18.8mm (0.74”) diameter |
| **Control Cable** | | All | Included in Power Cable | |
| **Cable Length** | Standard: 15m (49 feet) | | Optional: 20m (65 feet), 30m (98 feet) - Consult Factory for Longer Lengths | |

* Special versions ordered with cable suitable for both 230 volt and 460 volt operation will be equipped with the cable type and diameter shown in the “230 volt” section of the table

## Pump Data

| | | | | | |
|---|---|---|---|---|---|
| **Discharge Size** | 4” flanged, compatible with 4” class 125 ANSI flanges | | | | |
| **Suction Size** | 4” flanged, compatible with 4” class 125 ANSI flanges, threaded for 8 x 5/8-11 UNC bolts, 28mm (1.1”) deep | | | | |
| **Volute pressure rating** | 10 bar (145 psi) | | | | |
| **Impeller Type** | Semi-open, 1-vane, ContraBlock Plus w/ Seal Protection System | | | | |
| **Impeller Size** | .1 | .2 | .3 | .4 | .5 |
| **Solids Passage Size** | 80mm (3.14”) | 80mm (3.14”) | 80mm (3.14”) | 80mm (3.14”) | 80mm (3.14”) |
| **Impeller DIA** | 250mm (9.4“) | 240mm (9.4“) | 225mm (8.6“) | 215mm (8.5”) | 195mm (7.7”) |
| **Impeller Weight** | 9.7 Kg (21.3lb) | 8.8 Kg (19.4lb) | 8.4 Kg (18.5lb) | 6.6 Kg (14.5 lb) | 6.3 Kg (13.9 lb) |
| **Min Recommended Flow, GPM** | 160 | 160 | 160 | 130 | 130 |

## Materials of Construction

| | | Standard | Optional |
|---|---|---|---|
| **Motor Housing** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Oil Chamber** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Seal Plate** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Impeller** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Volute** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Bottom Plate CB** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Cable Entry Casting** | | Cast Iron EN-GJL-250 (ASTM A-48, Class 35B) | |
| **Pump and Motor Shaft** | | Stainless Steel 1.4021 (AISI 420 SS) | |
| **External Hardware** | | Stainless Steel 1.4401 (AISI 316 SS) | |
| **Lifting Hoop** | | Stainless Steel 1.4401 (AISI 316 SS) | |
| **O-Rings** | | Nitrile (Buna-N) | |
| **Cable Glands** | | Nitrile (Buna-N) | |
| **Tandem Mechanical Seal** | **Lower** | Silicon Carbide on Silicon Carbide | |
| | **Upper** | Silicon Carbide on Silicon Carbide | |
| **Coating** | | Two part epoxy, black, 120µm (4.7 mil) DFT | Two part epoxy, black, 400µm (15.7 mil) DFT |

## General Data

| | PE 75/4 | PE 90/4 | PE 105/4 |
|---|---|---|---|
| **Overall Height** | 762mm (30”) | 762mm (30”) | 832mm (32.8“) |
| **Pump Weight** | 177 kg (390 lb) | 177 kg (390 lb) | 188.5 kg (415.6 lb) |

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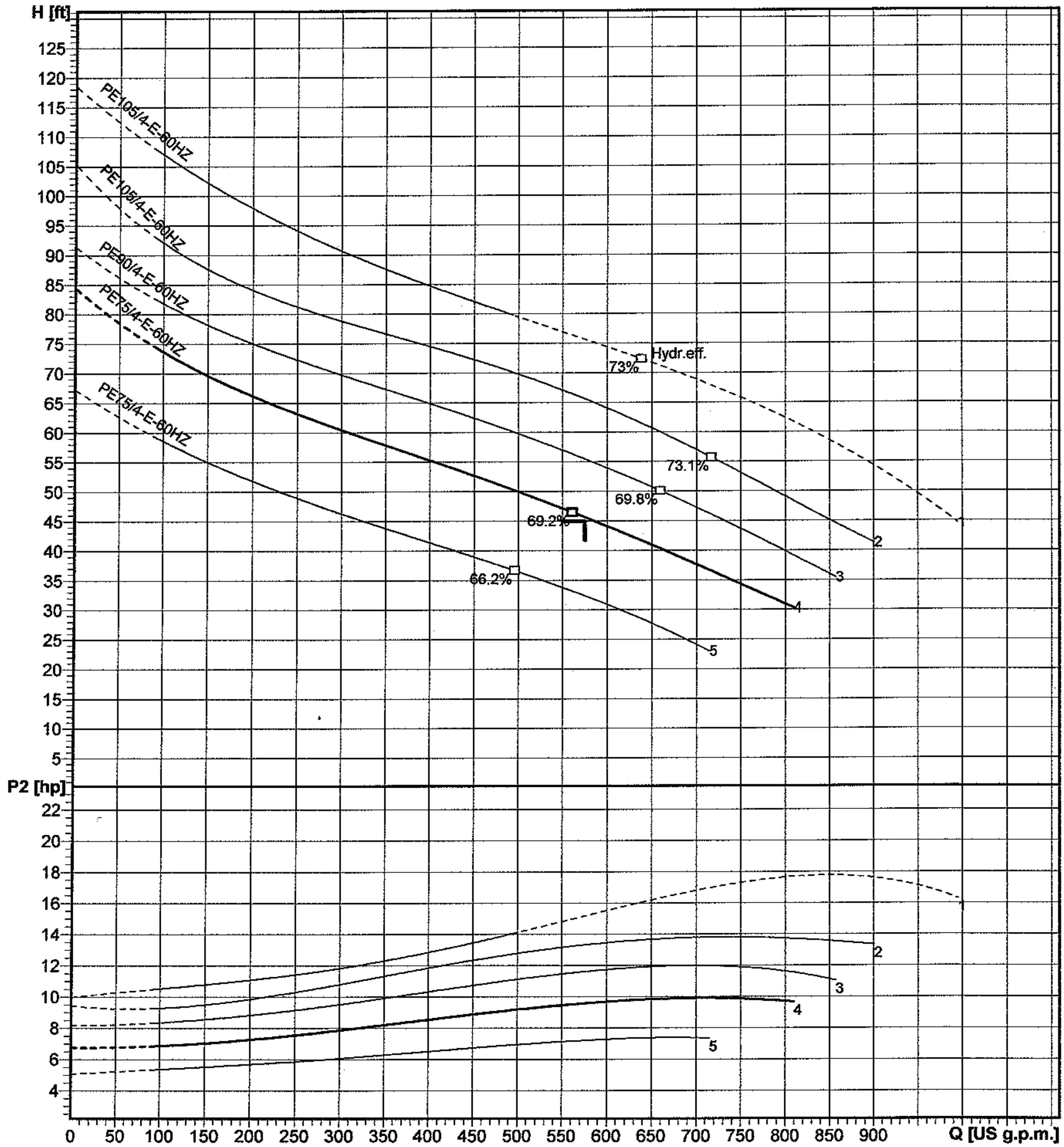
# Pump performance curves
# XFP100E CB1 60HZ

| | | | | |
|---|---|---|---|---|
| | | | Discharge<br>DN100 | Curve number |
| | | | | Reference curve<br>XFP100E CB1 |
| | | | | Frequency<br>60 Hz |
| Density<br>62.43 lb/ft³ | Viscosity<br>1.57 cSt | Testnorm<br>ISO 9906 Gr 2 Annex A1/A2 | Rated speed<br>1765 rpm | Date<br>2010-11-30 |
| Flow<br>578 US g.p.m. | Head<br>45.5 ft | Rated power<br>9.6 hp | Hydraulic efficiency<br>69.1 % | NPSH<br>10.2 ft |




| Impeller size | N° of vanes | Impeller | Solid size | Revision 2009-11-12 |
|---|---|---|---|---|
| 8.46 inch | 1 | Contrabloc Plus impeller, 1 vane | 3 1/8" | |



ABSEL PRO 1.7.2 / 2006-12-21

| Massblatt XFP 100E-CB1 Trockeninstallation | No: AN-M.22.569-01 |
|---|---|
| Dimension sheet DRY-WELL Installation | Drawn: 11.05.09 / D.Whelan |
| Dimensioni Installazione a secco | Issue Date: 11.05.09 |
| Hoja de dimensiones instalación en seco | Änderungen vorbehalten<br>Technical changes reserved<br>Con riserva di modifiche |
| Plan d'encombrement Installation á sec | Con reserva de modificaciones<br>Sous réserve de modification |

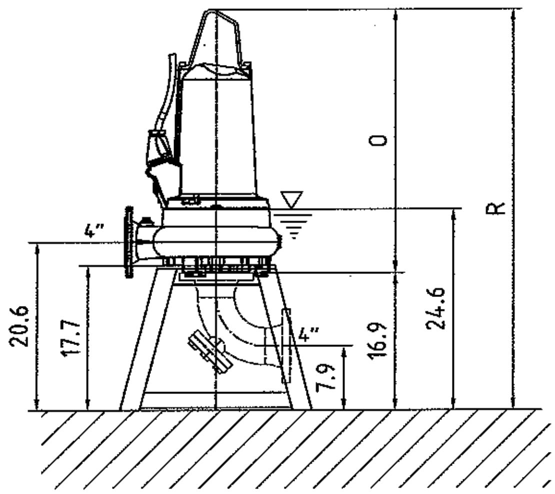
**50 Hz**

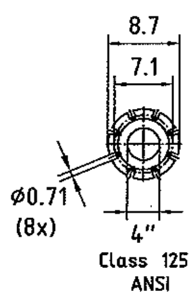
**U.S.**

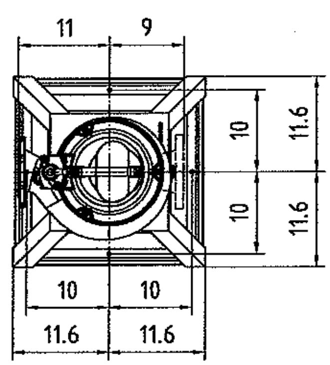
| Typ<br>Type<br>Tipo | Gewicht<br>Weight<br>Poids<br>Peso<br>(lbs) | O<br>(") | R<br>(") |
|---|---|---|---|
| PE 60/4 | 367 | 29.5 | 46.4 |
| PE 90/4 | 392 | 32.3 | 49.1 |

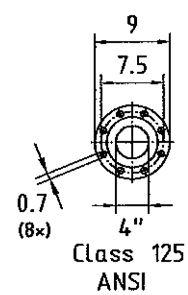
**60 Hz**

| Typ<br>Type<br>Tipo | Gewicht<br>Weight<br>Poids<br>Peso<br>(lbs) | O<br>(") | R<br>(") |
|---|---|---|---|
| PE 35/6 | 326 | 29.5 | 46.4 |
| PE 75/4 | 367 | 29.5 | 46.4 |
| PE 90/4 | 367 | 29.5 | 46.4 |
| PE 105/4 | 392 | 32.3 | 49.1 |




Guss-Allgemeintoleranzen nach DIN1680 - GTB16
General tolerances for castings in acc. to DIN1680-GTB16
Tolleranze generali delle fusioni secondo DIN1680-GTB16
Tolerancias generales para la fundición seg. de DIN1680-GTB16
Tolérance générale de la fonderie selon DIN1680-GTB16

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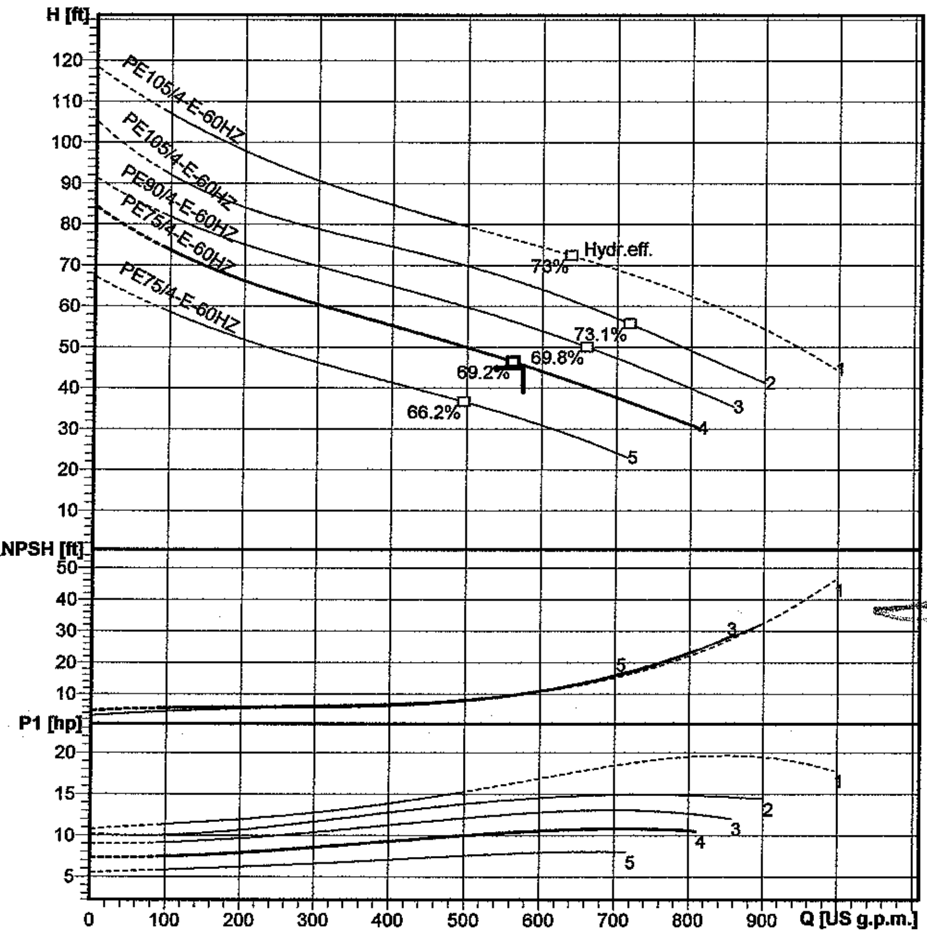
# XFP100E CB1 60HZ




Testnorm
ISO 9906 Gr 2 Annex A1/A2

2009-11-12

**Operating data specification**

| | | | |
|---|---|---|---|
| Flow | 578 US g.p.m. | Head | 45.5 ft |
| Efficiency | 69.1 % | Shaft power | 9.6 hp |
| NPSH | 10.2 ft | Fluid | Water |
| Temperature | 39 °F | Nature of system | Single head pump |
| No. of pumps | 1 | | |

**Pump data**

| | | | |
|---|---|---|---|
| Type | XFP100E CB1 60HZ | Make | ABS |
| Series | XFP PE1-PE3 | Impeller | Contrabloc Plus impeller, 1 vane |
| N° of vanes | 1 | Impeller size | 8.46 inch |
| Free passage | 3 1/8" | Suction port | DN100 |
| Discharge port | DN100 | | |

**Motor data**

| | | | |
|---|---|---|---|
| Rated voltage | 460 V | Frequency | 60 Hz |
| Rated power P2 | 10.1 hp | Nominal speed | 1765 rpm |
| Number of poles | 4 | Efficiency | 91.7 % |
| Power factor | 0.742 | Rated current | 13.8 A |
| Starting current | 80.4 A | Rated torque | 29.9 lbf ft |
| Starting torque | 58.4 lbf ft | Degree of protection | IP68 |
| Insulation class | H | | |

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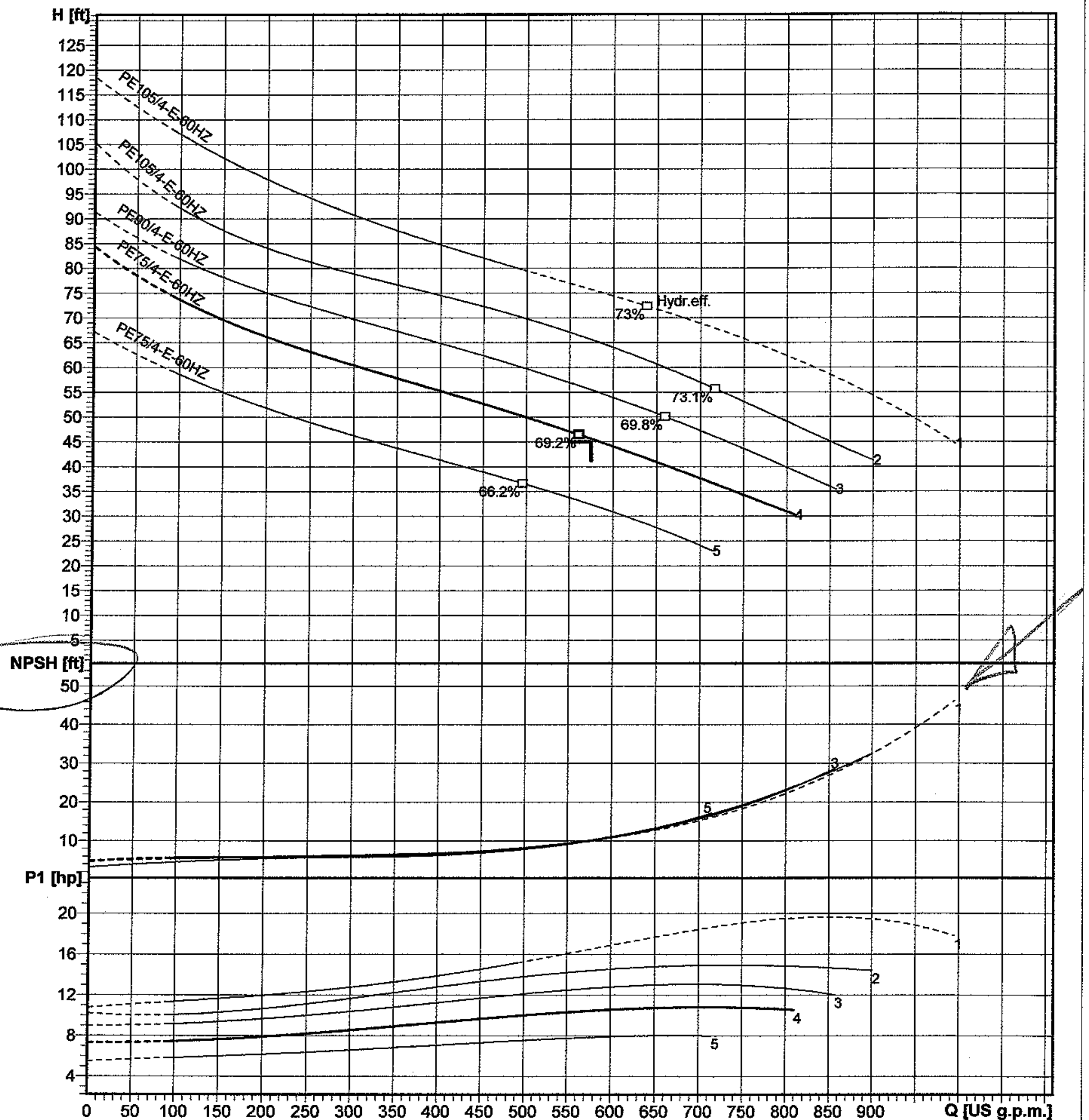
# Pump performance curves
## XFP100E CB1 60HZ

| | | | | |
|---|---|---|---|---|
| | | Pump performance curves XFP100E CB1 60HZ | | Curve number |
| | | | | Reference curve XFP100E CB1 |
| | | | Discharge DN100 | Frequency 60 Hz |
| Density 62.43 lb/ft³ | Viscosity 1.57 cSt | Testnorm ISO 9906 Gr 2 Annex A1/A2 | Rated speed 1765 rpm | Date 2010-12-27 |
| Flow 578 US g.p.m. | Head 45.5 ft | Rated power 9.6 hp | Hydraulic efficiency 69.1 % | NPSH 10.2 ft |




| | | | | |
|---|---|---|---|---|
| Impeller size 8.46 inch | N° of vanes 1 | Impeller Contrabloc Plus impeller, 1 vane | Solid size 3 1/8" | Revision 2009-11-12 |



ABSEL PRO 1.7.2 / 2006-12-21

# APPENDIX G
# STRUCTURAL CATALOG CUTS

SEWERGARD - TROWELABLE NO. 210

## PHYSICAL PROPERTIES

| | |
|---|---|
| Application time (ASTM C-308 modified) | |
| Working time at 70ºF | 40-50 minutes |
| Initial set at 70ºF | 17 hours |
| Components | 3 parts |
| Bond strength to concrete (ASTM D-4541) | Concrete failure |
| Coefficient of thermal expansion (ASTM C-531) | $3.5 \times 10^{-5}$ /Fº ($1.9 \times 10^{-5}$/Cº) |
| Compressive strength (ASTM C-579) | 7,300 psi (513.2 kg/cm$^2$) |
| Density (ASTM C-905) | 113 pcf (1.81 gm/cm$^3$) |
| Flexural strength (ASTM C-580) | 4,900 psi (344.5 kg/cm$^2$) |
| Maximum service temperature | 150ºF (65ºC) |
| Modulus of elasticity (ASTM C-580) | $2.75 \times 10^5$ psi ($1.9 \times 10^4$ kg/cm$^2$) |
| Tensile strength (ASTM C-307) | 2,000 psi (140.6 kg/cm$^2$) |
| Thickness | 1/8 inch (3.175 mm) |
| Water Vapor Transmission | |
| Moisture absorption (ASTM D-570-95) | < 0.04% |
| Permeance (ASTM E-96-94, A) | $6.88 \times 10^{-9}$ U.S. Perms |

Physical properties were determined on specimens prepared under laboratory conditions using applicable ASTM procedures. Actual field conditions may vary and yield different results; therefore, data are subject to reasonable deviation. Data should not be used for specification purposes.

## CHARACTERISTICS

- ☐ Resistant to corrosive conditions common to the municipal wastewater treatment industry.
- ☐ Suitable for application over damp or dry concrete surfaces.
- ☐ Trowelable nonsagging consistency ensures ease of application on vertical and overhead surfaces.
- ☐ Does not require a primer.
- ☐ Prohibits water infiltration.

Sauereisen SewerGard No. 210 is an aggregate-filled epoxy material. This lining system is specifically designed to protect concrete surfaces of municipal wastewater treatment structures and collection systems from chemical attack and physical abuse. No. 210's nonsagging application properties permit economical repair and protection of vertical, horizontal and overhead surfaces of both new or rehabilitated substrates.

When cured, No. 210 provides an impermeable, high strength, corrosion-resistant lining for manholes, lift stations, grit chambers, aeration basins, and related structures subject to infiltration and attack from hydrogen sulfide and acid generated by microbiological sources.

## AREA PREPARATION

**Temperature of Working Area**
Maintain a temperature of 60º-85ºF on air, substrate, Liquid, Hardener, and Powder components during mixing, application, and cure.

The monolithic components should be maintained at 65ºF to 80ºF for 48 hours prior to beginning work.

At temperatures below 65ºF, the application becomes more difficult and curing is retarded. Above 80ºF, the material working time decreases.

Application in direct sunlight and rising surface temperature may result in blistering of the materials due to expansion of entrapped air or moisture in the substrate. Concrete surfaces that have been in direct sunlight must be shaded for 24 hours prior to application and remain shaded until the initial set has taken place. In rising temperatures it may be necessary to postpone the application or apply during cooler hours.

**Surface Preparation**
Surfaces should be made free of oil, grease, water, and other contaminants that may inhibit bond. This can be achieved by chemical cleaning.

*Concrete* - Refer to SSPC-SP13/NACE 6 "Surface Preparation of Concrete" for detailed guidelines.

*New Concrete* - All structures must be properly designed and capable of withstanding imposed loads. Abrasive blast, high-pressure water blast, or acid etch concrete to remove laitance and obtain uniform surface texture. After surface preparation, voids left in concrete surface must be filled with Sauereisen Filler Compound No. 209.

*Old Concrete* - Concrete must be dry, firm and structurally sound as specified by the architect/engineer. Mechanical methods should be utilized to remove old paints, protective coatings, and attacked or deteriorated concrete. Abrasive blast or high-pressure water blast concrete to remove laitance and obtain uniform sound substrate.

Substrate surfaces requiring repairs in excess of 1/8 inch depth should be resurfaced with Sauereisen Underlayment No. F-120 to ensure proper rehabilitation of the substrate.

*Brick* - Abrasive blast or high-pressure water blast all foreign particles and attacked or unsound mortar from the joints. Loose brickwork or open joints should be regrouted with appropriate Sauereisen mortar to ensure structural integrity.

All active hydrostatic leaks must be stopped with Sauereisen materials such as InstaPlug No. F-180 or Hydroactive Urethane Grout No. F-370 prior to SewerGard application.

If chemical cleaning is utilized to remove contaminants, substrate must be neutralized. If abrasive or high-pressure water blasting is used as the method of surface preparation, all sand and/or debris must be removed by thoroughly vacuuming the area with an industrial vacuum cleaner. If surface does not have desired conditions, repeat surface preparation procedure.

No. 210 may be applied over damp surfaces that are free of standing water; best results are achieved with dry surfaces.

## APPLICATION

**Mixing**
No. 210 is packaged in pre-measured units of Powder, Liquid, and Hardener components. Mixing should be done mechanically with a "Jiffy" mixer blade chucked into a drill motor. The mixing equipment must be clean and free of Portland cement or other contaminants.

Remix both Liquid and Hardener prior to combining components. Empty contents of the Liquid into a clean, dry mixing container. Empty contents of Hardener into Liquid and mix thoroughly until blended for at least one minute. Add Powder component gradually while mixing to a uniform consistency.

Mix only complete batches. Material which has begun to set must be discarded. Do not try to retemper the material. Do not add solvent, additive or adulterant to any component or mixed material.

Remove the entire batch from the mixer when mixing is completed to prevent build-up in the equipment. While pouring one batch, another should be mixed in order to eliminate delays and to permit continuous operation.

**Installation**
No. 210 is applied by trowel at a minimum 1/8 inch thickness. Theoretical coverage is 44 $ft^2$ per unit at 1/8 inch thick-ness. Actual coverage may vary, depending upon jobsite conditions. Screed bars may be used to control thickness on large surface areas.

To provide a pinhole-free surface and removal of trowel marks in No. 210, a short-nap mohair paint roller slightly dampened with water may be used. Excess water should be shaken off prior to back-rolling.

After No. 210 has achieved a hardened surface, a holiday detector should be utilized to ensure a continuous pinhole-free lining. A Sauereisen SewerGard Patch Kit may be used to conveniently repair any pinholes. Consult Sauereisen for details.

For details regarding construction joints, protrusions or penetrations through concrete, consult Sauereisen for specific recommendations.

## COVERAGE

No. 210 44 $ft^2$ per unit at 1/8 inch.

*Coverage is theoretical and will vary depending upon surface conditions, porosity, application techniques and specific project conditions.

## SETTING/CURING

SewerGard No. 210 will take an initial set in 17 hours at 70ºF. Do not allow water or chemicals on the material surface for a minimum of 24 hours. For temperatures below 70ºF, cure a minimum of 48 hours prior to water or chemical exposure.

## PACKAGING

No. 210 is packaged in a premeasured unit consisting of:

Part A Hardener:
3.2 lbs. in a 1-gal. can

Part B Liquid:
10.1 lbs. in a 2-gal. bucket

Part C Powder:
40 lbs. in a paper or plastic bag

*Containers are filled by weight, not volume. Container size does not indicate volume of contents.

## CLEAN-UP

All equipment should be cleaned with MEK before material cures. If removal is required after cure consult Sauereisen for specific recommendation.

## SHELF LIFE

Sauereisen SewerGard No. 210 has a shelf life of one (1) year, when stored in unopened, tightly sealed containers in a dry location at 70ºF. Avoid freezing. If there is a doubt as to the quality of the materials, consult a Sauereisen representative.

## CAUTION

Consult Material Safety Data Sheets and container label Caution Statements for hazards in handling these materials.

## WARRANTY

We warrant that our goods will conform to the description contained in the order, and that we have good title to all goods sold. WE GIVE NO WARRANTY, WHETHER OF MERCHANTABILITY, FITNESS FOR PURPOSE OR OTHERWISE, EXPRESS OR IMPLIED, OTHER THAN AS EXPRESSLY SET FORTH HEREIN. We are glad to offer suggestions or to refer you to customers using Sauereisen cements and compounds for a similar application. Users shall determine the suitability of the product for intended application before using, and users assume all risk and liability whatsoever in connection therewith regardless of any suggestions as to application or construction. In no event shall we be liable hereunder or otherwise for incidental or consequential damages. Our liability and your exclusive remedy hereunder or otherwise, in law or in equity, shall be expressly limited to our replacement of nonconforming goods at our factory or, at our sole option, to repayment of the purchase price of nonconforming goods.

- **Distributors and agents in major cities throughout the world. Consult manufacturer for locations.**
- **Information concerning government safety regulations available upon request.**
- **Sauereisen also produces inorganic compounds for assembling, sealing, electrically insulating and grouting.**

SAUEREISEN ...since 1899
160 Gamma Drive
Pittsburgh, PA 15238-2989 USA
Phone 412/963-0303 Fax 412/963-7620
www.sauereisen.com

# APPENDIX H
# ELECTRICAL CALCULATIONS AND CATALOG CUTS

## ELECTRICAL LOAD CALCULATIONS

1. **Alternative 2 - Existing 120/240V, 1-phase, 3-wire service to remain; Provide two 15 HP pumps with variable frequency drives to limit startup current**

| Load Description | Load (KVA) |
| --- | --- |
| 15 HP lead pump | 14.1 |
| 15 HP lag pump | 14.1 |
| 3/4 HP exhaust fan | 1.6 |
| 3/4 HP supply fan | 1.6 |
| 1/2 HP sump pump | 1.1 |
| Air conditioning for electric room | 2.0 |
| General electrical loads | 3.0 |
| SCADA system electrical loads | 2.0 |
| Lighting | 2.0 |
| Spare | 10.0 |
| **Total** | **51.5** |
| **Recommended generator size** | **100KW** |

2. **Alternative 3 - Existing 120/240V, 1-phase, 3-wire service to remain; Provide two 15 HP pumps with controls to limit operation to only 1 pump operating at any given time**

| Load Description | Load (KVA) |
| --- | --- |
| 15 HP pump | 14.1 |
| 3/4 HP exhaust fan | 1.6 |
| 3/4 HP supply fan | 1.6 |
| 1/2 HP sump pump | 1.1 |
| Air conditioning for electric room | 2.0 |
| General electrical loads | 3.0 |
| SCADA system electrical loads | 2.0 |

| | |
|---|---|
| Lighting | 2.0 |
| Spare | 10.0 |
| **Total** | **37.4** |

**Recommended generator size** **60 KW**

**3. Alternative 4 - Existing 120/240V, 1-phase, 3-wire service to remain; Provide two 10 HP pumps**

| Load Description | Load (KVA) |
|---|---|
| 10 HP lead pump | 11.0 |
| 10 HP lag pump | 11.0 |
| 3/4 HP exhaust fan | 1.6 |
| 3/4 HP supply fan | 1.6 |
| 1/2 HP sump pump | 1.1 |
| Air conditioning for electric room | 2.0 |
| General electrical loads | 3.0 |
| SCADA system electrical loads | 2.0 |
| Lighting | 2.0 |
| Spare | 10.0 |
| **Total** | **45.3** |

**Recommended generator size** **60 KW**

**4. Alternative Option - Upgrade HECO service to 480V, 3-phase, 3-wire**

| Load Description | Load (KVA) |
|---|---|
| 15 HP lead pump | 14.1 |
| 15 HP lag pump | 14.1 |
| 3/4 HP exhaust fan | 1.6 |
| 3/4 HP supply fan | 1.6 |

| | | |
|---|---|---|
| 1/2 HP sump pump | | 1.1 |
| Air conditioning for electric room | | 2.0 |
| General electrical loads | | 3.0 |
| SCADA system electrical loads | | 2.0 |
| Lighting | | 2.0 |
| Spare | | 10.0 |
| | **Total** | **51.5** |
| **Recommended generator size** | | **50 KW** |

# DIESEL GENERATOR SET

CATERPILLAR®

ALTERNATIVE NO. 2

## STANDBY 80-100 kW
## PRIME 72-90 kW

### 60 Hz

| Model | Standby kW (kVA) | Prime kW (kVA) |
|---|---|---|
| D80-6 | 80 (100) | 72 (90) |
| D80-2S | 80 (80) | 72 (72) |
| D100-6 | 100 (125) | 90 (112.5) |
| D100-6S | 100 (100) | 90 (90) |

Tier 3 EPA Approved, Emissions Certified

## FEATURES

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### ENGINE
- Governor, electronic
- Electrical system, 12 VDC
- Cartridge type filters
- Battery rack and cables
- Coolant and lube drains piped to edge of base

### GENERATOR
- Insulation system, class H
- Drip proof generator air intake (NEMA 2, IP23)
- Electrical design in accordance with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

### MOUNTING ARRANGEMENT
- Heavy-duty fabricated steel base with lifting points
- Anti-vibration pads to ensure vibration isolation
- Complete OSHA guarding
- Stub-up pipe ready for connection to silencer pipework
- Flexible fuel lines to base with NPT connections

### COOLING SYSTEM
- Radiator and cooling fan complete with protective guards
- Standard ambient temperatures up to 50° C (122° F)

### CIRCUIT BREAKER
- UL/CSA listed
- 3-pole with solid neutral
- NEMA 1 steel enclosure, vibration isolated
- Electrical stub-up area directly below circuit breaker

### AUTOMATIC VOLTAGE REGULATOR
- Voltage within ± 0.5% 3-phase and ± 1.0% single phase at steady state from no load to full load
- Provides fast recovery from transient load changes

### EQUIPMENT FINISH
- All electroplated hardware
- Anticorrosive paint protection
- High gloss polyurethane paint for durability and scuff resistance

### QUALITY STANDARDS
- BS4999, BS5000, BS5514, EN61000-6, IEC60034, NEMA MG-1.33, NFPA 110 (with optional equipment)

### DOCUMENTATION
- Operation and maintenance manuals provided
- Wiring diagrams included

### WARRANTY
- All equipment carries full manufacturer's warranty.

## OPTIONAL EQUIPMENT*

### ENCLOSURE
- B Series weather protective enclosure (includes internal silencer system)
  – Single point lift
  – Panel viewing window
  – External emergency stop pushbutton
- Sound attenuated enclosure (includes internal silencer system)

### SILENCER SYSTEM – OPEN UNIT
- Level 1 silencer
- Level 2 silencer
- Level 3 silencer
- Mounting kit
- Through-wall installation kits

### ENGINE
- Battery heater
- Lube oil drain pump
- High lube oil temperature shutdown
- Lube oil sump heater

### CIRCUIT BREAKER
- Auxiliary voltfree contacts
- Shunt trip (100+ amp breakers)

### GENERATOR
- Anti-condensation heater
- Permanent magnet generator
- AREP excitation system (3-Phase only)
- Generator upgrade 1 size (3-Phase only)

### CONTROL SYSTEM
- No control system
- EMCP 3.2 digital control panel

### MOUNTING ACCESSORIES
- Seismic (Zone 4) vibration isolators

### FUEL SYSTEM
- UL listed closed top-diked skid-mounted fuel tank base (12/24-hour capacity) with fuel alarm (low level/leak detected)
- Critical high fuel alarm
- Critical low fuel level shutdown

### COOLING SYSTEM
- Coolant heater
- Low coolant temperature alarm
- Low coolant level shutdown
- Radiator transition flange

### REMOTE ANNUNCIATORS
- 16-channel remote annunciator panel (supplied loose)

### MISCELLANEOUS ACCESSORIES
- Toolkit
- Additional operator's manual pack
- Special enclosure color
- UL listing
- CSA certification
- French or Spanish language labels

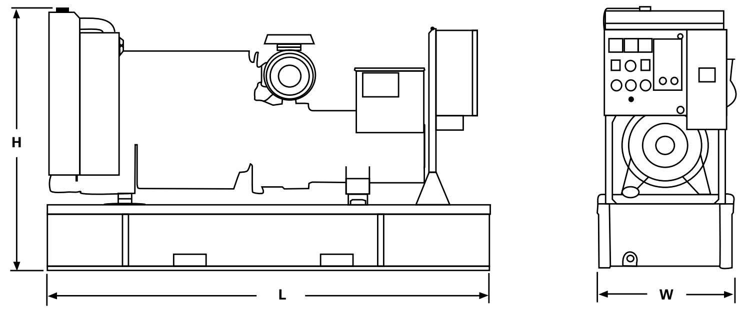
### EXTENDED SERVICE CONTRACTS
- Extended Service Coverage available

### TESTING
- Factory test and report at both 1.0 pf and 0.8 pf

* Some options may not be available on all models.
  Not all options are listed.

CATERPILLAR®

## GENERATOR SET DIMENSIONS AND WEIGHTS




| Model | Length mm (in) | Width mm (in) | Height mm (in) | Weight kg (lb)* |
|---|---|---|---|---|
| D80-6 | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 960 (2,116) |
| D80-2S | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 934 (2,059) |
| D100-6 | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 1389 (3,062) |
| D100-6S | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 1066 (2,350) |

**NOTE:** General configuration not to be used for installation. See specific dimensional drawings for detail.

*Includes oil and coolant

# SPECIFICATIONS

## GENERATOR

Voltage regulation ........ ± 0.5% 3-phase and ± 1.0% single phase at steady state from no load to full load
Frequency ..... ± 0.25% for constant load, no load to full load
Waveform distortion .................. THD < 4%, at no load
Radio interference .............. Compliance with EN61000-6
Telephone interference.................. TIF < 50, THF < 2%
Overspeed limit .................................. 2250 rpm
Insulation.......................................... Class H
Temperature rise ...................... Within Class H limits
Available voltages ....... 1-phase – 120/240, 115/230, 110/220
3-phase – 277/480, 266/460, 120/240, 127/220, 120/208, 347/600
Deration ............... Consult factory for available outputs
Ratings ............... At 30° C (86° F), 152.4 m (500 ft), 60% humidity, 1.0 pf (1-phase), 0.8 pf (3-phase)

## ENGINE

Manufacturer .................................... Caterpillar
Type ............................................ 4-cycle
Bore – mm (in) ................................ 105.0 (4.13)
Stroke – mm (in)............................... 127.0 (5.00)
Governor Type................................. Electronic
Class............................................... G2
Piston speed – m/sec (ft/sec)..................... 7.62 (25.0)
Engine speed – rpm ................................. 1800
Air cleaner type ...................... Dry, replaceable paper element type with restriction indicator

**D80-6, D80-2S – C4.4**
Aspiration.................................. Turbocharged
Cylinder configuration............................. In-line 4
Displacement – L (cu in)........................... 4.4 (269)
Compression ratio .................................. 19.2:1
Max power at rated rpm – kW (hp)
Standby........................................ 97 (130)
Prime .......................................... 88 (118)
BMEP – kPa (psi)
Standby ..................................... 1476 (213)
Prime......................................... 1335 (194)
Regenerative power – kW (hp) ................... 13.8 (18.5)

**D100-6, D100-6S – C4.4**
Aspiration.................................. Turbocharged
Cylinder configuration............................. In-line 4
Displacement – L (cu in)........................... 4.4 (269)
Compression ratio .................................. 19.2:1
Max power at rated rpm – kW (hp)
Standby..................................... 117 (156.9)
Prime ....................................... 106 (142.1)
BMEP – kPa (psi)
Standby .................................... 1612 (233)
Prime........................................ 1771 (257)
Regenerative power – kW (hp) ................... 13.8 (18.5)

## CONTROL PANEL

- Heavy duty sheet steel enclosure with lockable hinged door
- Vibration isolated from generating set
- LCD display
- AC metering
- DC metering
- Fail to start shutdown
- Low oil pressure shutdown
- High engine temperature
- Low/high battery voltage
- Underspeed/overspeed
- Loss of engine speed detection
- 2 spare fault channels
- 20 event fault log
- 2 LED status indicators
- Lockdown emergency stop push button

# RATING DEFINITIONS AND CONDITIONS

**Standby** – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator is peak rated (as defined in ISO8528-3).

**Prime** – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10 percent overload power for 1 hour in 12 hours.

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## D100-6S (1-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** (at 240V) | kW | kVA | 100 | 100 | 90 | 90 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 29.7 | 7.8 | 27.3 | 7.2 |
| 75% load | L/hr | gal/hr | 23.7 | 6.3 | 21.9 | 5.8 |
| 50% load | L/hr | gal/hr | 17.6 | 4.6 | 16.3 | 3 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 61.0 | 3,472 | 57.0 | 3,244 |
| Total heat radiated to room at rated power | kW | Btu/min | 18.0 | 1,025 | 15.0 | 854 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 8.4 | 297 | 8.5 | 300 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 22.5 | 794 | 20.0 | 705 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 580 | 1,076 | 540 | 1,004 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 98 | | 97 | |

| Generator Technical Data | | 120/240V | 115/230V | 110/220V |
|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | |
| (30% voltage dip) | Self excited | 187 | 175 | 162 |
| | PM excited** | 187 | 175 | 162 |
| **Full Load Efficiencies:** | Standby | 90.5 | 90.0 | 89.4 |
| | Prime | 90.9 | 90.4 | 89.4 |
| **Reactances (per unit):** | $X_d$ | 2.67 | 2.91 | 3.18 |
| Reactances shown are applicable to the standby rating. | $X'_d$ | 0.21 | 0.23 | 0.25 |
| | $X''_d$ | 0.127 | 0.138 | 0.151 |
| | $X_q$ | 1.60 | 1.74 | 1.90 |
| | $X''_q$ | 0.151 | 0.164 | 0.180 |

| **Time Constants:** | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 165 ms | 13 ms | 2734 ms | 20 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

# DIESEL GENERATOR SET

ALTERNATIVE NO. 3 AND 4

# STANDBY
## 60 ekW 75 kVA
## 60 Hz 1800 rpm 240 Volts

**Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.**

Image shown may not reflect actual package.

## FEATURES

**Caterpillar Model D60-6 3 phase**

### FUEL/EMISSIONS STRATEGY
• EPA Tier 3

### DESIGN CRITERIA
• The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

### FULL RANGE OF ATTACHMENTS
• Wide range of bolt-on system expansion attachments, factory designed and tested
• Flexible packaging options for easy and cost effective installation

### SINGLE-SOURCE SUPPLIER
• Fully prototype tested with certified torsional vibration analysis available

### WORLDWIDE PRODUCT SUPPORT
• Caterpillar® dealers provide extensive post sale support including maintenance and repair agreements
• Caterpillar dealers have over 1,600 dealer branch stores operating in 200 countries
• The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

### CAT® C4.4 DIESEL ENGINE
• Reliable, rugged, durable design
• Field-proven in thousands of applications worldwide
• Four-stroke diesel engine combines consistent performance and excellent fuel economy with minimum weight
• Electronic engine control

### GENERATOR SET
• Complete system designed and built at ISO 9001 certified facilities
• Factory tested to design specifications at full load conditions

### CONTROL SYSTEM
• EMCP 3.1 digital control panel
• Vibration isolated NEMA 1 enclosure with lockable hinged door
• DC and AC wiring harnesses

# STANDBY 60 ekW 75 kVA

**60 Hz 1800 rpm 240 Volts**

## FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

| System | Standard | Optional |
|---|---|---|
| Air Inlet | • Dry replaceable paper element type with restriction indicator | |
| Cooling | • Radiator and cooling fan complete with protective guards<br>• Standard ambient temperatures up to 50 degrees C (122 degrees F) | • Coolant heater<br>• Low coolant temperature alarm<br>• Low coolant level shutdown<br>• Radiator transition flange |
| Engine | • Governor, mechanical<br>• Electrical system, 12 VDC<br>• Cartridge type filters<br>• Battery rack and cables<br>• Coolant and lube drains piped to edge of base | • Governor, electronic<br>• Battery heater<br>• Lube oil drain pump<br>• High lube oil temperature shutdown<br>• Lube oil sump heater |
| Generator | • Class H insulation<br>• Drip proof generator air intake (NEMA 2,IP23)<br>• Electrical design in accordance with with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33<br>• IP23 Protection | • Anti-condensation space heater<br>• Permanent magnet excitation<br>• Internal Excitation<br>• Generator upgrade 1 size |
| Circuit Breaker | • UL/CSA listed<br>• 3-pole with solid neutral<br>• NEMA 1 steel enclosure, vibration isolated<br>• Electrical stub-up area directly below circuit breaker | • Auxiliary voltfree contacts<br>• Shunt trip |
| Control Panels | • EMCP 3.1 digital control panel<br>• Vibration isolated NEMA 1 enclosure with lockable hinged door<br>• DC and AC Wiring harnesses | • No control system<br>• EMCP 3.2 digital control panel |
| Mounting | • Heavy-duty fabricated steel base with lifting points<br>• Anti-vibration pads to ensure vibration isolation<br>• Complete OSHA guarding<br>• Stub-up pipe ready for connection to silencer pipework<br>• Flexible fuel lines to base with NPT connections | • Seismic (Zone 4) vibration isolators |
| General | • High gloss polyurethane paint, Caterpillar yellow except rails and radiators gloss black<br>• Anticorrosive paint protection<br>• All electroplated hardware | • Toolkit<br>• Additional operator's manual pack<br>• Special enclosure color<br>• UL Listing, CSA Certification<br>• French or Spanish language labels |

## SPECIFICATIONS

### CAT GENERATOR

Frame Size....................LC2014H
Excitation....................Self Excited
Pitch....................0.6667
Number of Poles....................4
Number of bearings....................Single Bearing
Number of Leads....................012
IP Rating....................IP23
Overspeed capability....................125
Wave form deviation (Line Wave Form to Line).......002.00
Paralleling kit droop transformer....................Standard
Voltage regulator.3 Phase sensing with selectible volts/Hz
Telephone Influence Factor....................Less than 50

### CAT ENGINE

C4.4 In-line 4, 4-cycle diesel
Bore - mm....................105.00 mm (4.13 in)
Stroke - mm....................127.00 mm (5.0 in)
Displacement-L....................4.40 L (268.5 $in^3$)
Compression ratio....................16.2:1
Aspiration....................T
Fuel system....................Common Rail
Governor type....................Mechanical

### Emissions (Nominal)

NOx g/hp-hr....................5.40
CO g/hp-hr....................1.69
HC g/hp-hr....................32
PM g/hp-hr....................28

### Control Panel

Heavy duty sheet steel enclosure with lockable hinged door
Vibration isolated from generating set
LCD display
AC metering
DC metering
Fail to start shutdown
Low oil pressure shutdown
High engine temperature
Low / high battery voltage
Underspeed/overspeed
Loss of engine speed detection
2 spare fault channels
20 event fault log
2 LED status indicators
Lockdown emergency stop push button

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## TECHNICAL DATA

| Open Generator Set - - 1800 rpm/60 Hz/240 Volts | PM3468 | |
|---|---|---|
| **Tier 3** | | |
| **Generator Set Package Performance** | | |
| Genset Power rating @ 0.8 pf | 75 kVA | |
| Genset Power rating with fan | 60 ekW | |
| **Fuel Consumption** | | |
| 100% load with fan | 20.0 L/hr | 5.3 Gal/hr |
| **Cooling System** [1] | | |
| Air flow restriction (system) | 0.12 kPa | 0.48 in. water |
| Air flow (max @ rated speed for radiator arrangement) | $m^3$/min | |
| Engine Coolant capacity with radiator/exp. tank | 6.7 L | 1.8 gal |
| Engine coolant capacity | .7 L | 0.2 gal |
| Radiator coolant capacity | 6.0 L | 1.6 gal |
| **Inlet Air** | | |
| Combustion air inlet flow rate | 6.0 $m^3$/min | 211.9 cfm |
| **Exhaust System** | | |
| Exhaust stack gas temperature | 550.0 ° C | 1022.0 ° F |
| Exhaust gas flow rate | 15.1 $m^3$/min | 533.3 cfm |
| Exhaust flange size (internal diameter) | 6.4 mm | 0.3 in |
| **Heat Rejection** | | |
| Heat rejection to coolant (total) | 50 kW | 2843 Btu/min |
| Heat rejection to exhaust (total) | 68 kW | 3867 Btu/min |
| Heat rejection to atmosphere from generator | 6.9 kW | 392.4 Btu/min |
| **Alternator**[2] | | |
| Motor starting capability @ 30% voltage dip | 127 skVA | |
| Frame | LC2014H | |
| Temperature Rise | 150 ° C | 270 ° F |

[1] For ambient and altitude capabilities consult your Caterpillar dealer. Airflow restriction (system) is added to existing restriction from factory.
[2] Generator temperature rise is based on a 40 C (104 F) ambient per NEMA MG1-32.

## RATING DEFINITIONS AND CONDITIONS

**Meets or Exceeds International Specifications:** AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 72/23/EEC, 98/37/EC, 2004/108/EC

**Standby** - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. Standby power in accordance with ISO8528. Fuel stop power in accordance with ISO3046. Standby ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the shutdown temperature.

**Ratings** are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

**Fuel rates** are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Caterpillar representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Caterpillar dealer.

# STANDBY 60 ekW 75 kVA

**60 Hz 1800 rpm 240 Volts**

## DIMENSIONS

| Package Dimensions | | |
|---|---|---|
| **Length** | **2208.0 mm** | **86.93 in** |
| **Width** | **1000.0 mm** | **39.37 in** |
| **Height** | **1265.9 mm** | **49.84 in** |
| **Weight** | | |

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions. (General Dimension Drawing #3301889).

Performance No.: PM3468

Feature Code: NAC089P

Gen. Arr. Number: 2652661

Source: U.S. Sourced

LEHE0097 02/09

14171950

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# APPENDIX I
# COST ESTIMATE

ESTC
MECHANICAL

# CONSTRUCTION COST ESTIMATE

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**

**Preliminary Design Alternatives Report**

**Alternative No. 1 - No Action**

LOCATION: **Kahanahou Wastewater Pump Station**

ENGINEER: **OKAHARA AND ASSOCIATES, INC.**

ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY

JOB NUMBER: 210-002

CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |

| | |
|---|---|
| SUBTOTAL | **0.00** |
| MOB/DEMOB 15% | **0.00** |
| CONTINGENCY 35% | **0.00** |
| PROFIT 10% | **0.00** |
| TAX 4.72% | **0.00** |
| ESCALATION (5%/YR FOR 1 YEAR) | **0.00** |
| **ALT. No. 1 TOTAL** | **0.00** |

ESTC
MECHANICAL

# CONSTRUCTION COST ESTIMATE

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**

**Preliminary Design Alternatives Report**

**Alternative No. 2 - New 15HP C/S Submersible Pumps w/ VFD**

LOCATION: **Kahanahou Wastewater Pump Station**

ENGINEER: **OKAHARA AND ASSOCIATES, INC.**

ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY

JOB NUMBER: 210-002

CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***CIVIL / MECHANICAL*** | | | | | | | | |
| 1. DEMOLITION | 1 | LS | | | | | 7,600.00 | **7,600.00** |
| 2. DRY PIT SUBMERSIBLE PUMPS | 3 | EA | 15,625.50 | **46,876.50** | 13,086.00 | **39,258.00** | 28,711.50 | **86,134.50** |
| 3. VFD (15 HP) | 2 | EA | 2,250.33 | **4,500.66** | 1,307.00 | **2,614.00** | 3,557.33 | **7,114.66** |
| 4. DRY WELL SUMP PUMP | 1 | EA | 275.88 | **275.88** | 116.32 | **116.32** | 392.20 | **392.20** |
| 5. 6"x4" DI REDUCER | 4 | EA | 935.20 | **3,740.80** | 193.89 | **775.56** | 1,129.09 | **4,516.36** |
| 6. 4" DI PIPE | 10 | FT | 20.49 | **204.90** | 31.41 | **314.06** | 51.90 | **518.96** |
| 7. 6" DI PIPE | 120 | FT | 32.88 | **3,945.60** | 48.49 | **5,818.91** | 81.37 | **9,764.51** |
| 8. 8" DI PIPE | 120 | FT | 47.95 | **5,754.00** | 60.20 | **7,223.47** | 108.15 | **12,977.47** |
| 9. 6" DI ELBOW | 6 | EA | 473.45 | **2,840.70** | 193.89 | **1,163.35** | 667.34 | **4,004.05** |
| 10. 8" DI ELBOW | 2 | EA | 818.30 | **1,636.60** | 218.10 | **436.20** | 1,036.40 | **2,072.80** |
| 11. 8"x8"x6" DI WYE | 2 | EA | 1,432.03 | **2,864.06** | 348.96 | **697.92** | 1,780.99 | **3,561.98** |
| 12. 6" GATE VALVE | 6 | EA | 1,011.19 | **6,067.14** | 581.60 | **3,489.60** | 1,592.79 | **9,556.74** |
| 13. 8" GATE VALVE | 2 | EA | 1,811.95 | **3,623.90** | 697.92 | **1,395.84** | 2,509.87 | **5,019.74** |
| 14. 6" CHECK VALVE | 2 | EA | 894.29 | **1,788.58** | 581.60 | **1,163.20** | 1,475.89 | **2,951.78** |
| 15. 6" FLANGED COUPLING ADAPTER | 2 | EA | 157.82 | **315.64** | 72.70 | **145.40** | 230.52 | **461.04** |
| 16. 4" FLANGES | 1 | EA | 69.79 | **69.79** | 232.64 | **232.64** | 302.43 | **302.43** |
| 17. 6" FLANGES | 12 | EA | 137.59 | **1,651.08** | 348.96 | **4,187.52** | 486.55 | **5,838.60** |
| 18. 8" FLANGES | 13 | EA | 252.04 | **3,276.52** | 465.28 | **6,048.64** | 717.32 | **9,325.16** |
| 19. 4" GASKET & BOLT SET | 2 | EA | 10.52 | **21.04** | 72.70 | **145.40** | 83.22 | **166.44** |
| 20. 6" GASKET & BOLT SET | 12 | EA | 17.30 | **207.60** | 96.91 | **1,162.91** | 114.21 | **1,370.51** |
| 21. 8" GASKET & BOLT SET | 7 | EA | 19.82 | **138.74** | 116.32 | **814.24** | 136.14 | **952.98** |
| 22. PIPE SUPPORTS | 1 | LS | | | | | 30,000.00 | **30,000.00** |
| 23. PRESSURE (LEVEL) TRANSDUCERS | 1 | LS | | | | | 5,000.00 | **2,500.00** |
| 24. PRESSURE TRANSDUCERS | 1 | LS | | | | | 5,000.00 | **2,500.00** |
| 25. NEW PIPE PENETRATIONS | 2 | LS | | | | | 5,000.00 | **10,000.00** |
| 26. PATCH PIPE PENETRATIONS | 2 | LS | | | | | 2,500.00 | **5,000.00** |
| 27. TEMP SUMP PUMPS (PURCHASE) | 2 | EA | 40,000.00 | **80,000.00** | 40,000.00 | **80,000.00** | 80,000.00 | **160,000.00** |
| 28. TEMP HDPE PIPING | 150 | LF | 25.00 | **3,750.00** | 75.00 | **11,250.00** | 100.00 | **15,000.00** |

**ALT. NO. 2 SUBTOTAL - PAGE 1** **399,602.91**

ESTC
MECHANICAL

**CONSTRUCTION COST ESTIMATE**

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**
**Preliminary Design Alternatives Report**
**Alternative No. 2 - New 15HP C/S Submersible Pumps w/ VFD**
LOCATION: **Kahanahou Wastewater Pump Station**
ENGINEER: **OKAHARA AND ASSOCIATES, INC.**
ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY
JOB NUMBER: 210-002
CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***CIVIL / MECHANICAL CONTINUED*** | | | | | | | | |
| 1. CONCRETE / REBAR | 3 | CYD | 250.00 | **750.00** | 1,163.20 | **3,489.60** | 1,413.20 | **4,239.60** |
| 2. CONCRETE JACKET 8" SEWER | 50 | LF | | | | | 300.00 | **15,000.00** |
| 3. COMBINATION EYE WASH/SHOWER | 1 | EA | 719.00 | | 290.80 | | 1,009.80 | **1,009.80** |
| 4. 1" TYPE L COPPER | 60 | LF | 6.96 | **417.60** | 8.58 | **514.72** | 15.54 | **932.32** |
| 5. TESTING | 1 | LS | | | 11,632.00 | | 11,632.00 | **11,632.00** |
| 6. CLEANUP | 1 | LS | | | 11,632.00 | | 11,632.00 | **11,632.00** |
| ***METER VAULT*** | | | | | | | | |
| 1. 8" VENTURI METER | 1 | EA | 4,180.00 | **4,180.00** | 1,163.20 | **1,163.20** | 5,343.20 | **5,343.20** |
| 2. METER VAULT | 1 | EA | | | | | 40,000.00 | **40,000.00** |
| 3. EXCAVATION | 30 | CYD | | **0.00** | 145.40 | **4,362.00** | 145.40 | **4,362.00** |
| 4. CRUSHED ROCK BACKFILL | 5 | CYD | 100.00 | **500.00** | 72.70 | **363.50** | 172.70 | **863.50** |
| 5. BASE COURSE | 3 | CYD | 100.00 | **300.00** | 72.70 | **218.10** | 172.70 | **518.10** |
| 6. DUPLEX SUMP PUMP | 1 | EA | 1,200.00 | **1,200.00** | 581.60 | **581.60** | 1,781.60 | **1,781.60** |
| 7. 2" DWV COPPER (INCLUDE TRENCH) | 100 | LF | 14.67 | **1,467.00** | 100.00 | **10,000.00** | 114.67 | **11,467.00** |
| 8. DEWATERING | 10 | DAYS | 100.00 | **1,000.00** | 581.60 | **5,816.00** | 681.60 | **6,816.00** |
| ***GENSET BUILDING*** | | | | | | | | |
| 1. CMU BUILDING | 350 | SF | | | | | 350.00 | **122,500.00** |
| ***MODIFY EXISTING GENSET ROOM INTO SCADA ROOM*** | | | | | | | | |
| 1. GENSET ROOM | 100 | SF | | | | | 100.00 | **10,000.00** |
| ***REFURBISH EXISTING PUMP BUILDING EXTERIOR AND INTERIOR*** | | | | | | | | |
| 1. PUMP STATION | 900 | SF | | | | | 50.00 | **45,000.00** |
| 2. WETWELL LINER | 1000 | SF | | | | | 40.00 | **40,000.00** |

**ALT. NO. 2 SUBTOTAL - PAGE 2** **333,097.12**

ESTC
MECHANICAL

| CONSTRUCTION COST ESTIMATE | OKAHARA STANDARD FORM<br>DATE: JANUARY 2011<br>PAGE 3 OF 3 |
|---|---|
| PROJECT: **Kahanahou Wastewater Pump Station Upgrade**<br>**Preliminary Design Alternatives Report**<br>**Alternative No. 2 - New 15HP C/S Submersible Pumps w/ VFD**<br>LOCATION: **Kahanahou Wastewater Pump Station**<br>ENGINEER: **OKAHARA AND ASSOCIATES, INC.**<br>ESTIMATOR: TYSON T. TOYAMA | BASIS FOR ESTIMATE: PRELIMINARY<br>JOB NUMBER: 201-029<br>CHECKED BY: TYSON T. TOYAMA |

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***SUBTOTAL - PAGE 1*** | | | | | | | | **399,602.91** |
| ***SUBTOTAL - PAGE 2*** | | | | | | | | **333,097.12** |
| ***HAZARDOUS MATERIAL REMOVAL*** | | | | | | | | |
| 1. ASBESTOS/LEAD | 1 | LS | | | | | 20,000.00 | **20,000.00** |
| 2. AIR MONITORING | 1 | LS | | | | | 10,000.00 | **10,000.00** |
| ***MISCELLANEOUS*** | | | | | | | | |
| 1. NOISE MITIGATION MEASURES | 1 | LS | | | | | 10,000.00 | **10,000.00** |
| 2. CONSTRUCTION TRAILER | 24 | MONTH | | | | | 2,000.00 | **48,000.00** |
| ***MECHANICAL - A/C AND VENTILATION SYSTEM - See Attached*** | | | | | | | | **59,400.00** |
| ***FUEL SYSTEM - See Attached*** | | | | | | | | **88,200.00** |
| ***GENSET EXHAUST SYSTEM - See Attached*** | | | | | | | | **22,500.00** |
| ***ELECTRICAL - See Attached*** | | | | | | | | **636,970.00** |

| | |
|---|---|
| SUBTOTAL | **1,627,770.03** |
| MOB/DEMOB/PHASING 25% | **406,942.51** |
| CONTINGENCY 25% | **508,678.13** |
| OVERHEAD & PROFIT 10% | **254,339.07** |
| TAX 4.72% | **132,052.84** |
| ESCALATION (5%/YR FOR 1 YEAR) | **146,489.13** |
| **ALT. No. 2 TOTAL** | **3,076,271.71** |

ESTC
MECHANICAL

# C O N S T R U C T I O N   C O S T   E S T I M A T E

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**

**Preliminary Design Alternatives Report**

**Alternative No. 3 - New 15HP C/S Submersible Pumps w/ Soft Starters**

LOCATION: **Kahanahou Wastewater Pump Station**

ENGINEER: **OKAHARA AND ASSOCIATES, INC.**

ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY

JOB NUMBER: 210-002

CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***CIVIL / MECHANICAL*** | | | | | | | | |
| 1. DEMOLITION | 1 | LS | | | | | 7,600.00 | **7,600.00** |
| 2. DRY PIT SUBMERSIBLE PUMPS | 3 | EA | 15,625.50 | **46,876.50** | 13,086.00 | **39,258.00** | 28,711.50 | **86,134.50** |
| 3. SOFT STARTERS | 2 | EA | 806.61 | **1,613.22** | 581.60 | **1,163.20** | 1,388.21 | **2,776.42** |
| 4. DRY WELL SUMP PUMP | 1 | EA | 275.88 | **275.88** | 116.32 | **116.32** | 392.20 | **392.20** |
| 5. 6"x4" DI REDUCER | 4 | EA | 935.20 | **3,740.80** | 193.89 | **775.56** | 1,129.09 | **4,516.36** |
| 6. 4" DI PIPE | 10 | FT | 20.49 | **204.90** | 31.41 | **314.06** | 51.90 | **518.96** |
| 7. 6" DI PIPE | 120 | FT | 32.88 | **3,945.60** | 48.49 | **5,818.91** | 81.37 | **9,764.51** |
| 8. 8" DI PIPE | 120 | FT | 47.95 | **5,754.00** | 60.20 | **7,223.47** | 108.15 | **12,977.47** |
| 9. 6" DI ELBOW | 6 | EA | 473.45 | **2,840.70** | 193.89 | **1,163.35** | 667.34 | **4,004.05** |
| 10. 8" DI ELBOW | 2 | EA | 818.30 | **1,636.60** | 218.10 | **436.20** | 1,036.40 | **2,072.80** |
| 11. 8"x8"x6" DI WYE | 2 | EA | 1,432.03 | **2,864.06** | 348.96 | **697.92** | 1,780.99 | **3,561.98** |
| 12. 6" GATE VALVE | 6 | EA | 1,011.19 | **6,067.14** | 581.60 | **3,489.60** | 1,592.79 | **9,556.74** |
| 13. 8" GATE VALVE | 2 | EA | 1,811.95 | **3,623.90** | 697.92 | **1,395.84** | 2,509.87 | **5,019.74** |
| 14. 6" CHECK VALVE | 2 | EA | 894.29 | **1,788.58** | 581.60 | **1,163.20** | 1,475.89 | **2,951.78** |
| 15. 6" FLANGED COUPLING ADAPTER | 2 | EA | 157.82 | **315.64** | 72.70 | **145.40** | 230.52 | **461.04** |
| 16. 4" FLANGES | 1 | EA | 69.79 | **69.79** | 232.64 | **232.64** | 302.43 | **302.43** |
| 17. 6" FLANGES | 12 | EA | 137.59 | **1,651.08** | 348.96 | **4,187.52** | 486.55 | **5,838.60** |
| 18. 8" FLANGES | 13 | EA | 252.04 | **3,276.52** | 465.28 | **6,048.64** | 717.32 | **9,325.16** |
| 19. 4" GASKET & BOLT SET | 2 | EA | 10.52 | **21.04** | 72.70 | **145.40** | 83.22 | **166.44** |
| 20. 6" GASKET & BOLT SET | 12 | EA | 17.30 | **207.60** | 96.91 | **1,162.91** | 114.21 | **1,370.51** |
| 21. 8" GASKET & BOLT SET | 7 | EA | 19.82 | **138.74** | 116.32 | **814.24** | 136.14 | **952.98** |
| 22. PIPE SUPPORTS | 1 | LS | | | | | 30,000.00 | **30,000.00** |
| 23. PRESSURE (LEVEL) TRANSDUCERS | 1 | LS | | | | | 5,000.00 | **2,500.00** |
| 24. PRESSURE TRANSDUCERS | 1 | LS | | | | | 5,000.00 | **2,500.00** |
| 25. NEW PIPE PENETRATIONS | 2 | LS | | | | | 5,000.00 | **10,000.00** |
| 26. PATCH PIPE PENETRATIONS | 2 | LS | | | | | 2,500.00 | **5,000.00** |
| 27. TEMP SUMP PUMPS (PURCHASE) | 2 | EA | 40,000.00 | **80,000.00** | 40,000.00 | **80,000.00** | 80,000.00 | **160,000.00** |
| 28. TEMP HDPE PIPING | 150 | LF | 25.00 | **3,750.00** | 75.00 | **11,250.00** | 100.00 | **15,000.00** |
| | | | | | **ALT. NO. 3 SUBTOTAL - PAGE 1** | | | **395,264.67** |

ESTC
MECHANICAL

# CONSTRUCTION COST ESTIMATE

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**

**Preliminary Design Alternatives Report**

**Alternative No. 3 - New 15HP C/S Submersible Pumps w/ Soft Starters**

LOCATION: **Kahanahou Wastewater Pump Station**

ENGINEER: **OKAHARA AND ASSOCIATES, INC.**

ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY

JOB NUMBER: 210-002

CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***CIVIL / MECHANICAL CONTINUED*** | | | | | | | | |
| 1. CONCRETE / REBAR | 3 | CYD | 250.00 | **750.00** | 1,163.20 | **3,489.60** | 1,413.20 | **4,239.60** |
| 2. CONCRETE JACKET 8" SEWER | 50 | LF | | | | | 300.00 | **15,000.00** |
| 3. COMBINATION EYE WASH/SHOWER | 1 | EA | 719.00 | | 290.80 | | 1,009.80 | **1,009.80** |
| 4. 1" TYPE L COPPER | 60 | LF | 6.96 | **417.60** | 8.58 | **514.72** | 15.54 | **932.32** |
| 5. TESTING | 1 | LS | | | 11,632.00 | | 11,632.00 | **11,632.00** |
| 6. CLEANUP | 1 | LS | | | 11,632.00 | | 11,632.00 | **11,632.00** |
| ***METER VAULT*** | | | | | | | | |
| 1. 8" VENTURI METER | 1 | EA | 4,180.00 | **4,180.00** | 1,163.20 | **1,163.20** | 5,343.20 | **5,343.20** |
| 2. METER VAULT | 1 | EA | | | | | 40,000.00 | **40,000.00** |
| 3. EXCAVATION | 30 | CYD | | **0.00** | 145.40 | **4,362.00** | 145.40 | **4,362.00** |
| 4. CRUSHED ROCK BACKFILL | 5 | CYD | 100.00 | **500.00** | 72.70 | **363.50** | 172.70 | **863.50** |
| 5. BASE COURSE | 3 | CYD | 100.00 | **300.00** | 72.70 | **218.10** | 172.70 | **518.10** |
| 6. DUPLEX SUMP PUMP | 1 | EA | 1,200.00 | **1,200.00** | 581.60 | **581.60** | 1,781.60 | **1,781.60** |
| 7. 2" DWV COPPER (INCLUDE TRENCH) | 100 | LF | 14.67 | **1,467.00** | 100.00 | **10,000.00** | 114.67 | **11,467.00** |
| 8. DEWATERING | 10 | DAYS | 100.00 | **1,000.00** | 581.60 | **5,816.00** | 681.60 | **6,816.00** |
| ***GENSET BUILDING*** | | | | | | | | |
| 1. CMU BUILDING | 350 | SF | | | | | 350.00 | **122,500.00** |
| ***MODIFY EXISTING GENSET ROOM INTO SCADA ROOM*** | | | | | | | | |
| 1. GENSET ROOM | 100 | SF | | | | | 100.00 | **10,000.00** |
| ***REFURBISH EXISTING PUMP BUILDING EXTERIOR AND INTERIOR*** | | | | | | | | |
| 1. PUMP STATION | 900 | SF | | | | | 50.00 | **45,000.00** |
| 2. WETWELL LINER | 1000 | SF | | | | | 40.00 | **40,000.00** |

**ALT. NO. 3 SUBTOTAL - PAGE 2** **333,097.12**

ESTC
MECHANICAL

| CONSTRUCTION COST ESTIMATE | OKAHARA STANDARD FORM<br>DATE: JANUARY 2011<br>PAGE 3 OF 3 |
|---|---|
| PROJECT: **Kahanahou Wastewater Pump Station Upgrade**<br>**Preliminary Design Alternatives Report**<br>**Alternative No. 3 - New 15HP C/S Submersible Pumps w/ Soft Starters**<br>LOCATION: **Kahanahou Wastewater Pump Station**<br>ENGINEER: **OKAHARA AND ASSOCIATES, INC.**<br>ESTIMATOR: TYSON T. TOYAMA | BASIS FOR ESTIMATE: PRELIMINARY<br>JOB NUMBER: 201-029<br>CHECKED BY: TYSON T. TOYAMA |

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***SUBTOTAL - PAGE 1*** | | | | | | | | **395,264.67** |
| ***SUBTOTAL - PAGE 2*** | | | | | | | | **333,097.12** |
| ***HAZARDOUS MATERIAL REMOVAL*** | | | | | | | | |
| 1. ASBESTOS/LEAD | 1 | LS | | | | | 20,000.00 | **20,000.00** |
| 2. AIR MONITORING | 1 | LS | | | | | 10,000.00 | **10,000.00** |
| ***MISCELLANEOUS*** | | | | | | | | |
| 1. NOISE MITIGATION MEASURES | 1 | LS | | | | | 10,000.00 | **10,000.00** |
| 2. CONSTRUCTION TRAILER | 24 | MONTH | | | | | 2,000.00 | **48,000.00** |
| ***MECHANICAL - A/C AND VENTILATION SYSTEM - See Attached*** | | | | | | | | **59,400.00** |
| ***FUEL SYSTEM - See Attached*** | | | | | | | | **88,200.00** |
| ***GENSET EXHAUST SYSTEM - See Attached*** | | | | | | | | **22,500.00** |
| ***ELECTRICAL - See Attached*** | | | | | | | | **610,792.00** |

| | |
|---|---|
| SUBTOTAL | **1,597,253.79** |
| MOB/DEMOB/PHASING 25% | **399,313.45** |
| CONTINGENCY 25% | **499,141.81** |
| OVERHEAD & PROFIT 10% | **249,570.90** |
| TAX 4.72% | **129,577.21** |
| ESCALATION (5%/YR FOR 1 YEAR) | **143,742.86** |
| **ALT. No. 3 TOTAL** | **3,018,600.02** |

ESTC
MECHANICAL

**C O N S T R U C T I O N   C O S T   E S T I M A T E**

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**
**Preliminary Design Alternatives Report**
**Alternative No. 4 - New 10HP C/S Submersible Pumps w/ Soft Starters**
LOCATION: **Kahanahou Wastewater Pump Station**
ENGINEER: **OKAHARA AND ASSOCIATES, INC.**
ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY
JOB NUMBER: 210-002
CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***CIVIL / MECHANICAL*** | | | | | | | | |
| 1. DEMOLITION | 1 | LS | | | | | 7,600.00 | **7,600.00** |
| 2. DRY PIT SUBMERSIBLE PUMPS | 3 | EA | 14,205.00 | **42,615.00** | 13,086.00 | **39,258.00** | 27,291.00 | **81,873.00** |
| 3. SOFT STARTERS | 2 | EA | 432.53 | **865.06** | 387.71 | **775.42** | 820.24 | **1,640.48** |
| 4. DRY WELL SUMP PUMP | 1 | EA | 275.88 | **275.88** | 116.32 | **116.32** | 392.20 | **392.20** |
| 5. 6"x4" DI REDUCER | 4 | EA | 935.20 | **3,740.80** | 193.89 | **775.56** | 1,129.09 | **4,516.36** |
| 6. 4" DI PIPE | 10 | FT | 20.49 | **204.90** | 31.41 | **314.06** | 51.90 | **518.96** |
| 7. 6" DI PIPE | 120 | FT | 32.88 | **3,945.60** | 48.49 | **5,818.91** | 81.37 | **9,764.51** |
| 8. 8" DI PIPE | 120 | FT | 47.95 | **5,754.00** | 60.20 | **7,223.47** | 108.15 | **12,977.47** |
| 9. 6" DI ELBOW | 6 | EA | 473.45 | **2,840.70** | 193.89 | **1,163.35** | 667.34 | **4,004.05** |
| 10. 8" DI ELBOW | 2 | EA | 818.30 | **1,636.60** | 218.10 | **436.20** | 1,036.40 | **2,072.80** |
| 11. 8"x8"x6" DI WYE | 2 | EA | 1,432.03 | **2,864.06** | 348.96 | **697.92** | 1,780.99 | **3,561.98** |
| 12. 6" GATE VALVE | 6 | EA | 1,011.19 | **6,067.14** | 581.60 | **3,489.60** | 1,592.79 | **9,556.74** |
| 13. 8" GATE VALVE | 2 | EA | 1,811.95 | **3,623.90** | 697.92 | **1,395.84** | 2,509.87 | **5,019.74** |
| 14. 6" CHECK VALVE | 2 | EA | 894.29 | **1,788.58** | 581.60 | **1,163.20** | 1,475.89 | **2,951.78** |
| 15. 6" FLANGED COUPLING ADAPTER | 2 | EA | 157.82 | **315.64** | 72.70 | **145.40** | 230.52 | **461.04** |
| 16. 4" FLANGES | 1 | EA | 69.79 | **69.79** | 232.64 | **232.64** | 302.43 | **302.43** |
| 17. 6" FLANGES | 12 | EA | 137.59 | **1,651.08** | 348.96 | **4,187.52** | 486.55 | **5,838.60** |
| 18. 8" FLANGES | 13 | EA | 252.04 | **3,276.52** | 465.28 | **6,048.64** | 717.32 | **9,325.16** |
| 19. 4" GASKET & BOLT SET | 2 | EA | 10.52 | **21.04** | 72.70 | **145.40** | 83.22 | **166.44** |
| 20. 6" GASKET & BOLT SET | 12 | EA | 17.30 | **207.60** | 96.91 | **1,162.91** | 114.21 | **1,370.51** |
| 21. 8" GASKET & BOLT SET | 7 | EA | 19.82 | **138.74** | 116.32 | **814.24** | 136.14 | **952.98** |
| 22. PIPE SUPPORTS | 1 | LS | | | | | 30,000.00 | **30,000.00** |
| 23. PRESSURE (LEVEL) TRANSDUCERS | 1 | LS | | | | | 5,000.00 | **2,500.00** |
| 24. PRESSURE TRANSDUCERS | 1 | LS | | | | | 5,000.00 | **2,500.00** |
| 25. NEW PIPE PENETRATIONS | 2 | LS | | | | | 5,000.00 | **10,000.00** |
| 26. PATCH PIPE PENETRATIONS | 2 | LS | | | | | 2,500.00 | **5,000.00** |
| 27. TEMP SUMP PUMPS (PURCHASE) | 2 | EA | 40,000.00 | **80,000.00** | 40,000.00 | **80,000.00** | 80,000.00 | **160,000.00** |
| 28. TEMP HDPE PIPING | 150 | LF | 25.00 | **3,750.00** | 75.00 | **11,250.00** | 100.00 | **15,000.00** |

**ALT. NO. 4 SUBTOTAL - PAGE 1** **389,867.23**

ESTC
MECHANICAL

| **CONSTRUCTION COST ESTIMATE** | OKAHARA STANDARD FORM<br>DATE: JANUARY 2011<br>PAGE 2 OF 3 |
|---|---|
| PROJECT: **Kahanahou Wastewater Pump Station Upgrade**<br>**Preliminary Design Alternatives Report**<br>**Alternative No. 4 - New 10HP C/S Submersible Pumps w/ Soft Starters**<br>LOCATION: **Kahanahou Wastewater Pump Station**<br>ENGINEER: **OKAHARA AND ASSOCIATES, INC.**<br>ESTIMATOR: TYSON T. TOYAMA | BASIS FOR ESTIMATE: PRELIMINARY<br>JOB NUMBER: 210-002<br>CHECKED BY: TYSON T. TOYAMA |

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***CIVIL / MECHANICAL CONTINUED*** | | | | | | | | |
| 1. CONCRETE / REBAR | 3 | CYD | 250.00 | **750.00** | 1,163.20 | **3,489.60** | 1,413.20 | **4,239.60** |
| 2. CONCRETE JACKET 8" SEWER | 50 | LF | | | | | 300.00 | **15,000.00** |
| 3. COMBINATION EYE WASH/SHOWER | 1 | EA | 719.00 | | 290.80 | | 1,009.80 | **1,009.80** |
| 4. 1" TYPE L COPPER | 60 | LF | 6.96 | **417.60** | 8.58 | **514.72** | 15.54 | **932.32** |
| 5. TESTING | 1 | LS | | | 11,632.00 | | 11,632.00 | **11,632.00** |
| 6. CLEANUP | 1 | LS | | | 11,632.00 | | 11,632.00 | **11,632.00** |
| ***METER VAULT*** | | | | | | | | |
| 1. 8" VENTURI METER | 1 | EA | 4,180.00 | **4,180.00** | 1,163.20 | **1,163.20** | 5,343.20 | **5,343.20** |
| 2. METER VAULT | 1 | EA | | | | | 40,000.00 | **40,000.00** |
| 3. EXCAVATION | 30 | CYD | | **0.00** | 145.40 | **4,362.00** | 145.40 | **4,362.00** |
| 4. CRUSHED ROCK BACKFILL | 5 | CYD | 100.00 | **500.00** | 72.70 | **363.50** | 172.70 | **863.50** |
| 5. BASE COURSE | 3 | CYD | 100.00 | **300.00** | 72.70 | **218.10** | 172.70 | **518.10** |
| 6. DUPLEX SUMP PUMP | 1 | EA | 1,200.00 | **1,200.00** | 581.60 | **581.60** | 1,781.60 | **1,781.60** |
| 7. 2" DWV COPPER (INCLUDE TRENCH) | 100 | LF | 14.67 | **1,467.00** | 100.00 | **10,000.00** | 114.67 | **11,467.00** |
| 8. DEWATERING | 10 | DAYS | 100.00 | **1,000.00** | 581.60 | **5,816.00** | 681.60 | **6,816.00** |
| ***GENSET BUILDING*** | | | | | | | | |
| 1. CMU BUILDING | 350 | SF | | | | | 350.00 | **122,500.00** |
| ***MODIFY EXISTING GENSET ROOM INTO SCADA ROOM*** | | | | | | | | |
| 1. GENSET ROOM | 100 | SF | | | | | 100.00 | **10,000.00** |
| ***REFURBISH EXISTING PUMP BUILDING EXTERIOR AND INTERIOR*** | | | | | | | | |
| 1. PUMP STATION | 900 | SF | | | | | 50.00 | **45,000.00** |
| 2. WETWELL LINER | 1000 | SF | | | | | 40.00 | **40,000.00** |

**ALT. NO. 4 SUBTOTAL - PAGE 2** **333,097.12**

ESTC
MECHANICAL

## C O N S T R U C T I O N   C O S T   E S T I M A T E

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**
**Preliminary Design Alternatives Report**
**Alternative No. 4 - New 10HP C/S Submersible Pumps w/ Soft Starters**
LOCATION: **Kahanahou Wastewater Pump Station**
ENGINEER: **OKAHARA AND ASSOCIATES, INC.**
ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY
JOB NUMBER: 201-029
CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***SUBTOTAL - PAGE 1*** | | | | | | | | **389,867.23** |
| ***SUBTOTAL - PAGE 2*** | | | | | | | | **333,097.12** |
| ***HAZARDOUS MATERIAL REMOVAL*** | | | | | | | | |
| 1. ASBESTOS/LEAD | 1 | LS | | | | | 20,000.00 | **20,000.00** |
| 2. AIR MONITORING | 1 | LS | | | | | 10,000.00 | **10,000.00** |
| ***MISCELLANEOUS*** | | | | | | | | |
| 1. NOISE MITIGATION MEASURES | 1 | LS | | | | | 10,000.00 | **10,000.00** |
| 2. CONSTRUCTION TRAILER | 24 | MONTH | | | | | 2,000.00 | **48,000.00** |
| ***MECHANICAL - A/C AND VENTILATION SYSTEM - See Attached*** | | | | | | | | **59,400.00** |
| ***FUEL SYSTEM - See Attached*** | | | | | | | | **88,200.00** |
| ***GENSET EXHAUST SYSTEM - See Attached*** | | | | | | | | **22,500.00** |
| ***ELECTRICAL - See Attached*** | | | | | | | | **584,614.00** |

| | |
|---|---|
| SUBTOTAL | **1,565,678.35** |
| MOB/DEMOB/PHASING 25% | **391,419.59** |
| CONTINGENCY 25% | **489,274.48** |
| OVERHEAD & PROFIT 10% | **244,637.24** |
| TAX 4.72% | **127,015.66** |
| ESCALATION (5%/YR FOR 1 YEAR) | **140,901.27** |
| **ALT. No. 3 TOTAL** | **2,958,926.58** |

ESTC
MECHANICAL

# C O N S T R U C T I O N   C O S T   E S T I M A T E

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**
**Preliminary Design Alternatives Report**
**Standby Engine Generator Fuel System**
LOCATION: **Kahanahou Wastewater Pump Station**
ENGINEER: **OKAHARA AND ASSOCIATES, INC.**
ESTIMATOR: TYSON T. TOYAMA

BASIS FOR ESTIMATE: PRELIMINARY
JOB NUMBER: 210-002
CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***MECHANICAL*** | | | | | | | | |
| 1. DEMOLITION | 1 | LS | | | | | 5,100.00 | **5,100.00** |
| 2. 1000 GALLON UST | 1 | EA | 10,603.00 | **10,603.00** | 714.07 | **714.07** | 11,317.07 | **11,317.07** |
| 3. EXCAVATION | 8 | CYD | | **0.00** | 145.40 | **1,163.20** | 145.40 | **1,163.20** |
| 4. BACKFILL (PEA GRAVEL) | 8 | CYD | 150.00 | **1,200.00** | 72.70 | **581.60** | 222.70 | **1,781.60** |
| 5. CONCRETE / REBARS | 4 | CYD | 250.00 | **1,000.00** | 581.60 | **2,326.40** | 831.60 | **3,326.40** |
| 6. 1" STAINLESS STEEL PIPE | 60 | LF | 23.09 | **1,385.40** | 30.53 | **1,832.04** | 53.62 | **3,217.44** |
| 7. 2" FRP CONTAINMENT PIPE | 80 | LF | 11.22 | **897.60** | 21.52 | **1,721.54** | 32.74 | **2,619.14** |
| 8. 3" FRP CONTAINMENT PIPE | 40 | LF | 13.27 | **530.80** | 22.39 | **895.66** | 35.66 | **1,426.46** |
| 9. 1" SST SHUTOFF VALVE | 10 | EA | 631.26 | **6,312.60** | 41.51 | **415.12** | 672.77 | **6,727.72** |
| 10. 50 GALLON DAY TANK | 1 | EA | 7,500.00 | **7,500.00** | 3,750.00 | **3,750.00** | 11,250.00 | **11,250.00** |
| 11. TANK MONITOR CONTROL PANEL | 1 | EA | 6,000.00 | **6,000.00** | 3,000.00 | **3,000.00** | 9,000.00 | **9,000.00** |
| 12. INVENTORY PROBE | 1 | EA | 1,750.00 | **1,750.00** | 875.00 | **875.00** | 2,625.00 | **2,625.00** |
| 13. LIQUID LEAK SENSOR | 2 | EA | 500.00 | **1,000.00** | 250.00 | **500.00** | 750.00 | **1,500.00** |
| 14. OIL/FUEL FILTER | 1 | EA | 500.00 | **500.00** | 290.80 | **290.80** | 790.80 | **790.80** |
| 15. FUEL HANDLING & POLISHING | 1 | EA | 4,000.00 | **4,000.00** | 2,000.00 | **2,000.00** | 6,000.00 | **6,000.00** |
| 16. CONDUIT AND WIRING | 1 | LS | | | | | 1,500.00 | **1,500.00** |
| 17. TESTING AND STARTUP | 1 | EA | | | 2,908.00 | **2,908.00** | 2,908.00 | **2,908.00** |
| 18. CLEAN UP | 1 | EA | | | 2,908.00 | **2,908.00** | 2,908.00 | **2,908.00** |
| 19. TEMPORARY FUEL SYSTEM | 1 | LS | 6,000.00 | **6,000.00** | 2,000.00 | **2,000.00** | 8,000.00 | **8,000.00** |
| 20. TEMPORARY CONTROLS | 1 | LS | | | 5,000.00 | **5,000.00** | 5,000.00 | **5,000.00** |
| | | | | **GENERATOR FUEL SYSTEM SUBTOTAL** | | | | **88,160.82** |

ESTC
MECHANICAL

# CONSTRUCTION COST ESTIMATE

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**

**Standby Engine Generator Exhaust System**

BASIS FOR ESTIMATE: PRELIMINARY

LOCATION: **Kahanahou Wastewater Pump Station**

ENGINEER: **OKAHARA AND ASSOCIATES, INC.**

JOB NUMBER: 210-002

ESTIMATOR: TYSON T. TOYAMA

CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***STANDBY ENGINE GENERATOR EXHAUST SYSTEM*** | | | | | | | | |
| 1. DEMOLITION | 1 | LS | | | | | 2,000.00 | **2,000.00** |
| 2. FLEXIBLE CONNECTION | 1 | EA | 1,000.00 | **1,000.00** | 290.80 | **290.80** | 1,290.80 | **1,290.80** |
| 3. WALL THIMBLE | 1 | EA | 2,500.00 | **2,500.00** | 581.60 | **581.60** | 3,081.60 | **3,081.60** |
| 4. SILENCER | 3 | EA | 2,500.00 | **7,500.00** | 581.60 | **1,744.80** | 3,081.60 | **9,244.80** |
| 5. 5" SST EXHAUST PIPE | 30 | LF | 106.76 | **3,202.80** | 36.35 | **1,090.50** | 143.11 | **4,293.30** |
| 6. 5" INSULATION AND JACKETING | 30 | LF | 25.72 | **771.60** | 21.30 | **639.03** | 47.02 | **1,410.63** |
| 7. CLEAN UP | 1 | EA | | | 1,163.20 | **1,163.20** | 1,163.20 | **1,163.20** |

**ENGINE GENERATOR EXHAUST SYSTEM SUBTOTAL** **22,484.33**

ESTC
MECHANICAL

# CONSTRUCTION COST ESTIMATE

OKAHARA STANDARD FORM
DATE: JANUARY 2011


PROJECT: **Kahanahou Wastewater Pump Station Upgrade**
**Air Conditioning and Ventilation System**

BASIS FOR ESTIMATE: PRELIMINARY

LOCATION: **Kahanahou Wastewater Pump Station**
ENGINEER: **OKAHARA AND ASSOCIATES, INC.**

JOB NUMBER: 210-002

ESTIMATOR: TYSON T. TOYAMA
CHECKED BY: TYSON T. TOYAMA

| DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEER ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | no. of units | unit | unit cost | cost | unit cost | cost | unit cost | total cost |
| HOURLY RATE: $72.70/HR | | | | | | | | |
| ***MECHANICAL - A/C AND VENTILATION*** | | | | | | | | |
| 1. DEMOLITION | 1 | LS | | | | | 1,250.00 | **1,250.00** |
| 2. DUCTLESS SPLIT SYSTEM | 2 | EA | 2,279.55 | **4,559.10** | 796.21 | **1,592.42** | 3,075.76 | **6,151.52** |
| 3. SUPPLY FAN W/ FILTERS | 1 | EA | 1,432.03 | **1,432.03** | 727.00 | **727.00** | 2,159.03 | **2,159.03** |
| 4. EXHAUST FAN | 1 | EA | 1,432.03 | **1,432.03** | 727.00 | **727.00** | 2,159.03 | **2,159.03** |
| 5. DUCT SILENCERS (GEN. INLET) | 4 | EA | 2,308.78 | **9,235.12** | 290.80 | **1,163.20** | 2,599.58 | **10,398.32** |
| 6. DUCT SILENCERS (GEN. OUTLET) | 4 | EA | 2,308.78 | **9,235.12** | 290.80 | **1,163.20** | 2,599.58 | **10,398.32** |
| 7. DUCTWORK (SST) | 500 | LBS | 4.70 | **2,350.00** | 13.38 | **6,688.40** | 18.08 | **9,038.40** |
| 8. DUCT LINER (2-INCH, 3 PCF) | 250 | SF | 1.38 | **345.00** | 9.67 | **2,417.28** | 11.05 | **2,762.28** |
| 9. DUCT INSULATION (2-IN, 3 PCF) | 50 | SF | 0.33 | **16.50** | 3.85 | **192.66** | 4.18 | **209.16** |
| 10. DAMPERS (16x12) | 2 | EA | 38.00 | **76.00** | 34.24 | **68.48** | 72.24 | **144.48** |
| 11. SUPPLY AIR REGISTERS (6x18) | 3 | EA | 96.44 | **289.32** | 32.28 | **96.84** | 128.72 | **386.16** |
| 12. EXHAUST REGISTERS (16x16) | 2 | EA | 59.03 | **118.06** | 34.24 | **68.48** | 93.27 | **186.54** |
| 13. FAN SUPPORTS | 2 | EA | | | | | 250.00 | **500.00** |
| 14. THERMOSTAT | 2 | EA | 175.47 | **350.94** | 72.70 | **145.40** | 248.17 | **496.34** |
| 15. 1-1/8" DWV COPPER | 40 | LF | 8.05 | **322.00** | 10.83 | **433.29** | 18.88 | **755.29** |
| 16. 3/8" INSULATION AND JACKET. | 80 | LF | 2.38 | **190.40** | 9.81 | **785.16** | 12.19 | **975.56** |
| 17. 1-1/8" INSULATION | 40 | LF | 2.95 | **118.00** | 5.96 | **238.46** | 8.91 | **356.46** |
| 18. 3-3/8" INSULATION JACKET | 40 | LF | 1.66 | **66.40** | 7.42 | **296.62** | 9.08 | **363.02** |
| 19. CURRENT SWITCH | 4 | EA | | | | | 500.00 | **2,000.00** |
| 20. TEMPERATURE SENSOR | 1 | EA | | | | | 500.00 | **500.00** |
| 21. AIR BALANCING | 1 | LS | | | | | 1,715.00 | **1,715.00** |
| 22. TESTING AND STARTUP | 1 | LS | | | 1,163.20 | **1,163.20** | 1,163.20 | **1,163.20** |
| 23. CLEANUP | 1 | LS | | | 1,163.20 | **1,163.20** | 1,163.20 | **1,163.20** |
| 24. MAINTENANCE | 1 | YR | | | 4,071.20 | **4,071.20** | 4,071.20 | **4,071.20** |

**A/C AND VENTILATION SYSTEM SUBTOTAL** **59,302.50**

# COST ESTIMATE



| | |
|---|---|
| PROJECT: KAHANAHOU WASTEWATER PUMP STATION<br>PRELIMINARY DESIGN ALTERNATIVES REPORT | DATE: JANUARY 5, 2011 |
| | DESIGN STATUS: |
| LOCATION: KANEOHE, OAHU, HAWAII | RONALD N.S. HO & ASSOC. (BO) |

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| Alternative No. 2 | | | | | | | 636,970 |
| Alternative No. 3 | | | | | | | 610,792 |
| Alternative No. 4 | | | | | | | 584,614 |
| Alternative Option - Replace light fixtures | | | | | | | 10,857 |
| Alternative Option - Upgrade elec service | | | | | | | 174,283 |
| Alternative Option - Generator receptacle | | | | | | | 3,242 |
| Alternative Option - Smoke detectors | | | | | | | 12,663 |

# COST ESTIMATE



PROJECT: KAHANAHOU WASTEWATER PUMP STATION
PRELIMINARY DESIGN ALTERNATIVES REPORT
LOCATION: KANEOHE, OAHU, HAWAII

DATE: JANUARY 5, 2011
DESIGN STATUS:
RONALD N.S. HO & ASSOC. (BO)

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE NO. 2 | | | | | | | |
| Demolition Work | | | | | | | |
| Remove MCC | 1 | EA | 0 | 0 | 1,000 | 1,000 | 1,000 |
| Remove emergency generator | 1 | EA | 0 | 0 | 1,500 | 1,500 | 1,500 |
| Remove SCADA cabinet | 1 | EA | 0 | 0 | 500 | 500 | 500 |
| Disconnect station pump | 2 | EA | 0 | 0 | 60 | 120 | 120 |
| Disconnect exhaust fan | 1 | EA | 0 | 0 | 45 | 45 | 45 |
| Disconnect sump pump | 1 | EA | 0 | 0 | 45 | 45 | 45 |
| Remove meter socket | 1 | EA | 0 | 0 | 150 | 150 | 150 |
| Remove battery charger | 1 | EA | 0 | 0 | 60 | 60 | 60 |
| Remove electric service conductors | 1 | LS | 0 | 0 | 2,000 | 2,000 | 2,000 |
| Remove emergenct generator feeder | 1 | LS | 0 | 0 | 500 | 500 | 500 |
| Miscellaneous | 1 | LS | 500 | 500 | 3,000 | 3,000 | 3,500 |
| Subtotal Demolition Work | | | | 500 | | 8,920 | 9,420 |
| Temporary Electrical Work | | | | | | | |
| Temporary MCC | 1 | EA | 75,000 | 75,000 | 3,000 | 3,000 | 78,000 |
| Temporary emergency generator | 1 | EA | 80,000 | 80,000 | 0 | 0 | 80,000 |
| Temporary electrical feeders | 500 | LF | 5 | 2,500 | 30 | 15,000 | 17,500 |
| Miscellaneous | 1 | LS | 2,500 | 2,500 | 2,500 | 2,500 | 5,000 |
| Subtotal Temporary Electrical Work | | | | 160,000 | | 20,500 | 180,500 |

# COST ESTIMATE



| | |
|---|---|
| PROJECT: KAHANAHOU WASTEWATER PUMP STATION PRELIMINARY DESIGN ALTERNATIVES REPORT | DATE: JANUARY 5, 2011 |
| | DESIGN STATUS: |
| LOCATION: KANEOHE, OAHU, HAWAII | RONALD N.S. HO & ASSOC. (BO) |

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| <u>ALTERNATIVE NO. 2</u> | | | | | | | |
| <u>New Electrical Work</u> | | | | | | | |
| MCC, 225A | 1 | EA | 100,000 | 100,000 | 3,000 | 3,000 | 103,000 |
| Emergency generator, 100kW | 1 | EA | 60,000 | 60,000 | 4,000 | 4,000 | 64,000 |
| SCADA cabinet | 1 | EA | 20,000 | 20,000 | 40,000 | 40,000 | 60,000 |
| Automatic transfer switch | 1 | EA | 25,000 | 25,000 | 2,500 | 2,500 | 27,500 |
| Meter socket, NEMA 3R SS | 1 | EA | 4,000 | 4,000 | 360 | 360 | 4,360 |
| Panelboard | 1 | EA | 1,000 | 1,000 | 480 | 480 | 1,480 |
| Electrical equipment connection | 5 | EA | 20 | 100 | 60 | 300 | 400 |
| Disconnect switch, 3P30A | 2 | EA | 240 | 480 | 90 | 180 | 660 |
| Duplex receptacle, 20A | 5 | EA | 15 | 75 | 50 | 250 | 325 |
| Smoke detector | 1 | EA | 150 | 150 | 75 | 75 | 225 |
| Door security device | 1 | EA | 250 | 250 | 75 | 75 | 325 |
| Junction box, 18"sq, NEMA 4X SS | 2 | EA | 1,500 | 3,000 | 225 | 450 | 3,450 |
| Underground electric service wiring | 150 | LF | 20 | 3,000 | 50 | 7,500 | 10,500 |
| Branch circuit wiring | 700 | LF | 5 | 3,500 | 10 | 7,000 | 10,500 |
| Miscellaneous | 1 | LS | 5,000 | 5,000 | 5,000 | 5,000 | 10,000 |
| Subtotal New Electrical Work | | | | 225,555 | | 71,170 | 296,725 |
| Subtotal | | | | | | | 486,645 |
| Overhead & Profit | 25% | | | | | | 121,661 |
| Taxes | 4.712% | | | | | | 28,663 |
| **Total Alternative No. 2** | | | | | | | **$ 636,970** |

# COST ESTIMATE

SHEET **4** OF 10

| PROJECT: KAHANAHOU WASTEWATER PUMP STATION PRELIMINARY DESIGN ALTERNATIVES REPORT | DATE: JANUARY 5, 2011 |
|---|---|
| | DESIGN STATUS: |
| LOCATION: KANEOHE, OAHU, HAWAII | RONALD N.S. HO & ASSOC. (BO) |

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE NO. 3 | | | | | | | |
| Demolition Work | | | | | | | |
| Remove MCC | 1 | EA | 0 | 0 | 1,000 | 1,000 | 1,000 |
| Remove emergency generator | 1 | EA | 0 | 0 | 1,500 | 1,500 | 1,500 |
| Remove SCADA cabinet | 1 | EA | 0 | 0 | 500 | 500 | 500 |
| Disconnect station pump | 2 | EA | 0 | 0 | 60 | 120 | 120 |
| Disconnect exhaust fan | 1 | EA | 0 | 0 | 45 | 45 | 45 |
| Disconnect sump pump | 1 | EA | 0 | 0 | 45 | 45 | 45 |
| Remove meter socket | 1 | EA | 0 | 0 | 150 | 150 | 150 |
| Remove battery charger | 1 | EA | 0 | 0 | 60 | 60 | 60 |
| Remove electric service conductors | 1 | LS | 0 | 0 | 2,000 | 2,000 | 2,000 |
| Remove emergenct generator feeder | 1 | LS | 0 | 0 | 500 | 500 | 500 |
| Miscellaneous | 1 | LS | 500 | 500 | 3,000 | 3,000 | 3,500 |
| Subtotal Demolition Work | | | | 500 | | 8,920 | 9,420 |
| Temporary Electrical Work | | | | | | | |
| Temporary MCC | 1 | EA | 75,000 | 75,000 | 3,000 | 3,000 | 78,000 |
| Temporary emergency generator | 1 | EA | 80,000 | 80,000 | 0 | 0 | 80,000 |
| Temporary electrical feeders | 500 | LF | 5 | 2,500 | 30 | 15,000 | 17,500 |
| Miscellaneous | 1 | LS | 2,500 | 2,500 | 2,500 | 2,500 | 5,000 |
| Subtotal Temporary Electrical Work | | | | 160,000 | | 20,500 | 180,500 |

# COST ESTIMATE

SHEET 5 OF 10

| PROJECT: KAHANAHOU WASTEWATER PUMP STATION | DATE: JANUARY 5, 2011 |
|---|---|
| PRELIMINARY DESIGN ALTERNATIVES REPORT | DESIGN STATUS: |
| LOCATION: KANEOHE, OAHU, HAWAII | RONALD N.S. HO & ASSOC. (BO) |

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE NO. 3 | | | | | | | |
| New Electrical Work | | | | | | | |
| MCC, 225A | 1 | EA | 100,000 | 100,000 | 3,000 | 3,000 | 103,000 |
| Emergency generator, 60kW | 1 | EA | 40,000 | 40,000 | 4,000 | 4,000 | 44,000 |
| SCADA cabinet | 1 | EA | 20,000 | 20,000 | 40,000 | 40,000 | 60,000 |
| Automatic transfer switch | 1 | EA | 25,000 | 25,000 | 2,500 | 2,500 | 27,500 |
| Meter socket, NEMA 3R SS | 1 | EA | 4,000 | 4,000 | 360 | 360 | 4,360 |
| Panelboard | 1 | EA | 1,000 | 1,000 | 480 | 480 | 1,480 |
| Electrical equipment connection | 5 | EA | 20 | 100 | 60 | 300 | 400 |
| Disconnect switch, 3P30A | 2 | EA | 240 | 480 | 90 | 180 | 660 |
| Duplex receptacle, 20A | 5 | EA | 15 | 75 | 50 | 250 | 325 |
| Smoke detector | 1 | EA | 150 | 150 | 75 | 75 | 225 |
| Door security device | 1 | EA | 250 | 250 | 75 | 75 | 325 |
| Junction box, 18"sq, NEMA 4X SS | 2 | EA | 1,500 | 3,000 | 225 | 450 | 3,450 |
| Underground electric service wiring | 150 | LF | 20 | 3,000 | 50 | 7,500 | 10,500 |
| Branch circuit wiring | 700 | LF | 5 | 3,500 | 10 | 7,000 | 10,500 |
| Miscellaneous | 1 | LS | 5,000 | 5,000 | 5,000 | 5,000 | 10,000 |
| Subtotal New Electrical Work | | | | 205,555 | | 71,170 | 276,725 |
| Subtotal | | | | | | | 466,645 |
| Overhead & Profit | 25% | | | | | | 116,661 |
| Taxes | 4.712% | | | | | | 27,485 |
| **Total Alternative No. 3** | | | | | | | **$ 610,792** |

# COST ESTIMATE



| PROJECT: KAHANAHOU WASTEWATER PUMP STATION PRELIMINARY DESIGN ALTERNATIVES REPORT | DATE: JANUARY 5, 2011 |
|---|---|
| LOCATION: KANEOHE, OAHU, HAWAII | DESIGN STATUS: |
| | RONALD N.S. HO & ASSOC. (BO) |

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE NO. 4 | | | | | | | |
| Demolition Work | | | | | | | |
| Remove MCC | 1 | EA | 0 | 0 | 1,000 | 1,000 | 1,000 |
| Remove emergency generator | 1 | EA | 0 | 0 | 1,500 | 1,500 | 1,500 |
| Remove SCADA cabinet | 1 | EA | 0 | 0 | 500 | 500 | 500 |
| Disconnect station pump | 2 | EA | 0 | 0 | 60 | 120 | 120 |
| Disconnect exhaust fan | 1 | EA | 0 | 0 | 45 | 45 | 45 |
| Disconnect sump pump | 1 | EA | 0 | 0 | 45 | 45 | 45 |
| Remove meter socket | 1 | EA | 0 | 0 | 150 | 150 | 150 |
| Remove battery charger | 1 | EA | 0 | 0 | 60 | 60 | 60 |
| Remove electric service conductors | 1 | LS | 0 | 0 | 2,000 | 2,000 | 2,000 |
| Remove emergenct generator feeder | 1 | LS | 0 | 0 | 500 | 500 | 500 |
| Miscellaneous | 1 | LS | 500 | 500 | 3,000 | 3,000 | 3,500 |
| Subtotal Demolition Work | | | | 500 | | 8,920 | 9,420 |
| Temporary Electrical Work | | | | | | | |
| Temporary MCC | 1 | EA | 75,000 | 75,000 | 3,000 | 3,000 | 78,000 |
| Temporary emergency generator | 1 | EA | 80,000 | 80,000 | 0 | 0 | 80,000 |
| Temporary electrical feeders | 500 | LF | 5 | 2,500 | 30 | 15,000 | 17,500 |
| Miscellaneous | 1 | LS | 2,500 | 2,500 | 2,500 | 2,500 | 5,000 |
| Subtotal Temporary Electrical Work | | | | 160,000 | | 20,500 | 180,500 |

# COST ESTIMATE



PROJECT: KAHANAHOU WASTEWATER PUMP STATION
PRELIMINARY DESIGN ALTERNATIVES REPORT
LOCATION: KANEOHE, OAHU, HAWAII

DATE: JANUARY 5, 2011
DESIGN STATUS:
RONALD N.S. HO & ASSOC. (BO)

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE NO. 4 | | | | | | | |
| New Electrical Work | | | | | | | |
| MCC, 225A | 1 | EA | 80,000 | 80,000 | 3,000 | 3,000 | 83,000 |
| Emergency generator, 60kW | 1 | EA | 40,000 | 40,000 | 4,000 | 4,000 | 44,000 |
| SCADA cabinet | 1 | EA | 20,000 | 20,000 | 40,000 | 40,000 | 60,000 |
| Automatic transfer switch | 1 | EA | 25,000 | 25,000 | 2,500 | 2,500 | 27,500 |
| Meter socket, NEMA 3R SS | 1 | EA | 4,000 | 4,000 | 360 | 360 | 4,360 |
| Panelboard | 1 | EA | 1,000 | 1,000 | 480 | 480 | 1,480 |
| Electrical equipment connection | 5 | EA | 20 | 100 | 60 | 300 | 400 |
| Disconnect switch, 3P30A | 2 | EA | 240 | 480 | 90 | 180 | 660 |
| Duplex receptacle, 20A | 5 | EA | 15 | 75 | 50 | 250 | 325 |
| Smoke detector | 1 | EA | 150 | 150 | 75 | 75 | 225 |
| Door security device | 1 | EA | 250 | 250 | 75 | 75 | 325 |
| Junction box, 18"sq, NEMA 4X SS | 2 | EA | 1,500 | 3,000 | 225 | 450 | 3,450 |
| Underground electric service wiring | 150 | LF | 20 | 3,000 | 50 | 7,500 | 10,500 |
| Branch circuit wiring | 700 | LF | 5 | 3,500 | 10 | 7,000 | 10,500 |
| Miscellaneous | 1 | LS | 5,000 | 5,000 | 5,000 | 5,000 | 10,000 |
| Subtotal New Electrical Work | | | | 185,555 | | 71,170 | 256,725 |
| Subtotal | | | | | | | 446,645 |
| Overhead & Profit | 25% | | | | | | 111,661 |
| Taxes | 4.712% | | | | | | 26,307 |
| **Total Alternative No. 4** | | | | | | | **$ 584,614** |

# COST ESTIMATE



PROJECT: KAHANAHOU WASTEWATER PUMP STATION
PRELIMINARY DESIGN ALTERNATIVES REPORT
LOCATION: KANEOHE, OAHU, HAWAII

DATE: JANUARY 5, 2011
DESIGN STATUS:
RONALD N.S. HO & ASSOC. (BO)

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE OPTION - REPLACE LIGHT FIXTURES | | | | | | | |
| Demolition Work | | | | | | | |
| Remove fluorescent fixture | 6 | EA | 0 | 0 | 30 | 180 | 180 |
| Remove incandescent fixture | 4 | EA | 0 | 0 | 30 | 120 | 120 |
| Remove HID fixture | 5 | EA | 0 | 0 | 50 | 250 | 250 |
| Remove emergency light fixtures | 3 | EA | 0 | 0 | 30 | 90 | 90 |
| Miscellaneous | 1 | LS | 100 | 100 | 500 | 500 | 600 |
| Subtotal Demolition Work | | | | 100 | | 1,140 | 1,240 |
| New Electrical Work | | | | | | | |
| Fluorescent light fixture | 12 | EA | 120 | 1,440 | 80 | 960 | 2,400 |
| Compact fluorescent light fixture | 1 | EA | 225 | 225 | 90 | 90 | 315 |
| HID light fixture | 4 | EA | 400 | 1,600 | 150 | 600 | 2,200 |
| Emergency light fixture | 6 | EA | 140 | 840 | 0 | 0 | 840 |
| Miscellaneous | 1 | LS | 300 | 300 | 1,000 | 1,000 | 1,300 |
| Subtotal New Electrical Work | | | | 4,405 | | 2,650 | 7,055 |
| Subtotal | | | | | | | 8,295 |
| Overhead & Profit | 25% | | | | | | 2,074 |
| Taxes | 4.712% | | | | | | 489 |
| **Total Alternative Option - Repalce Light Fixtures** | | | | | | | **$ 10,857** |

# COST ESTIMATE

PROJECT: KAHANAHOU WASTEWATER PUMP STATION
PRELIMINARY DESIGN ALTERNATIVES REPORT
LOCATION: KANEOHE, OAHU, HAWAII

DATE: JANUARY 5, 2011
DESIGN STATUS:
RONALD N.S. HO & ASSOC. (BO)

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE OPTION - UPGRADE ELECTRIC SERVICE | | | | | | | |
| New Electrical Work | | | | | | | |
| Electric Service Feeder | 150 | LF | 25 | 3,750 | 50 | 7,500 | 11,250 |
| Reduction of MCC cost | 1 | EA | -30,000 | -30,000 | 0 | 0 | -30,000 |
| Reduction of generator cost | 1 | EA | -5,000 | -5,000 | 0 | 0 | -5,000 |
| Miscellaneous | 1 | LS | 1,000 | 1,000 | 3,000 | 3,000 | 4,000 |
| Subtotal | | | | | | | -19,750 |
| Overhead & Profit | 25% | | | | | | -4,938 |
| Taxes | 4.172% | | | | | | -1,030 |
| HECO Service Charges | | | | | | | 200,000 |
| **Total Alternative Option - Upgrade Electric Service** | | | | | | | **$ 174,283** |

# COST ESTIMATE

| PROJECT: KAHANAHOU WASTEWATER PUMP STATION PRELIMINARY DESIGN ALTERNATIVES REPORT | DATE: JANUARY 5, 2011 |
|---|---|
| LOCATION: KANEOHE, OAHU, HAWAII | DESIGN STATUS: |
| | RONALD N.S. HO & ASSOC. (BO) |

| DESCRIPTION | NO | UNIT | MATERIAL COST | | LABOR COST | | LINE TOTAL |
|---|---|---|---|---|---|---|---|
| | | | UNIT | TOTAL | UNIT | TOTAL | |
| ALTERNATIVE OPTION - | | | | | | | |
| ADD GENERATOR RECEPTACLE | | | | | | | |
| New Electrical Work | | | | | | | |
| 250V weatherproof receptacle | 1 | EA | 300 | 300 | 90 | 90 | 390 |
| Electrical wiring | 50 | LF | 10 | 500 | 20 | 1,000 | 1,500 |
| Miscellaneous | 1 | LS | 100 | 100 | 500 | 500 | 600 |
| Subtotal | | | | | | | 2,490 |
| Overhead & Profit | 25% | | | | | | 623 |
| Taxes | 4.172% | | | | | | 130 |
| **Total Alternative Option - Add Generator Receptacle** | | | | | | | **$ 3,242** |
| ALTERNATIVE OPTION - | | | | | | | |
| ADD SMOKE DETECTORS | | | | | | | |
| New Electrical Work | | | | | | | |
| Smoke detector | 5 | EA | 150 | 750 | 75 | 375 | 1,125 |
| Electrical wiring | 200 | LF | 5 | 1,000 | 10 | 2,000 | 3,000 |
| Program SCADA system | 1 | LS | 0 | 0 | 5,000 | 5,000 | 5,000 |
| Miscellaneous | 1 | LS | 100 | 100 | 500 | 500 | 600 |
| Subtotal | | | | | | | 9,725 |
| Overhead & Profit | 25% | | | | | | 2,431 |
| Taxes | 4.172% | | | | | | 507 |
| **Total Alternative Option - Add Smoke Detectors** | | | | | | | **$ 12,663** |

# APPENDIX J
# PRESENT WORTH COST ANALYSIS

# TABLE J-1 KAHANAHOU WWPS
# ALTERNATIVE NO. 1: NO ACTION
# PRESENT WORTH COST ANALYSIS
**PAGE (1 OF 2)**

| YEAR | COST ITEM DESCRIPTION[1] | COST ($) | TOTAL DISCOUNT (%)[2] | PRESENT WORTH COST ($) |
|---|---|---|---|---|
| 0 | Pump Replacement Costs[3] | $100,800 | 0 | $100,800 |
| | Pump Energy Consumption Costs[4] | $6,185 | 0 | $6,185 |
| 1 | Preventive Maintenance[5] | $3,350 | 5 | $3,190 |
| | Pump Energy Consumption Costs[4] | $6,185 | 5 | $5,890 |
| 2 | Preventive Maintenance[5] | $3,350 | 10.3 | $3,037 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 10.3 | $23,264 |
| | Pump Energy Consumption Costs[4] | $6,185 | 10.3 | $5,607 |
| 3 | Preventive Maintenance[5] | $3,350 | 15.8 | $2,893 |
| | Pump Energy Consumption Costs[4] | $6,185 | 15.8 | $5,341 |
| 4 | Preventive Maintenance[5] | $3,350 | 21.6 | $2,755 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 21.6 | $21,102 |
| | Pump Energy Consumption Costs[4] | $6,185 | 21.6 | $5,086 |
| 5 | Preventive Maintenance[5] | $3,350 | 27.6 | $2,625 |
| | Motor Rewinding[7] | $10,600 | 27.6 | $8,307 |
| | Pump Energy Consumption Costs[4] | $6,185 | 27.6 | $4,847 |
| 6 | Preventive Maintenance[5] | $3,350 | 34 | $2,500 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 34 | $19,149 |
| | Pump Energy Consumption Costs[4] | $6,185 | 34 | $4,616 |
| 7 | Preventive Maintenance[5] | $3,350 | 40.7 | $2,381 |
| | Pump Energy Consumption Costs[4] | $6,185 | 40.7 | $4,396 |
| 8 | Preventive Maintenance[5] | $3,350 | 47.7 | $2,268 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 47.7 | $17,373 |
| | Pump Energy Consumption Costs[4] | $6,185 | 47.7 | $4,188 |
| 9 | Preventive Maintenance[5] | $3,350 | 55.1 | $2,160 |
| | Pump Energy Consumption Costs[4] | $6,185 | 55.1 | $3,988 |
| 10 | Pump Replacement Costs[3] | $100,800 | 62.9 | $61,878 |
| | Pump Energy Consumption Costs[4] | $6,185 | 62.9 | $3,797 |
| 11 | Preventive Maintenance[5] | $3,350 | 71 | $1,959 |
| | Pump Energy Consumption Costs[4] | $6,185 | 71 | $3,617 |
| 12 | Preventive Maintenance[5] | $3,350 | 79.6 | $1,865 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 79.6 | $14,287 |
| | Pump Energy Consumption Costs[4] | $6,185 | 79.6 | $3,444 |
| 13 | Preventive Maintenance[5] | $3,350 | 88.6 | $1,776 |
| | Pump Energy Consumption Costs[4] | $6,185 | 88.6 | $3,279 |
| 14 | Preventive Maintenance[5] | $3,350 | 98 | $1,692 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 98 | $12,960 |
| | Pump Energy Consumption Costs[4] | $6,185 | 98 | $3,124 |
| 15 | Preventive Maintenance[5] | $3,350 | 107.9 | $1,611 |
| | Motor Rewinding[7] | $10,600 | 107.9 | $5,099 |
| | Pump Energy Consumption Costs[4] | $6,185 | 107.9 | $2,975 |

# TABLE J-1 KAHANAHOU WWPS
# ALTERNATIVE NO. 1: NO ACTION
# PRESENT WORTH COST ANALYSIS
**PAGE (2 OF 2)**

| YEAR | COST ITEM DESCRIPTION[1] | COST ($) | TOTAL DISCOUNT (%)[2] | PRESENT WORTH COST ($) |
|---|---|---|---|---|
| 16 | Preventive Maintenance[5] | $3,350 | 118.3 | $1,535 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 118.3 | $11,754 |
| | Pump Energy Consumption Costs[4] | $6,185 | 118.3 | $2,833 |
| 17 | Preventive Maintenance[5] | $3,350 | 129.2 | $1,462 |
| | Pump Energy Consumption Costs[4] | $6,185 | 129.2 | $2,699 |
| 18 | Preventive Maintenance[5] | $3,350 | 140.7 | $1,392 |
| | Impeller and Mechanical Seal Replacement[6] | $25,660 | 140.7 | $10,661 |
| | Pump Energy Consumption Costs[4] | $6,185 | 140.7 | $2,570 |
| 19 | Preventive Maintenance[5] | $3,350 | 152.7 | $1,326 |
| | Pump Energy Consumption Costs[4] | $6,185 | 152.7 | $2,448 |
| | | | | |
| | **ALTERNATIVE NO. 1 TOTAL 20 YEAR PRESENT WORTH COST** | | | **$425,991** |

[1]Design costs were excluded from analysis. Fuel system maintenance costs were assumed to be similar for all of the alternatives and weren't included in the analysis.

[2]Discount rate of 5% per year used.

[3]Pump replacement costs based on $28,000 replacement cost per pump, 25% mob/demob, 25% contingency, 10% profit, and 4.72% GE tax.

[4]Annual WWPS energy consumption based on 2009 energy consumption of 26,421 kwh, and an electricity rate of $0.234 per kwh consumed.

[5]Preventive Maintenance based on 16 man hours of effort per pump, $72.7 hourly rate, 25% mob/demob, 10% profit, and 4.72% GE tax.

[6]Impeller and Mechanical Seal Replacement includes a material cost of $6,000 per pump, 40 man hours of effort per pump, $72.7 hourly rate, 25% mob/demob, 10% profit, and 4.72% GE tax.

[7]Motor rewinding costs based on $1,500 rewinding cost per pump, 30 man hours of effort per pump, $72.7 hourly rate, 25% mob/demob, 10% profit, and 4.72% GE tax.

# TABLE J-4 KAHANAHOU WWPS
# ALTERNATIVE NO. 2: NEW C/S DRY PIT SUBMERSIBLE PUMPS W/ VFD
# PRESENT WORTH COST ANALYSIS

**PAGE (1 OF 1)**

| YEAR | COST ITEM DESCRIPTION[1] | COST ($) | TOTAL DISCOUNT (%)[2] | PRESENT WORTH COST ($) |
|---|---|---|---|---|
| 0 | Pump Replacement Costs[3] | $3,076,000 | 0 | $3,076,000 |
| | Pump Energy Consumption Costs[4] | $7,110 | 0 | $7,110 |
| 1 | Pump Energy Consumption Costs[4] | $7,110 | 5 | $6,771 |
| 2 | Pump Energy Consumption Costs[4] | $7,110 | 10.3 | $6,446 |
| 3 | Pump Energy Consumption Costs[4] | $7,110 | 15.8 | $6,140 |
| 4 | Pump Energy Consumption Costs[4] | $7,110 | 21.6 | $5,847 |
| 5 | Pump Replacement Costs[5] | $103,350 | 27.6 | $80,995 |
| | Pump Energy Consumption Costs[4] | $7,110 | 27.6 | $5,572 |
| 6 | Pump Energy Consumption Costs[4] | $7,110 | 34 | $5,306 |
| 7 | Pump Energy Consumption Costs[4] | $7,110 | 40.7 | $5,053 |
| 8 | Pump Energy Consumption Costs[4] | $7,110 | 47.7 | $4,814 |
| 9 | Pump Energy Consumption Costs[4] | $7,110 | 55.1 | $4,584 |
| 10 | Pump Replacement Costs[5] | $103,350 | 62.9 | $63,444 |
| | Pump Energy Consumption Costs[4] | $7,110 | 62.9 | $4,365 |
| 11 | Pump Energy Consumption Costs[4] | $7,110 | 71 | $4,158 |
| 12 | Pump Energy Consumption Costs[4] | $7,110 | 79.6 | $3,959 |
| 13 | Pump Energy Consumption Costs[4] | $7,110 | 88.6 | $3,770 |
| 14 | Pump Energy Consumption Costs[4] | $7,110 | 98 | $3,591 |
| 15 | Pump Replacement Costs[5] | $103,350 | 107.9 | $49,711 |
| | Pump Energy Consumption Costs[4] | $7,110 | 107.9 | $3,420 |
| 16 | Pump Energy Consumption Costs[4] | $7,110 | 118.3 | $3,257 |
| 17 | Pump Energy Consumption Costs[4] | $7,110 | 129.2 | $3,102 |
| 18 | Pump Energy Consumption Costs[4] | $7,110 | 140.7 | $2,954 |
| 19 | Pump Energy Consumption Costs[4] | $7,110 | 152.7 | $2,814 |
| | | | | |
| | **ALTERNATIVE NO. 2 TOTAL 20 YEAR PRESENT WORTH COST** | | | **$3,363,183** |

[1]Design costs were excluded from analysis. Fuel system maintenance costs were assumed to be similar for all of the alternatives and weren't included in the analysis. Assumed no preventative maintenance required for submersible pumps.

[2]Discount rate of 5% per year used.

[3]Pump replacement costs based on cost estimate.

[4]Annual WWPS energy consumption based on 2009 energy consumption of 26,421 kwh, an electricty rate of $0.234 per kwh consumed, and an increase of TDH from 45 feet to 46.5 feet.

[5]Pump replacement costs based on $28,710 replacement cost per pump, 25% mob/demob, 25% contingency, 10% profit, and 4.72% GE tax.

# TABLE J-4 KAHANAHOU WWPS
# ALTERNATIVE NO. 3: NEW C/S DRY PIT SUB. PUMPS W/ SOFT STARTERS
# PRESENT WORTH COST ANALYSIS
**PAGE (1 OF 1)**

| YEAR | COST ITEM DESCRIPTION[1] | COST ($) | TOTAL DISCOUNT (%)[2] | PRESENT WORTH COST ($) |
|---|---|---|---|---|
| 0 | Pump Replacement Costs[3] | $3,019,000 | 0 | $3,019,000 |
| | Pump Energy Consumption Costs[4] | $7,110 | 0 | $7,110 |
| 1 | Pump Energy Consumption Costs[4] | $7,110 | 5 | $6,771 |
| 2 | Pump Energy Consumption Costs[4] | $7,110 | 10.3 | $6,446 |
| 3 | Pump Energy Consumption Costs[4] | $7,110 | 15.8 | $6,140 |
| 4 | Pump Energy Consumption Costs[4] | $7,110 | 21.6 | $5,847 |
| 5 | Pump Replacement Costs[5] | $103,350 | 27.6 | $80,995 |
| | Pump Energy Consumption Costs[4] | $7,110 | 27.6 | $5,572 |
| 6 | Pump Energy Consumption Costs[4] | $7,110 | 34 | $5,306 |
| 7 | Pump Energy Consumption Costs[4] | $7,110 | 40.7 | $5,053 |
| 8 | Pump Energy Consumption Costs[4] | $7,110 | 47.7 | $4,814 |
| 9 | Pump Energy Consumption Costs[4] | $7,110 | 55.1 | $4,584 |
| 10 | Pump Replacement Costs[5] | $103,350 | 62.9 | $63,444 |
| | Pump Energy Consumption Costs[4] | $7,110 | 62.9 | $4,365 |
| 11 | Pump Energy Consumption Costs[4] | $7,110 | 71 | $4,158 |
| 12 | Pump Energy Consumption Costs[4] | $7,110 | 79.6 | $3,959 |
| 13 | Pump Energy Consumption Costs[4] | $7,110 | 88.6 | $3,770 |
| 14 | Pump Energy Consumption Costs[4] | $7,110 | 98 | $3,591 |
| 15 | Pump Replacement Costs[5] | $103,350 | 107.9 | $49,711 |
| | Pump Energy Consumption Costs[4] | $7,110 | 107.9 | $3,420 |
| 16 | Pump Energy Consumption Costs[4] | $7,110 | 118.3 | $3,257 |
| 17 | Pump Energy Consumption Costs[4] | $7,110 | 129.2 | $3,102 |
| 18 | Pump Energy Consumption Costs[4] | $7,110 | 140.7 | $2,954 |
| 19 | Pump Energy Consumption Costs[4] | $7,110 | 152.7 | $2,814 |
| | | | | |
| | **ALTERNATIVE NO. 3 TOTAL 20 YEAR PRESENT WORTH COST** | | | **$3,306,183** |

[1]Design costs were excluded from analysis. Fuel system maintenance costs were assumed to be similar for all of the alternatives and weren't included in the analysis. Assumed no preventative maintenance required for submersible pumps.

[2]Discount rate of 5% per year used.

[3]Pump replacement costs based on cost estimate.

[4]Annual WWPS energy consumption based on 2009 energy consumption of 26,421 kwh, an electricty rate of $0.234 per kwh consumed, and an increase of TDH from 45 feet to 46.5 feet.

[5]Pump replacement costs based on $28,710 replacement cost per pump, 25% mob/demob, 25% contingency, 10% profit, and 4.72% GE tax.

# TABLE J-4 KAHANAHOU WWPS
# ALTERNATIVE NO. 4: NEW C/S DRY PIT SUB. PUMPS W/ SOFT STARTERS
# PRESENT WORTH COST ANALYSIS

**PAGE (1 OF 1)**

| YEAR | COST ITEM DESCRIPTION[1] | COST ($) | TOTAL DISCOUNT (%)[2] | PRESENT WORTH COST ($) |
|---|---|---|---|---|
| 0 | Pump Replacement Costs[3] | $3,019,000 | 0 | $3,019,000 |
| | Pump Energy Consumption Costs[4] | $6,365 | 0 | $6,365 |
| 1 | Pump Energy Consumption Costs[4] | $6,365 | 5 | $6,062 |
| 2 | Pump Energy Consumption Costs[4] | $6,365 | 10.3 | $5,771 |
| 3 | Pump Energy Consumption Costs[4] | $6,365 | 15.8 | $5,497 |
| 4 | Pump Energy Consumption Costs[4] | $6,365 | 21.6 | $5,234 |
| 5 | Pump Replacement Costs[5] | $103,350 | 27.6 | $80,995 |
| | Pump Energy Consumption Costs[4] | $6,365 | 27.6 | $4,988 |
| 6 | Pump Energy Consumption Costs[4] | $6,365 | 34 | $4,750 |
| 7 | Pump Energy Consumption Costs[4] | $6,365 | 40.7 | $4,524 |
| 8 | Pump Energy Consumption Costs[4] | $6,365 | 47.7 | $4,309 |
| 9 | Pump Energy Consumption Costs[4] | $6,365 | 55.1 | $4,104 |
| 10 | Pump Replacement Costs[5] | $103,350 | 62.9 | $63,444 |
| | Pump Energy Consumption Costs[4] | $6,365 | 62.9 | $3,907 |
| 11 | Pump Energy Consumption Costs[4] | $6,365 | 71 | $3,722 |
| 12 | Pump Energy Consumption Costs[4] | $6,365 | 79.6 | $3,544 |
| 13 | Pump Energy Consumption Costs[4] | $6,365 | 88.6 | $3,375 |
| 14 | Pump Energy Consumption Costs[4] | $6,365 | 98 | $3,215 |
| 15 | Pump Replacement Costs[5] | $103,350 | 107.9 | $49,711 |
| | Pump Energy Consumption Costs[4] | $6,365 | 107.9 | $3,062 |
| 16 | Pump Energy Consumption Costs[4] | $6,365 | 118.3 | $2,916 |
| 17 | Pump Energy Consumption Costs[4] | $6,365 | 129.2 | $2,777 |
| 18 | Pump Energy Consumption Costs[4] | $6,365 | 140.7 | $2,644 |
| 19 | Pump Energy Consumption Costs[4] | $6,365 | 152.7 | $2,519 |
| | | | | |
| | **ALTERNATIVE NO. 4 TOTAL 20 YEAR PRESENT WORTH COST** | | | **$3,296,435** |

[1]Design costs were excluded from analysis. Fuel system maintenance costs were assumed to be similar for all of the alternatives and weren't included in the analysis. Assumed no preventative maintenance required for submersible pumps.

[2]Discount rate of 5% per year used.

[3]Pump replacement costs based on cost estimate.

[4]Annual WWPS energy consumption based on 2009 energy consumption of 26,421 kwh, an electricty rate of $0.234 per kwh consumed, and an increase of TDH from 45 feet to 46.5 feet.

[5]Pump replacement costs based on $28,710 replacement cost per pump, 25% mob/demob, 25% contingency, 10% profit, and 4.72% GE tax.

# APPENDIX K
# PERMITS

## TABLE K-1 KAHANAHOU WWPS
## PROJECT PERMIT LIST

| PERMIT | AGENCY | PHONE |
|---|---|---|
| HRS 103-50 Document Transmittal Form | Disability and Communication Access Board | (808) 586-8121 |
| Form 1 | Department of Health, Noise and Radiation Branch | (808) 586-4700 |
| Building Permit | City and County of Honolulu, Department of Planning and Permitting | (808) 768-8257 |
| Application and Permit for Tank Installation | City and County of Honolulu, Honolulu Fire Department, Fire Prevention Bureau | (808) 723-7094 |
| Application for an Underground Storage Tank Permit | Department of Health, Solid and Hazardous Waste Branch | (808) 586-4226 |
| Temporary Industrial Wastewater Discharge Permit | City and County of Honolulu, Department of Environmental Services | (808) 768-3249<br>(808) 768-3261<br>(808) 768-3262<br>(808) 768-3271 |
| Special Management Area | City and County of Honolulu, Department of Planning and Permitting, land Use Permits Division | (808) 768-8014 |
| Trenching Permit | City and County of Honolulu, Department of Planning and Permitting, Site Development Division, Civil Engineering Branch | (808) 768-8218<br>(808) 768-8219 |

# APPENDIX L
# REFERENCES

# REFERENCES

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# Appendix B

Kahanahou Wastewater Pump Station Force Main Sewer Line Study, Kaneohe, Oahu, Hawaii

Okahara and Associates, Inc., December 2013

# FINAL ENGINEERING REPORT

## KAHANAHOU WASTEWATER PUMP STATION
## SEWER FORCE MAIN STUDY
## KANEOHE, OAHU, HAWAII

Prepared For:
City and County of Honolulu
Department of Design and Construction
Wastewater Division
650 South King Street
Honolulu, Hawaii 96813


Prepared By:
Okahara and Associates, Inc.
200 Kohola Street
Hilo, Hawaii 96720



December 2013,
Revised June 2015

## TABLE OF CONTENTS

## LIST OF FIGURES



## APPENDIX

## EXECUTIVE SUMMARY

The City and County of Honolulu has mandated by the U.S. Government through the 2010 Consent Decree, to eliminate all sanitary sewer overflows. The Kahanahou Wastewater Pump Station with its force main was named to be assessed in the consent decree. Based on the projected 5-year flow of 1.27 MGD from the Sewer Inflow and Infiltration Assessment and Rehabilitation Program Update Project, the existing Kahanahou WWPS and FM will require upgrading.

This Final Engineering Report is for the new force main (FM) only. A Design Alternatives Report is currently being conducted for the WWPS. The FM will be 10-inch fusible HDPE pipe. Manual air relief valves and access vaults will also be installed.

The Preliminary Engineering Report studied four possible routes and recommended Route 2. See Figures 3-1, 3-2, 3-4, and 3-6 for the four routes. Route 2 is on Figure 3-6. See Figure 2-1 for the existing force main.

| Route | Length (feet) | TDH (feet) | Private Parcels | Budget Estimate ($M) | Comments |
|---|---|---|---|---|---|
| 1 | 3500 | >100 | 0 | n/a | Over 100' on static alone. Not acceptable. |
| 2 | 3240 | 88[1] | 2 | 1.32[3] | Recommended, one narrow area, minimal private properties. |
| 3 | 2940 | <100[2] | 4 | 1.26[3] | Most private parcels, two narrow areas. |
| 4 | 3680 | <100[2] | 2 | 1.38[3] | Through rock wall w/pool, in Makani Kai Marina and recently paved private roads, not preferred by Marina Management. |

1. Includes static head inside the pump house. The total losses due to friction within the pump house are assumed to be less than 12 feet.
2. TDH not estimated but assumed to be less than 100' since the total static head is approximately 74.5' or less for Routes 3 & 4.
3. The estimate does not include land acquisition.

A meeting was held on October 15, 2013 in which these alternate routes were presented and discussed. Route 2 was chosen. See Attachment 11 for the meeting minutes. The Consultant was given the directive to proceed with completing the Design Alternative Report for the pump station upgrade and then begin the design process.

*The following report is in accordance with Section 11 – Engineering Report of the "Design Standards" of the Department of Wastewater Management, City and County of Honolulu, State of Hawaii dated July 1993. The draft "Wastewater System Design Standards and Guidelines" of the Department of Environmental Services, City and County of Honolulu, State of Hawaii dated January 2004 has also been referenced.*

## SECTION 1 - GENERAL INFORMATION

### 1.1 Project Description

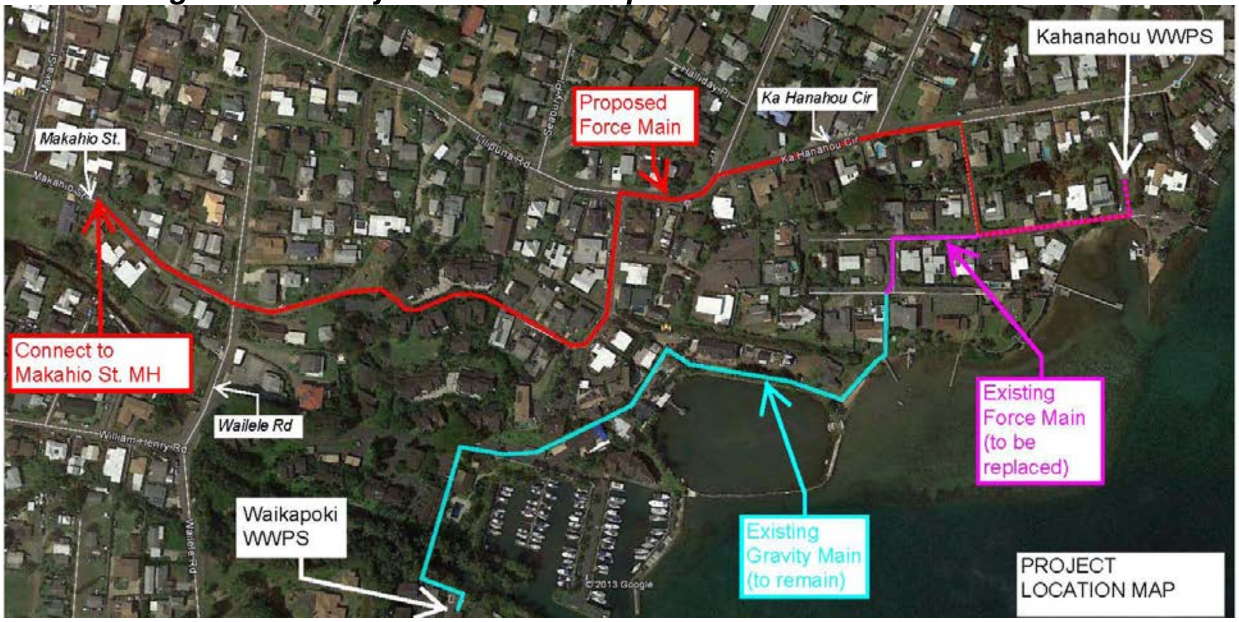
The City and County of Honolulu has been mandated by the U.S. Government through the 2010 Consent Decree to eliminate all sanitary sewer overflows. The Kahanahou Wastewater Pump Station with its force main was named to be assessed in the consent decree. Based on the projected peak design flow of 1.27 mgd from "The Sewer Inflow and Infiltration Assessment and Rehabilitation Program Update Project" (hereinafter referred to as the I/I Report), the existing Kahanahou WWPS and FM will require upgrading. This Final Engineering Report is for the new force main (FM) only. A Design Alternatives Report is currently being conducted for the WWPS.

This project replaces a portion of the existing sewer force main served by the Kahanahou wastewater pump station (WWPS). The existing City and County of Honolulu sewer force main has had a history of leak problems and has been mandated to be upgraded as mentioned above. The new sewer force main will be routed along an alignment that adequately serves the affected areas and is desirable to the City and County of Honolulu.

### 1.2 Project Location

This project is located in Kaneohe, Oahu. The existing sewer system analyzed by this project starts as a force main from the Kahanahou WWPS on Kahanahou Place (TMK 4-5-047:095). The existing force main ends at a manhole on Springer Place, where it then continues as a gravity main around the marina area (TMK 4-5-0002:001, Address: 45-995 Wailele Road) to the Waikapoki WWPS. The proposed force main also begins at the Kahanahou WWPS, continues southwest along Kahanahou Circle and through some private properties, and discharges at a sewer manhole on Makahio Street near the intersection with Wailele Road. The proposed force main bypasses the Waikapoki WWPS. See Figure 1-1 below for project location map.

*Figure 1-1: Project Location Map*




## 1.3 Project Topography

The existing ground topography along the proposed force main alignment varies from roughly 4.6 feet to 65.6 feet in elevation. The beginning of the proposed force main on Kahanahou Place is the low point of the line (elevation 4.6 feet), thus the need for the WWPS. The existing ground generally slopes upward to a high point near the intersection of Lilipuna Road and Lilipuna Place (elevation 65.6 feet). The ground then varies up and down in slope until the end of the proposed force main along Makahio Street (elevation 64.6 feet). See Attachment 1 for the preliminary plan and profile sheets with topographic survey background.

## 1.4 Future Population

Population data from the City and County of Honolulu's INFIX version 3.0 flow model was reviewed for this report; however this data was not utilized in the design of the proposed force main (see Section 2.3 Basis of Design for the design flow information). For reference, see Attachment 2 for INFIX data printout for the Kahanahou WWPS (designated as Plant/Station KK32).

## 1.5 Field Survey Data

*A flow report for the Kahanahou area is from the I/I Report procured by the City. The I/I Report was unavailable at the time of the preliminary engineering report. However, the necessary information has been provided by the City to complete this final engineering report.*

No soil investigations, core borings, corrosivity studies, or noise attenuation studies have been performed specifically for this project at this time. The corrosivity study is not believed to be essential, since the proposed pipe material is plastic and will not corrode. A reference drawing from the project entitled "Kahanahou Sewage Pumping Station & Force Main" dated March 3, 1964 provides boring log information at the Kahanahou WWPS. This boring shows the ground to consist of clayey silts, sands, and coral, with the water table approximately 4½ feet below grade. See Attachment 3 for boring log plan sheet. Geotechnical investigation will be performed during the design phase.

## 1.6 Flooding

The entire proposed force main alignment is in FEMA FIRM Zone X, which is outside the 500-year floodplain. See Attachment 4 for FEMA flood zone map.

## 1.7 Permits and Clearances

The following is a list of permits and clearances associated with land use restrictions. In accordance with the Revised Ordinances of Honolulu dated 1990, this project is subject to the following permits and clearances:

- Flood Hazard District - NO
- Special Management Area (SMA) Use – NO
- Shoreline Setback – CITY TO SEEK FOR VARIANCE (force main will be installed within the 40' shoreline setback)
- Special District Permit - NO
- Hawaii Coastal Zone Management Program/Hawaii Coastal Nonpoint Pollution Control Program, Federal Consistency – NO
- Conservation District Use Application – NO (urban district state land use)
- Historic and Cultural Site Review – AN ARCHAEOLOGICAL LITERATURE REVIEW AND FIELD INSPECTION REPORT HAS BEEN ORDERED BY THE CITY
- National Pollutant Discharge Elimination System (NPDES) permit for Stormwater and Dewatering - YES
- Underground Injection Control (UIC) Permit – NO
- Permit for Work in Ocean Waters – NO
- Department of Army Permits – DETERMINATION PENDING CONSULTATION WITH THE CORPS
- Stream Channel Alteration Permit - NO
- Water Quality Certification – NO
- Total Maximum Daily Load (TMDL) – NO

This project will also be subject to the following permits:

- City and County of Honolulu Trenching Permit
- City and County of Honolulu Street Usage Permit
- City and County of Honolulu Sewer Connection Application
- State DCAB HRS 130-50 Document Transmittal Form

- National Pollutant Discharge Elimination System (NPDES) permit for Stormwater and Dewatering
- State Department of Health Community Noise Permit and Noise Variance

## SECTION 2 - SEWER SYSTEM

### 2.1 Description of Existing Sewer System

The existing sewer system starts at the Kahanahou WWPS and consists of approximately 800 lineal feet of an 8-inch diameter high density polyethylene (HDPE) force main. The force main discharges to a manhole located within Springer Place, where it then continues as an 8-inch and 10-inch gravity main through the marina area to the Waikapoki WWPS. The gravity main is approximately 1,900 feet in length. See Figure 2-1 below for a map of the existing sewer system.

The existing tributary areas for the Waikapoki WWPS are shown on Figure 2-2 below. The tributary areas labeled “Kahanahou Tributary”, “Waikapoki Tributary 1” and “Waikapoki Tributary 2” all currently discharge to the Waikapoki WWPS (the “Kahanahou Tributary” first discharges to the Kahanahou WWPS).

The project area is currently zoned residential district R-10. The Koolaupoko Sustainable Communities Plan dated August 2000 designates the project area as low density residential land use, and states that the area is projected to have limited future population growth.

***Figure 2-1: Existing Sewer System***

### *Figure 2-2: Existing Waikapoki WWPS Tributary Area*

## 2.2 Description of Proposed Sewer System

The proposed force main will replace the existing force main, with the existing force main being abandoned in place. The existing gravity main from the end of the existing force main discharging to Waikapoki WWPS is to remain in service, as it will still serve the “Waikapoki Tributary 1” area shown in light purple on Figure 2-2 via several existing sewer laterals. The proposed force main is about 3,100 lineal feet, is sized at 10 inches, and will be HDPE SDR 11 fusible pipe. Pipe SDR specification is in accordance with Section 1-2.6(h) of the Draft Wastewater System Design Standards and Guidelines of the Department of Environmental Services, dated January 2004.Equally possible is the use of fusible C900 PVC pipe. The attached plan and profile sheets are conceptual and call out HDPE pipe and are curved both horizontally and vertically at the turns where possible to reduce friction. The cold bend minimum radius for HDPE SDR 11 is 25 x OD. Mitered fused bends are also an option for HDPE and required for PVC unless using large radii. The use of tracer wire is recommended. As HDPE has high buoyancy, considerations must be made to anchor sections where the water table is high.

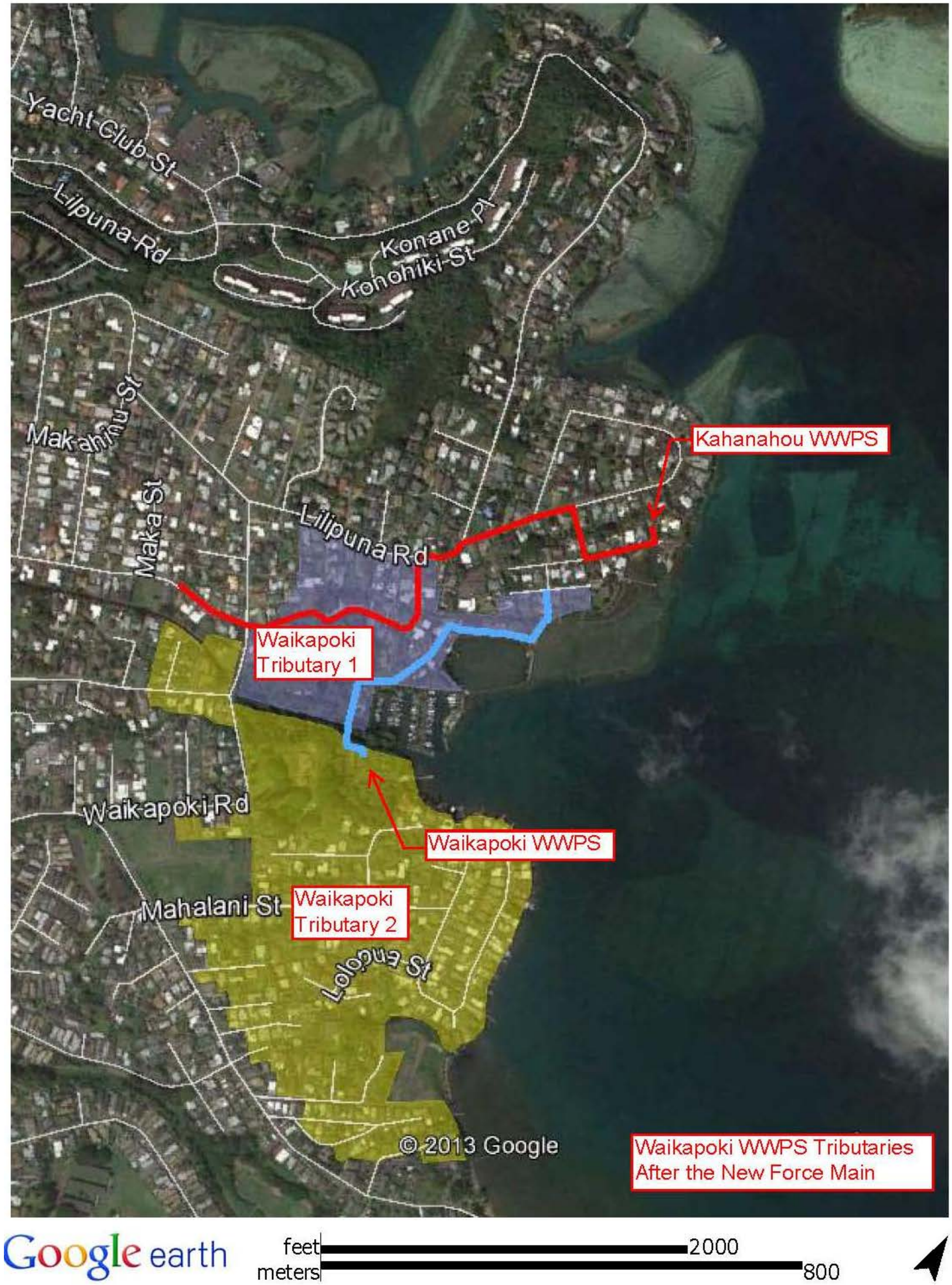
The proposed force main will start at the Kahanahou WWPS and discharge to an existing sewer manhole on Makahio Street, where it connects to an existing 8 inch gravity sewer line. At the point of connection, the existing 8-inch gravity sewer line has an estimated capacity of 0.463 mgd; this capacity is not sufficient to handle the peak design flow of 1.27 mgd (see next section for design flow information). However, the initial years of flows should be low enough to pass through this section. The City will determine when an upgrade is necessary. Both the existing and proposed sewer systems flow to the Kaneohe Wastewater Treatment Plant; therefore there will be no change in the amount of discharge to this downstream facility. The new force main is located within areas previously disturbed by utility lines, residential development, and/or road construction; force main construction will not disturb previously undisturbed areas. See Figures 2-3 and 2-4 below for a map of the proposed sewer system.

Since the proposed force main will no longer connect to the existing gravity main discharging to Waikapoki WWPS, the “Kahanahou Tributary” area will no longer flow to the Waikapoki WWPS; this tributary area will be diverted to the Waikalua WWPS. The total tributary area discharging to the Waikapoki WWPS will be significantly reduced with the proposed force main installation, making it possible to reduce improvement needs for the Waikapoki WWPS to that of maintenance only and not for upgrading. See Figure 2-5 below for the proposed Waikapoki WWPS tributary areas.

***Figure 2-3: Proposed Sewer System***

## *Figure 2-4: Overall Sewer System to Kaneohe WWTP*

*Figure 2-5: Proposed Waikapoki WWPS Tributary Area*



### 2.3 Basis of Design

The Sewer Inflow and Infiltration Assessment and Rehabilitation Program Update Project (I/I Report) developed a computer hydraulic model of the City's collection system. The following results are from the model's 2030b – 2yr network and were used in the preliminary design of the proposed force main:

- Design Period = 5-year, 24-hour storm
- Design Flow Rate = 1.27 mgd
- Pipe Slope and Elevation = varies
- Pipe Length = total of 3,195 linear feet
- Hazen-Williams Coefficient C = 150 (for new HDPE or C900 PVC pipe)

The client (City and County of Honolulu Wastewater Division) provided the directive to use the future (year 2030) 5-year 24-hour flow from the I/I Report. See Attachment 5 for the design flow guidance email.

The above design data resulted in the following force main properties (see Attachment 6 for Route 2 force main calculations):

- Pipe Size = 10 inches
- Total Dynamic Head = 88 ft *(100 ft max; losses in pump house not included but assumed to be less than 12 feet)*
- Full-Flow Velocity = 3.60 ft/s *(1.75 ft/s min, 10 ft/s max)*

See Attachment 1 for the preliminary plan and profile sheets for Route 2. The highest point of the force main will be at the discharge point in order to keep the entire pipe at full flow. A new manhole will be installed prior to the discharge manhole to keep the FM outlet submerged. The required minimum pipe cover of 4 feet will be maintained along the force main; if minimum pipe cover cannot be maintained then the main will be concrete jacketed. Concrete jacketing will also be used in areas where maintenance is a concern, such as within private properties. Due to the varying existing ground slope, manual air relief valves will be installed at the high points along the force main. The City will periodically open these valves to release any air in the force main; the City will take measures to control the odor emitted. Additionally, capped access tees will be installed in vaults for monitoring and maintenance. No manholes will be installed.

## SECTION 3 - RECOMMENDATIONS

### 3.1 Alternatives

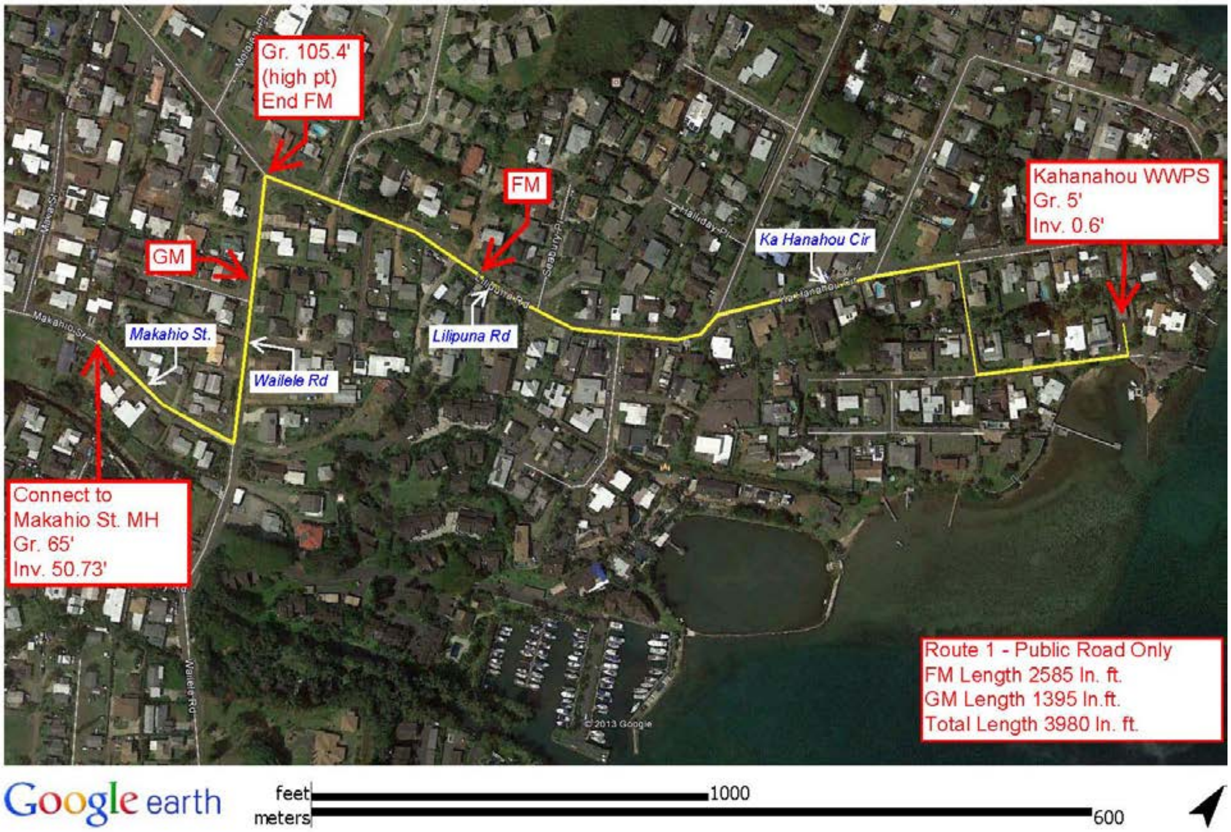
The two initial general alternatives for this project were a new force main from the Kahanahou WWPS discharging to the Waikapoki WWPS or from the Kahanahou WWPS discharging to the Waikalua WWPS. The alternative that discharges to the Waikapoki WWPS would involve improving the existing gravity main in that area, which is located right next to the shore at some points. The City dismissed this alternative early on; therefore it is not discussed further in this report. The four alternatives discussed below all discharge to the Waikalua WWPS.

There were a total of four alternative routes examined for the proposed force main. All routes started at the Kahanahou WWPS, generally ran in the southwesterly direction and connected to a City and County of Honolulu sewer manhole either in Makahio Street or William Henry Road. The proposed routes bypass the Waikapoki WWPS (where the existing force main currently discharges) and instead discharge to the Waikalua WWPS. The following is a description of each alternative route and the reasons for dismissal or selection. A “Delayed Action” alternative and a “No Action” alternative were also considered, and are briefly described below.

Route 1

Route 1 consisted of a force main running west along Kahanahou Circle and Lilipuna Road. At the intersection of Lilipuna Road and Wailele Road the alignment hits its high point; thereby ending the force main and beginning a gravity main. The gravity main alignment turned south and ran down Wailele Road until Makahio Street. The alignment then turns west on Makahio Street and connects to an existing sewer manhole. This route was dismissed because the estimated total dynamic head of over 100 feet exceeds the force main requirements in the Design Standards.

***Figure 3-1: Alternative Route 1 Map***




<u>Route 3</u>

Route 3 consisted of a force main running west through a number of private properties and ending at the existing sewer manhole on Makahio Street. This route was dismissed because of the narrow construction space along certain areas of the proposed alignment. One specific problem area was a narrow path between an existing fence line and house structure; see the below photos. This route also crosses through the greatest number of private properties, which is undesirable per the Design Standards (standards state to locate force mains in streets or along road right-of-ways whenever possible).

*Figure 3-2: Alternative Route 3 Map*

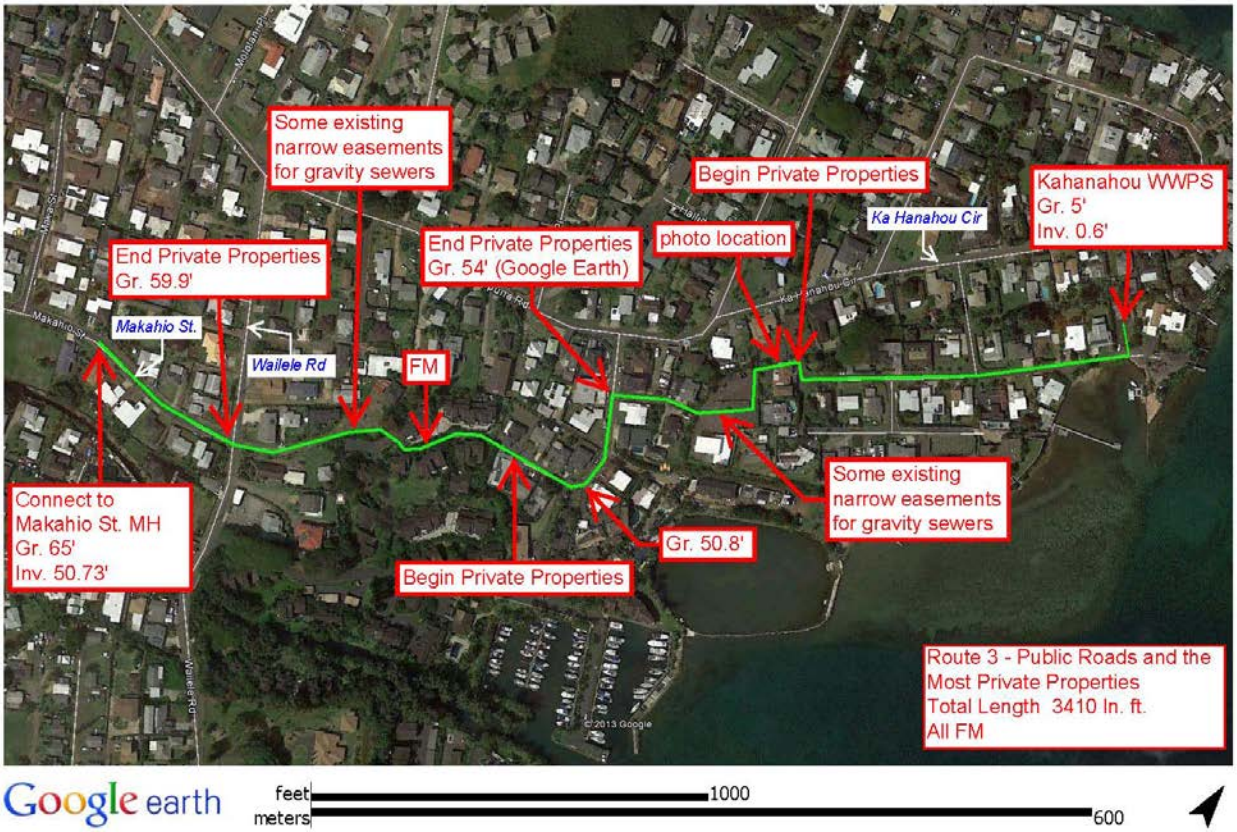


***Figure 3-3: Alternative Route 3 Photos***


Route 4
Route 4 was an early version of the proposed alignment. It consisted of running the force main west along Kahanahou Circle, turning south and running through some private properties, running across a bridge on Wailele Road, and ending at the existing sewer manhole on William Henry Road. This route was dismissed because it would penetrate an existing rock wall that retains a concrete lined pond. The Makani Kai Marina manager was concerned that the wall could fail and injure residents. Also, the pond was added recently and the wall was not designed for this added surcharge.

The Wailele Road bridge crossing was another complexity with this route that contributed to its dismissal. Complexities with the bridge crossing include the following: 1) Requires obtaining permits such as DOH Section 401, Army Section 404, and DLNR Stream Channel Alteration Permit (SCAP), 2) Difficulty of construction with hanging utilities on bridge deck or burying under the stream, 3) Coordination with other utilities currently hanging on the bridge, 4) High construction cost, and 5) Potential spills during and after construction. Also, the sewer manhole connection point within William Henry Road is at a lower elevation than the manhole in Makahio Street (the connection point for the other routes); this will likely result in a very deep force main line at the high point at Lilipuna Road and Lilipuna Place in order to keep a full-flowing force main.

***Figure 3-4: Alternative Route 4 Map***

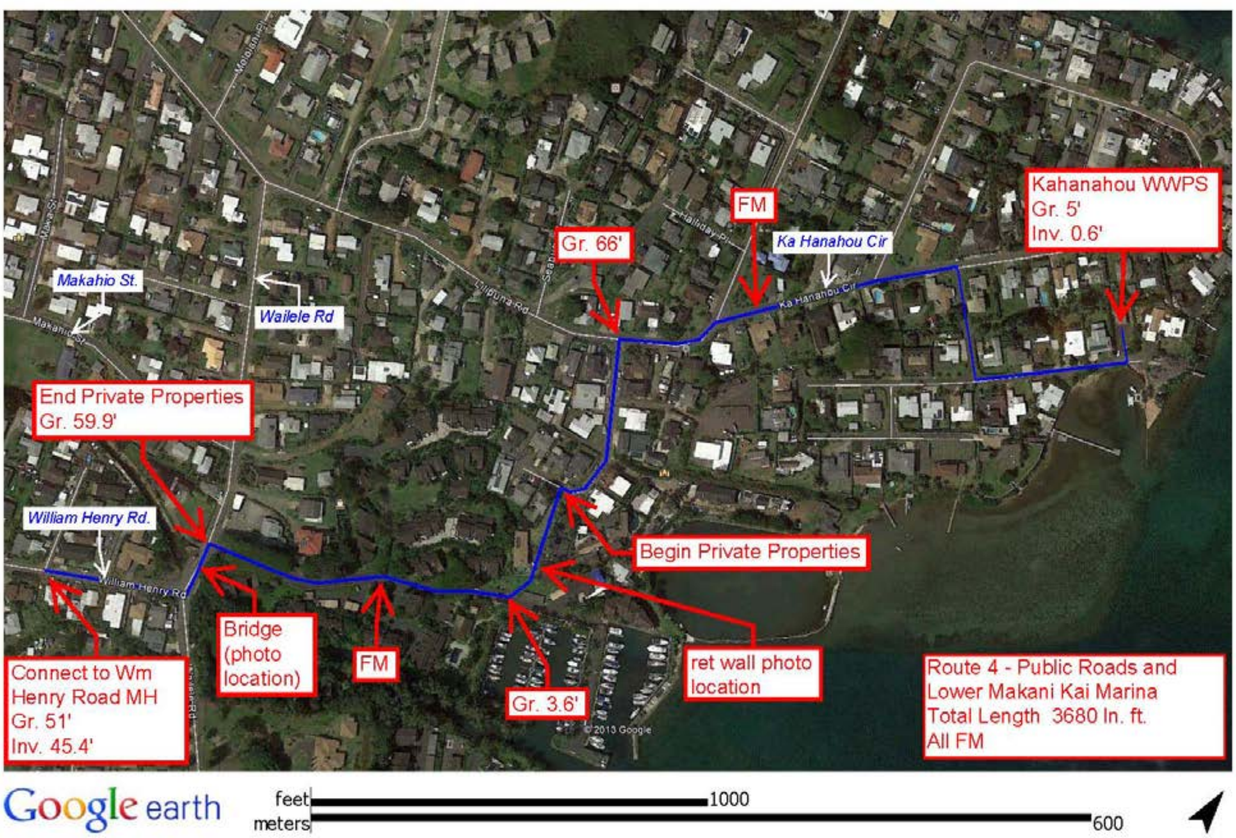


***Figure 3-5: Alternative Route 4 Photos***



Photo 4-c: Route 4
Lower Part of Marina

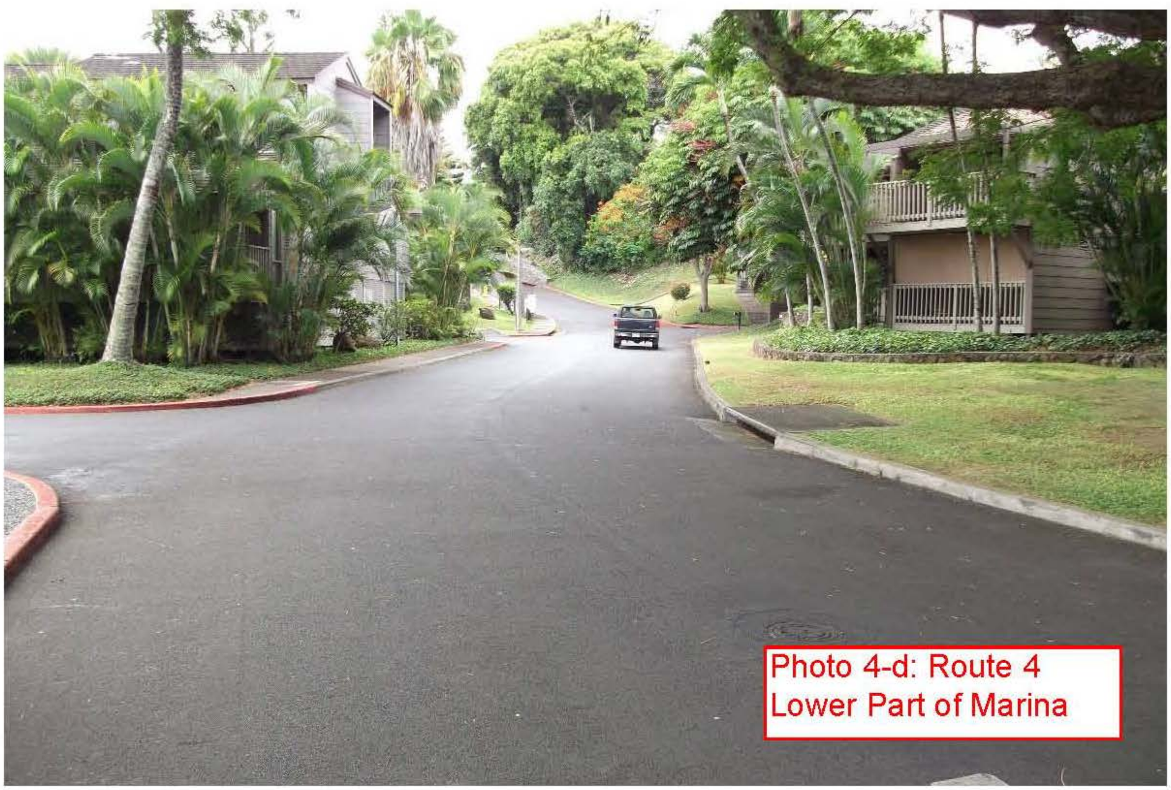


Photo 4-d: Route 4
Lower Part of Marina


Photo 4-e: Route 4
Lower Part of Marina


Photo 4-f: Route 4
Exiting the Marina onto
Wailele Street

Photo 4-g: Route 4
Wailele Rd. Bridge

Photo 4-h: Route 4
Wailele Rd. Bridge

<u>Delayed Action</u>

As an alternative to upgrading the Kahanahou WWPS and the sewer lines servicing it, the City could delay implementation of the proposed project. However, this is undesirable, as it would not allow the Kahanahou WWPS to be in compliance with the 2010 Consent Decree, which mandates that upgrades be completed by June 30, 2020. Delaying the proposed project could also result in sewage overflows and therefore possible fines.

<u>No Action</u>
Similarly, “No Action” is not considered a feasible alternative because it would not be in compliance with the 2010 Consent Decree, could result in sewage overflows and therefore possible fines.

<u>Route 2 (Chosen Alternative)</u>
Route 2 consists of a force main running west along Kahanahou Circle, turning south and running through some private properties, and ending at the existing sewer manhole on Makahio Street. This route has an acceptable total dynamic head of roughly 85 feet, avoids the problematic areas mentioned with Routes 3 and 4, and crosses through a lesser amount of private properties compared to Route 3. For these reasons, Route 2 is the chosen alignment for this project. See Attachment 7 for the TMK maps showing the affected private properties.

Route 2 Known Issues:

1. There is an existing 5’ wide easement through Mr. Robert Miyazaki’s parcel (TMK 4-5-057:015, Address: 45-2 Lilipuna Place) through which the new FM is to traverse. See Photo 2b of Figure 3-7. The existing easement is narrow because it is bounded by the overhang of the house car port. The owner’s grandson is planning on demolishing the existing house and building a new home. It is unknown when this will take place. The City may request a wider easement from the owner in the future.

2. The Makani Kai Marina (TMK 4-5-0002:001, Address: 45-995 Wailele Road) landscaped pathway is important to the manager and residents. See Photos 2-c and 2-d of Figure 3-7. It is preferred that the existing landscaping and sidewalk layout remains the same or close to it. It is likely that sidewalks and landscaping through the marina will be significantly impacted if an open-trench type installation is utilized for force main construction. The design plans will give the contractor the option to utilize a trenchless installation method (micro-tunneling) in this area.

3. There is a high point in the FM located in the Makani Kai Marina landscaped pathway. See Sheet 2 of Attachment 1. Manual air relief valves will be installed at the high points along the force main. The City will periodically open these valves to release any air in the force main; the City will take measures to control the odor emitted.

*Figure 3-6: Alternative Route 2 Map*


*Figure 3-7: Alternative Route 2 Photos*


Existing 5' wide easement
Photo 2-b: Routes 2 & 3 looking towards Photo 2-a from upper Marina


Photo 2-c: Routes 2 & 3 through upper Marina

Photo 2-d: Routes 2 & 3 through upper Marina

Photo 2-e: Routes 2 & 3 exiting Marina to private driveway to Wailele Road


### 3.2 Sewer System

The proposed 10-inch HDPE force main system will replace the existing force main from the Kahanahou WWPS. The proposed system is sized to handle the design flow selected by the City and County of Honolulu, which accounts for projected future development. The City will determine when an upgrade is necessary for the existing sewer system downstream of the proposed force main The proposed force main alignment also re-routes part of the existing Waikapoki WWPS tributary area such that less flow is directed to the Waikapoki WWPS, eliminating the need to upgrade the Waikapoki WWPS.

### 3.3 Financing

See Attachment 8 for a budgetary opinion of probable construction cost. The total estimated construction cost is roughly $1.27M, and is subject to change as design progresses.

## SECTION 4 - CONSTRUCTION

### 4.1 Summary

Upgrading the Kahanahou WWPS and constructing the new 10-inch force main from the WWPS are likely to be constructed at the same time but could also be done in two separate projects. It is unknown at this time how these projects will be phased during construction. In order to ensure that the existing sewer system service continues uninterrupted, a conceptual construction sequence plan has been included in the next section. This construction sequence plan assumes that the new force main will be constructed before upgrading the WWPS, and takes some measures to prepare the site for the WWPS upgrades. Additional assumptions are as follows:

- FM connections done at night
- Dry weather conditions
- One hour to make both connections
- Flow of .45 MGD (derived from average of monthly minimum flows x 2)
    - ~313 gpm
    - 18,800 gallons of storage required for one hour shut down time
- Allowed to use distribution system to temporarily store sewage (capacity unknown)
- Sufficient pumps and tankers are available to be used as backup
- Other utilities may have to be rerouted.

See Attachment 9 for a construction sequence site plan. A test shutdown may also be implemented to determine how much time the contractor might have to complete the connections.

### 4.2 Construction Sequence

Force Main in WWPS Site:

1. Install new piping, valves, and vaults up to the connection points – flow tube and ball valve within the site but away from proposed generator building footprint.

2. Prepare connection points:
    a. Flow tube
        i. Open trench, outlet side of existing vault
        ii. Existing pipe is HDPE
        iii. New pipe installed up to connection point
        iv. Complete any pre-assemblies
    b. Ball valve
        i. Opening in vault wall for pipe penetration

ii. Existing pipe is HDPE
iii. New pipe installed up to connection point
iv. Complete any pre-assemblies.

3. Install temporary above ground piping system as a backup.
4. Install temporary pumps with intakes in wet wells and discharge in tankers:
   a. Only as backup.
   b. Use distribution system as storage.
   c. Monitor lowest manhole.
   d. Pump as needed.

5. Make connections:
   a. Night construction and weather conditions as close to ideal as possible.
   b. Stop flow into WWPS.
   c. Shut off booster pumps.
   d. Make connections simultaneously.

6. Start up boosters.

7. Shut off temporary pumps, demob pumps/tankers.

8. Backfill trenches.

Gravity Main in WWPS Site:

1. Install new sewer line outside of proposed generator building footprint.

2. Install and run bypass system from MH fronting WWPS site to MH near wet well.

3. Install two new MH between the two MH described above and connect to new pipe.

4. Remove temporary bypass.

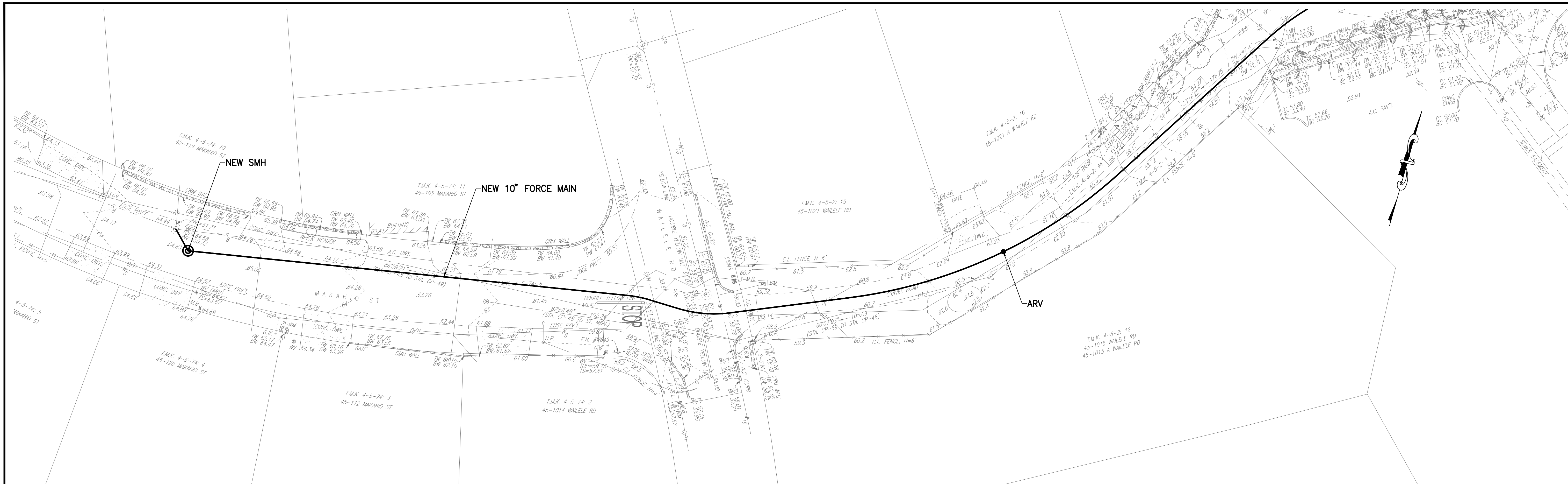
Construction Method Notes:
- Other options to minimize down time during the connection will be explored.
- Other methods of handling the sewage flow during the connections will be explored as well; the method used will be the City-approved method.

- Trenchless installation methods may be utilized in certain areas to minimize disturbance to existing improvements; methods to be determined during the design phase.
- Force main construction will not cause odors to be released since it does not require opening of the existing sewer system.
- Traffic control plans will either be included in the construction documents or will be provided by the contractor.

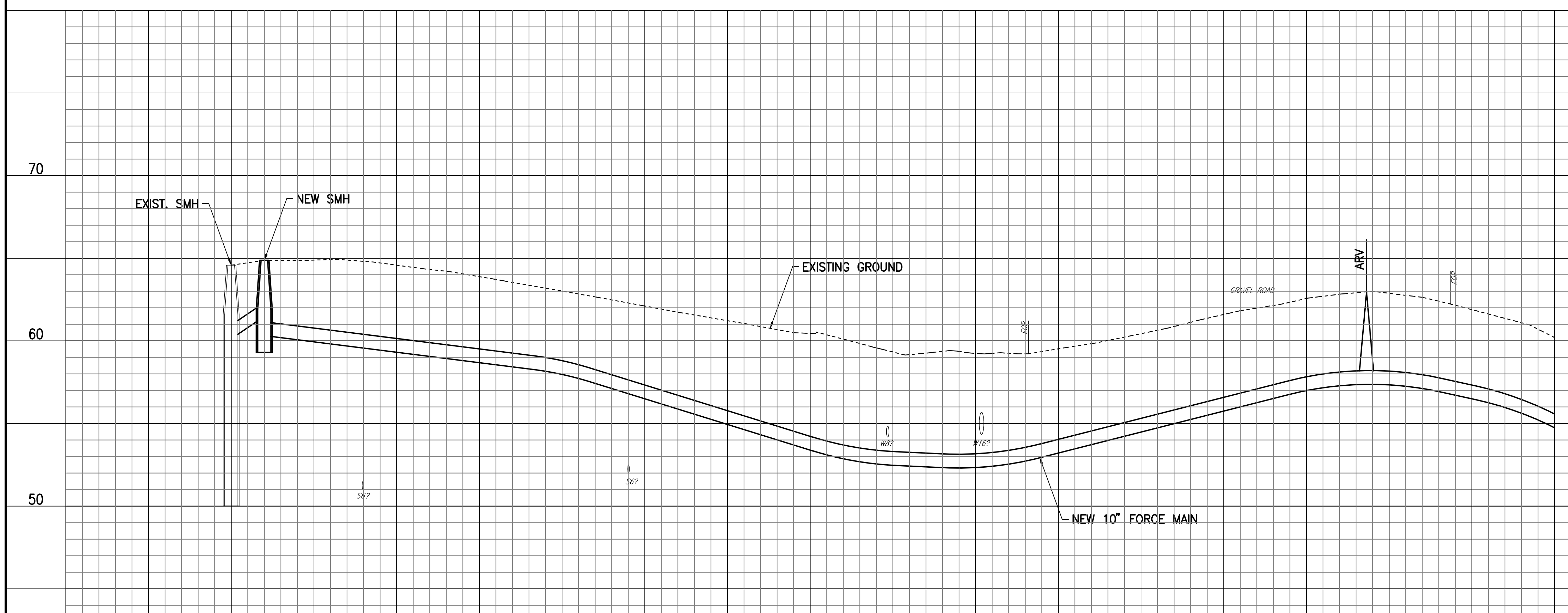
# APPENDIX

# Attachment 1

## Preliminary Plan & Profile Sheets




PLAN
SCALE: 1"=20'




PROFILE
SCALE: HORIZ. 1"=20'
VERT. 1"=4'

| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH
DRAWN BY: BKHM
APPROVED:
CHECKED BY: BKM
SECTION HEAD
BRANCH HEAD
CHIEF
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

EXPIRATION DATE OF THE LICENSE

**W8-06**

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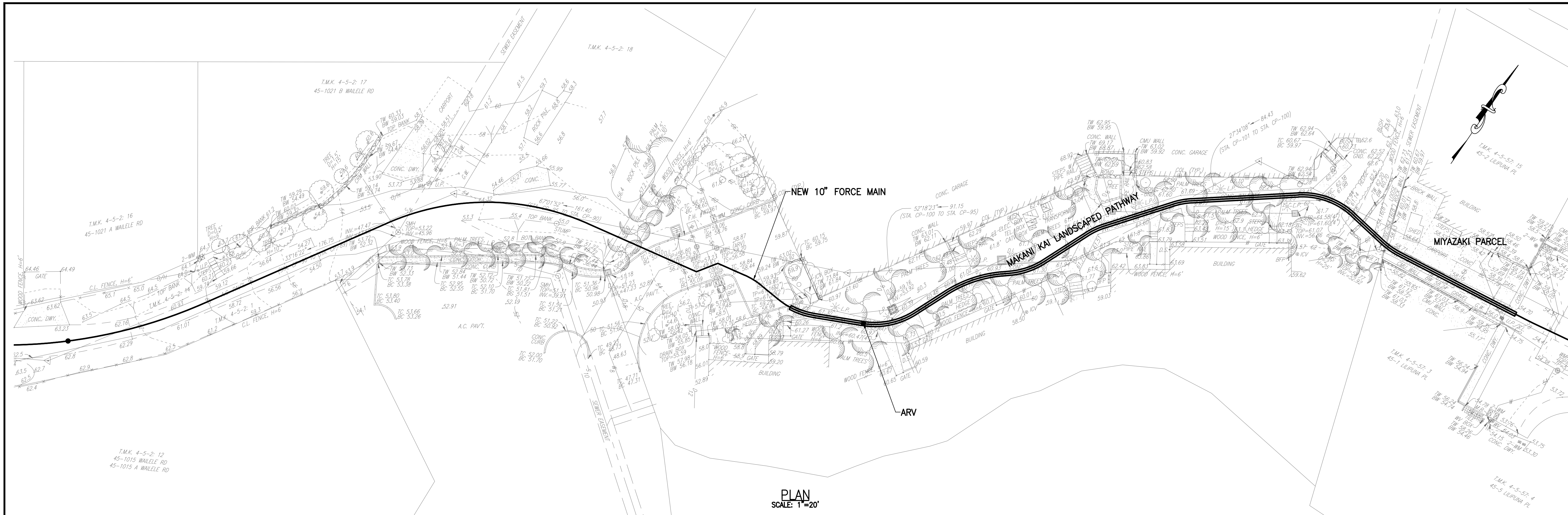


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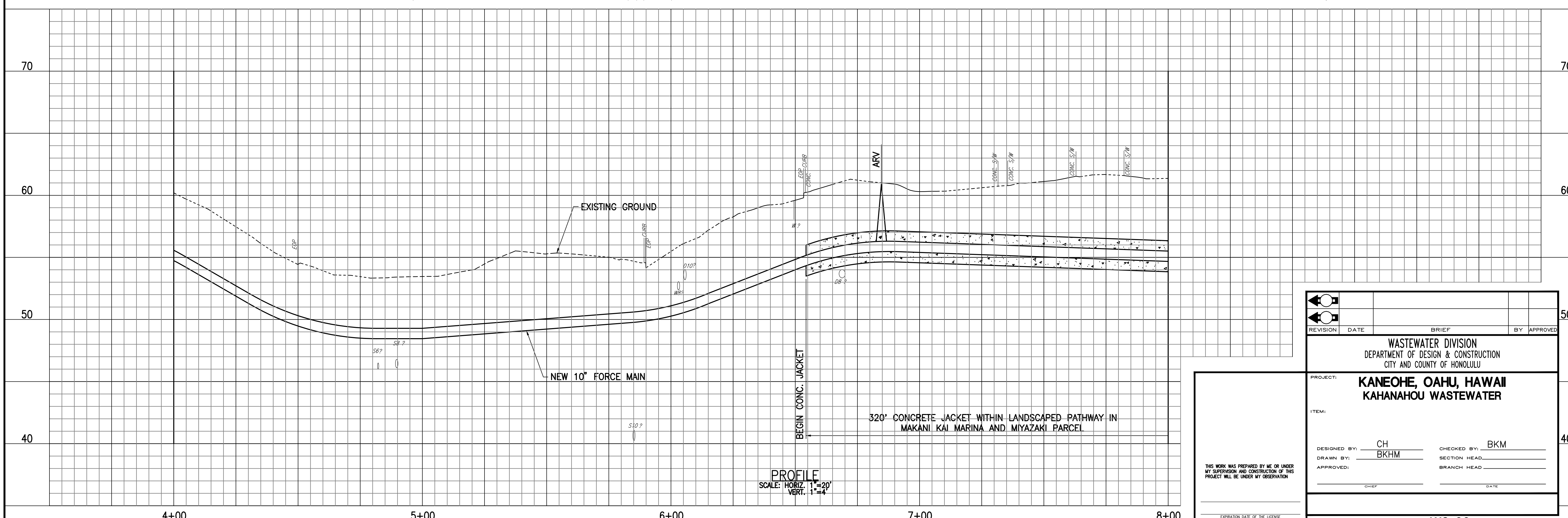
SCALE: 1"=20'




PROFILE
SCALE: HORIZ. 1"=20'
VERT. 1"=4'

| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH CHECKED BY: BKM
DRAWN BY: BKHM SECTION HEAD
APPROVED: BRANCH HEAD
CHIEF DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

EXPIRATION DATE OF THE LICENSE

**W8-06**

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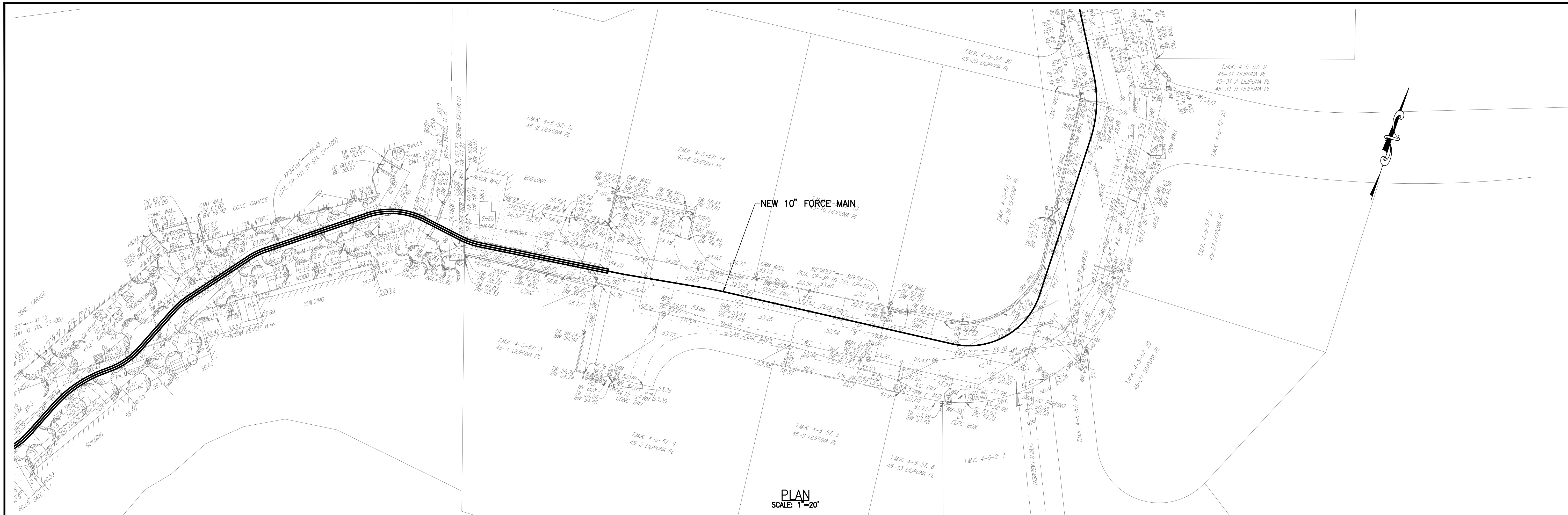


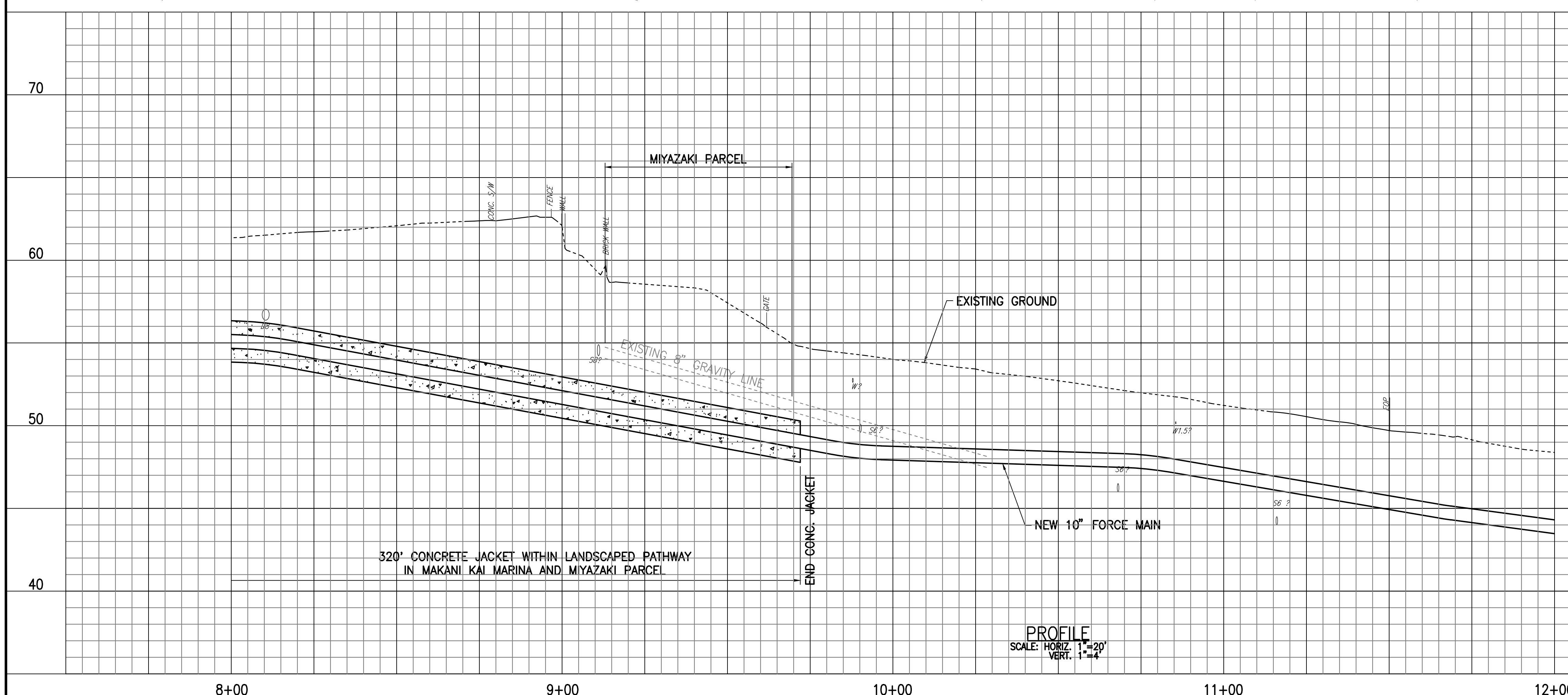


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|---|---|---|---|---|
| | | | | |

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH    CHECKED BY: BKM
DRAWN BY: BKHM    SECTION HEAD:
APPROVED:    BRANCH HEAD:
CHIEF    DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

EXPIRATION DATE OF THE LICENSE

**W8-06**

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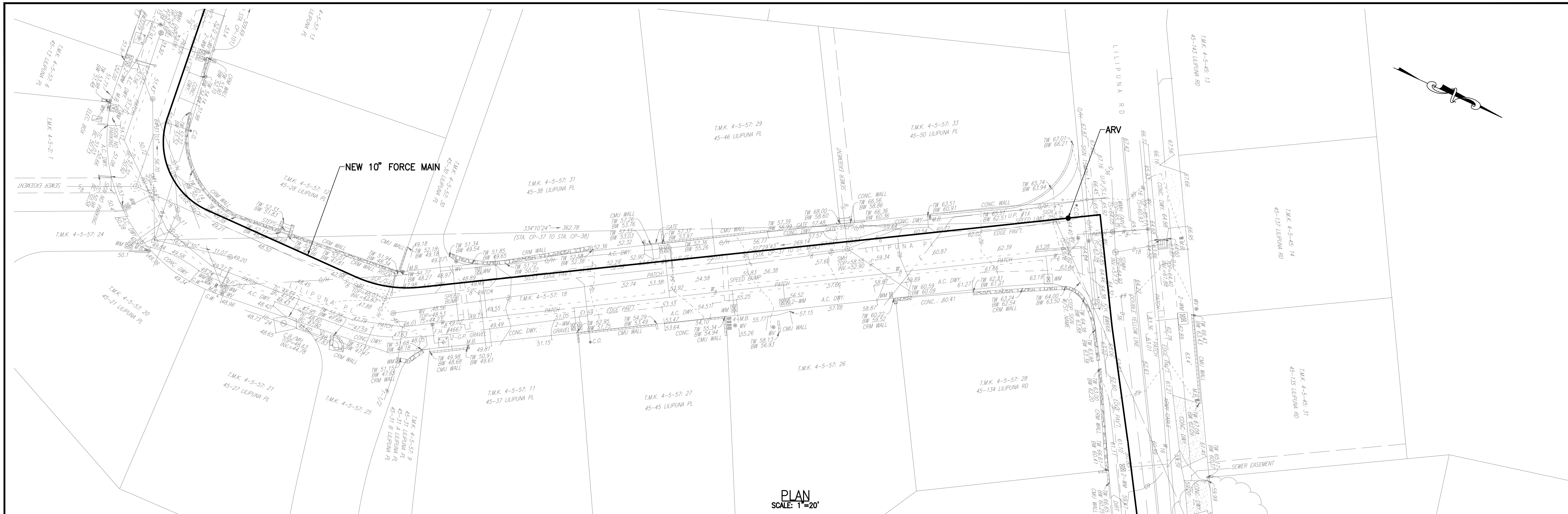
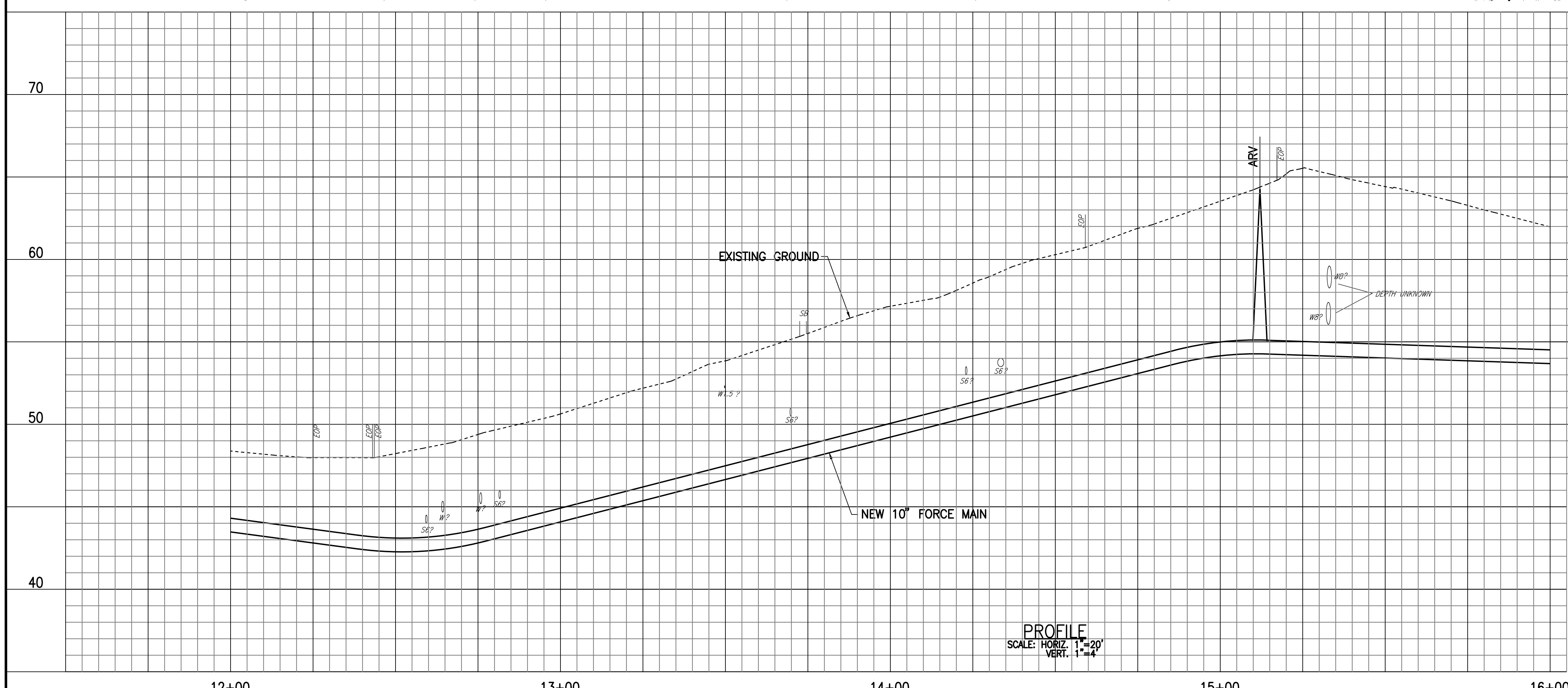



| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|
| | | | | |
| | | | | |

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH
DRAWN BY: BKHM
APPROVED:
CHIEF

CHECKED BY: BKM
SECTION HEAD
BRANCH HEAD
DATE

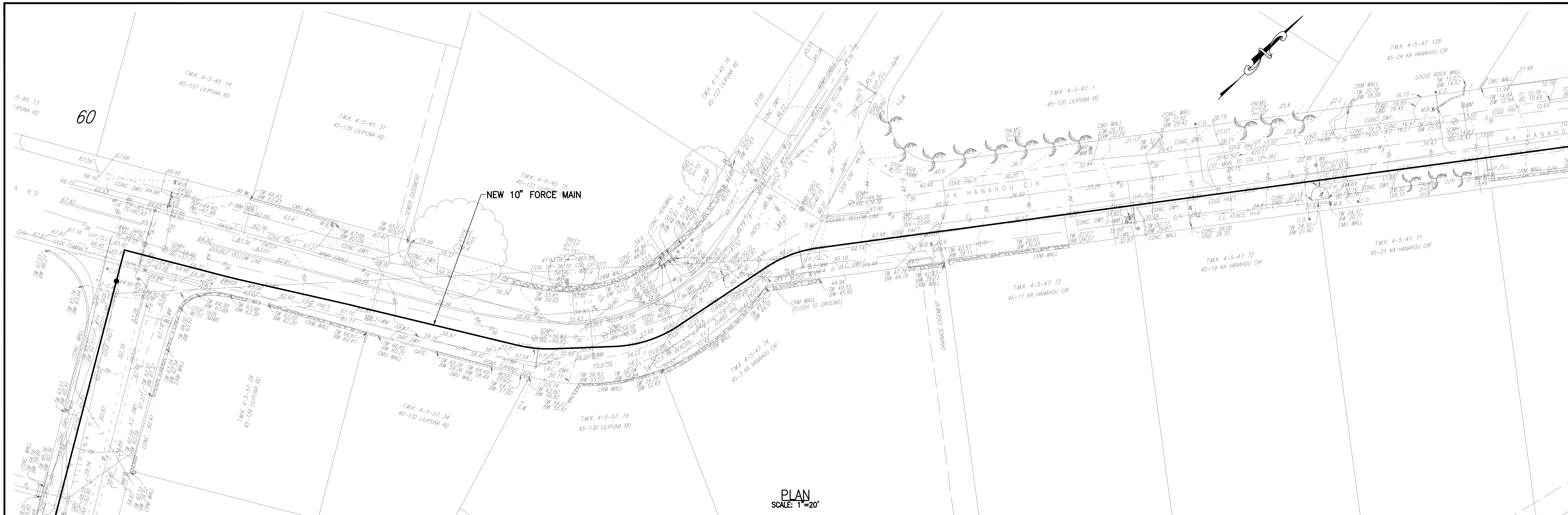
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

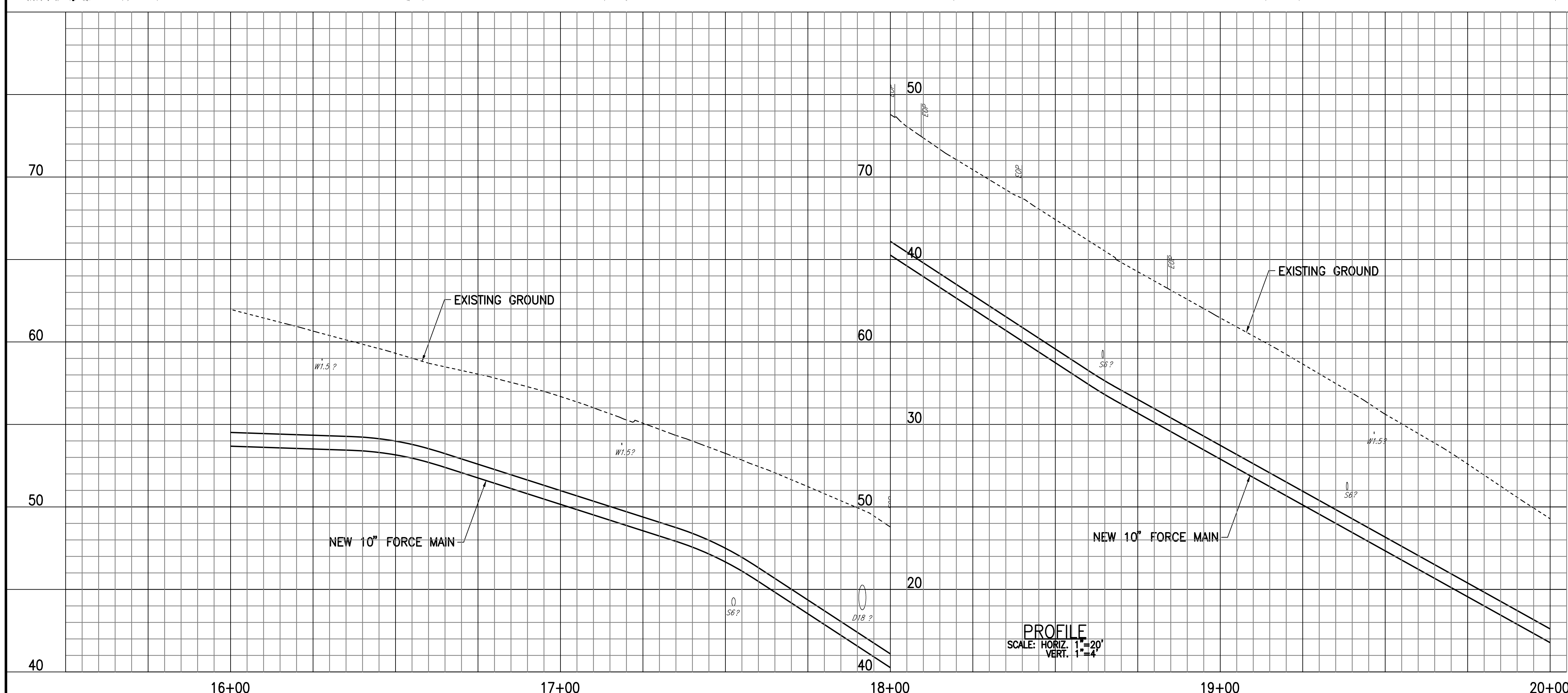
EXPIRATION DATE OF THE LICENSE

**W8-06**

DRAWING 4 SHEET ____ OF ____

| FILE | POCKET | FOLDER | NO. |
|---|---|---|---|
| | | | |




| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|
| | | | | |
| | | | | |

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH CHECKED BY: BKM
DRAWN BY: BKHM SECTION HEAD
APPROVED: BRANCH HEAD
CHIEF DATE

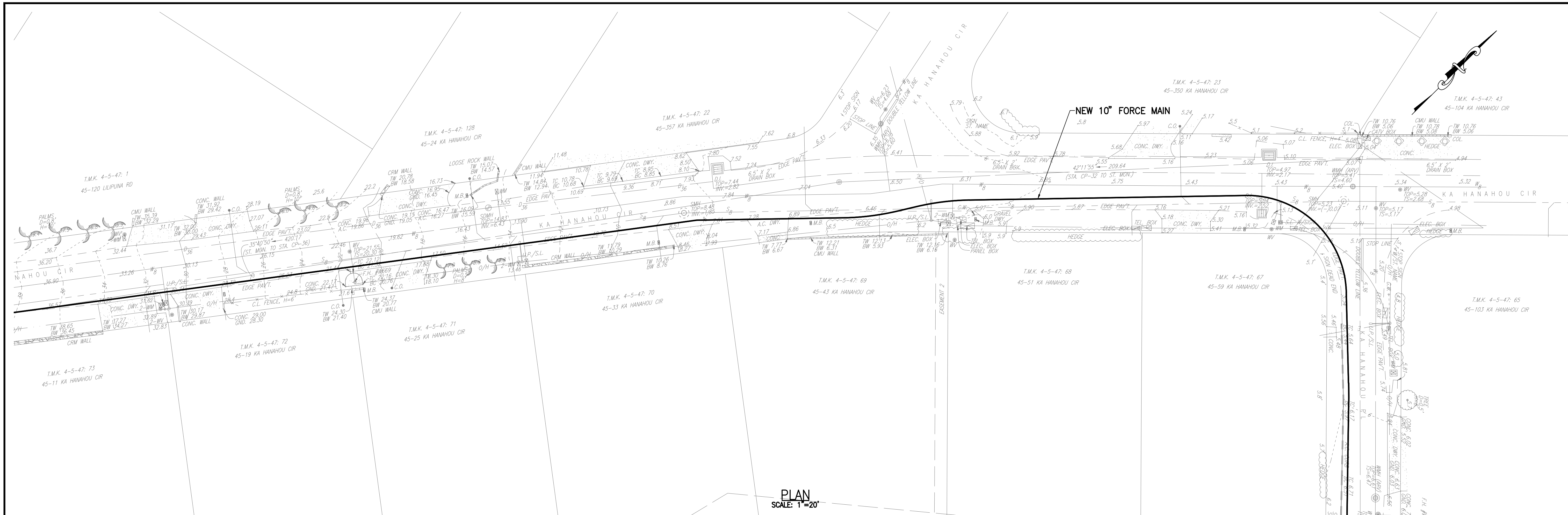
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

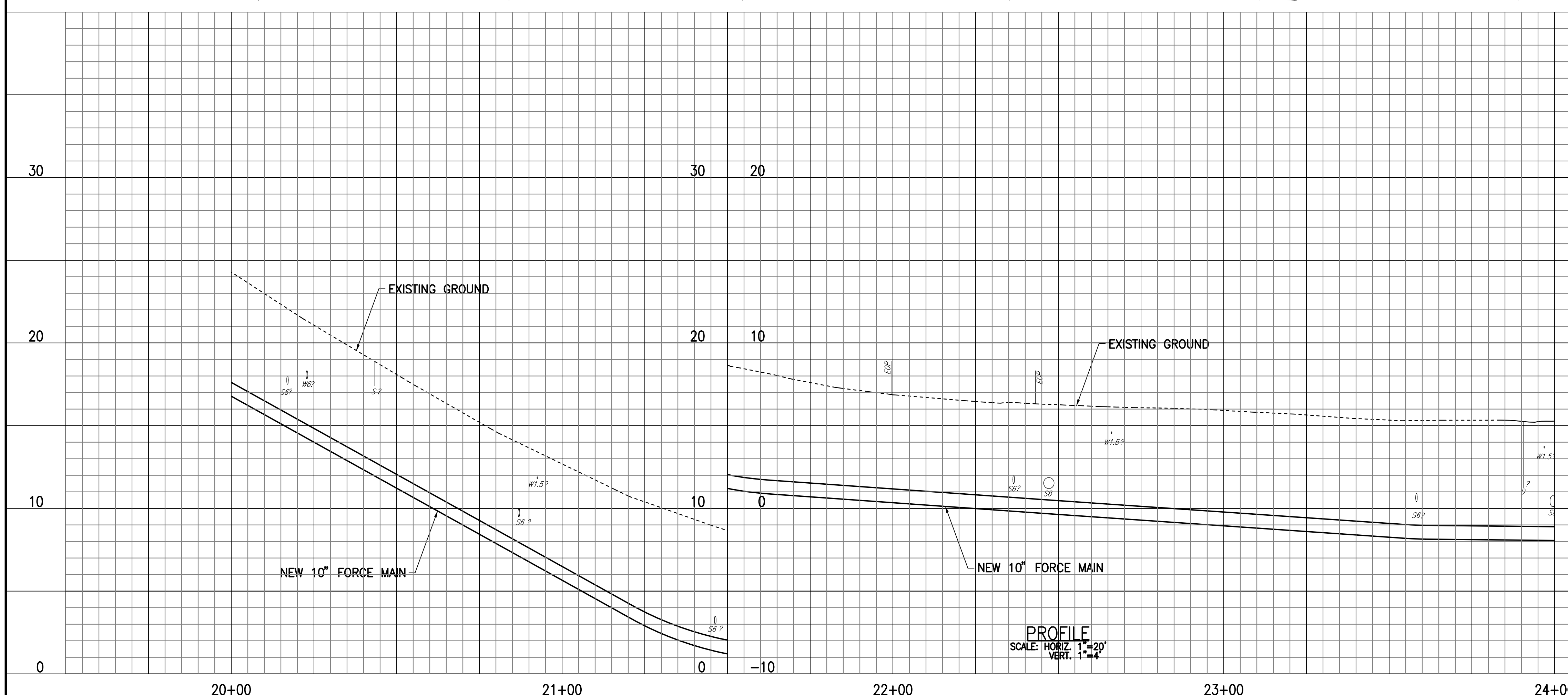
EXPIRATION DATE OF THE LICENSE

**W8-06**

DRAWING 5 SHEET ____ OF ____

| FILE | POCKET | FOLDER | NO. |
|---|---|---|---|
| | | | |




THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

EXPIRATION DATE OF THE LICENSE

| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|
| | | | | |
| | | | | |

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

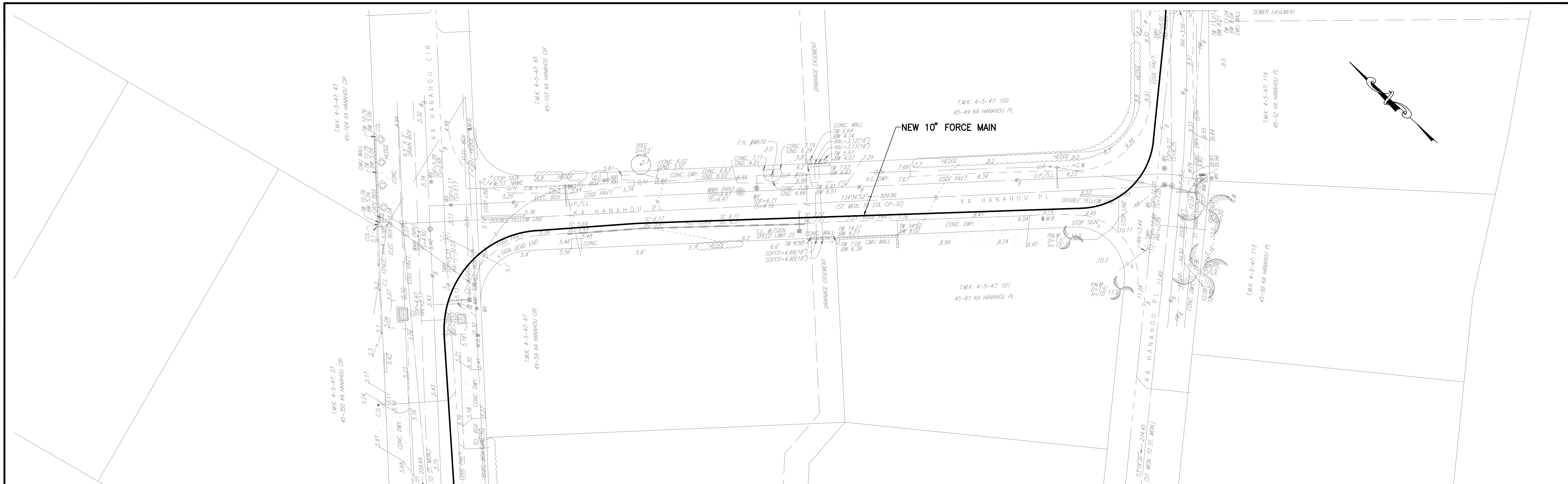
DESIGNED BY: CH
DRAWN BY: BKHM
APPROVED:
CHIEF

CHECKED BY: BKM
SECTION HEAD
BRANCH HEAD
DATE

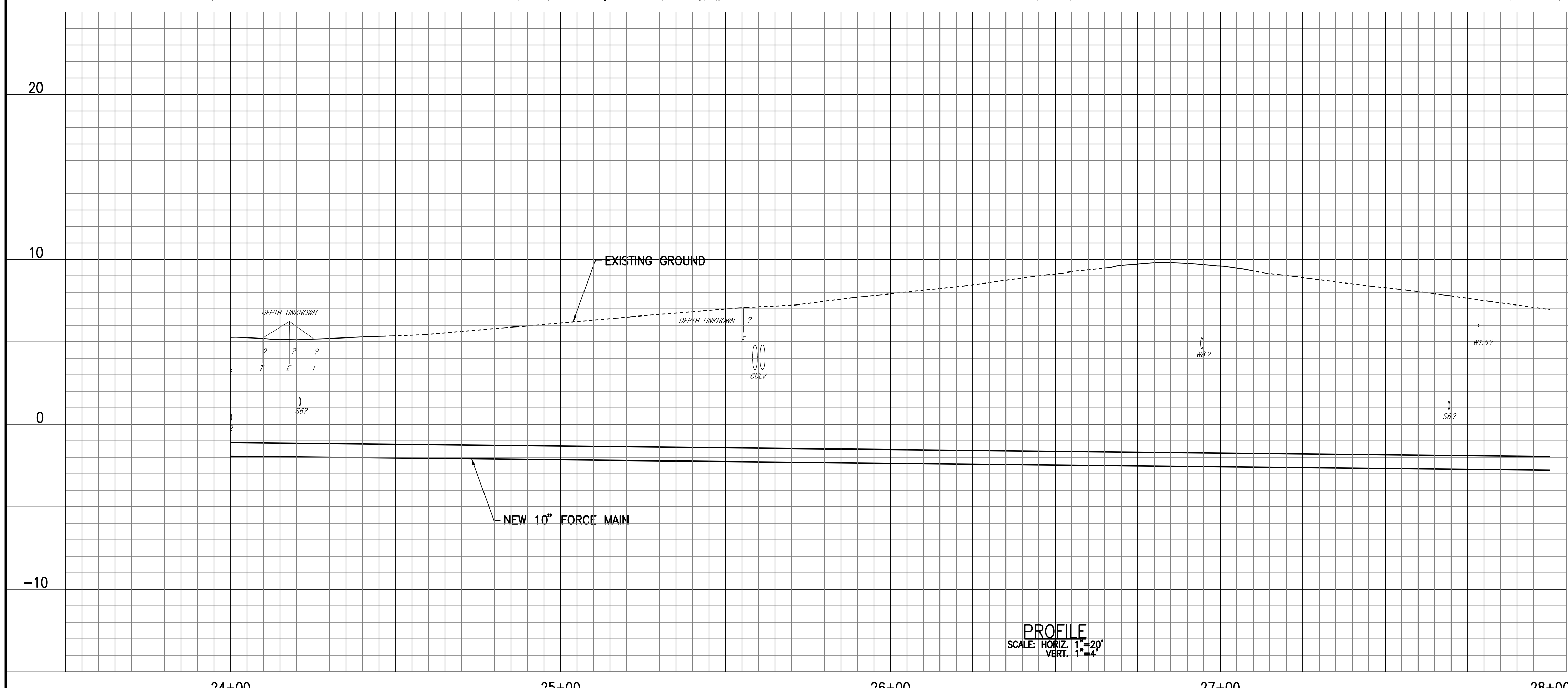
**W8-06**

DRAWING 6 SHEET ____ OF ____

| FILE | POCKET | FOLDER | NO. |
|---|---|---|---|
| | | | |




PLAN
SCALE: 1"=20'




PROFILE
SCALE: HORIZ. 1"=20'
VERT. 1"=4'

| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH
DRAWN BY: BKHM
APPROVED:
CHIEF

CHECKED BY: BKM
SECTION HEAD
BRANCH HEAD
DATE

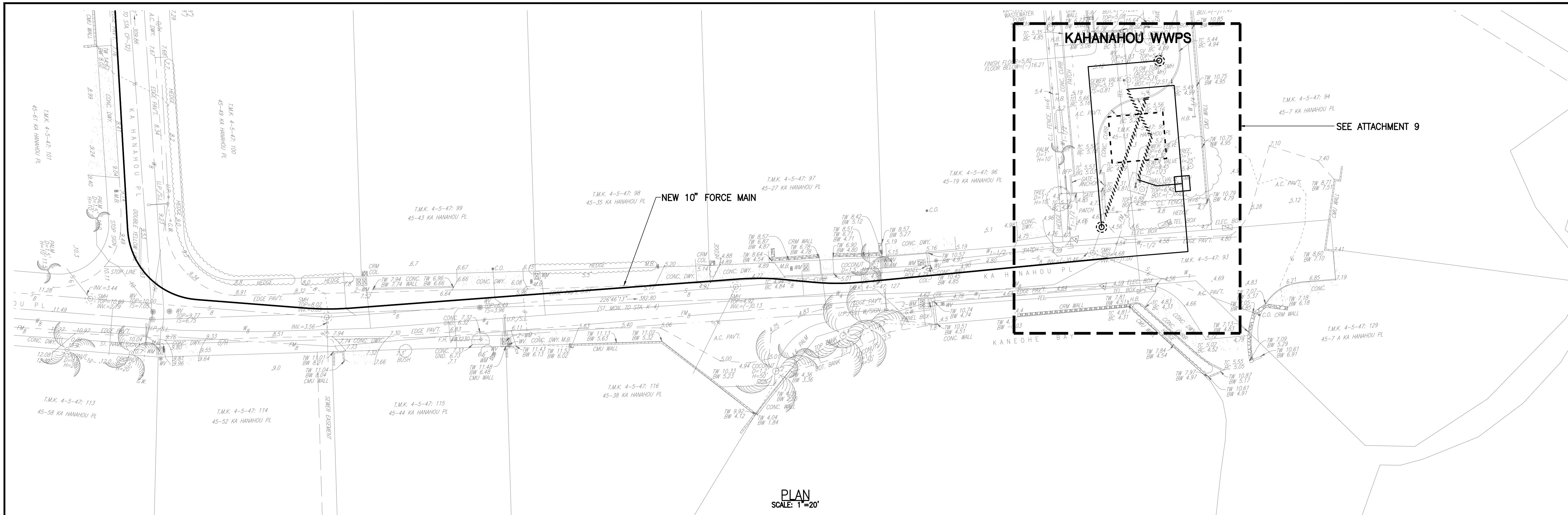
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

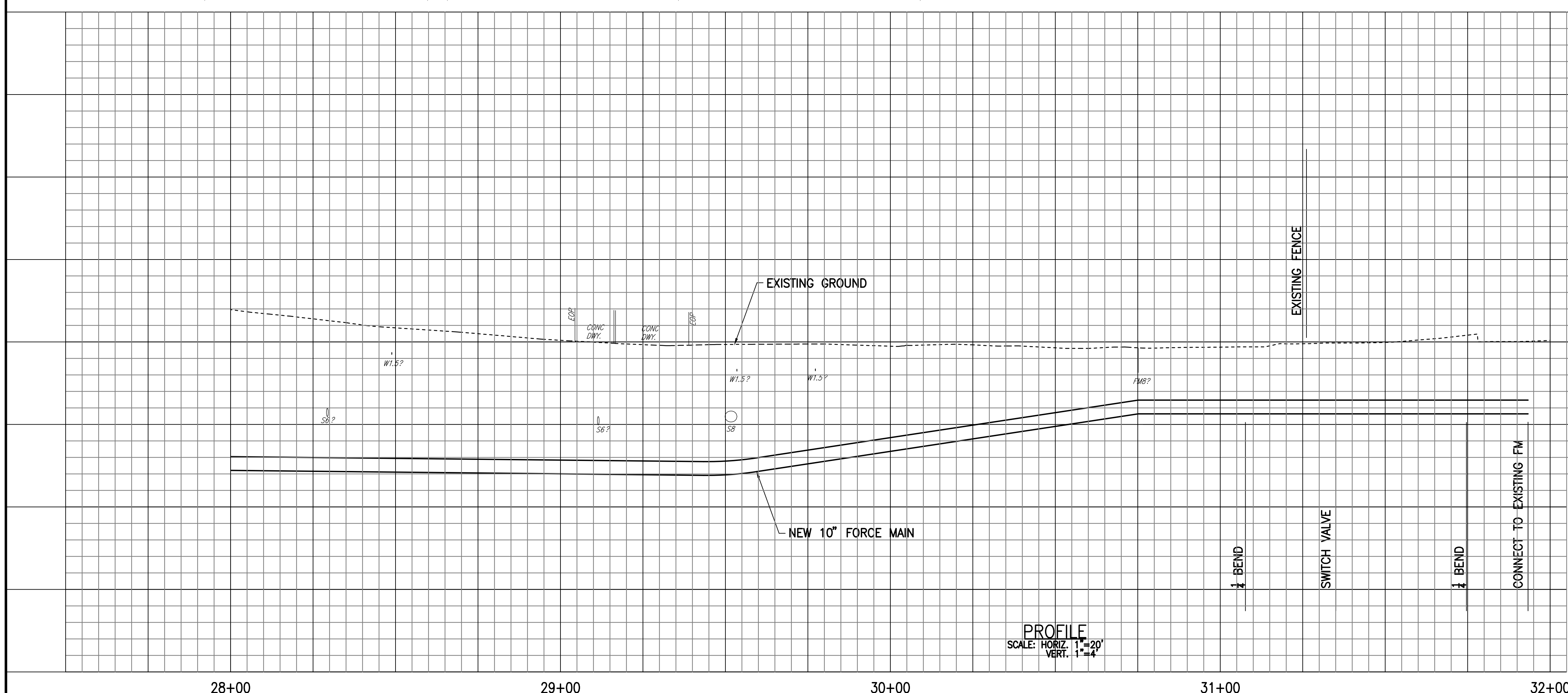
EXPIRATION DATE OF THE LICENSE

**W8-06**

DRAWING 7 SHEET ____ OF ____

| FILE | POCKET | FOLDER | NO. |
|---|---|---|---|
| | | | |




| REVISION | DATE | BRIEF | BY | APPROVED |
|---|---|---|---|---|

WASTEWATER DIVISION
DEPARTMENT OF DESIGN & CONSTRUCTION
CITY AND COUNTY OF HONOLULU

PROJECT: **KANEOHE, OAHU, HAWAII**
**KAHANAHOU WASTEWATER**

ITEM:

DESIGNED BY: CH CHECKED BY: BKM
DRAWN BY: BKHM SECTION HEAD
APPROVED: BRANCH HEAD

CHIEF DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

EXPIRATION DATE OF THE LICENSE

**W8-06**

DRAWING 8 SHEET ____ OF ____

| FILE | POCKET | FOLDER | NO. |
|---|---|---|---|

# Attachment 2

## INFIX Data Printout

PUMP STATION FLOW REPORT - EXISTING FLOW - BABBIT'S FLOW FACTOR
AREA : KANEOHE BASIN
PREPARED BY : CITY & COUNTY OF HONOLULU



Date : 01/06/11

| PLANT/ STATION | TRIBUTARY AREA (ACRES) | TRIBUTARY EQUIVALENT POPULATION RES. | OTHER | TOTAL | WASTEWATER FLOW COMPUTATION AVE. Q (MGD) | MAX FF | MAX Q (MGD) | DRY I/I (MGD) | DESIGN AVE (MGD) | DESIGN Q MAX (MGD) | WET I/I (MGD) | DESIGN Q PEAK (MGD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KK 20 | 619.7 | 8267 | 3006 | 11273 | 0.9018 | 3.08 | 2.7777 | 0.0695 | 0.9713 | 2.8472 | 0.8198 | 3.6670 |
| KK 21 | 16.2 | 373 | 12 | 385 | 0.0308 | 5.00 | 0.1541 | 0.0019 | 0.0327 | 0.1560 | 0.0202 | 0.1762 |
| KK 22 | 195.2 | 2040 | 135 | 2176 | 0.1740 | 4.28 | 0.7449 | 0.0240 | 0.1981 | 0.7690 | 0.2891 | 1.0581 |
| KK 23 | 171.6 | 1900 | 62 | 1963 | 0.1570 | 4.37 | 0.6860 | 0.0221 | 0.1791 | 0.7080 | 0.2554 | 0.9634 |
| KK 24 | 103.6 | 1154 | 17 | 1171 | 0.0936 | 4.84 | 0.4537 | 0.0128 | 0.1064 | 0.4665 | 0.1493 | 0.6158 |
| KK 30 | 4151.8 | 51276 | 40850 | 92126 | 7.3700 | 2.02 | 14.9129 | 0.6261 | 7.9960 | 15.5389 | 6.1627 | 21.7016 |
| KK 31 | 9.0 | 88 | 24 | 112 | 0.0090 | 5.00 | 0.0449 | 0.0006 | 0.0095 | 0.0454 | 0.0113 | 0.0567 |
| KK 32 | 68.6 | 832 | 22 | 854 | 0.0684 | 5.00 | 0.3418 | 0.0149 | 0.0832 | 0.3567 | 0.1218 | 0.4784 |
| KK 33 | 42.4 | 674 | 226 | 900 | 0.0720 | 5.00 | 0.3598 | 0.0095 | 0.0815 | 0.3694 | 0.0731 | 0.4424 |
| KK 34 | 142.5 | 2364 | 0 | 2364 | 0.1891 | 4.21 | 0.7961 | 0.0118 | 0.2009 | 0.8079 | 0.1781 | 0.9861 |
| KK 35 | 425.5 | 743 | 931 | 1674 | 0.1339 | 4.51 | 0.6041 | 0.0084 | 0.1423 | 0.6124 | 1.1111 | 1.7235 |
| KK 36 | 165.5 | 2354 | 2105 | 4459 | 0.3567 | 3.71 | 1.3226 | 0.0329 | 0.3896 | 1.3555 | 0.2251 | 1.5806 |
| KK 37 | 181.1 | 2695 | 277 | 2972 | 0.2377 | 4.02 | 0.9560 | 0.0459 | 0.2837 | 1.0019 | 0.3231 | 1.3251 |
| KK 45 | 27.7 | 442 | 61 | 503 | 0.0402 | 5.00 | 0.2012 | 0.0025 | 0.0428 | 0.2037 | 0.0346 | 0.2383 |
| KK 48 | 4.2 | 68 | 0 | 68 | 0.0054 | 5.00 | 0.0272 | 0.0003 | 0.0058 | 0.0275 | 0.0053 | 0.0328 |
| KK 50 | 464.4 | 4724 | 1078 | 5802 | 0.4642 | 3.52 | 1.6328 | 0.0869 | 0.5511 | 1.7197 | 0.7669 | 2.4866 |
| KK 51 | 280.9 | 2658 | 797 | 3455 | 0.2764 | 3.90 | 1.0784 | 0.0610 | 0.3374 | 1.1394 | 0.4651 | 1.6045 |
| KK 52 | 175.7 | 1763 | 776 | 2538 | 0.2031 | 4.15 | 0.8428 | 0.0536 | 0.2567 | 0.8964 | 0.3193 | 1.2157 |
| KK 53 | 42.0 | 392 | 19 | 411 | 0.0329 | 5.00 | 0.1645 | 0.0061 | 0.0390 | 0.1706 | 0.0815 | 0.2521 |

PUMP STATION FLOW REPORT - FUTURE FLOW - BABBIT'S FLOW FACTOR
AREA : KANEOHE BASIN
PREPARED BY : CITY & COUNTY OF HONOLULU

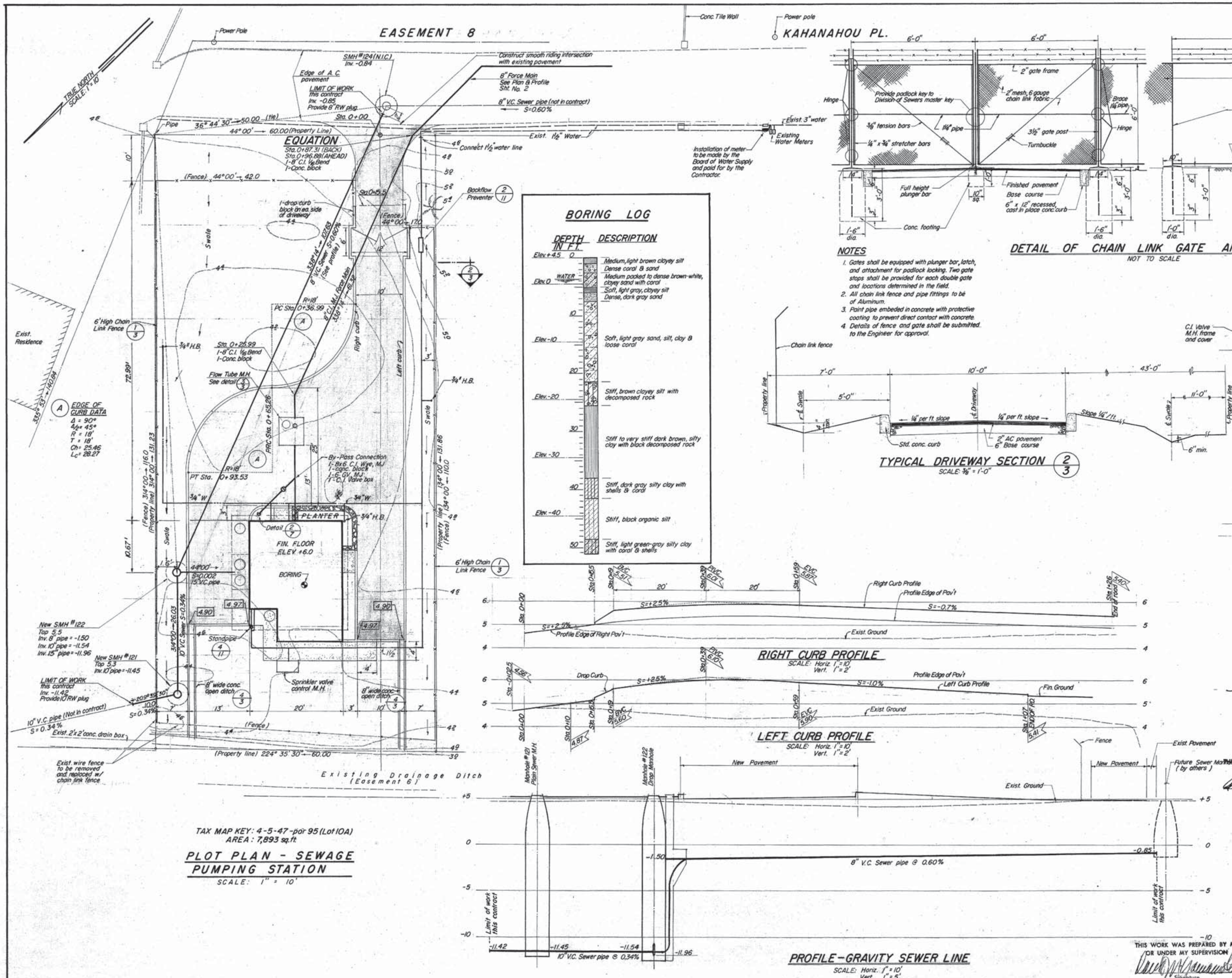


Date : 01/06/11

| PLANT/ STATION | TRIBUTARY AREA (ACRES) | TRIBUTARY EQUIVALENT POPULATION RES. | OTHER | TOTAL | WASTEWATER FLOW COMPUTATION AVE. Q (MGD) | MAX FF | MAX Q (MGD) | DRY I/I (MGD) | DESIGN AVE (MGD) | DESIGN Q MAX (MGD) | WET I/I (MGD) | DESIGN Q PEAK (MGD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KK 20 | 892.7 | 18101 | 4398 | 22500 | 1.8001 | 2.68 | 4.8286 | 0.2966 | 2.0967 | 5.1252 | 1.5703 | 6.6955 |
| KK 21 | 162.4 | 2780 | 12 | 2792 | 0.2234 | 4.07 | 0.9095 | 0.0858 | 0.3091 | 0.9953 | 0.4223 | 1.4176 |
| KK 22 | 313.0 | 4721 | 1314 | 6035 | 0.4829 | 3.49 | 1.6853 | 0.1343 | 0.6172 | 1.8196 | 0.6130 | 2.4326 |
| KK 23 | 178.2 | 2943 | 56 | 2999 | 0.2400 | 4.01 | 0.9631 | 0.0363 | 0.2762 | 0.9994 | 0.2736 | 1.2730 |
| KK 24 | 110.3 | 1747 | 17 | 1763 | 0.1411 | 4.46 | 0.6298 | 0.0202 | 0.1613 | 0.6500 | 0.1675 | 0.8176 |
| KK 30 | 4470.7 | 83082 | 46631 | 129713 | 10.3771 | 1.89 | 19.6087 | 1.0568 | 11.4339 | 20.6655 | 7.0392 | 27.7047 |
| KK 31 | 9.0 | 88 | 97 | 185 | 0.0148 | 5.00 | 0.0739 | 0.0009 | 0.0157 | 0.0748 | 0.0113 | 0.0861 |
| KK 32 | 76.0 | 1123 | 18 | 1141 | 0.0913 | 4.87 | 0.4447 | 0.0206 | 0.1120 | 0.4653 | 0.1422 | 0.6075 |
| KK 33 | 42.4 | 757 | 261 | 1018 | 0.0814 | 4.98 | 0.4055 | 0.0113 | 0.0927 | 0.4168 | 0.0731 | 0.4899 |
| KK 34 | 142.5 | 2643 | 0 | 2643 | 0.2115 | 4.12 | 0.8705 | 0.0132 | 0.2247 | 0.8837 | 0.1781 | 1.0618 |
| KK 35 | 425.5 | 811 | 931 | 1742 | 0.1394 | 4.47 | 0.6236 | 0.0087 | 0.1481 | 0.6323 | 1.1111 | 1.7434 |
| KK 36 | 170.9 | 3850 | 2177 | 6027 | 0.4822 | 3.49 | 1.6833 | 0.0440 | 0.5262 | 1.7274 | 0.2398 | 1.9671 |
| KK 37 | 188.5 | 3260 | 405 | 3665 | 0.2932 | 3.86 | 1.1306 | 0.0567 | 0.3499 | 1.1874 | 0.3436 | 1.5310 |
| KK 45 | 27.7 | 530 | 61 | 591 | 0.0473 | 5.00 | 0.2365 | 0.0030 | 0.0503 | 0.2395 | 0.0346 | 0.2740 |
| KK 48 | 4.2 | 92 | 0 | 92 | 0.0074 | 5.00 | 0.0369 | 0.0005 | 0.0078 | 0.0373 | 0.0053 | 0.0426 |
| KK 50 | 464.4 | 7198 | 1145 | 8343 | 0.6675 | 3.27 | 2.1834 | 0.1114 | 0.7788 | 2.2947 | 0.7669 | 3.0616 |
| KK 51 | 280.9 | 4637 | 831 | 5468 | 0.4375 | 3.56 | 1.5572 | 0.0824 | 0.5198 | 1.6395 | 0.4651 | 2.1046 |
| KK 52 | 175.7 | 2983 | 776 | 3759 | 0.3007 | 3.84 | 1.1536 | 0.0692 | 0.3699 | 1.2228 | 0.3193 | 1.5421 |
| KK 53 | 42.0 | 643 | 19 | 662 | 0.0529 | 5.00 | 0.2647 | 0.0122 | 0.0651 | 0.2769 | 0.0815 | 0.3584 |

# Attachment 3

## Boring Log Plan Sheet




THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION
Signature

RUSSELL L. SMITH, JR. REGISTERED PROFESSIONAL ENGINEER No. 711 HAWAII, U.S.A.

DAVID M. YAMAMOTO REGISTERED PROFESSIONAL ENGINEER No. 1399 HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION
Signature

| REVISION | DATE | BRIEF | MADE BY | APPROVED |
|---|---|---|---|---|

ASA AUSTIN, SMITH & ASSOC., INC.
ENGINEERS HONOLULU, HAWAII

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
DIVISION OF SEWERS

KAHANAHOU SEWAGE PUMPING STATION & FORCE MAIN
KANEOHE, KOOLAUPOKO, OAHU, HAWAII

PLOT PLAN & SITE DETAILS

DESIGNED BY | TRACED BY | CHECKED BY
APPROVED: March 3, 1964
DIRECTOR, DIVISION OF SEWERS | REG. ENGINEER CERTIFICATE NO. 711

JOB NO. 63-63 SHEET NO. 3 OF 16 SHEETS

| FILE | POCKET | FOLDER | NO. |
|---|---|---|---|
| 11 | 7 | 3 | 4C |

# Attachment 4

## FEMA Flood Zone Map


tional Flood Insurance Program at 1-800-638-6620.

**MAP SCALE 1" = 1000'**

00 0 1000 2000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0270H

# FIRM

## FLOOD INSURANCE RATE MAP

**CITY AND COUNTY OF HONOLULU, HAWAII**

**PANEL 270 OF 395**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
| --- | --- | --- | --- |
| HONOLULU, CITY AND COUNTY OF | 150001 | 0270 | H |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER 15003C0270H**

**MAP REVISED JANUARY 19, 2011**

**Federal Emergency Management Agency**

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

# Attachment 5

## Design Flow Guidance Email

| | |
|---|---|
| **From:** | Nikaido, Jason Y |
| **To:** | "bmeyers@okahara.com"; Tamashiro, Roy J |
| **Cc:** | "Tyson Toyama"; hilo@okahara.com; Oahu Office |
| **Subject:** | RE: Design Flow for Kahanahou |
| **Date:** | Wednesday, June 19, 2013 12:33:08 PM |

Bruce –

The 2-year flow is 1.18 mgd. The 5-year flow is 1.27 mgd. Both flows are for the 24-hour design storm as they are higher than the 6-hour storm. Based on the small difference, I would recommend designing to the 5-year flow. The results are from the 2030b – 2yr model which means 2030 flows with all 2-year bottlenecks removed. Please let me know if you have any questions.

Jason Nikaido, P.E.
City and County of Honolulu
Department of Design and Construction
Wastewater Division, Collection System Engr. Branch
650 S. King Street, 14th Floor
Honolulu, HI 96813
jnikaido@honolulu.gov
Phone: (808) 768 - 8775
Fax: (808) 768 - 4642

---

**From:** Bruce K. Meyers [mailto:bmeyers@okahara.com]
**Sent:** Wednesday, June 19, 2013 9:29 AM
**To:** Tamashiro, Roy J
**Cc:** Nikaido, Jason Y; 'Tyson Toyama'; hilo@okahara.com; Oahu Office
**Subject:** Design Flow for Kahanahou

Hi Roy,

It was good talking to you yesterday. I'll be sending the revised schedule today or tomorrow. Also, we discussed what design flow to use and that you were going to follow-up on what that will be for our DAR/PER purposes. If that has been determined, please send it at your earliest convenience.

Thank you,
Bruce
210-002

# Attachment 6

## Force Main Calculations

# TOTAL DYNAMIC HEAD CALCULATIONS FOR ROUTE 2

**STATIC HEAD LOSSES**

| | |
|---|---|
| Pump Off Elev at intake in pump house = | -14.5 ft |
| Discharge Elev (Sta. 0+00) = | 60 ft |
| **Static Head Loss =** | **-74.5 ft** |

**PIPE FRICTION LOSSES**

*See FlowMaster Worksheets:*

| | |
|---|---|
| Existing 8" FM (25 linear feet) = | -0.28 ft |
| New 10" FM (3,195 linear feet) = | -11.97 ft |
| **Total Pipe Friction Loss =** | **-12.25 ft** |

**FIXTURE LOSSES**

| | |
|---|---|
| Along Exist 8" FM: | |
| 8"x6" D.I. Wye, M.J. | 14 ft |
| 8" Venturi Meter | 6 ft |
| 8" Valve | 6 ft |
| 8" HDPE Flanged Adapter | -- ft |
| Equivalent Straight Pipe Length = | 26 ft |
| Fixture Loss = | -0.29 ft |
| Along New 10" FM: | |
| 10"x8" 90 Degree Reducing Elbow | 26 ft |
| 10" 90 Degree Bend | 26 ft |
| 10" 90 Degree Bend | 26 ft |
| 10" Switch Valve | 7 ft |
| 10" 90 Degree Bend | 26 ft |
| 10" 45 Degree Bend | 14 ft |
| Air Relief Valve (ARV) | 7 ft |
| Air Relief Valve (ARV) | 7 ft |
| Air Relief Valve (ARV) | 7 ft |
| Equivalent Straight Pipe Length = | 146 ft |
| Fixture Loss = | -0.55 ft |
| **Total Fixture Losses =** | **-0.84 ft** |

| | |
|---|---|
| **TOTAL DYNAMIC HEAD LOSS =** | **-88 ft** |

Assumed friction loss in pump house is less than 12 feet.

# FlowMaster Worksheet - Exist 8" Force Main (Kahanahou WWPS to New FM)
## Worksheet for Pressure Pipe

| Project Description | |
|---|---|
| Worksheet | Exist 8" Force Main (Kahanahou WWF |
| Flow Element | Pressure Pipe |
| Method | Hazen-Williams Formula |
| Solve For | Pressure at 1 |

| Input Data | | |
|---|---|---|
| Pressure at : | 20.78 | psi |
| Elevation at | 1.50 | ft |
| Elevation at | 1.50 | ft |
| Length | 25.00 | ft |
| C Coefficien | 150.0 | |
| Diameter | 8 | in |
| Discharge | 1.270 | mg( |

| Results | | |
|---|---|---|
| Pressure at 1 | 20.66 | psi |
| Headloss | -0.28 | ft |
| Energy Grade at | 49.65 | ft |
| Energy Grade at | 49.92 | ft |
| Hydraulic Grade : | 49.15 | ft |
| Hydraulic Grade : | 49.43 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 2.09 | ft |
| Velocity | 5.63 | ft/s |
| Velocity Head | 0.49 | ft |
| Friction Slope | ).011110 | ft/ft |

# FlowMaster Worksheet - Proposed 10" Force Main (Exist 8" FM to Makahio SMH)
## Worksheet for Pressure Pipe

| Project Description | |
|---|---|
| Worksheet | Proposed 10" Force Main (Exist 8" FM to M |
| Flow Element | Pressure Pipe |
| Method | Hazen-Williams Formula |
| Solve For | Pressure at 1 |

| Input Data | | |
|---|---|---|
| Pressure at : | 0.00 | psi |
| Elevation at | 1.50 | ft |
| Elevation at | 61.40 | ft |
| Length | ,195.00 | ft |
| C Coefficien | 150.0 | |
| Diameter | 10 | in |
| Discharge | 1.270 | mg( |

| Results | | |
|---|---|---|
| Pressure at 1 | 20.78 | psi |
| Headloss | -11.97 | ft |
| Energy Grade at | 49.63 | ft |
| Energy Grade at | 61.60 | ft |
| Hydraulic Grade a | 49.43 | ft |
| Hydraulic Grade a | 61.40 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 2.62 | ft |
| Velocity | 3.60 | ft/s |
| Velocity Head | 0.20 | ft |
| Friction Slope | ı.003747 | ft/ft |

# FlowMaster Worksheet - Exist 8" Force Main Fixture Losses
## Worksheet for Pressure Pipe

| Project Description | |
|---|---|
| Worksheet | Exist 8" Force Main - Fixture L |
| Flow Element | Pressure Pipe |
| Method | Hazen-Williams Formula |
| Solve For | Pressure at 1 |

| Input Data | | |
|---|---|---|
| Pressure at : | 20.78 | psi |
| Elevation at | 1.50 | ft |
| Elevation at | 1.50 | ft |
| Length | 26.00 | ft |
| C Coefficien | 150.0 | |
| Diameter | 8 | in |
| Discharge | 1.270 | mg( |

| Results | | |
|---|---|---|
| Pressure at 1 | 20.65 | psi |
| Headloss | -0.29 | ft |
| Energy Grade at | 49.63 | ft |
| Energy Grade at | 49.92 | ft |
| Hydraulic Grade a | 49.14 | ft |
| Hydraulic Grade a | 49.43 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 2.09 | ft |
| Velocity | 5.63 | ft/s |
| Velocity Head | 0.49 | ft |
| Friction Slope | 0.011110 | ft/ft |

# FlowMaster Worksheet - Proposed 10" Force Main Fixture Losses
## Worksheet for Pressure Pipe

| Project Description | |
|---|---|
| Worksheet | Proposed 10" Force Main - Fixtur |
| Flow Element | Pressure Pipe |
| Method | Hazen-Williams Formula |
| Solve For | Pressure at 1 |

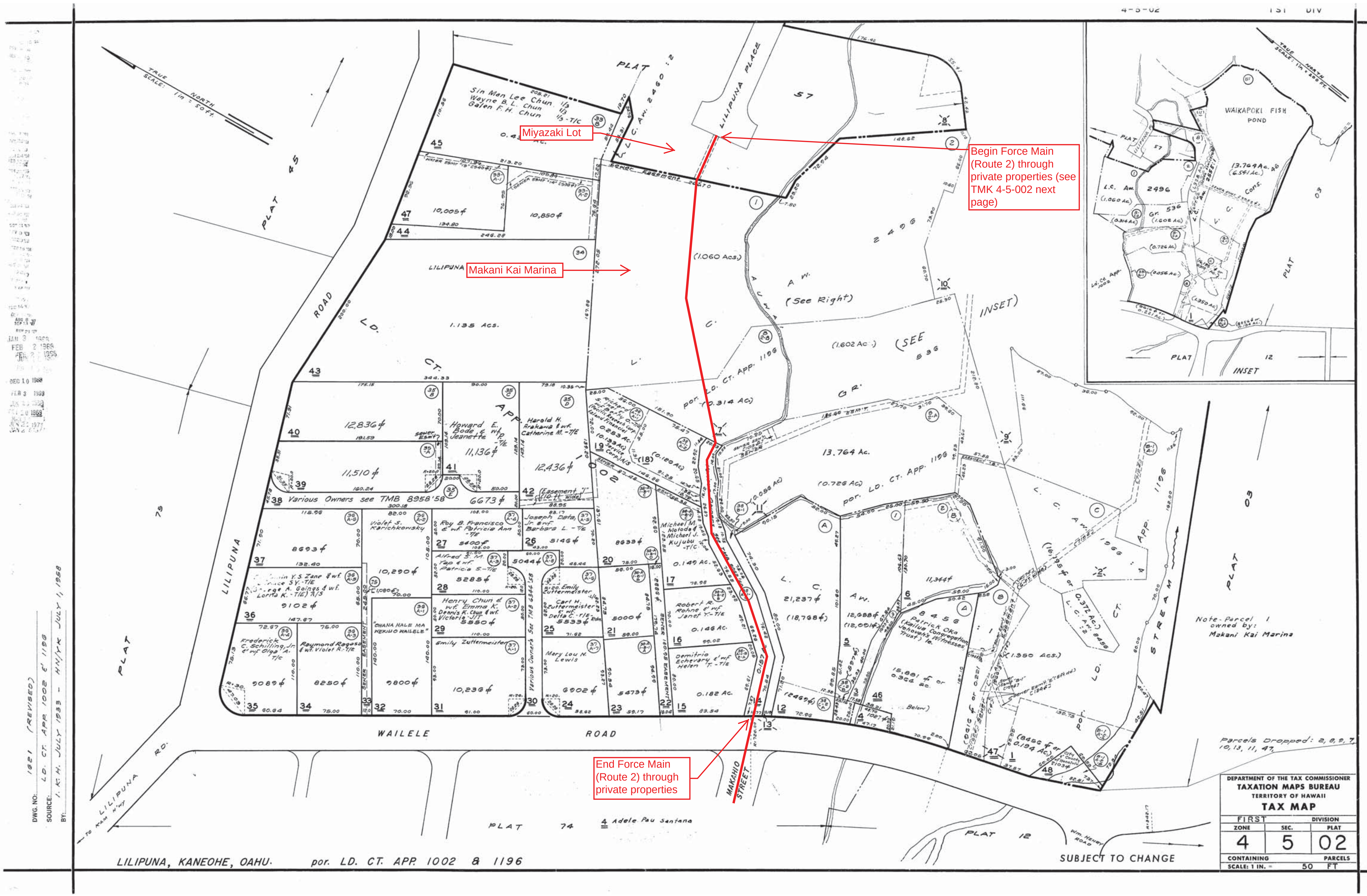
| Input Data | | |
|---|---|---|
| Pressure at : | 0.00 | psi |
| Elevation at | 1.50 | ft |
| Elevation at | 61.40 | ft |
| Length | 46.00 | ft |
| C Coefficien | 150.0 | |
| Diameter | 10 | in |
| Discharge | 1.270 | mg( |

| Results | | |
|---|---|---|
| Pressure at 1 | 25.73 | psi |
| Headloss | -0.55 | ft |
| Energy Grade at | 61.05 | ft |
| Energy Grade at | 61.60 | ft |
| Hydraulic Grade a | 60.85 | ft |
| Hydraulic Grade a | 61.40 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 2.62 | ft |
| Velocity | 3.60 | ft/s |
| Velocity Head | 0.20 | ft |
| Friction Slope | ).003747 | ft/ft |

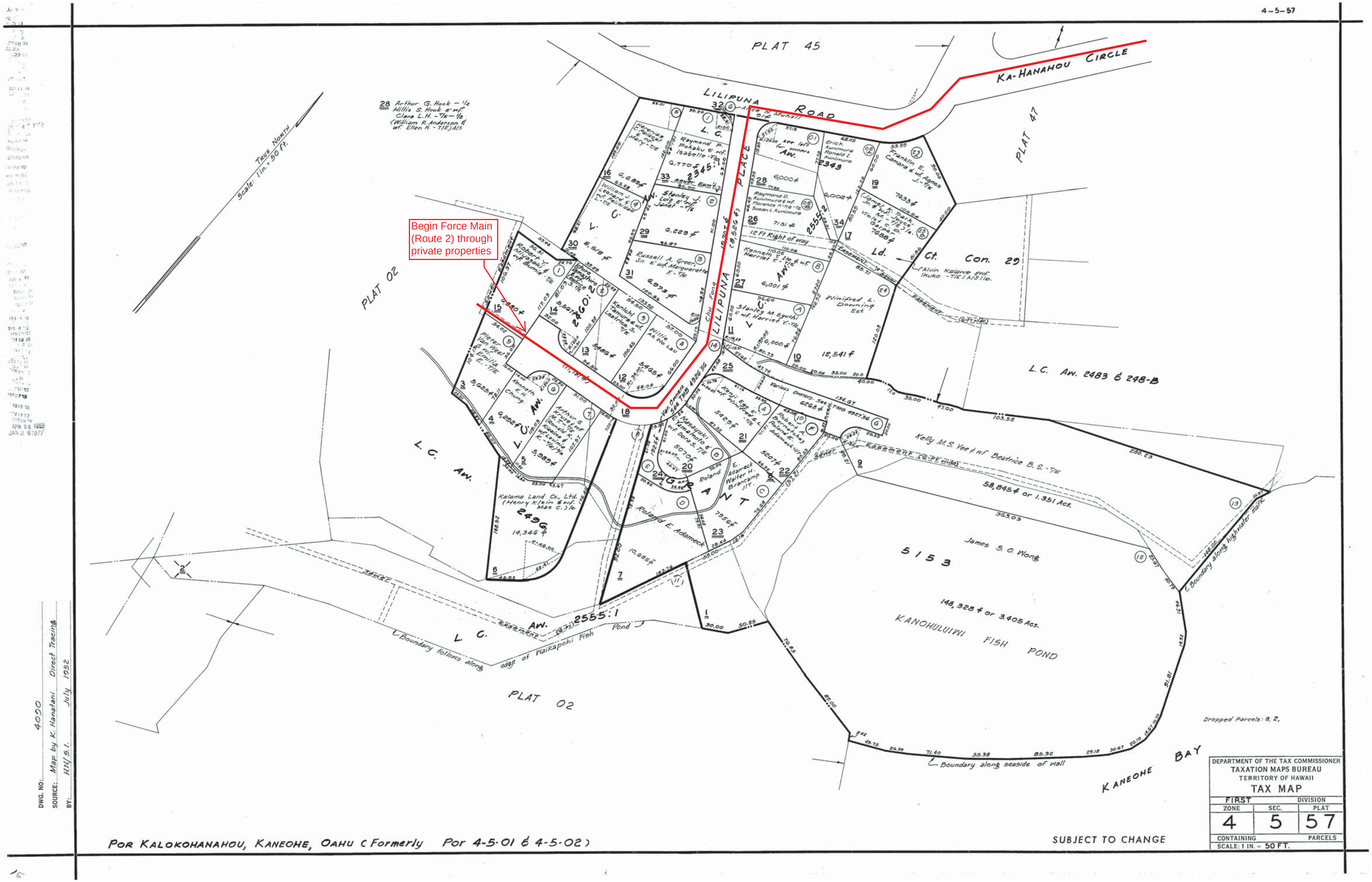
  

# Attachment 7

## TMK Maps showing Route 2 Private Properties



Miyazaki Lot
Begin Force Main (Route 2) through private properties (see TMK 4-5-002 next page)
Makani Kai Marina
End Force Main (Route 2) through private properties
LILIPUNA PLACE
LILIPUNA ROAD
WAILELE ROAD
MAKAHIO STREET
PLAT 45
PLAT 74
PLAT 12
PLAT 03
INSET
WAIKAPOKI FISH POND
Note - Parcel 1 owned by: Makani Kai Marina
Parcels Dropped: 2, 8, 9, 7, 10, 13, 11, 47.
LILIPUNA, KANEOHE, OAHU. por. LD. CT. APP. 1002 & 1196
SUBJECT TO CHANGE
DEPARTMENT OF THE TAX COMMISSIONER
TAXATION MAPS BUREAU
TERRITORY OF HAWAII
TAX MAP
FIRST DIVISION
ZONE 4 SEC. 5 PLAT 02
SCALE: 1 IN. = 50 FT
1821 (REVISED)
LD. CT. APP. 1002 & 1196
I. K. H. JULY 1933 - HH/YK JULY 1, 1958


4-5-57
PLAT 45
KA-HANAHOU CIRCLE
LILIPUNA ROAD
LILIPUNA PLACE
PLAT 47
PLAT 02
True North
Scale: 1 in. = 50 ft.
Begin Force Main
(Route 2) through
private properties
L. C. AW. 2345:1
L. C. AW. 2343
L. C. AW. 2555:2
L. C. AW. 2460:2
L. C. AW. 2555:1
L. C. AW. 2483 & 248-B
L. C. AW. 2496
GRANT 5153
Ct. Con. 29
Ld.
James S. O. Wong
148,328 # or 3.405 Acs.
KANOHULUIWI FISH POND
58,845 # or 1.351 Acs.
Kelly M. S. Yee & wf. Beatrice B. S. - T/E
Kalama Land Co., Ltd.
Winifred L. Downing Est.
Roland E. Adameck
Boundary follows along edge of Waikapoki Fish Pond
Boundary along seaside of wall
Boundary along high water mark
KANEOHE BAY
Dropped Parcels: 8, 2,
SUBJECT TO CHANGE
DWG. NO: 4050
SOURCE: Map by K. Hanatani Direct Tracing
BY: HN/S.I. July 1952
POR KALOKOHANAHOU, KANEOHE, OAHU (Formerly Por 4-5-01 & 4-5-02)
DEPARTMENT OF THE TAX COMMISSIONER
TAXATION MAPS BUREAU
TERRITORY OF HAWAII
TAX MAP
FIRST DIVISION
ZONE 4
SEC. 5
PLAT 57
CONTAINING PARCELS
SCALE: 1 IN. = 50 FT.

# Attachment 8

## Budgetary Opinion of Probable Construction Cost

# BUDGETARY OPINION OF PROBABLE COST
## Kahanahou WWPS Force Main Sewer Line Study
## New 10" Force Main - Route 2

Date: December 2013

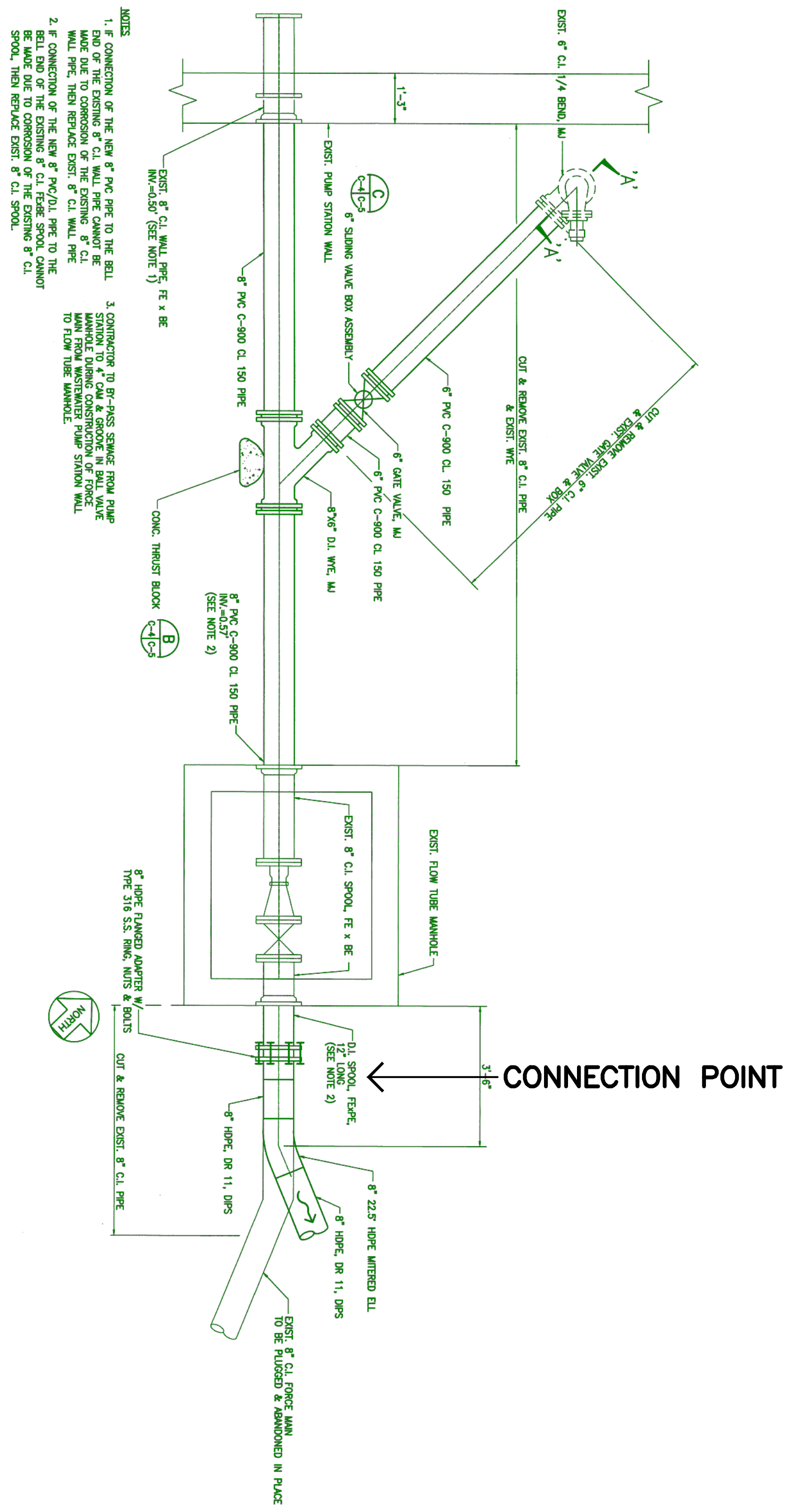
| ITEM NO. | DESCRIPTION | QTY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|
| | | | | | |
| | ***NEW 10" FORCE MAIN*** | | | | |
| | 10" HDPE Force Main Sewer (includes A.C. re-pave, trench, backfill) | 3,240 | LF | $200 | $648,000 |
| | 6'x6' Valve Box and Switch Valve | 1 | EA | $20,000 | $20,000 |
| | Manual Pressure Release Valve & Box | 3 | EA | $5,000 | $15,000 |
| | Vault w/Access Tee | 3 | EA | $10,000 | $30,000 |
| | Concrete Jacket (through private properties) | 750 | LF | $100 | $75,000 |
| | Sewer Manhole | 1 | EA | $7,000 | $7,000 |
| | Connection to Existing Sewer Manhole | 1 | EA | $3,000 | $3,000 |
| | Connection to Existing Force Main | 2 | EA | $3,000 | $6,000 |
| | Temporary Traffic Control | 1 | LPSM | $20,000 | $20,000 |
| | Temporary Bypass Measures (at Kahanahou WWPS connection) | 1 | LPSM | $50,000 | $50,000 |
| | | | | | |
| | ***NEW 8" GRAVITY MAIN (at Kahanahou WWPS)*** | | | | |
| | 8" HDPE Gravity Sewer Line (includes concrete re-pave, trench, backfill) | 108 | LF | $125 | $13,500 |
| | Sewer Manhole | 2 | EA | $5,000 | $10,000 |
| | Connection to Existing Gravity Sewer | 2 | EA | $2,000 | $4,000 |
| | Temporary Bypass Measures (at Kahanahou WWPS connection) | 1 | LPSM | $10,000 | $10,000 |
| | Miscellaneous Site Work | 1 | LPSM | $50,000 | $50,000 |
| | | | | | |
| | Subtotal | | | | $961,500 |
| | Mobilization (10% of subtotal) | | | | $96,150 |
| | Contingency (25% of subtotal+mobilization) | | | | $264,413 |
| | **GRAND TOTAL** | | | | **$1,322,063** |

*Notes:*

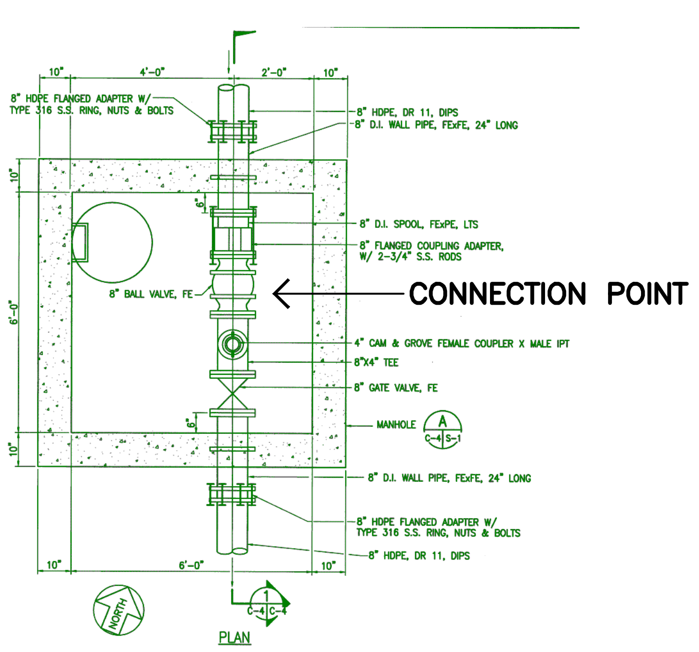
1. *This estimate is for budgetary and the final engineering report purposes only, and is subject to change as design progresses.*
2. *Overhead and profit are included in the above unit costs.*
3. *No piles for pipe support.*

# Attachment 9

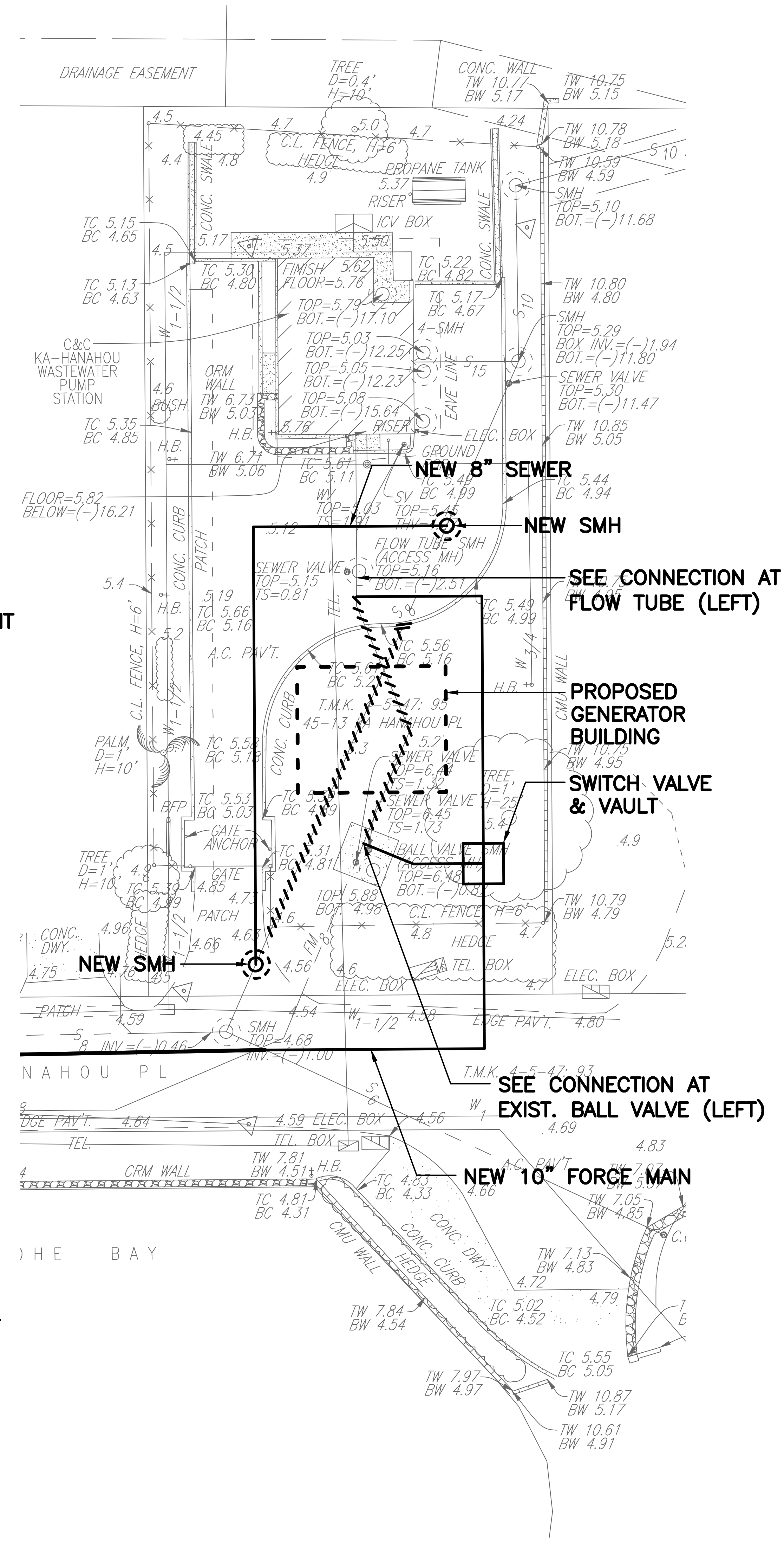
## Construction Sequence Site Plan




**CONNECTION AT FLOW TUBE**
(FROM 2005 FORCE MAIN CONSTRUCTION PLANS)
NOT TO SCALE




**CONNECTION AT EXIST. BALL VALVE**
(FROM 2005 FORCE MAIN CONSTRUCTION PLANS)
NOT TO SCALE




**SITE PLAN - KAHANAHOU WWPS**
NOT TO SCALE

DESCRIPTION

# FORCE MAIN AND GRAVITY MAIN CONCEPTUAL CONNECTION PLAN

DEPARTMENT OF DESIGN AND CONSTRUCTION
WASTEWATER DIVISION
CITY AND COUNTY OF HONOLULU

KAHANAHOU WASTEWATER

KANEOHE, OAHU

| OKAHARA AND ASSOCIATES | JOB NUMBER | DATE | | |
|---|---|---|---|---|
| | – | OCTOBER 2013 | | |

# Attachment 10

## SMA Exemption Letter

FILE

DEPARTMENT OF PLANNING AND PERMITTING
**CITY AND COUNTY OF HONOLULU**
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

2010/ELOG-449(AA)

March 10, 2010

**MEMORANDUM**

TO: CRAIG I. NISHIMURA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

ATTENTION: WASTEWATER DIVISION

FROM: DAVID K. TANOUE, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

SUBJECT: SPECIAL MANAGEMENT AREA DETERMINATION
KAHANAHOU WASTEWATER PUMP STATION UPGRADE PROJECT
45-13 KA HANAHOU PLACE - KANEOHE
TAX MAP KEY: 4-5-47: 95

This responds to your request, received on March 3, 2010, for information on the Special Management Area (SMA) use permit requirements to upgrade an existing wastewater pump station facility in the SMA.

The project will entail miscellaneous site improvements, and the repair and/or replacement of pumps, piping, mechanical and electrical equipment, emergency power system, structures, and ventilation system within an existing building. The project site is in the SMA; however, we confirm that the project will not require an SMA use permit pursuant to Sections 25-1.3(2)(D) and (M), Revised Ordinances of Honolulu. The proposed work is not expected to have any significant environmental or ecological effect on the SMA.

The project is subject to the environmental compliance law of Chapter 343 HRS. The applicant indicates that the project is exempt pursuant to Exemption Class #2 (Item 7) of the Department of Environmental Services Comprehensive Exemption List.

If you have any questions, please contact Ann Asaumi of our staff at 768-8020.

DKT:nw

2010/ELOG-449

**DEPARTMENT OF DESIGN AND CONSTRUCTION**
**CITY AND COUNTY OF HONOLULU**
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

MUFI HANNEMANN
MAYOR

CRAIG I. NISHIMURA, P.E.
DIRECTOR

COLLINS D. LAM, P.E.
DEPUTY DIRECTOR

RECEIVED
'10 MAR -3 P3:04
PLANNING & PERMITTING
CITY & COUNTY OF HONOLULU

WW.P10-046

March 3, 2010

MEMORANDUM

TO: DAVID K. TANOUE, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

FROM: for CRAIG I. NISHIMURA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

SUBJECT: KAHANAHOU WASTEWATER PUMP STATION UPGRADE PROJECT
SPECIAL MANAGEMENT AREA (SMA) USE PERMITS

We are requesting your concurrence that the above mentioned project is exempt from the SMA Use permit.

The Kahanahou Wastewater Pump Station Upgrade Project has been initiated by the Department of Environmental Services to upgrade/replace pumps, piping, mechanical and electrical equipment, emergency power system, structures, ventilation system, and miscellaneous site improvements. The wastewater pump station site is identified by TMK: 4-5-047:95 (See enclosed plan).

It is our understanding that repair and maintenance of appurtenant structures such as sewer pump stations are exempt from SMA Use permits. The scope of this project will be limited to upgrading the sewer pump station. Upon completion of project, all adjacent ground features disturbed during construction will be restored to its original or better condition.

If you have any questions or require additional information to make your determination, please feel free to call Roy Tamashiro of the Wastewater Division at 768-8760

I hereby concur with the SMA exemption for Kahanahou Wastewater Pump Station Upgrade Project.

David K. Tanoue, Director Date
Department of Planning & Permitting

Enclosure

# Attachment 11

## October 15, 2013 Meeting Minutes

| | |
|---|---|
| **From:** | Bruce K. Meyers |
| **To:** | "Tamashiro, Roy J" |
| **Cc:** | "hilo@okahara.com"; "oahu@okahara.com"; "Nikaido, Jason Y"; "Tyson Toyama" |
| **Subject:** | Kahanahou Mtg Minutes and Schedule |
| **Date:** | Thursday, November 7, 2013 11:47:00 AM |
| **Attachments:** | Route 2 - Public Roads and Upper Marina_for report.pdf |

Hi Roy,
Here are the meeting minutes for your review and comment.

Kahanahou WWPS Meeting Minutes
October 15, 2013
CSM Conference Room, Halawa

1. Purpose of meeting is to present the Preliminary Engineering Report (PER) and approve the recommended route.
2. The Kahanahou WWPS will be upgraded to pump the future design flow of 1.27 MGD.
3. Existing 8" diameter force main does not have the capacity for this flow.
4. Existing receiving gravity line that the existing FM discharges into goes along the shoreline, under buildings, through very narrow corridors, and has had a history of leaks at the shoreline. It was decided not to continue to discharge the Kahanahou WWPS effluent into this system.
5. A new force main is to be constructed to bypass this gravity, main which flows into the Waikapoki WWPS and discharge directly into the Waikalua tributary via the gravity main on Makahio Street.
6. Waikapoki WWPS upgrade issues (not in scope).
   a. In tight space and close to housing complex. Difficult to do significant upgrade.
   b. Noise complaints.
   c. The upgrade requirements are unknown at this time.
   d. Removing Kahanahou WWPS tributary will reduce Waikapoki WWPS upgrade requirements.
7. The PER describes four alternatives routes and makes a recommendation (see attached map for recommended route). The discussion concentrated on the recommended route.
   a. Route 1: The TDH exceeds 100 feet.
   b. Route 2: Recommended route.
   c. Route 3: Similar to Route 2 but goes through more private parcels and narrow corridors.
   d. Route 4: Similar to Route 2 but goes through the lower elevations of the Makani Kai Marina. Discouraged by Marina manager.
8. Route 2:
   a. Two private properties involved:
      1. Mr. Miyazaki has existing 5' wide easement. Try to increase easement width. Can fit FM in 5' easement if needed. Will concrete jacket.
      2. Makani Kai Marina has no existing easement. Will go through landscaped walkway. Concrete jacket also.
      3. Need to get City's Land Division involved.

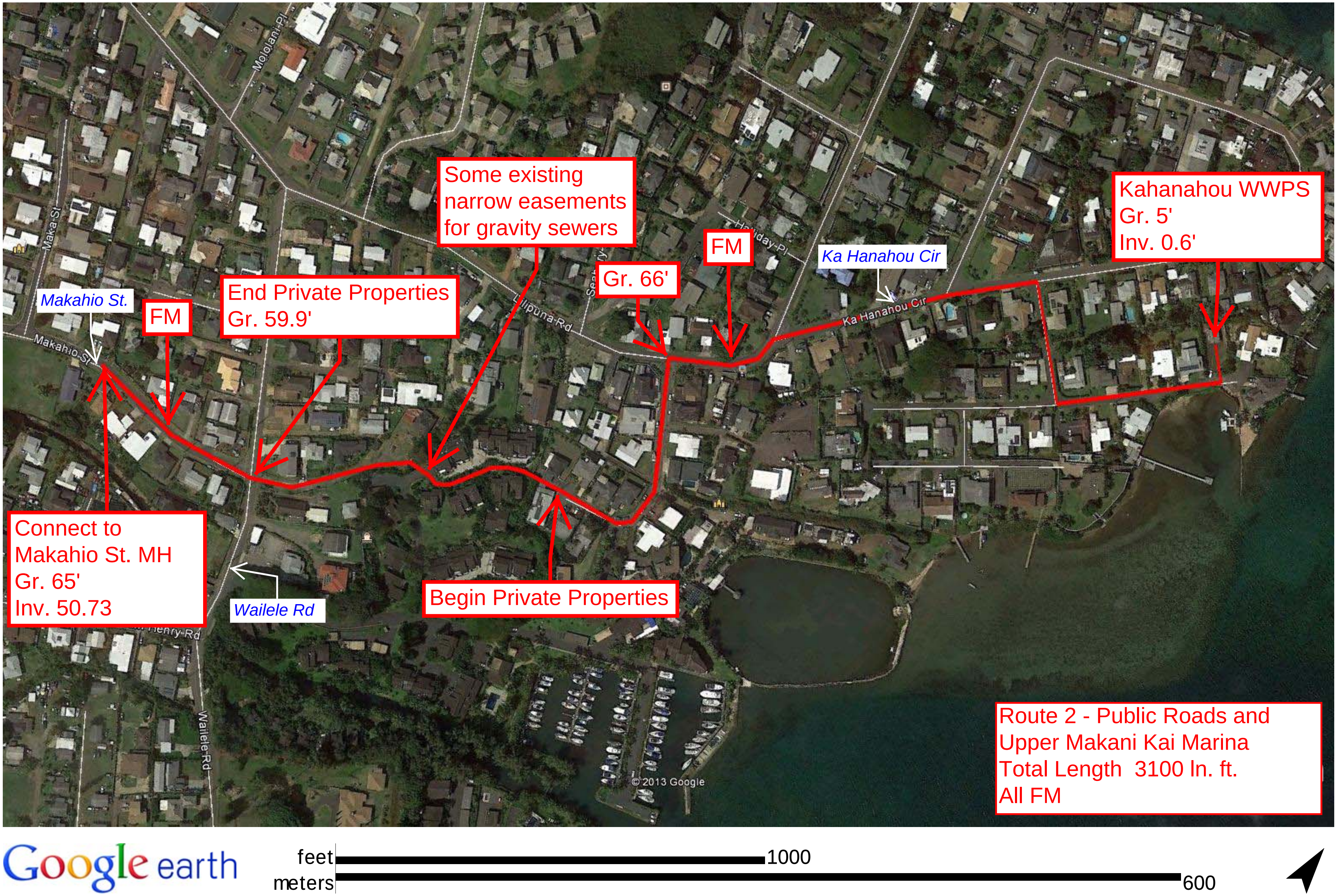
        4. Okahara to work on easement geometry.
    b. Remaining route in City streets.
9. Pipe will be fusible HDPE pipe.
10. Install manual relief valves in lieu of the automatic air relief valves.
11. Install vaults with tee and cap for maintenance access in lieu of pressurized manholes.
12. Recommended route, Route 2 was approved.
13. Next steps by Okahara:
    a. Finish Design Alternatives Report (DAR) for Kahanahou WWPS.
    b. Proceed with environmental work.
    c. Provide easement information to City.
    d. Update schedule.
14. Meeting adjourned.

All, please provide comments by November 12, 2013.

Thanks,
Bruce

**Bruce K. Meyers, P.E.**
**Okahara and Associates, Inc.**
ENGINEERING CONSULTANTS
**Hilo Office:**
**200 Kohola Street, Hilo, HI 96720**
**Website:** www.okahara.com
**Phone: (808) 961-5527**
**Watts from Oahu: 538-7716**
**Cell: (808) 640-8544**
**Fax: (808) 961-5529**
**Email:** bmeyers@okahara.com

**Oahu Office:**
**677 Ala Moana Blvd. Suite 703**
**Honolulu, HI 96713-5415**
**Phone: (808) 524-1224**
**Fax: (808) 521-3151**


Some existing
narrow easements
for gravity sewers
Kahanahou WWPS
Gr. 5'
Inv. 0.6'
FM
Ka Hanahou Cir
Gr. 66'
End Private Properties
Gr. 59.9'
Makahio St.
FM
Connect to
Makahio St. MH
Gr. 65'
Inv. 50.73
Wailele Rd
Begin Private Properties
Route 2 - Public Roads and
Upper Makani Kai Marina
Total Length 3100 ln. ft.
All FM
© 2013 Google
Google earth
feet
1000
meters
600

## Appendix C

Digital Flood Insurance Map (Federal Emergency Management Agency, 2013)
City and County of Honolulu Department of Planning and Permitting, March 2010


National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

0 1000 2000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0270H

# FIRM
## FLOOD INSURANCE RATE MAP

**CITY AND COUNTY OF HONOLULU, HAWAII**

**PANEL 270 OF 395**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| HONOLULU, CITY AND COUNTY OF | 150001 | 0270 | H |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER 15003C0270H**

**MAP REVISED JANUARY 19, 2011**

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

**Appendix D**

Pre-Environmental Assessment Consultation

**Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades**
**Preliminary Draft Environmental Assessment**

**APPENDIX D**
**Pre-Environmental Assessment Consultation**

The following parties were contacted during the preparation of the Draft Environmental Assessment. Those identified with a check mark provided comments

**CITY AND COUNTY OF HONOLULU**

Department of Environmental Services
Department of Facility Maintenance
Department of Planning and Permitting
Department of Transportation Services
Honolulu Board of Water Supply
Honolulu Fire Department
Honolulu Police Department
Neighborhood Board #30: Kaneohe
Honolulu City Council, District 3

**STATE OF HAWAII**

Department of Business, Economic Development & Tourism, Office of Planning
✓Department of Health, Environmental Management Division
Department of Land and Natural Resources
- Commission on Water Resource Management
- ✓Engineering Division
- Office of Conservation and Coastal Lands

State Historic Preservation Division
Department of Transportation, Highways Division
Office of Hawaiian Affairs
University of Hawaii at Manoa
- Environmental Center
- Water Resources Research Center

Hawaii State House of Representatives, District 48
Hawaii State Senate, District 24

**UTILITY COMPANIES**

Hawaii Gas
Hawaiian Electric Company
Hawaiian Telcom

**Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades**
**Preliminary Draft Environmental Assessment**

**APPENDIX D (continued)**
**Pre-Environmental Assessment Consultation**

The following parties were contacted during the preparation of the Draft Environmental Assessment. Those identified with a check mark provided comments:

**PRIVATE LANDOWNERS**

Makani Kai Marina townhouse complex
Affected landowners

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

LINDA ROSEN, M.D., M.P.H.
DIRECTOR OF HEALTH

**STATE OF HAWAII**
**DEPARTMENT OF HEALTH**
P. O. BOX 3378
**HONOLULU, HI 96801-3378**

In reply, please refer to:
File:

LUD-1 4 5 047 095-ID1736
Kahanahou WWPS initial Cons

May 23, 2014

Ms. Sherri Hiraoka, Senior Planner
Townscape, Inc.
Environmental and Community Planning
900 Fort Street Mall Suite 1160
Honolulu, Hawaii 96813

Dear Ms: Hiraoka:

Subject: Initial Consultation for the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades – start at TMK (1) 4-5-047: 095 / end at TMK (1) 4-5-002: 001
Kahanahou WWPS – Makani Kai Marina, Kaneohe, Hawaii 96744

We appreciate the opportunity to review the subject initial consultation information for the proposed project and have determined that we have no comments to offer at this time.

Should you have any questions, please contact Mr. Mark Tomomitsu of our branch at 586-4294.

Sincerely,

SINA PRUDER, P.E., CHIEF
Wastewater Branch

LM/MST:lmj

c: Ms. Laura McIntyre, DOH-Environmental Planning Office (14-037)
Mr. George I. Atta, C&C of Honolulu, Dept. of Planning & Permitting 7th Floor

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Ms. Sina Pruder, P.E., Chief
Wastewater Branch
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Ms. Pruder:

Thank you for informing us that the Wastewater Branch has no comments on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades at this time. Should you have any questions in the future, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

LINDA ROSEN, M.D., M.P.H.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File:
EPO 14-087

May 16, 2014

Ms. Sherri Hiraoka, Senior Planner
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

**SUBJECT: Initial Consultation for the Preparation of an Environmental Assessment for the Proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades**

The Department of Health (DOH), Environmental Planning Office (EPO), acknowledges receipt of your letter dated May 8, 2014. Thank you for allowing us to review and comment on the subject document. The document was routed to the relevant Environmental Health divisions and offices. They will provide specific comments to you if necessary. EPO recommends that you review the standard comments at: http://health.hawaii.gov/epo/home/landuse-planning-review-program/.
You are required to adhere to all applicable standard comments.

You may also wish to review the recently revised Water Quality Standards Maps that have been updated for all islands. The new Water Quality Standards Maps (2013) can be found at:
http://health.hawaii.gov/cwb/site-map/clean-water-branch-home-page/water-quality-standards/

The EPO suggests that you examine the many sources available on strategies to support the sustainable and healthy design of communities and buildings, including the following sites:
State of Hawaii, Office of Planning: www.planning.hawaii.gov and the 2013 ORMP;
U.H., School of Ocean and Earth Science and Technology: www.soest.hawaii.edu;
U.S. Health and Human Services: www.hhs.gov/about/sustainability;
U.S. Environmental Protection Agency's sustainability programs: www.epa.gov/sustainability; and
Intergovernmental Panel on Climate Change (IPCC):
http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap29_FGDall.pdf

The DOH encourages everyone to apply these sustainability strategies and principles early in the planning and review of projects. We also request that for future projects you consider conducting a Health Impact Assessment (HIA). More information is available at:
www.cdc.gov/healthyplaces/hia.htm; and
www.epa.gov/research/healthscience/health-impact-assessment.htm.

We request you share all of this information with others to increase community awareness on sustainable, innovative, inspirational, and healthy community design.

Mahalo,

Laura Leialoha Phillips McIntyre, AICP
Program Manager, Environmental Planning Office

c: Clean Water Branch, Wastewater Branch

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Ms. Laura McIntyre, AICP
Program Manager, Environmental Planning Office
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Ms. McIntyre:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. The project team has reviewed the DOH's Standard Comments and will address applicable comments during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

# OFFICE OF PLANNING
# STATE OF HAWAII

NEIL ABERCROMBIE
GOVERNOR

LEO R. ASUNCION
ACTING DIRECTOR
OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824
Web: http://planning.hawaii.gov/


Ref. No. P-14440

May 29, 2014

Ms. Sherri Hiraoka
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

Subject: Pre-Assessment Consultation Request for an Environmental Assessment for the Proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrade, Honolulu, Oahu, Hawaii; TMK: (1) 4-5-047:095; 4-5-057:15; 4-5-002:01

Thank you for the opportunity to provide comments on the Kahanahou Wastewater Pump Station Force Sewer Line Upgrades project. We have reviewed the documents you submitted to us by letter dated May 8, 2014, and have the following comments to offer:

1. The Office of Planning (OP) provides technical assistance to state and county agencies in administering the statewide planning system in Hawaii Revised Statutes (HRS) Chapter 226, the Hawaii State Plan. The Hawaii State Plan provides goals, objectives, priorities, and priority guidelines for growth, development, and the allocation of state resources. In particular, the Draft Environmental Assessment (Draft EA) should address how this project meets the principles to promote sustainability, see HRS § 226-108. The Sustainability Guidelines can be viewed or downloaded from the OP website at http://files.hawaii.gov/dbedt/op/docs/OP_TAM_2013-12-03.pdf

2. OP is the lead agency for the Hawaii Coastal Zone Management (CZM) Program. The coastal zone management area is defined as "all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea" see HRS § 205A-1 (definition of "coastal zone management area"). The Draft EA should include a discussion of the proposed project's ability to meet the objectives and policies set forth in HRS § 205A-2. These objectives and policies include: recreational resources, historic resources, scenic and open space resources, coastal ecosystems, economic uses, coastal hazards, managing development, public participation, and marine resources.

3. The Draft EA should include the Coastal Zone Management Act, HRS Chapter 205A, in a list of "relationships to land use plans, policies, and controls."

4. In the Draft EA, please provide a list of any Federal, State, or county permits required for this project. A listing of required permits will allow the Office of Planning to determine whether a Coastal Zone Management Federal Consistency evaluation is necessary for this project.

5. A portion of the proposed project may lie within the Special Management Area (SMA) delineated by City and County of Honolulu. Please confirm with the City and County of Honolulu's Department of Planning and Permitting to make a determination on where your project lies in relation to the SMA boundaries and if a SMA permit or Shoreline Setback variance is required.

6. Because of the frequent rainy weather patterns for Windward, Oahu, and the close proximity of the project to Kaneohe Bay, this project may have nonpoint pollution implications on coastal waters. Trenching work for the sewer line upgrades and/or grading and clearing work for the pump station may result in erosion and sediment loss and have a negative environmental impact. Please review the Hawaii Watershed Guidance, which provides a summary and links to management measures that may be implemented to minimize coastal nonpoint pollution impact. Specifically, please examine page 122 (Site Development Management Measure for urban runoff). The Watershed Guidance can be viewed or downloaded from the OP website at http://files.hawaii.gov/dbedt/op/czm/initiative/nonpoint/HI Watershed Guidance Final.pdf

7. Please consider utilizing the OP's *Stormwater Impact Assessment* to identify and evaluate information on hydrology (i.e. proximity to drainage ways, stream channels, sensitive ecosystems in receiving waters), stressors (i.e. water quality and pollutants), sensitivity of resources (i.e. aquatic resources and riparian resources), and management considerations. This guidance document will assist in integrating stormwater impact assessment within your review process.

   The purpose of this document is to provide guidance on assessing stormwater impacts in the planning phase of project development. The goal is to provide a suggested framework and various tools for integrating stormwater impacts assessment. The Appendices include a list of Data Resources, Best Management Practice Techniques and a Reviewers Checklist. The *Stormwater Impact Assessment* guidance document can be found at http://files.hawaii.gov/dbedt/op/czm/initiative/stomwater_imapct/final_stormwater_impact_assessments_guidance.pdf.

If you have any questions regarding this comment letter, please contact Josh Hekekia of our Hawaii CZM Program at 587-2845.

Sincerely,

Rodney Funakoshi

for Leo R. Asuncion
Acting Director

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Josh Hekekia
Hawaii CZM Program, Office of Planning
Dept. of Business, Economic Development & Tourism
State of Hawai'i
235 South Beretania Street, 6th Floor
Honolulu, HI 96804

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Hekekia:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. Your comments will be addressed either in the Draft Environmental Assessment or during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

NEIL ABERCROMBIE
GOVERNOR OF HAWAII



**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**

ENGINEERING DIVISION
POST OFFICE BOX 373
HONOLULU, HAWAII 96809

MAY 2 2 2014

Ms. Sherri Hiraoka, Senior Planner
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

**Initial Consultation for the Preparation of an Environmental Assessment for the Proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades**

Thank you for the opportunity to provide comments on any issues that may be identified as important and addressed in the subject environmental assessment.

According to the Flood Insurance Rate Map (FIRM), the project site is located in Zone X. The National Flood Insurance Program (NFIP) does not regulate developments within Zone X. A copy of the Flood Hazard Assessment Report, which contains the FIRM, is enclosed for your information and use.

Should you have any questions, please call Mr. Dennis Imada of my staff at 587-0257, or email him at dennis.t.imada@hawaii.gov.

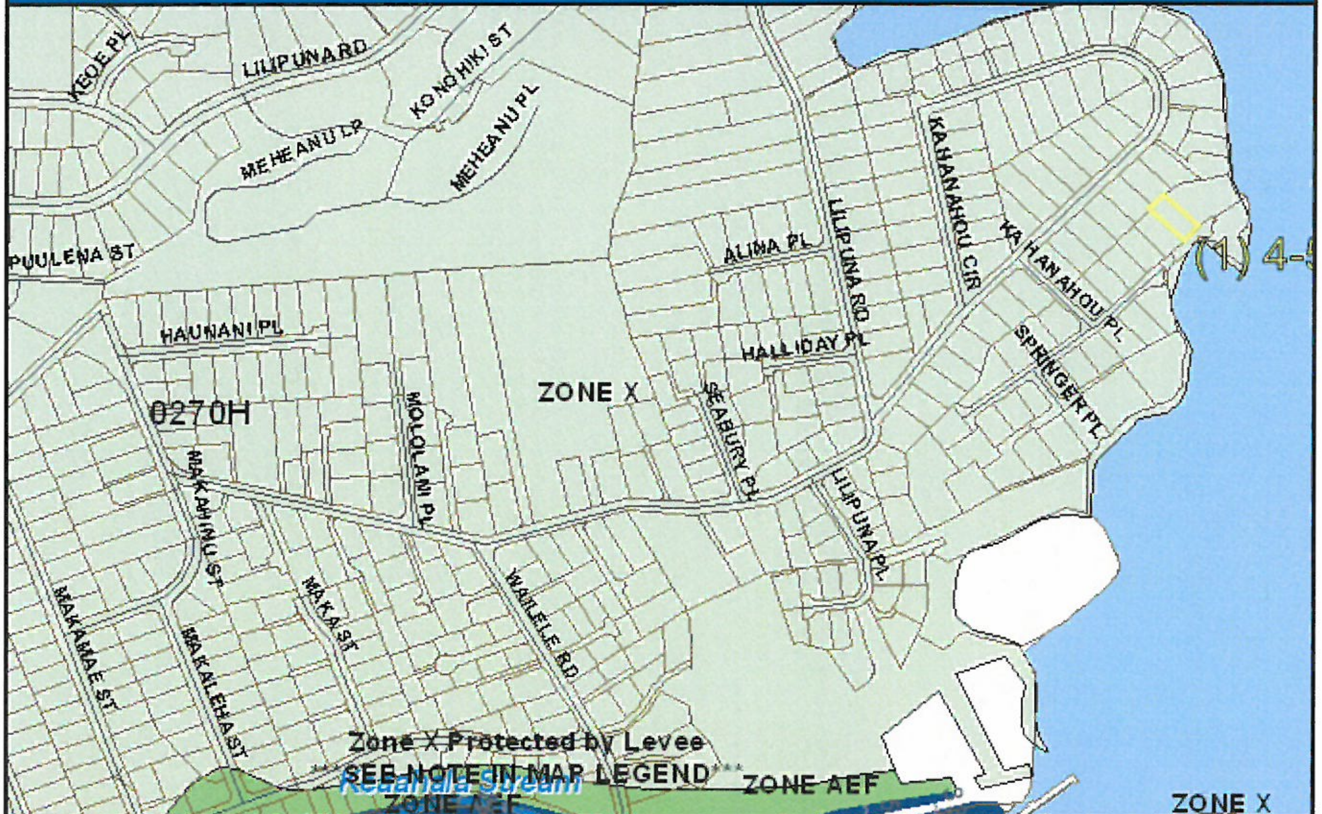
Sincerely,

CARTY S. CHANG
Chief Engineer

DI:et
Enclosure

State of Hawaii

# FLOOD HAZARD ASSESSMENT REPORT




## NATIONAL FLOOD INSURANCE PROGRAM

### FLOOD ZONE DEFINITIONS

**SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD –** The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water-surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

- **Zone A:** No BFE determined.
- **Zone AE:** BFE determined.
- **Zone AH:** Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
- **Zone AO:** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
- **Zone V:** Coastal flood zone with velocity hazard (wave action); no BFE determined.
- **Zone VE:** Coastal flood zone with velocity hazard (wave action); BFE determined.
- **Zone AEF:** Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

**NON-SPECIAL FLOOD HAZARD AREA –** An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

- **Zone XS (X shaded):** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X:** Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D:** Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

### PROPERTY INFORMATION

| | |
|---|---|
| COUNTY: | HONOLULU |
| TMK NO: | (1) 4-5-047-095 |
| PARCEL ADDRESS: | 45-13 KA HANAHOU PL<br>KANEOHE, HI 96744 |
| FIRM INDEX DATE: | JANUARY 19, 2011 |
| LETTER OF MAP CHANGE(S): | NONE |
| FEMA FIRM PANEL(S): | 15003C0270H |
| PANEL EFFECTIVE DATE: | JANUARY 19, 2011 |

| | |
|---|---|
| PARCEL DATA FROM: | APRIL 2014 |
| IMAGERY DATA FROM: | MAY 2006 |

### IMPORTANT PHONE NUMBERS

County NFIP Coordinator
City and County of Honolulu
Mario Siu-Li, CFM (808) 768-8098
State NFIP Coordinator
Carol Tyau-Beam, P.E., CFM (808) 587-0267

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Dennis Imada
Engineering Division
Department of Land and Natural Resources
State of Hawai'i
P.O. Box 373
Honolulu, HI 96809

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Imada:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. We understand that the proposed project is in Zone X on the Flood Insurance Rate Map, which the National Flood Insurance Program does not regulate. This will be noted in the Draft Environmental Assessment.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

NEIL ABERCROMBIE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097



IN REPLY REFER TO:
HWY-1920
HWY-PS 2.7310

June 3, 2014

Ms. Sherri Hiraoka
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

Subject: Consultation for Preparation of an Environmental Assessment
Kahanahou Wastewater Pumping Station and Force Main, Kaneohe, Oahu
TMK: (1) 4-5-047:095 (var. parcels)

Thank you for requesting our comments on the proposed improvement to the Kahanahou wastewater pumping station and installation of a new force main. The proposed project will take place in residential areas of Kaneohe in the general vicinity of the Makani Kai Marina.

The roads in this area are under the jurisdiction of the City and County of Honolulu. We have no comment on the proposed project.

If there are any questions, please contact Gary Ashikawa, Systems Planning Engineer, Highways Division, Planning Branch, at 587-6336. Please reference file review number 2014-098 in all contacts and correspondence regarding these comments.

Very truly yours,

Alvin A. Takeshita

Alvin A. Takeshita
Highways Administrator

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Gary Ashikawa
Systems Planning Engineer
Department of Transportation Highways Division
State of Hawai'i
869 Punchbowl Street
Honolulu, HI 96813-5097

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Ashikawa:

Thank you for informing us that the Department of Transportation has no comments on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades at this time. Should you have any questions in the future, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

# Clean Water Branch
# Standard Comments

October 22, 2013

## Clean Water Branch

The Clean Water Branch (CWB) protects the public health of residents and tourists who enjoy playing in and around Hawaii's coastal and inland water resources. The CWB also protects and restores inland and coastal waters for marine life and wildlife. This is accomplished through statewide coastal water surveillance and watershed-based environmental management through a combination of permit issuance, monitoring, enforcement, sponsorship of polluted runoff control projects, and public education.

### Permit Issuance

- Any project and its potential impacts to State waters must meet the State's:
  1) Antidegradation policy, which requires that the existing uses and the level of water quality necessary to protect the existing uses of the receiving State water be maintained and protected;
  2) Designated uses, as determined by the classification of the receiving State waters; and
  3) Water quality criteria [Hawaii Administrative Rules (HAR), Chapter 11-54].

- A Section 401 Water Quality Certification (WQC) is required:
  - If your project/activity requires a federal license or permit; and
  - May result in a discharge into State waters. The term "discharge" is defined in Clean Water Act, Subsections 502(16), 502(12), and 502(6); Title 40 of the Code of Federal Regulations (CFR), Section 122.2; and HAR, Chapter 11-54.

  Typical federal license or permits that may trigger a Section 401 WQC include the Department of the Army permits (Tel: 808-438-9258), Federal Energy Regulatory Commission permits (Tel: 202-502-6088), and Environmental Protection Agency permits (Tel: 415-947-8000).

  To request a Section 401 WQC, you must complete and submit the Section 401 WQC application. This application is available on the e-Permitting Portal website located at: https://eha-cloud.doh.hawaii.gov/epermit/View/home.aspx.

- National Pollutant Discharge Elimination System (NPDES) permit coverage is required for:
  - Storm water associated with construction activities for land disturbances of one (1) acre or more. Land disturbance includes, but is not limited to, clearing, grading, grubbing, excavation, demolition, uprooting of vegetation, equipment staging, and storage areas.

  - Storm water associated with industrial activities for facilities with Standard Industrial Classification Codes regulated in 40 CFR 122.26(b)(14)(i) through (ix) and (xi).

- Storm water and certain non-storm water from a small Municipal Separate Storm Sewer System.

- Discharges of water pollutants into State surface waters. Examples of these discharges include, but are not limited to, cooling water, hydrotesting waters, dewatering effluent, and process wastewater.

- Discharges from the application of pesticides (including insecticides, herbicides, fungicides, rodenticides, and various other substances to control pest) to State waters.

An application for an NPDES individual permit must be submitted at least 180 calendar days before the commencement of the discharge or start of construction activities. To request an NPDES individual permit, you must complete and submit the NPDES individual permit application. This application is available on the e-Permitting Portal website located at:

https://eha-cloud.doh.hawaii.gov/epermit/View/home.aspx.

A Notice of Intent (NOI) for coverage under a specific NPDES general permit must be submitted at least 30 calendar days before the commencement of the discharge or start of construction activities. To request NPDES general permit coverage, you must complete and submit the NOI. The NOI is available on the e-Permitting Portal website located at: https://eha-cloud.doh.hawaii.gov/epermit/View/home.aspx.

- According to State law, all discharges related to the project construction or operation activities, whether or not NPDES permit coverage and/or Section 401 WQC are required, must comply with the State's Water Quality Standards.

**Monitoring**

- Effluent discharge and/or receiving water monitoring may be required as conditions of Section 401 Water Quality Certifications and NPDES General and Individual permits.

**Enforcement**

- Noncompliance with water quality requirements contained in HAR, Chapter 11-54 and/or permitting requirements specified in HAR, Chapter 11-55 may be subject to penalties of $25,000 per day per violation.

**Polluted Runoff Control Projects**

- Projects to address polluted runoff, identified in Watershed Based Plans, which meet EPA and State criteria, may qualify for federal grants administered by our office.

- At a minimum, grant funds must be matched 25% with match funding or in-kind contributions from non-federal sources and are subject to the requirements of EPA 40 CFR Chapter 1 (7-1-98 Edition), Section 31.24 Matching or Cost Sharing.

- Request for Proposals to solicit qualified projects for grant funding are issued on an annual basis and interested parties can request to be placed on a mailing list to receive a copy of the RFP when it is issued. The deadline for submittal of a proposal is usually one (1) month from the date of the RFP. For more information, please read our website at: http://health.hawaii.gov/cwb/.

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com


July 9, 2014

Mr. Alec Wong, P.E., Chief
Clean Water Branch
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Wong:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. The project team has reviewed the Clean Water Branch's Standard Comments (October 22, 2013) and will address them during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

POLICE DEPARTMENT

**CITY AND COUNTY OF HONOLULU**

801 SOUTH BERETANIA STREET · HONOLULU, HAWAII 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

KIRK CALDWELL
MAYOR

LOUIS M. KEALOHA
CHIEF

DAVE M. KAJIHIRO
MARIE A. McCAULEY
DEPUTY CHIEFS

OUR REFERENCE EO-WS

May 29, 2014

Dear Ms. Hiraoka:

This is in response to your letter dated May 8, 2014, requesting comments on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades project.

The Honolulu Police Department anticipates possible short-term impacts to neighborhood vehicular and pedestrian traffic during the construction phase of the project. The roadways that may be impacted are Springer Place, Ka Hanahou Place, Lilipuna Road, and Makahio Street.

We recommend that adequate personnel be hired to conduct traffic control. Additionally, we recommend that all necessary signs, lights, barricades, cones, and other safety equipment be installed and maintained by the contactor to facilitate the flow of vehicular and pedestrian traffic during certain phases of the construction. The contractor should give adequate notice to inform the public of any construction related road closures in the project area.

If there are any questions, please contact Major Ryan Borges of District 4 (Kaneohe/Kailua/Kahuku) at 723-8639 or via e-mail at rborges@honolulu.gov.

Sincerely,

LOUIS M. KEALOHA
Chief of Police

By Ral K. Macadangdang

RANDAL K. MACADANGDANG
Assistant Chief
Support Services Bureau

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Major Ryan Borges
Honolulu Police Department, District 4
City and County of Honolulu
801 South Beretania Street
Honolulu, HI 96813

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Major Borges:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. Your comments regarding short-term traffic impacts will be addressed in the Draft Environmental Assessment or during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

HONOLULU FIRE DEPARTMENT
**CITY AND COUNTY OF HONOLULU**
636 South Street
Honolulu, Hawaii 96813-5007
Phone: 808-723-7139 Fax: 808-723-7111 Internet: www.honolulu.gov/hfd

KIRK CALDWELL
MAYOR

MANUEL P. NEVES
FIRE CHIEF

LIONEL CAMARA JR.
DEPUTY FIRE CHIEF

May 29, 2014

Ms. Sherri Hiraoka, Senior Planner
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

Subject: Initial Consultation for the Preparation of an Environmental Assessment
Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

In response to your letter of May 8, 2014, regarding the above-mentioned subject, the Honolulu Fire Department determined that there will be no significant impact to fire department services.

Please notify Battalion Chief (BC) Alan Carvalho of our Fire Operations at 723-7182 or acarvalho@honolulu.gov to discuss possible road closures and alternate routes before the project commences.

Should you have questions, please contact Acting BC Terry Seelig of our Fire Prevention Bureau at 723-7151 or tseelig@honolulu.gov.

Sincerely,

Socrates D. Bratakos

SOCRATES D. BRATAKOS
Assistant Chief

SDB/SY:bh

cc: Fire Operations

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Terry Seeling
Acting Battalion Chief
Honolulu Fire Department, Fire Prevention Bureau
City and County of Honolulu
636 South Street
Honolulu, HI 96813-5007

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Acting Battalion Chief Seelig:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. Coordination with the Honolulu Fire Department regarding possible road closures and alternate routes will occur during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET, 3RD FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8305 • Fax: (808) 768-4730 • Internet: www.honolulu.gov

KIRK CALDWELL
MAYOR

MICHAEL D. FORMBY
DIRECTOR

MARK N. GARRITY, AICP
DEPUTY DIRECTOR

TP5/14-562448R

June 5, 2014

Ms. Sherri Hiraoka
Senior Planner
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

SUBJECT: Initial Consultation for Environmental Assessment
Kahanahou Wastewater Pump Station Force Main
Sewer Line Upgrades; Kaneohe, Oahu, Hawaii

In response to your letter dated May 8, 2014, we have the following comments:

1. The Draft Environmental Assessment should discuss any short-term traffic impacts that the project may have on any surrounding City roadways during construction and measures to mitigate these impacts.

2. The local Neighborhood Board, as well as the area residents, businesses, emergency personnel, Oahu Transit Services, Inc. (TheBus), etc., should be kept apprised of the details of the proposed project and the impacts, particularly during construction, the project may have on the adjoining local street area network.

3. Any construction materials and equipment should be transferred to and from the project site during off-peak traffic hours (8:30 a.m. to 3:30 p.m.) to minimize any possible disruption to traffic on the local streets.

4. Should the project require any temporary lane closure on a City street, a street usage permit will be required from our department. A traffic plan should be submitted to our Street Usage Section for approval.

Thank you for the opportunity to review this matter. Should you have any questions, please contact Renee Yamasaki of my staff at 768-8383.

Very truly yours,

Michael D. Formby
Director

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Ms. Renee Yamasaki
Department of Transportation Services
City and County of Honolulu
650 South King Street, 3rd Floor
Honolulu, HI 96813

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Ms. Yamasaki:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. Your comments regarding short-term traffic impacts will be addressed in the Draft Environmental Assessment or during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

**BOARD OF WATER SUPPLY**

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

May 29, 2014



Ms. Sherri Hiraoka, Senior Planner
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

Subject: Your Letter Dated May 8, 2014 on the Environmental Assessment Initial Consultation for the Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Thank you for the opportunity to comment on the proposed sewer line upgrades.

The construction drawings should be submitted for our review.

The construction schedule should be coordinated to minimize impact to the water system.

If you have any questions, please contact Robert Chun, Project Review Branch of our Water Resources Division at 748-5443.

Very truly yours,

ERNEST Y. W. LAU, P.E.
Manager and Chief Engineer

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

June 6, 2014

Mr. Robert Chun
Project Review Branch
Water Resources Divsion
Honolulu Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, HI 96843

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Chun:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. Your comments regarding submission of construction drawings and schedule to the Board of Water Supply will be addressed in the Draft Environmental Assessment or during the design and permitting phases of the project.

Should you have any questions, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

Hawaiian Telcom

June 5, 2014

Townscape, Inc.
Environmental and Community Planning
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813
Attention: Ms. Sherri Hiraoka

Dear Ms. Hiraoka:

Subject: **Initial consultation for the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades**

Thank you for the opportunity to review and comment on the initial consultation phase for the subject project.

In response to your letter dated May 8, 2014, Hawaiian Telcom does not have any comments to offer at this time.

If you have any questions or require assistance in the future on this project, please call me at 546-7761.

Sincerely,

Les Loo
Network Engineer – OSP Engineering
Network Engineering & Planning

cc: File [Kaneohe]

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Les Loo
Network Engineer – OSP Engineering
Hawaiian Telcom
P.O. Box 2200
Honolulu, HI 96841

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Loo:

Thank you for informing us that Hawaiian Telcom has no comments on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades at this time. Should you have any questions in the future, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

## Sherri Hiraoka

| | |
|---|---|
| **From:** | Liu, Rouen <rouen.liu@hawaiianelectric.com> |
| **Sent:** | Thursday, June 12, 2014 1:34 PM |
| **To:** | Sherri Hiraoka |
| **Cc:** | 1.11.136609@ecollab.heco.com |
| **Subject:** | Initial consultation - request for comments on the Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades |

Dear Ms. Hiraoka,

Thank you for the opportunity to comment on the subject project. Hawaiian Electric Company has no objections to the project. Should HECO have existing easements and facilities on the subject property, we will need continued access for maintenance of our facilities.

We appreciate your efforts to keep us apprised of the subject project in the planning process. As the Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades comes to fruition, please continue to keep us informed. Further along in the design, we will be better able to evaluate the effects on our system facilities.

If you have any questions, please call me at 543-7245.

Sincerely,
Rouen Q. W. Liu
Permits Engineer

---

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Rouen Q. W. Liu
Permits Engineer
Hawaiian Electric Co.
P.O. Box 2750
Honolulu, HI 96840

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Liu:

Thank you for informing us that HECO has no comments on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades at this time. We will continue to inform you of the project as it progresses to ensure coordination among the utilities.

Should you have any questions in the future, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

DEPARTMENT OF FACILITY MAINTENANCE

**CITY AND COUNTY OF HONOLULU**

1000 Ulu`ohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 768-3343 • Fax: (808) 768-3381
Website: www.honolulu.gov

KIRK CALDWELL
MAYOR

ROSS S. SASAMURA, P.E.
DIRECTOR AND CHIEF ENGINEER

EDUARDO P. MANGLALLAN
DEPUTY DIRECTOR

IN REPLY REFER TO:
DRM 14-500

June 25, 2014

Ms. Sherri Hiraoka, Senior Planner
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

SUBJECT: Initial Consultation for the Preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrade

Thank you for opportunity to review and comment on the subject project. We apologize for the late response. Our comments are as follows:

- Once construction phase commences, install approved Best Management Practice fronting all drainage facilities (catch basin/drainage inlets along the subject sewer line route).
- During construction and upon completion of project; any damages/deficiencies to any City maintained roadway's right-of-ways shall be corrected to City standards and accepted by the City.

If you have any questions, please call Mr. Kyle Oyasato of the Division of Road Maintenance, at 768-3600.

Sincerely,

Ross S. Sasamura, P.E.
Director and Chief Engineer

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Kyle Oyasato
Division of Road Maintenance
Department of Facility Maintenance
City and County of Honolulu
1000 Ulu'ohia Street, Suite 215
Kapolei, HI 96707

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Oyasato:

Thank you for commenting on the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades. Your comments regarding Best Management Practices and damages to City roadway rights of way will be addressed either in the Draft Environmental Assessment or during the design and permitting phases of the project.

Should you have any questions in the future, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

HAWAI'I GAS
THE CLEAN ENERGY COMPANY

June 30, 2014

Ms. Sherri Hiraoka
Townscape, Inc.
900 Fort Street Mall, Suite 1160
Honolulu, Hawaii 96813

Dear Ms. Hiraoka:

Subject: Initial Consultation for the preparation of an Environmental Assessment (EA) for the proposed Kahanahou Wastewater Pump Force Main Sewer Line Upgrades

In response to your letter dated June 30, 2014, it has been determined that the area is currently clear of utility gas facilities.

Thank you for the opportunity to review the map. Should there be any questions, or if additional information is desired, please feel free to call Kris Tanner at 596-1425.

Sincerely,

Hawaii Gas

Keith K. Yamamoto
Manager, Engineering

KKY:krs
14-180

**TOWNSCAPE, INC.**
ENVIRONMENTAL AND COMMUNITY PLANNING

900 Fort Street Mall, Suite 1160, Honolulu, HI 96813
Telephone (808) 536-6999 Facsimile (808) 524-4998
email address: mail@townscapeinc.com

July 9, 2014

Mr. Kris Tanner
Hawai'i Gas
P.O. Box 3000
Honolulu, HI 96802-3000

Subject: Response to comments on the preparation of an Environmental Assessment for the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades

Dear Mr. Tanner:

Thank you for informing us that the proposed Kahanahou Wastewater Pump Station Force Main Sewer Line Upgrades project area is currently clear of utility gas facilities. Should you have any questions in the future, please contact the undersigned at (808) 536-6999, extension 6 or via email at sherri@townscapeinc.com.

Sincerely,

Sherri Hiraoka

Sherri Hiraoka
Senior Planner

**Appendix E**

Archaeological Literature Review and Field Inspection,
Kahanahou Wastewater Pump Station Force Main Sewer Line Study,
Kaneohe Ahupuaa, Koolaupoko, Oahu, TMK: [1] 4-5-047:095
Cultural Surveys Hawaii, January 2013

# Draft

# Archaeological Literature Review and Field Inspection, Kahanahou Wastewater Pump Station Force Main Sewer Line Study, Kāne‘ohe Ahupua‘a, Ko‘olaupoko, O‘ahu, TMK: [1] 4-5-047:095

**Prepared for**
**Townscape, Inc.**


**Prepared by**
**Constance R. O'Hare, B.A.,**
**David W. Shideler, M.A.,**
**and**
**Hallett H. Hammatt, Ph.D.**

**Cultural Surveys Hawai‘i, Inc.**
**Kailua, Hawai‘i**
**(Job Code: KANEOHE 34)**


**January 2014**


**O‘ahu Office**
**P.O. Box 1114**
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**Maui Office**
**1860 Main St.**
**Wailuku, Hawai‘i 96793**
**Ph: (808) 242-9882**
**Fax: (808) 244-1994**

# Management Summary

| | |
|---|---|
| **Reference** | Archaeological Literature Review and Field Inspection, Kahanahou Wastewater Pump Station Force Main Sewer Line Study, Kāneʻohe Ahupuaʻa, Koʻolaupoko, Oʻahu, TMK: [1] 4-5-047:095 (O'Hare et al. 2013) |
| **Date** | January 2014 |
| **Project Number (s)** | Cultural Surveys Hawaiʻi, Inc. (CSH) Job Code: KANEOHE 34 |
| **Investigation Permit Number** | CSH conducted the archaeological field inspection for this investigation under state archaeological permit number 13-06, issued by Hawaiʻi State Historic Preservation Division/Department of Land and Natural Resources (SHPD). |
| **Project Location** | The project area is located in the Kahanahou Subdivision, on portions of Ka Hanahou Place, Ka Hanahou Circle, Lilipuna Road, and Lilipuna Place; it then crosses Wailele Road and extends to a small portion of Makahīʻō Street. |
| **Land Jurisdiction** | State of Hawaiʻi |
| **Agencies** | State Historic Preservation Division/State of Hawaiʻi Department of Land and Natural Resources (SHPD), State of Hawaiʻi |
| **Project Description** | The City and County of Honolulu, Wastewater Division, is planning to replace a portion of the existing sewer line that extends from the Kahanahou Wastewater Pump Station and discharges at a sewer manhole on Makahia Street. The current force main consists of an 8-inch high density polyethylene (HDPE), which will be replaced by a 10-inch HDPE fusible pipe. |
| **Project Acreage** | The proposed sewer line is approximately 1,000 m long, covering 2.9 acres. |
| **Document Purpose** | This investigation is not an archaeological inventory survey, per the requirements of Hawaiʻi Administrative Rules (HAR) §13-276; however, through historical, cultural, and archaeological background research, and a field inspection of the project area, this investigation was intended to identify any cultural resources that may be affected by the project. This document is intended to facilitate the project's planning and support the project's historic preservation compliance. Based on results, cultural resource management recommendations are presented.[1] |
| **Fieldwork Effort** | The fieldwork component for this historical resources study was conducted on 9 December 2013 by CSH archaeologists Constance R. O'Hare, B.A. and David W. Shideler, M.A. This fieldwork consisted of a limited field inspection of the water line area to identify any surface archaeological features, and to investigate and assess the potential for impact to historic properties. |

| | |
|---|---|
| **Historic Properties Potentially Affected** | This field inspection did not observe any property of cultural significance. However, there is a potential for encountering pre-Contact and post-Contact subsurface cultural deposits related to traditional Native Hawaiian land use and habitation. |
| **Discussion of Project Effect and Recommendations** | Based on this study's results, an archaeological inventory survey of the project area (per the requirements of HAR §13-276) does not appear warranted for development within the project area. Depending on the extent and location of ground disturbance during future proposed renovations in the project area, an archaeological monitoring program might be appropriate for portions of the project area as an historic preservation mitigation measure. Should the project proceed with open trench excavation then an archaeological monitoring program with on-site archaeological monitoring is recommended.<br><br>Early consultation with the SHPD is recommended (to be informed by this study) to determine appropriate cultural resource management. |

[1] In historic preservation parlance, cultural resources are the physical remains and/or geographic locations that reflect the activity, heritage, and/or beliefs of ethnic groups, local communities, states and/or nations. Generally, they are at least 50 years old, although there are exceptions, and include buildings and structures; groupings of buildings or structures (historic districts); certain objects; archaeological artifacts, features, sites, and/or deposits; groupings of archaeological sites (archaeological districts); and, in some instances, natural landscape features and/or geographic locations of cultural significance.

# Table of Contents

# List of Figures

# List of Tables

# Section 1 Introduction

## 1.1 Project Background

At the request of Townscape, Inc. (900 Fort Street Mall, Suite 1160, Honolulu, Hawaiʻi 96813), Cultural Surveys Hawaiʻi, Inc., (CSH) has prepared this archaeological literature review and field inspection (LRFI) to the Kahanahou Wastewater Pump Station Force Main Sewer Line Study, Kāneʻohe Ahupuaʻa, Koʻolaupoko, Oʻahu, TMK: [1] 4-5-047:095, as shown an a U.S. Geological Survey (USGS) topographic map (Figure 1), an aerial photograph (Figure 2), and three tax map plats (Figure 3 through Figure 5). The proposed sewer line is approximately 1,000 m long, covering 2.9 acres.

The project area is located in the Kahanahou Subdivision of Kāneʻohe, on portions of Ka Hanahou Place, Ka Hanahou Circle, Lilipuna Road, and Lilipuna Place; it then crosses Wailele Road and extends to a small portion of Makahīʻō Street, adjacent to portions of TMKs: [1] 4-4-002:045, 047, 057, and 074. The City and County of Honolulu, Wastewater Division, is planning to replace a portion of the existing sewer line that extends from the Kahanahou wastewater pump station and discharges at a sewer manhole on Makahia Street. The force main is located adjacent to roads in most sections, but also passes through some private properties between Lilipuna Place and Wailele Road. The current force main consists of an 8-inch high density polyethylene (HDPE), which will be replaced by a 10-inch HDPE fusible pipe.

This investigation is not an archaeological inventory survey, per the requirements of Hawaiʻi Administrative Rules (HAR) §13-276; however, through historical, cultural, and archaeological background research, and a field inspection of the project area, this investigation was intended to identify cultural resources that may be affected by the project. This document is intended to facilitate the project's planning and support the project's historic preservation compliance. Based on results, cultural resource management recommendations are presented.

## 1.2 Scope of Work

The scope of work for this project includes the following:

1. Historical research to include study of archival sources, historic maps, Land Commission Awards, and previous reports to construct a history of the project area and vicinity and to determine if there are any historic properties.
2. Limited field inspection of the project area. This assessment will identify any sensitive areas that may require further investigation for this report.
3. Preparation of a report to include the results of the historical research and the limited fieldwork assessment with recommendations for further work, if appropriate. It will also provide mitigation recommendation, if appropriate.

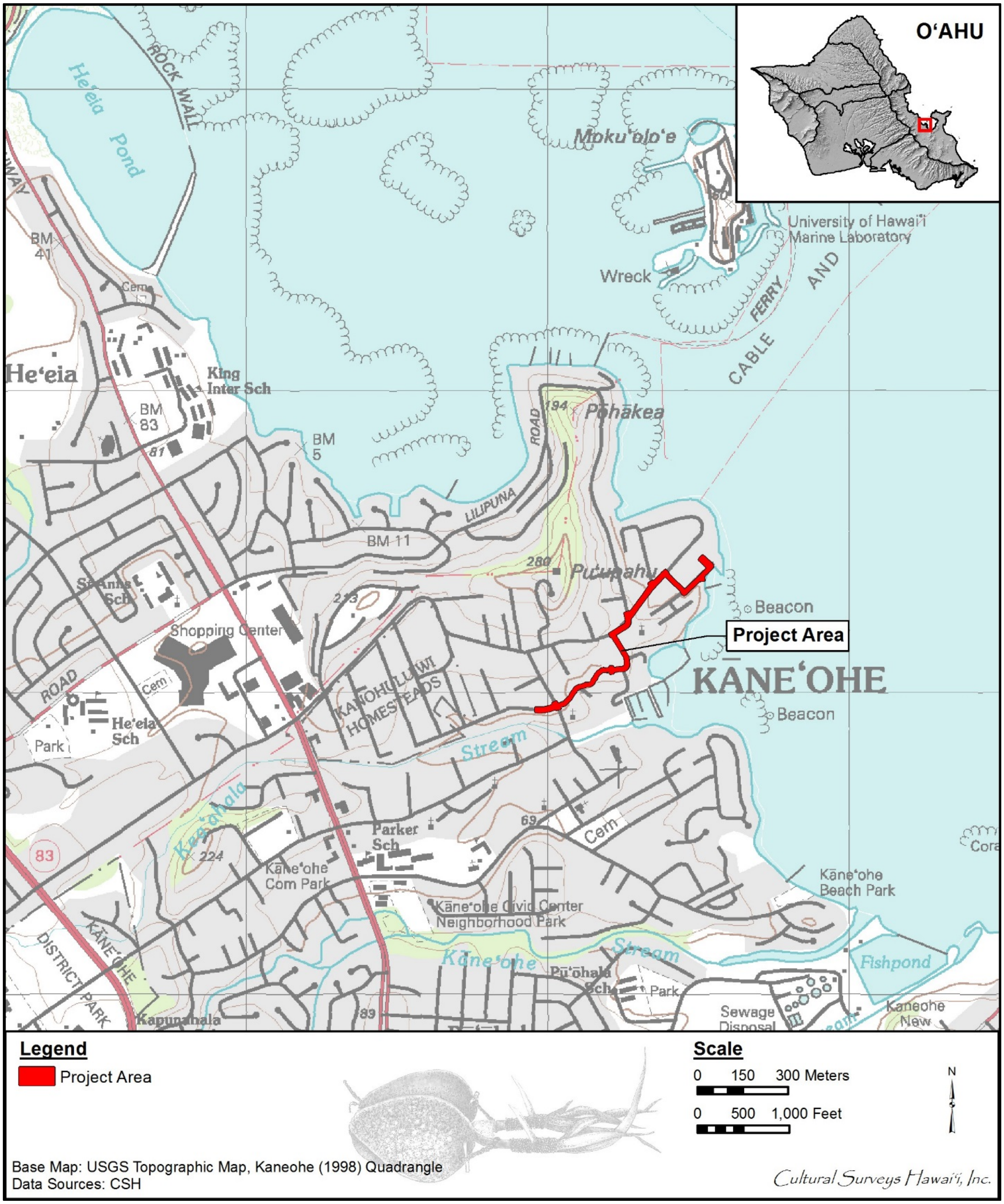



Figure 1. Portion of 1998 Kaneohe USGS 7.5-Minute Series Topographic Quadrangle, showing the location of the project area


Figure 2. Aerial photograph, showing the location of the project area (Google Earth 2013)

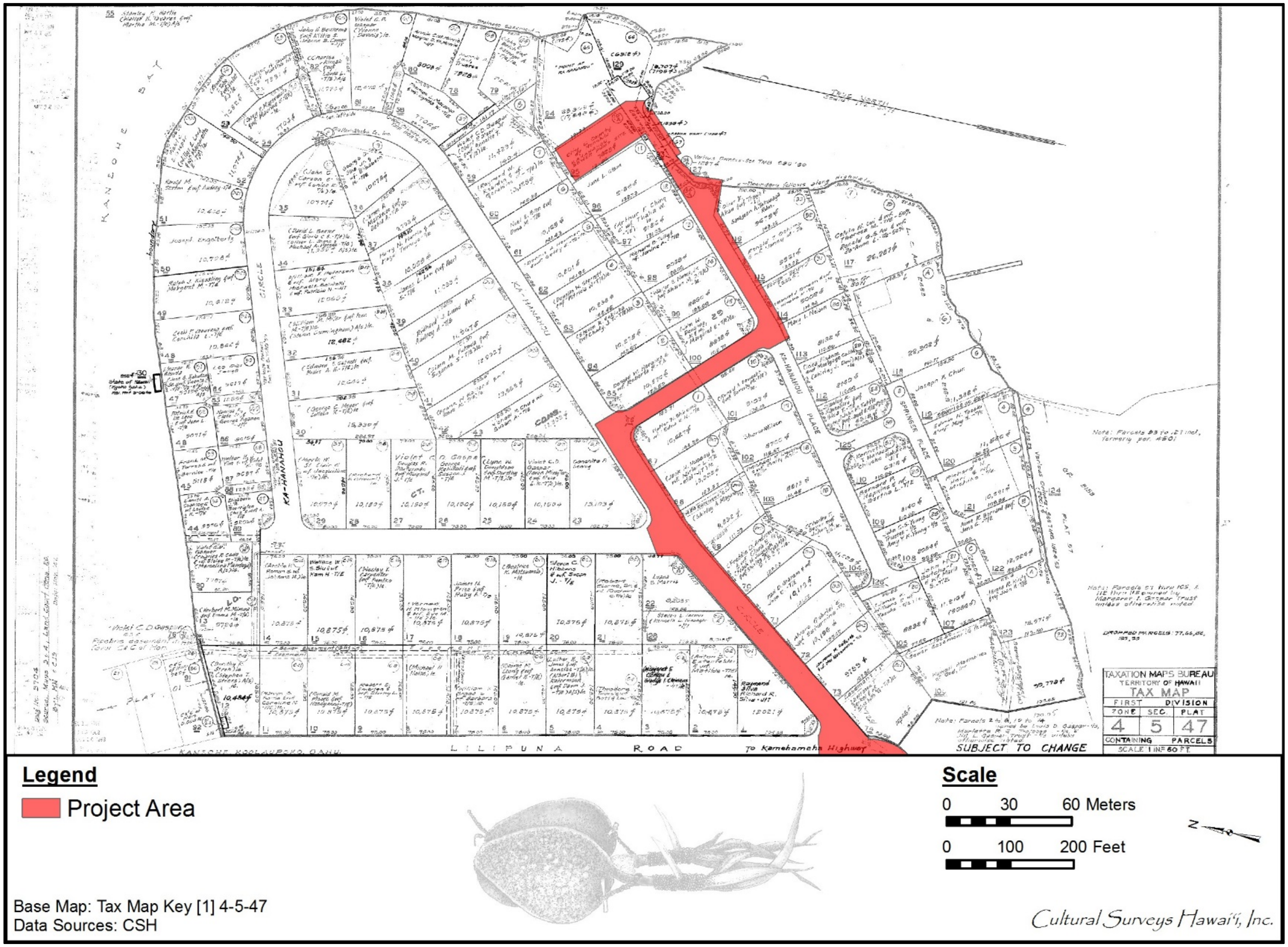



Figure 3. Tax Map Key (TMK) [1] 4-4-047, showing northern end of the project area

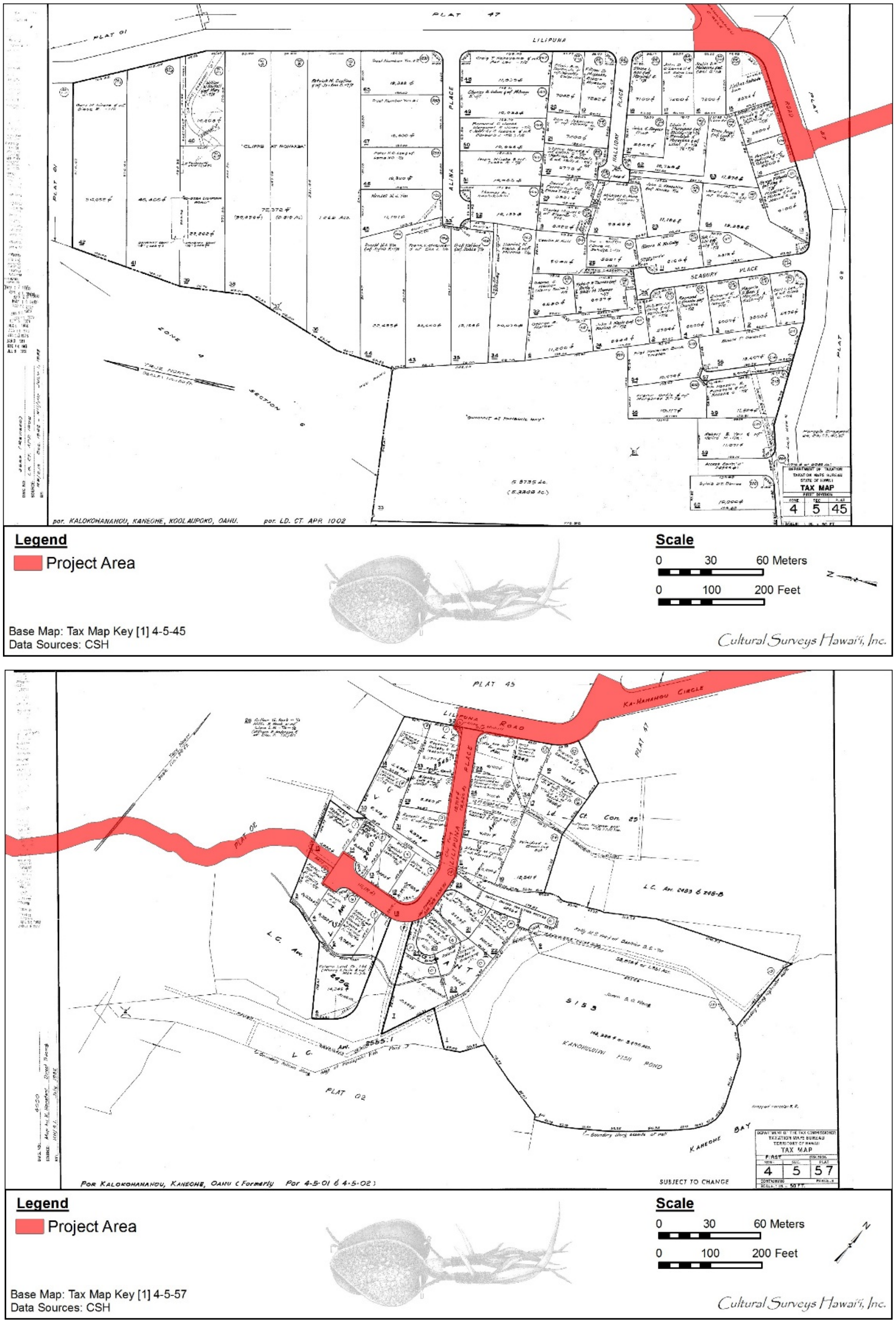
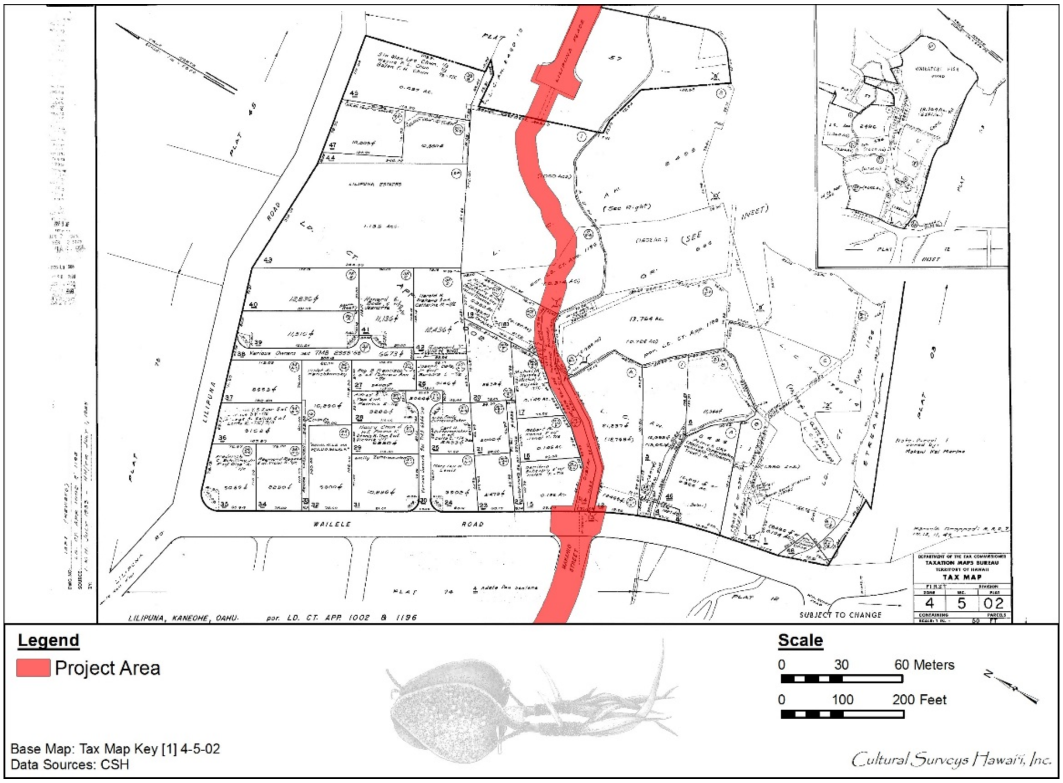



Figure 4. TMKs: [1] 4-4-045 (top) and [1] 4-4-057 (bottom) showing central section of the project area



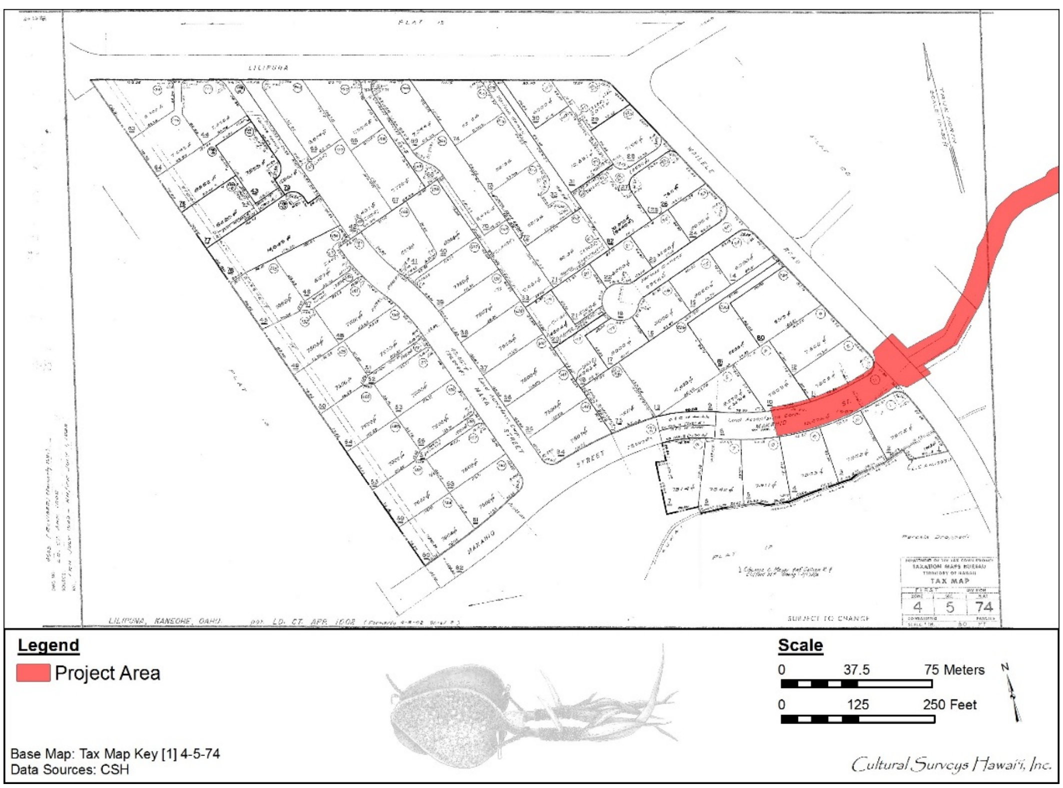




Figure 5. TMKs: [1] 4-4-002 (top) and [1] 4-4-074 (bottom), showing southern end of the project area

# 1.3 Environmental Setting

## 1.3.1 Natural Environment

The lands within the project treatment areas are generally level with elevations ranging from 0 to 12 m (0 to 40 ft) above mean sea level. Rainfall in this portion of Kāne‘ohe averages 1,000 mm (40 inches) per year (Giambelluca et al. 1986). The northern portion of the project area is within the former offshore fishpond, Kalokohanahou, which was filled to make the Ka Hanahou residential development around 1944. Thus all of the sediments in this area are Fill Land, which is a land type of areas filled with slurry from sugar mills, dredged material, and soil from excavations (Foote et al. 1972:31).

The central portion of the project area extends through an area of Kaneohe silty clay, 8 to 15% slopes (KcG) (Figure 6). Soils of the Keaau Series are described as:

> . . . well-drained soils on terraces and alluvial fans on the windward side of Oahu. These soils developed in alluvium and colluviums derived from basic igneous rock. . . . These soils are used for pasture, homesites, and urban development. [Foote et al. 1972:59]

Common modern vegetation includes guava (*Psidium guajava*), Boston fern (*Nephrolepis exaltata*), sensitive plant (*Mimosa pudica*), Hamakua *pamakani* (*Ageratina riparia*), glenwoodgrass (*Sacciolepis indica*), and hilograss (*Paspalum conjugatum*).

The southern end of the project area is in an area covered with Lolekaa silty clay, 3 to 8% slopes (LoB) (Figure 6). Soils of the Lolekaa series are described as:

> . . . well-drained soils on fans and terraces on the windward side of the island of Oahu. These soils developed in old, gravelly colluviums, and alluvium. . . . These soils are used for pasture, homesites, or chards, and truck crops. [Foote et al. 1972:83]

Common modern vegetation includes guava, christmasberry (*Schinus terebinthifolius*), *koa haole* (*Leucaena glauca*), californiagrass (*Brachiaria mutica*), ricegrass (*Paspalum orbiculare*), and hilograss.

## 1.3.2 Built Environment

The project area is in a residential section with houses set on both sides of the roads. The roads are generally two-lane streets with no sidewalks.

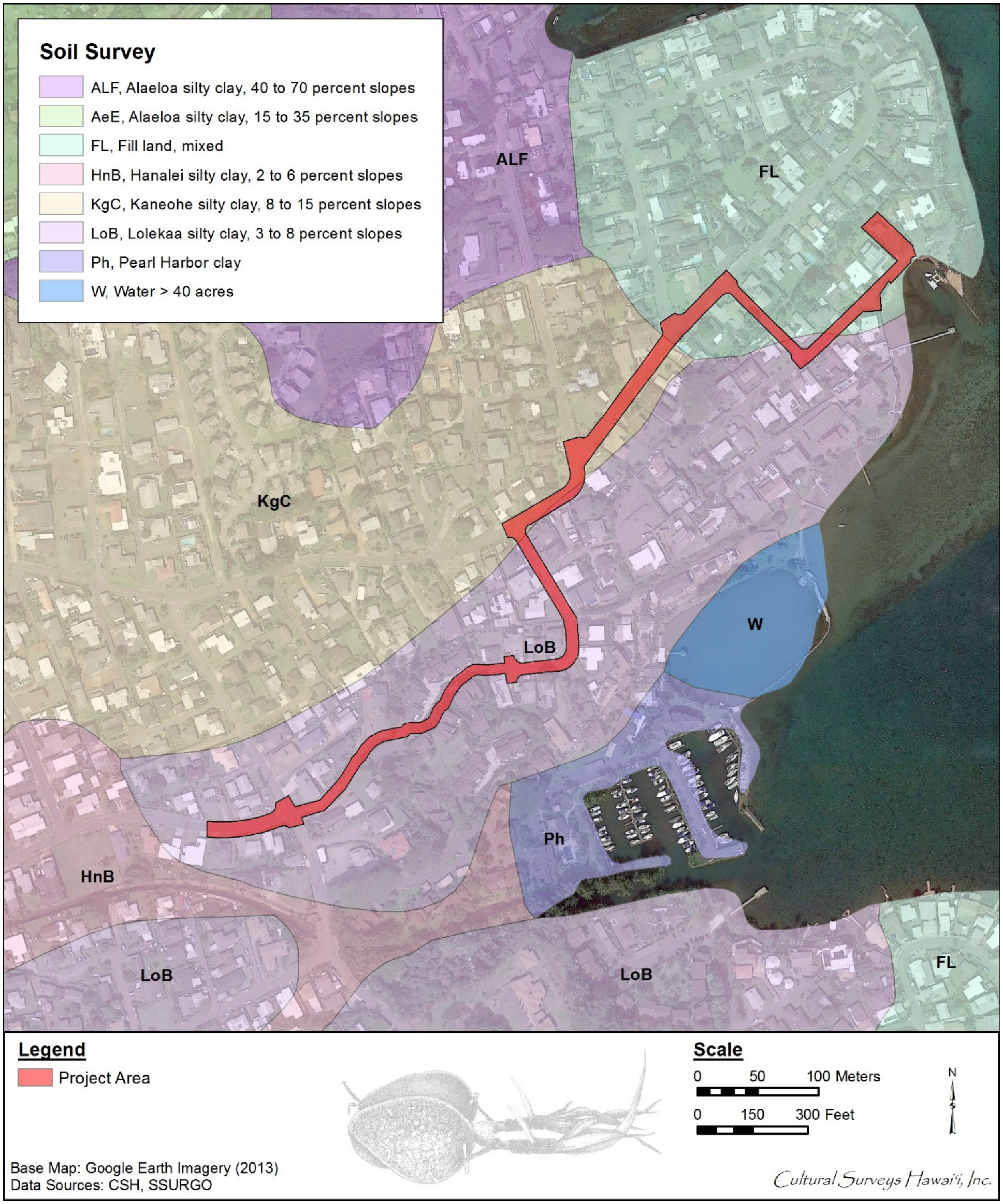



Figure 6. Aerial photograph (Google Earth 2013) with overlay of USDA soil boundaries (soil information from Foote et al. 1972)

## 1.4 Methods

### 1.4.1 Field Methods

The field inspection fieldwork was carried out 5 September 2013 by CSH archaeologists David W. Shideler and Constance R. O'Hare. One hour was required. All fieldwork was done under the general supervision of Hallett H. Hammatt, Ph.D. (principle investigator). CSH conducted the fieldwork component of this study under state archaeological fieldwork permit No. 13-06 issued by the State Historic Preservation Division (SHPD), per HAR §13-282. Representative photographs were taken of the project area.

### 1.4.2 Document Review

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division (SHPD) of the Department of Land and Natural Resources (DNLR). Archaeological reports, historic maps, and photographs contained within the CSH library were also consulted.

# Section 2 Traditional and Historic Background

## 2.1 Traditional Accounts

The project area is located within the Windward Oʻahu district of Koʻolaupoko, in the *ahupuaʻa* (land division) of Kāneʻohe. This report section focuses on the traditional background of the near-coastal locations of the western shore of Kāneʻohe Bay.

Kāneʻohe is a large *ahupuaʻa* of approximately 8,000 acres, extending from the crest of the Koʻolau Range to the coast at Kāneʻohe Bay, and including most of the Mōkapu Peninsula. It is watered by three streams, the Kawā Stream, Kaneʻohe Stream and its tributaries, and Keaʻahala ("the pandanus root") Stream. Heʻeia Ahupuaʻa is to the west and the boundary between these two *ahupuaʻa* at the coast extends from the boundary point called Pōhākea ("white stone") near the shore, inland to the peak called Puʻu Pahu. The project area is mainly located in the *ʻili* (small land divisions) of Kalokohanahou and Kanahuluʻiwi (Figure 7).

The meaning of the place name Kāneʻohe may come from *kāne* (man), which may be a reference to Kāne, the god of creation, and *ohe*, which means "bamboo." The word *kāne* has also been interpreted as "husband." The place name Kāneʻohe has been attributed to a story about a woman who compared her husband's cruelty to the cutting edge of a bamboo knife (Clark 2002:160-161). Kāneʻohe may also be derived from *ʻohe*, which is said to be one of the *kinolau* (body forms) of the god Kāne (Abbott 1992:15).

Puʻu Pahu and Pōhākea are the hills along the boundary and ridgeline that separate Kāneʻohe Ahupuaʻa to the east and Heʻeia Ahupuaʻa to the west. There was a *kahuna* (priest) named Manuwahi who lived with his sons in Laʻie. They controlled the *akua* (gods) of the area. In the early post-Contact period, Kamehameha I sent one of his bodyguards, Kahalaiu, to conquer the family and the land of Mālaekahana. Kahalaiu and his forces surrounded the home of Manuwahi, but the *kahuna* called up all of the *akua* to fight the soldiers, who were all slain except Kahalaiu. After the battle, Manuka, son of Manuwahi, moved to Kāneʻohe. When he died, the people dug a large grave and placed him in it. Before they could bury him, the *akua* brought red dirt from ʻEwa in a cloud and filled the grave, making a red hill, the only area with red dirt in the district (Rice 1977:125-126). A *heiau* (ceremonial structure) by the same name as the peak (Puʻu Pahu) was once located atop the hill, but was destroyed before 1933 (McAllister 1933:177). Nearby is an adjacent peak called Pōhākea. This name is also given to an underwater site off Kualoa Point; it can be translated as "first light of dawn," according to a local informant. A more prosaic translation of Pōhākea would be "white rock" as might have related to discoloration from the droppings of birds resting on a promontory.

The place name Puʻu Pahu may also relate to a legendary woman named Loʻe who was expelled from ʻEwa along with her three brothers for constantly fighting with their parents. In the story of the Kāneʻohe peak, Keahiakahoe, Pahu is a fisherman while Kahoe and Kahuauli are farmers living inland (these two names are also adjacent peaks behind Luluku) with their sister Loʻe. Pahu is the fisherman who withholds his catch from his brother Kahoe even though his brother supplies him with plenty of taro. He betrays the Hawaiian socio-economic tradition of sharing with family in the *ahupuaʻa*, but Kahoe finds out when the sister asked him if the *ʻulua* was finished cooking in the *imu* (earth oven). Then, during a time of famine, Pahu could only stare

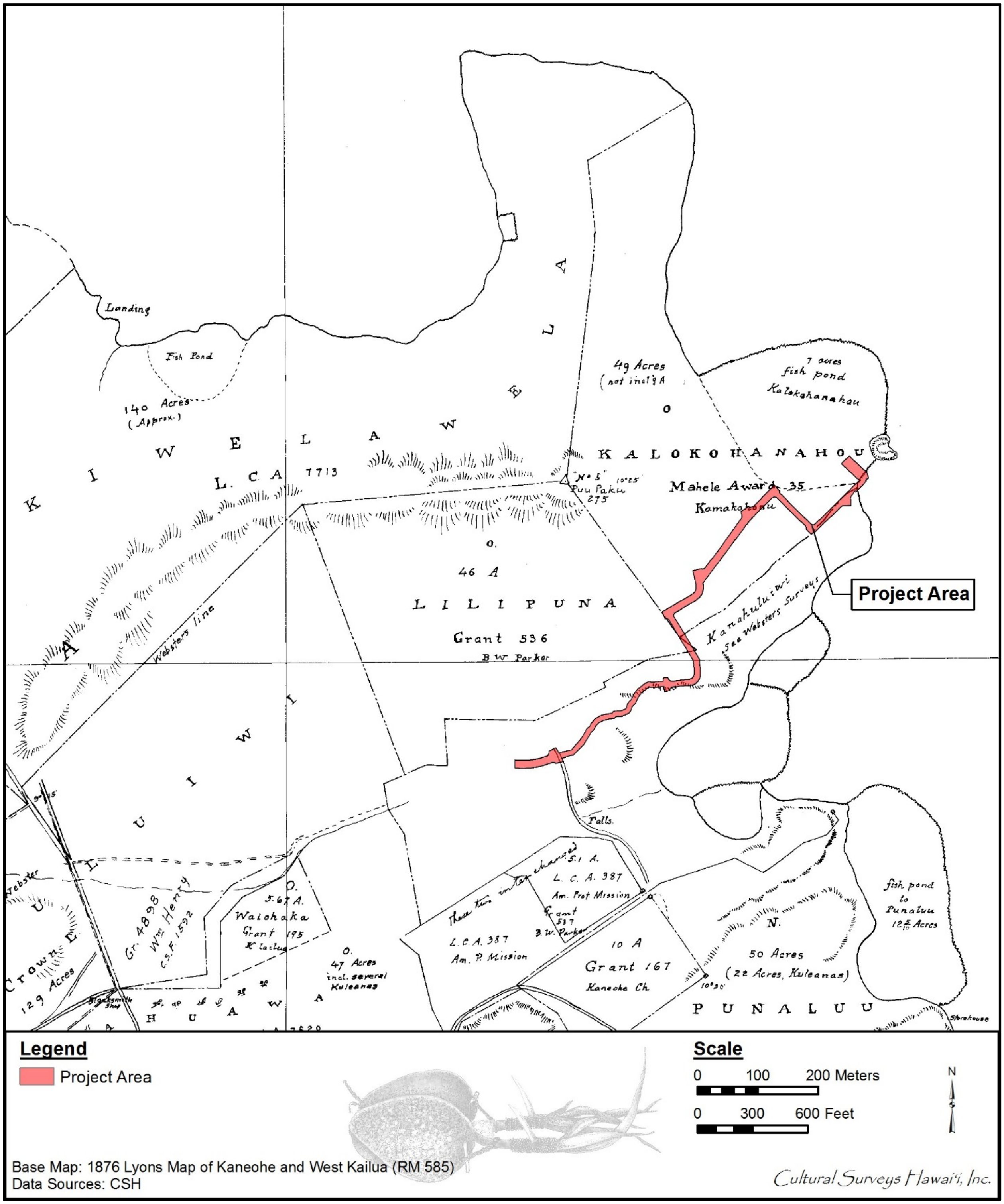



Figure 7. 1876 map of Kane‘ohe and West Kailua (portion), showing names and locations of *‘ili* surrounding the project area (Lyons 1876); note the project area is within the *‘ili* of Kalokohanahou and Kanohuli‘iwi, and on the boundary of the *‘ili* of Lilipuna

silently at the smoke from his brother's oven full of *kalo* because of the guilt he felt from the wrongdoing. Pahu became the hill near his residence, Pu‘u Pahu, and the islet Moku Lo‘e (Coconut Island) was named for Lo‘e. It was said that where Lo‘e's tears fell, they formed a spring in front of the cliff of Keahiakahoe facing Pahu and there it is to this day. Its name is Lo‘e-wai, and it is located near the site of Kukui o Kāne Heiau (Bishop Museum HEN:1:2181 in Sterling and Summers 1978:206).

## 2.2 Historic Background

### 2.2.1 Pre-Contact Period

The *ahupua‘a* of Kāne‘ohe was prosperous and densely populated in pre-Contact times. With fresh water from *mauka* (inland) springs and perennial streams, as well as a well-developed fishpond system, Kāne‘ohe was rich in agricultural and aquacultural productivity. It was one of the primary population centers on O‘ahu:

> . . . along the windward coast, beginning with Waikane and continuing through Waiahole, Ka‘alaea, Kahalu‘u, He‘eia, and Kane‘ohe, were broad valley bottoms and flatlands between the mountains and the sea which, taken all together, represent the most extensive wet-taro area on Oahu. These taro lands were irrigated from both streams and springs. Along the shores thereabouts were also some very large salt-water fishponds. This whole region must have supported a dense population . . .
>
> The area that included what is now Kane‘ohe and Kailua, which was rich in fishponds and tillable lands, was the seat of the ruling chiefs of Ko‘olaupoko (Short Ko‘olau) which was the southern portion of the windward coast. [Handy and Handy 1972:271-272]

Nathaniel Portlock, captain of the British vessel *King George*, provided the following description of Kāne‘ohe ca. the late 1780s, shortly after Western Contact:

> The [Kāne‘ohe] bay all round has a very beautiful appearance, the low land and valleys being in a high state of cultivation, and crowded with plantations of taro, sweet potatoes, sugar cane, etc., interspersed with a great number of coconut trees, which renders the prospect truly delightful. [Handy and Handy 1972:455]

Pre-Contact land use in Kāne‘ohe consisted primarily of plantations of *kalo* (taro), bananas, sweet potatoes, and coconut trees, as well as groves of *hala* (pandanus; used for making household furnishings such as mats) and *wauke* (paper mulberry; used for making cloth) (Handy and Handy 1972:456). Handy and Handy (1972) describe how the natural environment of Kāne‘ohe was conducive to development of a complex agricultural system:

> The broken topography of Kaneohe arranges the areas of flatland like chains of pockets connecting along its stream channels between hills. On the north side of the *ahupua‘a* near the boundary of He‘eia, Kea‘ahala Stream flows into Kalimukele, coming out of He‘eia. Some of the best *lo‘i* [taro patches] still in use in 1953, *mauka* of the highway, were irrigated by Kea‘ahala, and a large old *lo‘i* system once extended downstream below the highway. An elaborate system of

> water rights prevailed in ancient times throughout these sections irrigated from Keaʻahala.
>
> The other streams—Wailele (formerly Paniʻohelele), Hiʻilaniwai, Kahuaiki, Mamalahoa—likewise watered many taro *loʻi* . . . Hiʻilaniwai is a very long stream, with its origin in the slopes that drain Puʻu Lanihuli, the peak that flanks the northern side of the Nuʻuanu Pali road and the southern boundary of Kaneohe. In fact all of the *ahupuaʻa* is like a vast green amphitheater below the serrated sheer cliffs that extend from Puʻu Lanihuli northward to Haʻiku Valley and known as the Ke-ahi-a-Kahoe (Fires-of-Kahoe) Cliffs. As the ground rises steeply from the stream beds along their upper courses, there is little evidence of systematic terracing observable in these areas, as might have been expected. The lowland areas were so extensive that evidently the more laborious terracing of the interior slopes was not regarded by the early Hawaiians as necessary.
>
> The kula [pasture, wasteland] lands between the streams were planted in pandanus, *wauke*, bananas, and sweet potatoes. *Kalo maloʻo* (dry-taro) was not planted here. The number of names of *ʻili* and *kuleana* on *kula* lands along the Hiʻilaniwai and its tributaries, however, indicates intensive cultivation of products other than taro, and the abundant rains sweeping down from the cliffs made such cultivation profitable. [Handy and Handy 1972:455-456]

In general, lands suitable for development of *loʻi* (irrigated terraces) were located along main streams and coastal lowlands (Devaney et al. 1982:36). *Loʻi* development required diversion of stream water for irrigation, and construction of terraces to pond the water. Steen Bille, writing in Dutch, describes the system:

> . . . this [taro] root, the principal food of the inhabitants of these Islands, grows only in low, well watered places, and where no such places are provided by nature the natives frequently with great difficulty make excavations so that water may collect in these basins which frequently are several ells deep. [Devaney et al. 1982:35-36]

In addition to the extensive agricultural cultivation, the people of Kāneʻohe Bay sought the bountiful marine resources:

> The sea adjoining an *ahupuaʻa* [Kāneʻohe] was considered to be an extension of that *ahupuaʻa*; its resources were shared by the chief and all of the tenants (*hoaʻāina*) living in the *ahupuaʻa*. Access to the sea was part of the *mauka-makai* concept, which made the products of land and sea available to the people living in the *ahupuaʻa.* [Devaney et al. 1982:135]

Just as the land-based resources of the *ahupuaʻa* were managed through subdivision into *ʻili*, the marine resources of the *ahupuaʻa* were also partitioned, with discreet fisheries associated with the *ʻili* along the Kāneʻohe Bay coast. In addition to shoreline and offshore fishing, fishponds were constructed along the Kāneʻohe Bay shoreline to provide regular supplies of fish to the inhabitants of the *ahupuaʻa*:

> Shoreline fishing is highly susceptible to the vagaries of weather and surf conditions. With walled fishponds, Hawaiians provided for themselves a regular

> supply of fish when other types of fishing were not possible or yielded an insufficient supply. The fringing reefs along the shoreline of Kaneohe Bay were ideal for the type of walled fishponds that extended out from the land.
>
> Mullet, one of the world's most important food fishes, was the most common species raised by Hawaiians in their fishponds; *awa* (milkfish) followed a close second. [Devaney et al. 1982:140]

Several *loko* (fishponds) were located in the vicinity of the current project area, including (from west to east) Kalokokahanhou, Kanohuluiʻwi, Punaluʻu, Waikalua, and Keana. Kamakau relates the number of fishponds in an area to the population that would have been necessary for their construction:

> The making of walls (*kuapa*) of the shore ponds was heavy work, and required the labor of more than ten thousand men. Some of these fishponds covered an area of sixty of seventy acres, more or less. Walls had to be made on the seaward side sometime in deep water and sometime in shallow, and many stones were needed.
>
> Many *loko kuapa* [fishpond walls] were made on Oahu, Molokai and Kauai, and a few on Hawaii and Maui. This shows how numerous the population must have been in the old days, and how they must have kept the peace, for how could they have worked together in unity and make these walls if they had been frequently at war and in opposition one against another? [Kamakau 1976:47]

### 2.2.2 Early Historic Period to Mid-1800s

In 1795 Kamehameha, at that time the Hawaiʻi Island chief, invaded Oʻahu to secure control of the islands of Oʻahu, Molokaʻi, and Lānaʻi after his successful conquest of Maui. The Oʻahu Island chief Kalanikūpule, Molokaʻi Island chief Kaʻiana, and their forces met Kamehameha's army in the valley of Nuʻuanu. The following account describes the final stages of the battle at the Nuʻuanu Pali, the knife-edge ridge of the Koʻolau Range separating Nuʻuanu from Kāneʻohe Ahupuaʻa:

> The forces of Kamehameha charged; in the onslaught many of the Oahuans were slain, and the rest pursued with great slaughter until they were driven to the end of the valley, which terminates in a precipice of six hundred feet, nearly perpendicular height, forming a bold and narrow gorge between two forest-clad mountains. A few made their escape; some were driven headlong over its brink, and tumbled, mangled and lifeless corpses, on the rocks and trees beneath; others fought with desperation and met a warrior's death, among whom was Kalanikupule, who gallantly contested his inheritance to the last. [Jarves 1872:85]

Kamakau (1992:172) offers an alternate fate for Kalanikūpule, stating he escaped to the mountains with some of his men for several months, but was later discovered and sacrificed to Kamehameha's war god Kūkāʻilimoku.

Following the conquest of Oʻahu by Kamehameha, the lands of the island were divided between Kamehameha and his followers. Likely due to its agricultural and fishery productivity, Kāneʻohe Ahupuaʻa was seen as the "most valuable part" of the Koʻolaupoko District (Kamakau 1992:303). Kāneʻohe Ahupuaʻa was retained by Kamehameha as his personal property, and was later inherited by his sons Liholiho and Kauikeaouli, Kamehameha II and III (Kame‘eleihiwa 1992:233).

In the early 1800s, there were three primary routes to Windward O‘ahu from the growing town of Honolulu. These were

> around the island by canoe; through Kalihi Valley and over the pali [cliff] by ropes and ladders (Graham 1826:142); and over the Nuuanu Pali, the easiest, quickest, and most direct route. [Devaney et al. 1982:163]

The trail over the Nu‘uanu Pali was a heavily utilized transportation corridor since it allowed the people of Windward O‘ahu to bring their agricultural products to Honolulu for sale. The Reverend Reuben Tinker described his trip over the Nu‘uanu Pali in 1831:

> It seemed to me a sublime pass, yet almost too fearful to be enjoyed, for though not unaccustomed to hills, and the ups and downs of life, I suffered from apprehension lest I should fall from the rocky steep. I took off my shoes and by setting my feet in the crevices of the rocks, I worked myself along, assisted by a native, who saw nothing to wonder at but my awkwardness and fear on passing this grand highway, though to them common. The natives do not think it is either wonderful or difficult. It is the main road connecting the opposite sides of the island, and men and women are going up and down with their ordinary burdens on their shoulders, and in their arms, such as bundles of potatoes and taro, calabashes of poi, fowls, goats and swine.
>
> Mothers were passing along the most precipitous places with their children on their shoulders, as careless of danger as if they were on a level plain . . . [Tinker 1900:88]

Traditional agricultural practices, including wetland taro cultivation, continued to dominate land use in Kāne‘ohe in the early years following Western Contact, although to a lesser degree. Introduced diseases dramatically reduced the Native Hawaiian population to a fraction of its pre-Contact level. Native Hawaiian historian David Malo notes that:

> In the reign of Kamehameha, from the time I was born until I was nine years old, the pestilence (*mai ahulau*) visited the Hawaiian Islands, and the majority (*ka pau nui ana*) of the people from Hawaii to Niihau died. [Devaney et al. 1982:8]

Agricultural lands were subsequently abandoned due to the population decrease. In 1828, the missionary Levi Chamberlain embarked on a tour around the island of O‘ahu to determine the progress occurring at schools established to educate Native Hawaiians. During his tour, Chamberlain (1828:26) made observations of the landscape and people around the island commenting on the “present neglected state” of formerly cultivated agricultural lands:

> [The natives] ascribed it to the decrease in population. There have been two seasons of destructive sickness, both within the period of thirty years, by which, according to the account of the natives, more than one half of the population of the island was swept away. The united testimony of all, of whom I have ever made any inquiry respecting the sickness, has been, that ‘Greater was the number of the dead than of the living.’

> . . . it may, I think, be safely asserted, that since the discovery of these islands by Cap. Cook there has been a decrease of population, by desolating wars, the ravages of disease and other causes, of at least one half of the number of inhabitants that might have been fairly estimated, at the time that celebrated voyager last visited these islands. [Chamberlain 1828:26]

### 2.2.3 The Māhele (Land Divisions)

In 1845, the Board of Commissioners to Quiet Land Titles, also called the Land Commission, was established “for the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property” (Chinen 1958:8). This led to the Māhele, the division of lands between the king of Hawaii, the *ali‘i* (chiefs), and the common people, which introduced the concept of private property into Hawaiian society. In 1848, Kamehameha III divided the land into four categories: certain lands to be reserved for himself and the royal house were known as Crown Lands; lands set aside to generate revenue for the government were known as Government Lands; lands claimed by *ali‘i* and their *konohiki* (supervisors) were called Konohiki Lands; and habitation and agricultural plots claimed by the common people were called *kuleana* (Chinen 1958:8-15).

Kamehameha III inherited Kāne‘ohe and retained the bulk of the *ahupua‘a* during the Māhele. Following the death of Kamehameha III in 1854, his wife, Queen Kalama (Hakaleleponi), retained their Kāne‘ohe lands (Land Commission Award [LCA] 4452). Along with the *ahupua‘a* of Kailua and Hakipu‘u, Kāne‘ohe was seen as “her most valuable *‘Āina* [land] . . . all in the fertile, well-watered district of Ko‘olaupoko” (Kame‘eleihiwa 1992:264). Several *‘ili* in Kāne‘ohe were subsequently awarded as Konohiki Lands to the *ali‘i* and others with close ties to the royal family. The title to the *‘ili* typically included ownership of the *‘ili* fishpond and offshore fishing rights (Devaney et al. 1982:143). High-ranking *ali‘i* were awarded entire *‘ili*, while lesser *konohiki* were awarded half of an *‘ili* each (Kame‘eleihiwa 1992:269, 279). In addition to Queen Kalama, 14 *konohiki* LCA parcels were awarded for Kāne‘ohe lands (Kelly 1976:7).

An 1897 map of Kāne‘ohe (Figure 8) shows the Crown Lands, Government Lands, and large LCA lots distributed to the *ali‘i* and *konohiki* in the vicinity of the current project area.

The lands awarded as Crown Lands and Konohiki Lands, as well as lands designated as Government Lands, were “subject to the rights of native tenants” (Chinen 1958). The Kuleana Act of 1850 “authorized the Land Commission to award fee simple titles to all native tenants who occupied and improved any portion of Crown, Government, or Konohiki Lands” (Chinen 1958:29). Surveyor C.J. Lyons stated:

> Small tenants were permitted to acquire a full title to the lands which they had been improving for their own use. In the true view of the case, this was perfectly a measure of justice, for it was the labor of these people and their ancestors that had made the land what it was. [Lyons 1894:1699]

One hundred seventeen *kuleana* land claims were awarded in Kāne‘ohe Ahupua‘a, with the average award being approximately 2.4 acres (Kelly 1976:8). Testimonies associated with the LCA parcels indicated the primary land use for the claimed lands was *lo‘i*, irrigated fields used for cultivating taro (Kelly 1976:8). Testimonies include other land uses such as growing breadfruit, coconut, *hala* (*Pandanus tectorius*), gourds, melons, *ʻape* (*Alocasia macrorrhiza*), *pia* (*Tacca leontopetaloides*), pineapple, and banana; salt ponds; and *kula* (pasture) for raising animals (Devaney et al. 1982:23).

There are 11 LCA claims within of the current project area, as listed in Table 1 and shown on the 1897 map (see Figure 8) and on a 1931 map (Figure 9). The full texts of the 11 claims are presented in Appendix A.]

Most of the awardees claimed several *ʻāpana* (lots), at least one for irrigated taro cultivation, a house lot, and upland land ("*kula*"). The testimony of several mention a river or creek called Wailele or Kāneʻohe, an *ʻauwai* called Kanohuliʻiwi, the fishponds Kalokohanahou, Kanohuliʻiwi, and Waikapoki, a *pali* (cliff) called Waiʻape, and a high hill, probably Puʻu Pahu. The 1897 map indicates the water source for the irrigated taro was a stream, Kaneʻohe Stream, which flows toward the sea, then bends at a 90 degree angle to extend parallel to the coast. On the 1931 map this stream is labeled as an *ʻauwai* (irrigation ditch). When the claims have a separate house lot, it is usually located near the shore or in the uplands. The lots near the stream/*ʻauwai* are those used for *loʻi* (irrigated taro patches). Some of the claims also mention that neighbors have sweet potato patches near the shore. The current sewer line follows the alignment of this ancient stream/ditch, which was filled in later during residential development in the area.

Kalokohanahou was a 7-acre pond (Cobb 1905:748) awarded to the *aliʻi* Kamakahonu as part of his Konohiki Award (M.A. [Māhele Award] 30). It is interesting that the small island (LCA 1954) on the northeast shore of the fishpond was awarded to someone else. LCA 1954 was awarded to Kalaikau, who had a larger lot extending inland from the shore of the pond on which he raised taro and had a house lot. The Māhele information indicates the project area was used for irrigated taro cultivation and for house lots, which were utilized throughout the nineteenth century and into the early twentieth century.

### 2.2.4 Mid-1800s to early 1900s

The mid-nineteenth century brought great changes to Kāneʻohe Ahupuaʻa, including private and public land ownership laws during the Māhele, commercial rice, sugar cultivation, and ranching. Agricultural cultivation and ranching established the region as a source of market resources for Honolulu and beyond. Fishponds also became commercial entities during this period. A 1906 map (Figure 10) illustrates the ecological zones for the different types of resources in this section of Kāneʻohe, with the project area within extensive wetland areas used to grow taro and later rice, but also within the zone used as cattle pasture.

#### 2.2.4.1 Sugar

One of the earliest sugar plantations on Oʻahu was owned by Charles Coffin Harris, who came to Hawaiʻi in 1850, planning to practice law. He established the Kaneohe Sugar Plantation Company (ca. 1865) on 7,000 acres of Queen Kalama's land (Dorrance and Morgan 2000:41). In 1871, Harris bought Queen Kalama's Koʻolaupoko properties from her heir, Charles Kanaʻina, as well as some land in Honolulu for $22,448. The sale included ". . . livestock, tools, fishponds, and fishing rights" (Devaney et al 1982:29). The plantation land was used for a variety of purposes, as can be seen in the following 1884 description from McKenney's Hawaiian Directory:

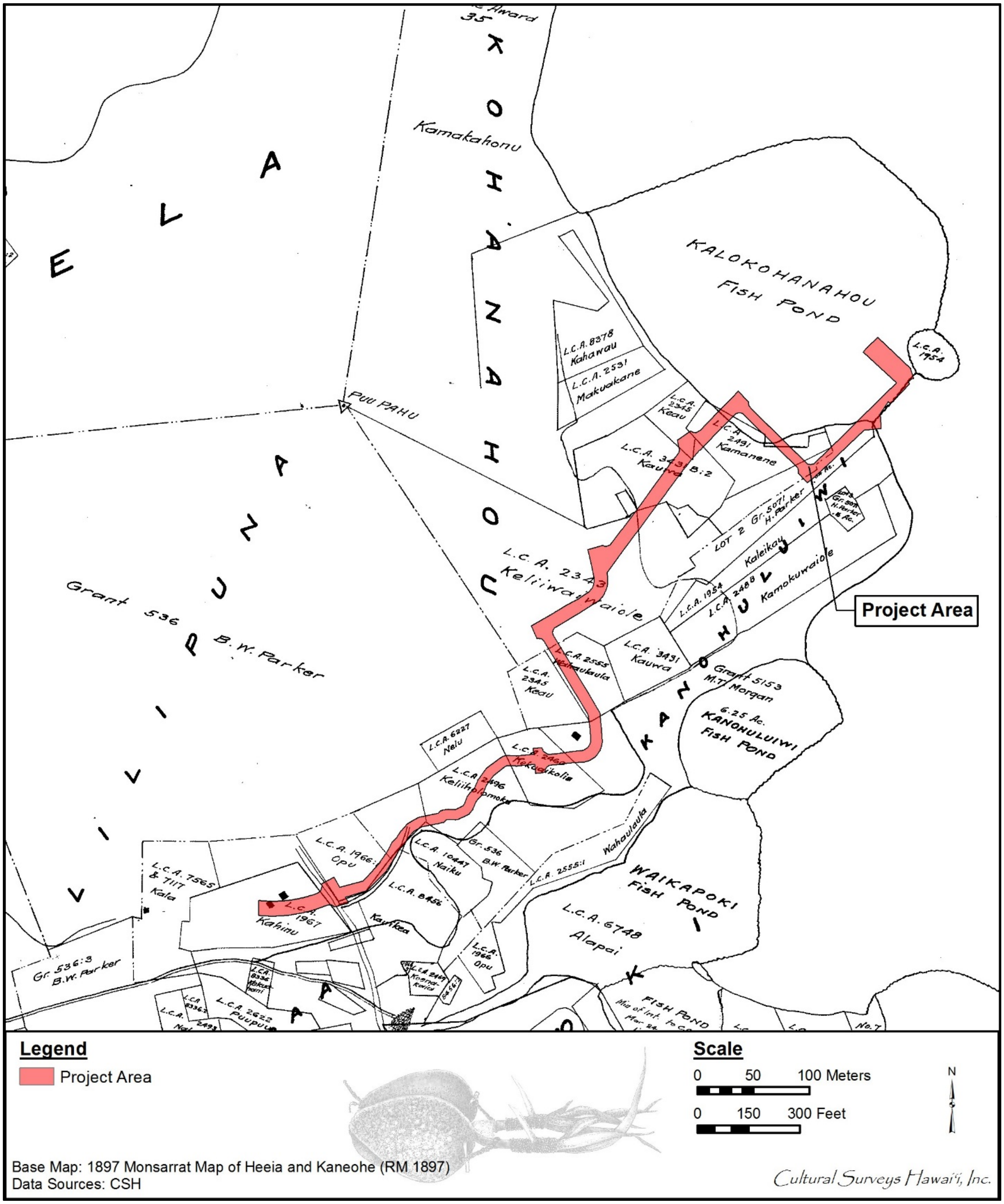



Figure 8. 1897 map of Kāneʻohe and Heʻeia (portion), showing Land Commission Awards near and within the project area (Monsarrat 1897)

Table 1. Land Commission Awards in the Project Area

| LCA # | Claimant | *ʻIli* | Acres | Description |
|---|---|---|---|---|
| 1954 | Kalaikau | Kalokohanahou | 1.67 | Sixteen taro *loʻi*, a *kula*, a house, and a small island on Kalokohanahou Pond |
| M.A. 35 | Kamakahonu | Kalokohanahou | 52.54 | No information on use of land |
| 2491B | Kamanene | Kalokohanahou [Lokohou] | 1.00 | No information on use of land; bounded by the stone wall of Kalokohanahou Fishpond |
| 2345 | Keau | Kalokohanahou [Kalokohou] | 0.48 | Four taro *loʻi*, one *kula*, and one house; the house is in a second lot near the project area, but not within it |
| 3431B | Kauwa | Kalokohanahou [Kalokohou] | 1.99 | Eleven *loʻi* in a lot near the project area; house lot within the project area |
| 2343 | Keliiwai-waiole | Kalokohanahou [Kalokohou] | 6.09 | Eighteen taro *loʻi*, one *moʻo* (garden), *kula*, and a house; mentions a neighbor's potato (sweet potatoes) patch, a fishpond, a river, and a high hill (probably Puʻu Pahu) as boundary marks |
| 2555 | Wahaulaula | Waikapoki | 0.89 | Taro land; bound by the fishpond of Kanohuouliwai to the north and east; house is on a separate lot in the uplands |
| 2460 | Kekuaikolia | Waiape | 0.88 | Five taro *loʻi*; house is in separate parcel; bound on the west side by the *pali* of Waiʻape and on the east by Kaneohe Creek |
| 2496 | Keliiholo-moku | Lilipuna | 2.27 | Four *loʻi*, one *kula*, and one house |
| 1966:1 | Opu | Waikapoki | 0.29 | Four taro *loʻi,* bounded on the west side by Wailele Creek; house lot on different parcel |
| 1967:1 | Kahinu | Kailipaa, Waikapoki | 2.22 | Seven taro *loʻi*; two houses on a fenced lot; bounded on the west by Wailele Creek |

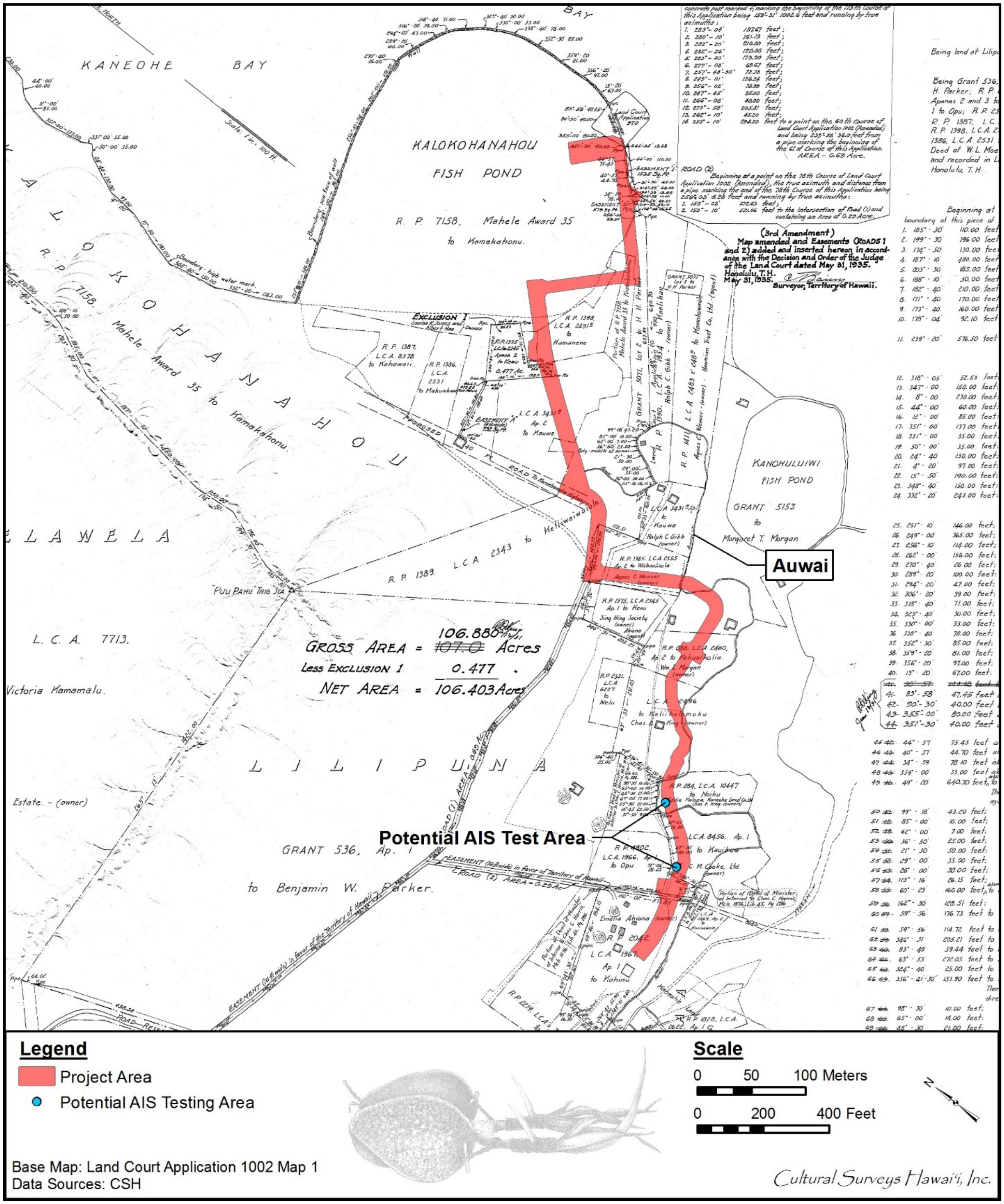



Figure 9. 1931 map of land acquisition by the Kaneohe Land Company, Ltd. for lands in the *ʻili* of Lilipuna, Kalaepaa, Kanohuluʻiwi, Wailele, Kalokohanahou, and Kaopulioloa (King 1931)

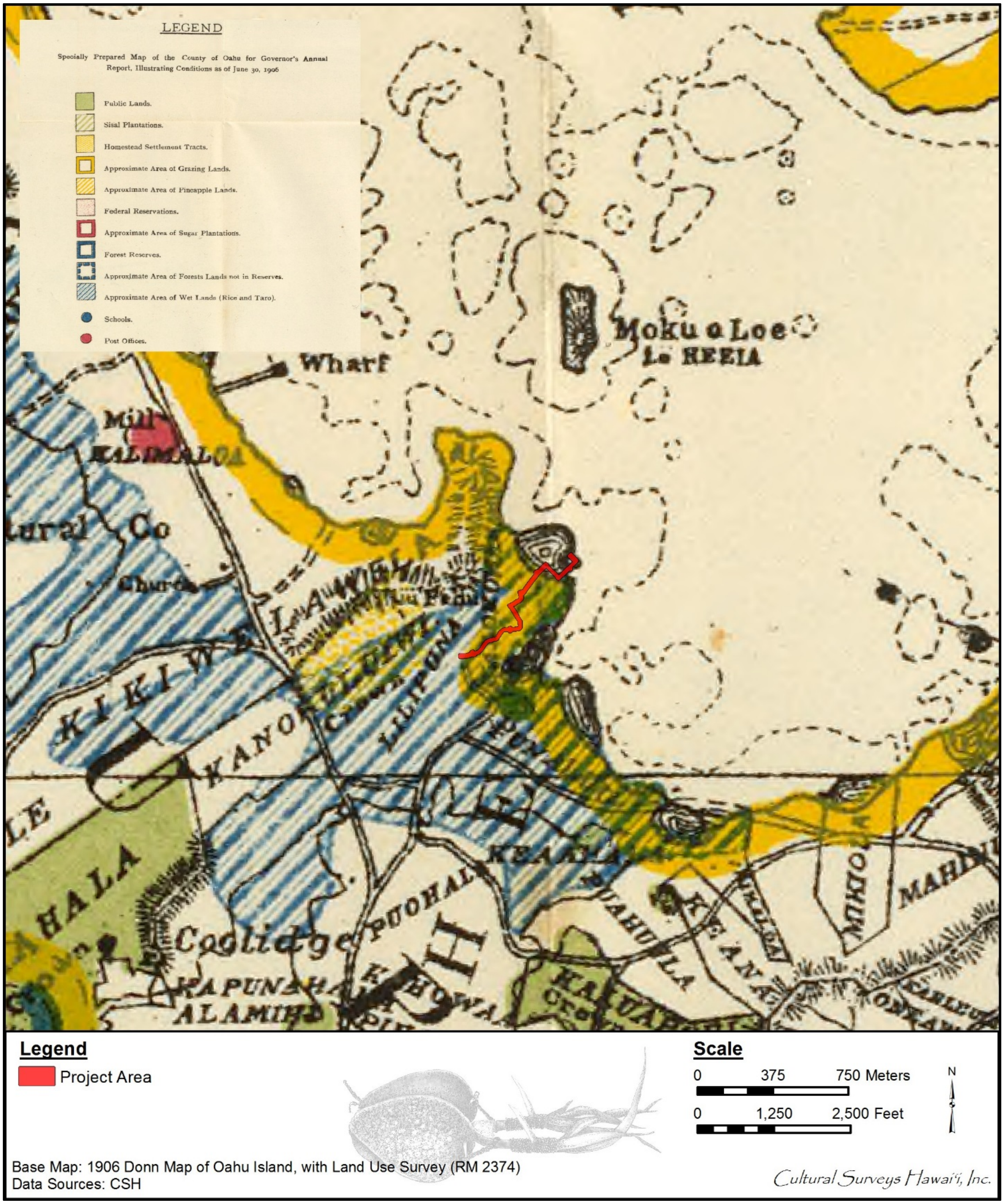



Figure 10. 1906 map of Oʻahu (portion), showing land use in the project area (Donn 1906); note the project area is in the wetlands area (diagonal blue lines) used for taro and then rice cultivation, but also partially within the boundary of "pasture land" used for ranching (between two solid yellow lines)

> Kaneohe Sugar Plantation, Mrs. N.R. Brewer proprietress, M. Rose manager . . . 10,000 acres, 500 acres under cultivation, 200 with sugar and 300 with rice, the remainder grazing land on which are 3,000 head of cattle, capacity of mill three tons per diem, estimated yield for 1884 500 tons, men employed seventy-five. [McCoy et al. 1972:9]

C.C. Harris's plantation closed in 1891 since the sugar yield was not enough to support the operation (Dorrance and Morgan 2000:41). Harris's daughter and heir, Mrs. David Rice, incorporated the lands as Kaneohe Ranch and converted them to stock farming. There were also a number of small dairy ranches in the area around the turn of the century (McCoy et al. 1972:9). James B. Castle purchased a large block of their land holdings in 1907 (Dorrance and Morgan 2000:42).

#### 2.2.4.2 Rice

Rice cultivation was to eventually supersede taro and dominate the lowlands of Kāneʻohe. The ancient taro *loʻi* and *ʻauwai* irrigation systems were used and additional new ditches were built to support rice cultivation. During the height of rice cultivation (ca. 1880-1920), Chinese dominated the business. "To a great extent the rice business, growing and milling was controlled by Chinese *hui* (firms), which recruited laborers from China, handled investment capital from rich absentee landlords, and tallied profits" (Devaney et al. 1982:49). By the late 1880s, virtually the entire floodplain area of Kāneʻohe was under rice cultivation. In 1892-1893, the Kaneohe Rice Mill was erected and began production on property adjoining Waikalua Stream. A flume brought water from the river to the rice mill. Mrs. Polly Ching related in a 1976 personal interview that about twice a week a steamer came into Kāneʻohe Bay to pick up and transport rice to market in Honolulu (Devaney et al. 1982:52).

By the 1920s, rice had gradually declined in importance due to a number of factors. Two of the primary reasons for this decline were the beginning of rice production in California and the "annexation of Hawaii by the United States in 1898 [which] resulted in restrictions on the number of Chinese laborers arriving from the Far East" (Devaney et al. 1982:53). However, rice cultivation, as well as some taro cultivation, continued up to ca. 1960.

#### 2.2.4.3 Pineapple

Commercial cultivation of pineapple in Kāneʻohe began in the 1890s and the first decade of the twentieth century. From approximately 1910 to 1925, pineapple cultivation was a major industry in this area. In 1911, the company of Libby, McNeill and Libby built a pineapple cannery in Heʻeia. At its peak, 2,500 acres were under pineapple cultivation on Windward Oʻahu (Harper 1972), stretching from Kāneʻohe to Kahaluʻu. Most of the pineapple lands in Kāneʻohe were "located below the Pali where the golf course, Hawaii Loa College, and the Hawaiian Memorial Park are today" (Kelly 1987:295-296). A *heiau*, Kaualauki Heiau in Heʻeia, was mostly destroyed by pineapple field clearance during this time—a likely fate of many archaeological sites (Kelly 1987:295-296). In 1919, the Kaneohe Ranch Company and Heeia Agricultural Company, Ltd. leased 1,000 acres of land in Heʻeia, Kāneʻohe, and Kailua, formerly planted in sugar, to the Libby Company for a term of 17 years. The extent of pineapple fields near the project area in the early twentieth century is shown on the 1906 land use map (see Figure 10). In 1917, Libby leased an additional 600 acres in He'eia (Devaney et al. 19982:61).

While the rice fields that covered old taro lands were mainly located near streams and near the coast, pineapple was also grown on the slopes of higher lands, usually on land subleased to individual Japanese farmers:

> Pineapples were planted by individual Chinese and Japanese farmers on moderately sloped hill land where rice and taro could not be grown . . . these areas included the dissected alluvial terraces and the lower slopes and spurs of the Koʻolau range. [Miyagi 1963:115]

The change to the Windward landscape due to pineapple cultivation is illustrated by the following passage from H.F. Alexander's 1914 *Mid Pacific Magazine* article on cycling around Oʻahu:

> At last we reached the foot of the Pali . . . Joe and I looked over the surrounding hills, but looked in vain for the great areas of guava through which but a few months ago we had fought and cut our way. As far as the eye could reach pineapple had taken the place of the forest of wild guava. The newest industry in Hawaii was beginning even to press upon the cane fields of this side of the island. [Devaney et al. 1982:62]

The pineapple fields were abandoned when Molokai and Lānaʻi pineapple cultivation began to boom, and Libby dissolved the Koʻolaupoko enterprise (Kelly 1976:47). The cannery closed in 1923 (Dorrance 1998:95), and most of the former pineapple land went to grass, some of which was used to graze cattle. Several of the small farmers returned to rice cultivation at that time (Kelly 1975:47).

2.2.4.4 Ranching

English Captain George Vancouver introduced cattle and sheep to Oʻahu in 1793 (Henke 1929:8) and by the 1840s, the cattle had multiplied into a large herd (Devaney et al. 1982:70). At its peak, Kaneohe Ranch extended from the ocean in Kailua to the Pali and included 12,000 acres and 2,000 head of cattle (Henke 1929:62). By the mid-1860s, the cattle were so numerous they caused environmental degradation. Alien grasses and other species such as pigeon peas were introduced to the area as cattle fodder (Henke 1929:62). Much of the land modification in the upland and hilly portions of Kāneʻohe may be the result of heavy cattle grazing over a long period of time. An 1854 visitor to the Islands, standing atop the Pali and looking down at Kāneʻohe, noted that "hundreds of cattle may be seen feeding on the rich pasture with which these plains are covered, adding to the landscape an exquisite finish (Bates 1854:104).

By the mid-1860s, we have an indication that livestock were altering the landscape. The undulating plains at the foot of Nuʻuanu Pali were described as "a rich land a while ago but now there are not many plants because animal are permitted there" (Devaney et al. 1982:70). In the post-World War II years, the dairy industry rose to prominence over beef cattle ranching. The shortage of available land due to urban expansion, the shortage of fee simple land, and the high price of land leases forced farmers in the dairy districts near Honolulu (e.g., Koko Head) to relocate to more remote areas of Oʻahu (Durand 1959:241). In the 1950s, Kailua-Kāneʻohe was an important dairy district of Windward Oʻahu. Dairy farming was dominated by Caucasians particularly of Portuguese and Spanish ancestry, and secondarily by Japanese farmers (Durand 1959:235). "Among the names of island dairymen, illustrating the Portuguese-Spanish-Mainland importance . . . are . . . Brazil, Carlos, Campos, Costa, Ferreria, Foster, Freitas, Knowles, Medeiros, Moniz, Ornellas, Rapoza, Santos, Toledo, Vause and White" (Durand 1959:235). This period, however, was relatively short-lived as the opening of the Pali route, exorbitant land prices in Honolulu, and more automobiles on O‘ahu contributed to rapid urbanization in Kailua-Kāne‘ohe (Durand 1959:244-245). Many landowners decided to develop their land for suburban housing and terminated leases with farm leaseholders.

By the end of World War II, ranching was no longer economically viable for Kaneohe Ranch, so the ranch became primarily a landlord to farmers. Following the war, residential developments began to change the face of Kāne‘ohe Ahupua‘a. The opening of the Wilson Tunnel and the expansion of the Pali Highway in the 1950s and 1960s, creating an easier passage from Honolulu to windward communities, led the way to a development boom on O‘ahu's windward side. High tax rates on real estate sales forced many old-time landowners to lease their land to residential developers rather than sell on a fee-simple basis. Kaneohe Ranch at one time leased out their land for over 5,000 single-family residential lots in Kailua and Kāne‘ohe. The vast majority of the leaseholds were later sold to the lessees.

2.2.4.5 Fishponds

As previously mentioned, during the Māhele, fishponds were considered to be part of the land to which they were attached. As such, fishponds were typically designated as Crown or Government Lands, or awarded to the *ali‘i* as Konohiki Lands. Some of the lands owned by the government and *ali‘i*, along with the fishponds, were subsequently sold to entities pursuing commercial agriculture, such as sugar cane and pineapple cultivation, or ranching.

Once fishponds were declared private property, they were taxed by the government along with the rest of the real property. When commercial agriculture brought promises of high profits, few large landowners paid much attention to the fishponds attached to their land holdings. They were satisfied to lease them to Hawaiians or Chinese who had the technical knowledge necessary to properly manage fishponds. Yet when disaster struck, such as a break in the fishpond wall, few lessees could afford the capital required to undertake repairs. As a result, many fishponds deteriorated with the passage of time, and the practice of aquaculture, for all practical purposes, ceased (Devaney et al. 1982:143). By 1901 only 16 fishponds were present within Kāne‘ohe Bay, perhaps less than half the fishponds present in the mid-1800s.

The extensive grazing and agricultural uses of the inland areas of Kāne‘ohe increased erosion and infilling of nearshore marine environments, including fishponds. In addition to being a bountiful source of fish, in 1976 oysters were cultivated in fishponds (Devaney et al. 1976:145). Local Japanese (Little-neck) clams (*V. philipinarum*) were introduced into various ponds along Kāne‘ohe Bay between 1920 and 1939, and some Kāne‘ohe fishponds were well-known as a desirable clamming destination during the September to October season. However, in 1969 an article in the *Honolulu Star-Bulletin* reported soil erosion caused a "massive wipe-out of the transplanted Japanese little-neck clams" (Devaney et al. 1982:101).

The western shore of Kāne‘ohe Bay was dotted with numerous fishponds—Kalokohanahou near the border with He‘eia Ahupua‘a at Pōhākea Peninsula, Kanohulu‘iwi Fishpond, Waikapoki Fishpond, an unnamed fishpond, and Punalu‘u Fishpond. An older name for Kalokohanahou ("the repaired pond") was Kahanahou, "the remaking" (Pukui et al 1974:63, 78). The pond was approximately 7 acres in size, with a small island at the northeast end but no oceanside *makaha* (gates). It was filled in the 1940s for the development of the Kahanahou residential neighborhood.

Three photographs (Figure 11 through Figure 13) illustrate fishpond evolution. An 1887 photograph shows Kalokohanahou Pond near the tip of a peninsula, with Kanohuluʻiwi Pond adjacent. The small island on the northeast side is also clearly visible. A 1930s photograph shows the fishponds from Kalokohanahou to Punaluʻu. The ponds are not filled, but appear to be unused and silted-in. The island on Kalokohanahou is still visible. The last photograph is from the 1940s. Although the island on Kalokohanahou is still present, the interior of the pond is in the process of filling. There are already a few structures visible in the interior over a layer of topsoil. The other ponds of Kāneʻohe on the western shore are filled with sediments and sand.

### 2.2.5 1900s to the Present

A series of USGS and U.S. Army War Department maps and photographs (Figure 14 through Figure 18) show the residential development of the western shore of Kāneʻohe Bay in the twentieth century. On a 1914 map (Figure 14), three ponds on the western shore of Kāneʻohe Bay are clearly delineated. Most of the inland roads are "unimproved" (not paved, denoted by dotted lines) and have scattered houses on both sides. The shore lands are shown as wetlands. There are cattle paddocks inland and near the shore. The map indicates the land at this time was used for agriculture, ranching, habitation, and fishpond use. The *ʻauwai* within the project area is still present. By 1936 (Figure 15), there are many improved, paved roads in the area branching off from the newly designated coastal highway, and houses are more formally placed and aligned with these main roads. The former cattle paddock area near the shore has been developed into the Coral Gardens residential area. On both the 1914 and 1936 maps (see Figure 14 and Figure 15), Kalokohanahou, Kanohuluʻiwi, and Punaluʻu fishponds are shown as open and unfilled. This is in contrast to the 1943 map (Figure 16), in which the ponds are shown as partially filled, either by natural sedimentation or by filling with dredged material. By 1954 (Figure 17), Kalokohanahou has been completely filled to develop the Kahanahou residential neighborhood, although the ponds to the east still remain unfilled. The area is densely developed for residences with numerous streets and houses aligned with the streets. In a 1978 aerial photograph (Figure 18), residential development is also shown. The outline of former pond boundaries offshore can also be seen in this photograph.

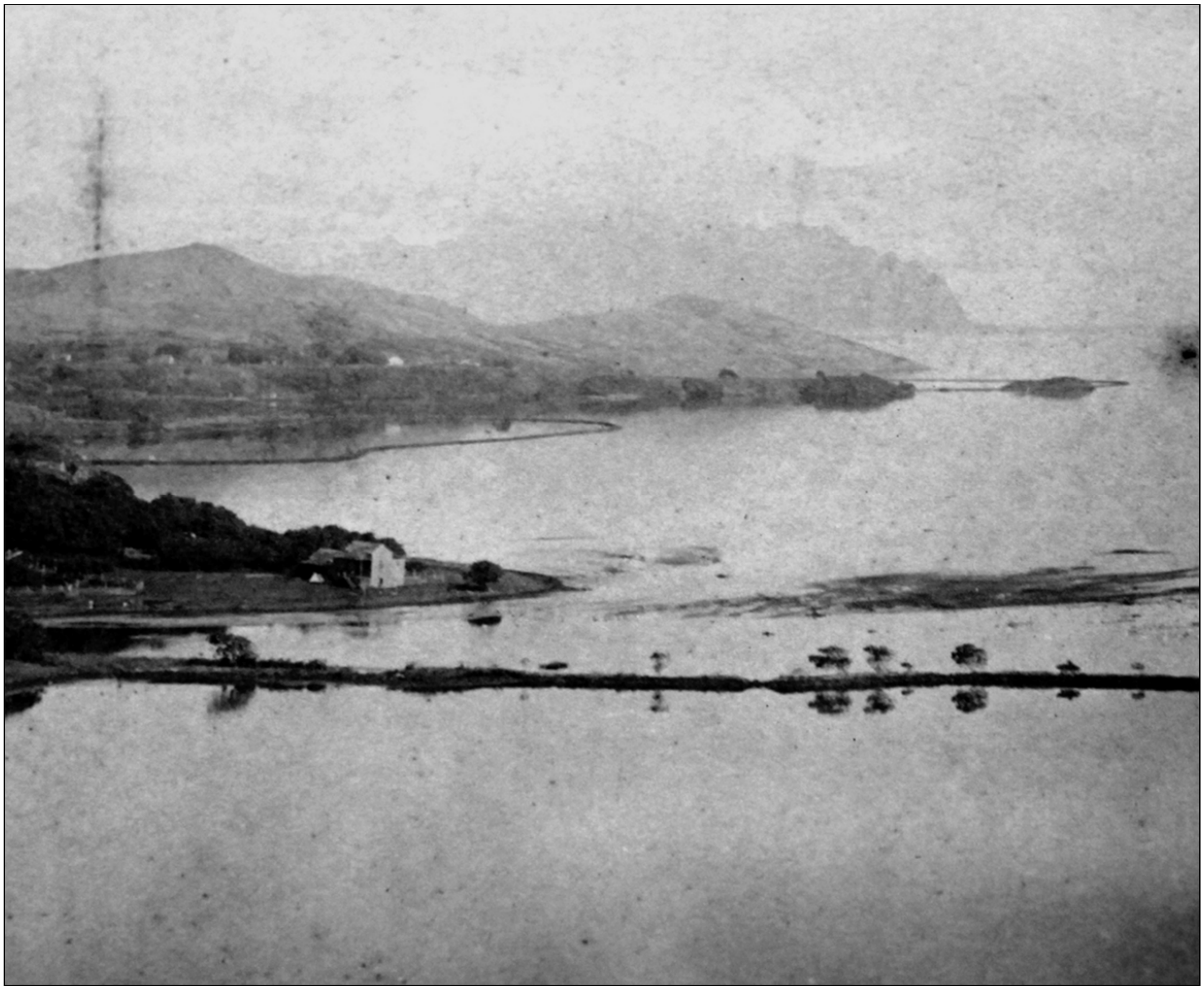


Figure 11. 1887 photograph of Kāneʻohe fishponds; Kalokohanahou (right background) and Kanohuluʻiwi (left center); ponds are unfilled (Hawaiʻi State Archives 1887)

Figure 12. 1930s photograph of west shore of Kāne‘ohe Bay, showing (from right to left) Kalokohanahou, Kanohulu‘iwi, Waikapoki, and Punalu‘u Fishponds (Hawai‘i State Archives 1930s); ponds are silted in

Figure 13. 1940s photograph of western shore of Kāne‘ohe Bay; Kalokohanahou Fishpond (center) has been filled to create the Kahanahou residential neighborhood (Hawai‘i State Archives 1940s)

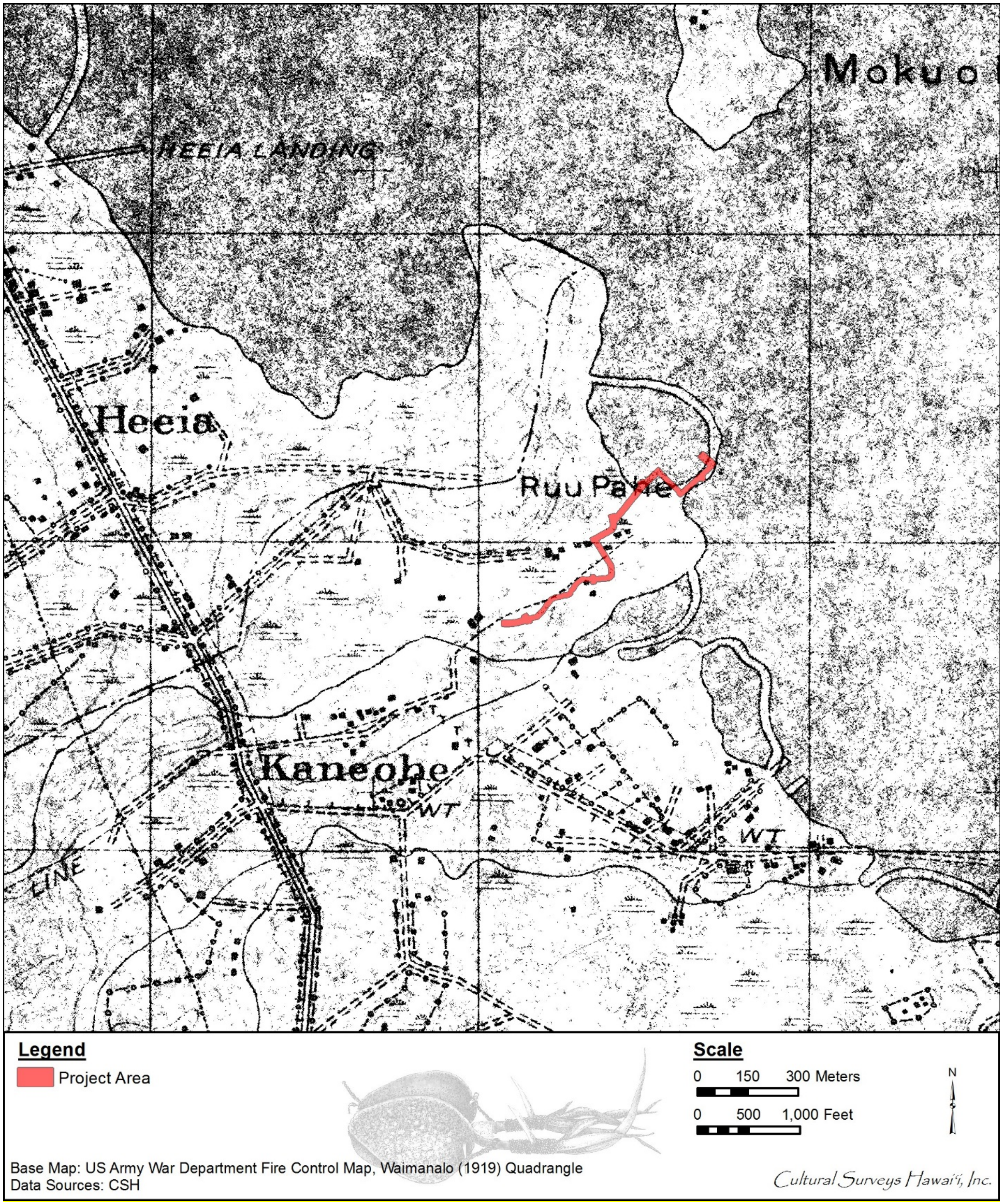



Figure 14. 1919 U.S. Army War Department fire control map, Waimanalo quadrangle, showing the project area with unfilled Kalokohanahou Pond; note the old *ʻauwai* is pictured as a ditch (dotted line)


Figure 15. 1936 U.S. Army War Department terrain map, Kaneohe quadrangle, showing the project area with unfilled Kalokohanahou Pond; there is no longer an *'auwai* or ditch labeled

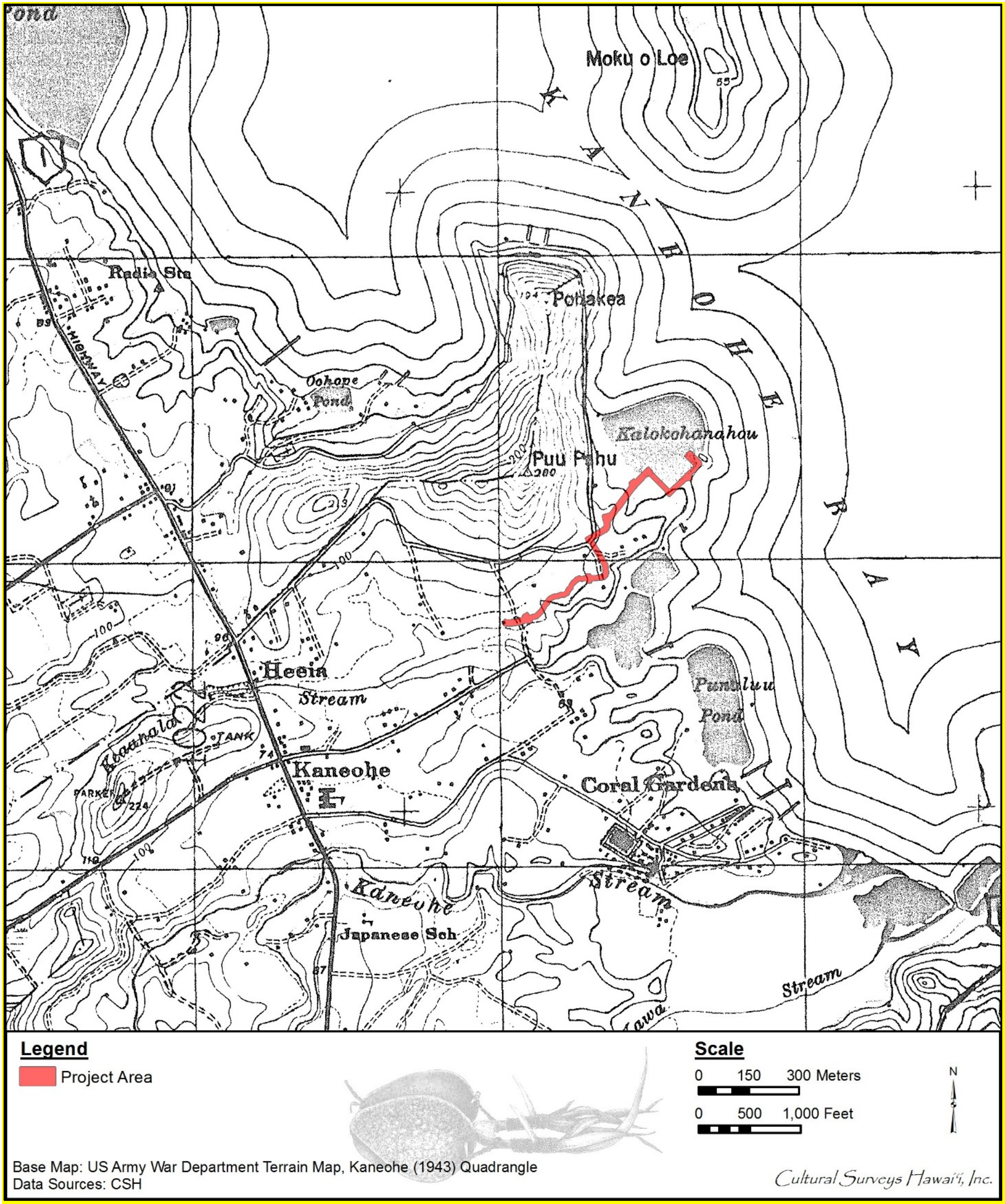



Figure 16. 1943 U.S. Army War Department terrain map, Kaneohe quadrangle, showing the project area with Kalokohanahou and adjacent fishponds partially filled

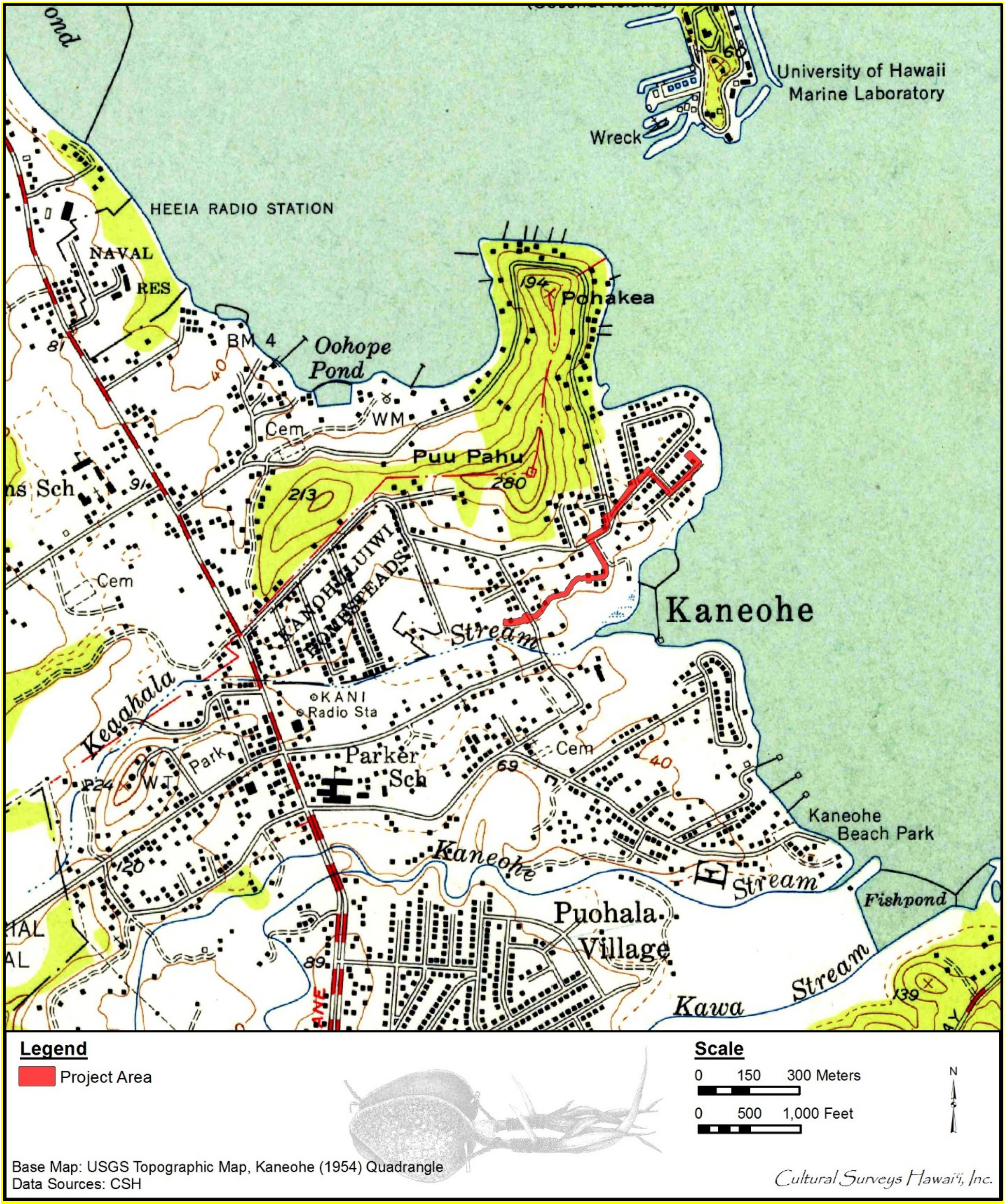



Figure 17. 1954 Kaneohe USGS topographic quadrangle; Kalokohanahou has been filled to create the Kahanahou residential neighborhood, while other fishponds to the east remain unfilled but are modified


Figure 18. 1978 aerial USGS orthophotoquad, Kaneohe quadrangle; Punalu‘u Pond at the right of the photo remains untilled

# Section 3 Previous Archaeological Research

Archaeological studies conducted in the vicinity of the current project area in Kāneʻohe Ahupuaʻa are summarized in Table 2. The location of previous studies and previously identified sites are shown on Figure 19 and Figure 20. A discussion of archaeological findings relevant to each portion of the project area follows.

## 3.1 Early Archaeological Surveys

The first systematic archaeological study of the Kāneʻohe area was conducted by J. Gilbert McAllister of the Bernice Pauahi Bishop Museum in the 1930s. McAllister (1933) consulted with knowledgeable informants about both physical and legendary sites of each district during his island-wide survey of Oʻahu. McAllister recorded a number of *heiau* and other sites in the vicinity of the current project area. The eight sites he recorded near the project area are sites 331–335 and 338–341. These can be located on Figure 12.

McAllister's sites:

> **Site 342**. Puʻupahu Heiau, said to have been located on the elevation called Puʻupahu Kāneʻohe. There are no remains now [ca. 1931]
>
> **Site 343**. Kalokohanahou fishpond, adjacent to Kalokohanahou and just beneath Puʻu Pahu.
>
> According to Bell, this is not the old name, but the one used by Parker when he rebuilt the pond. The walls are but a few feet wide, loosely built of lava stones through which the water seeps. A small island occupies a portion of the wall. There were two watch-houses and no outlet gates (*mākāhā*). According to Cobb, it covered 7 acres.
>
> [Cobb notes that the old name for this fishpond was Kohanahou (Cobb 1903)]
>
> **Site 344**. Kanohuluiwi pond, adjacent to Kanohuluiwi.
>
> The name was given me by John Bell. The pond is small, with narrow lava-rock walls, and covers an area of 2.5 acres. It is apparently still in use. On one of the old maps in the land office there are two adjacent ponds of about the same size. The broken wall of one is still to be seen, the name of which is probably Waiapoki, with an area of 4 acres. The other pond has been obliterated [by ca. 1931].
>
> **Site 345**. Punaluʻu Pond, adjacent to Punaluʻu Kāneʻohe. Covers 12.5 acres and has a wall length of approximately 1600 feet The walls are of basalt, a few feet in width.
>
> **Site 346**. Deep ditch dividing the lands of Punaluʻu and Waikalua, Kāneʻohe. Built by the chief of the district in order to keep his pigs from wandering from Waikalua, which seems to have been a land set aside for the royal swine. Occasionally there was built an incline leading from the bottom of the ditch to Waikalua, in order that the pigs that fell into the trench might again gain access to the pen in which they were kept.

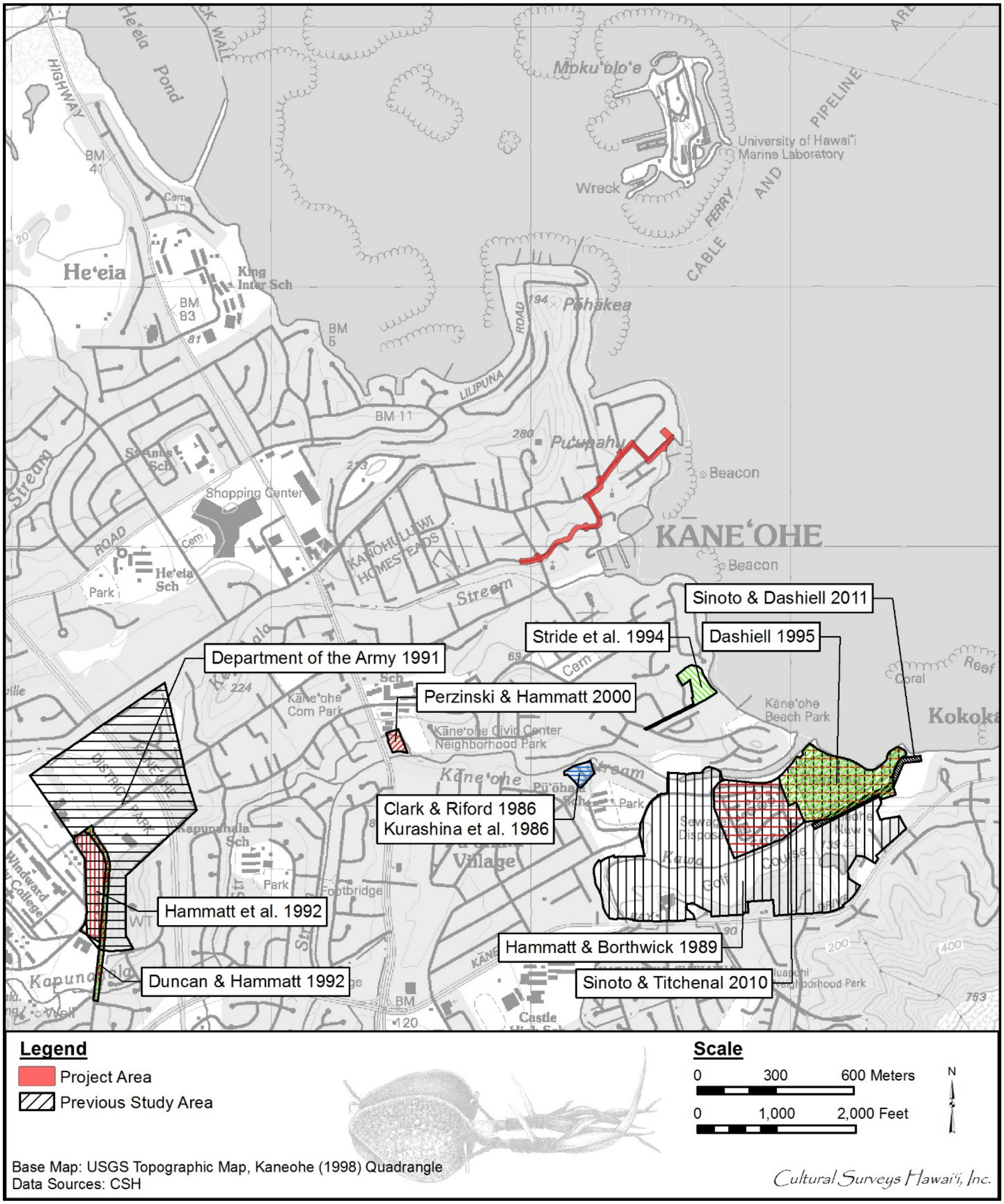



Figure 19. Previous archaeological studies in west coastal Kāneʻohe near the project area

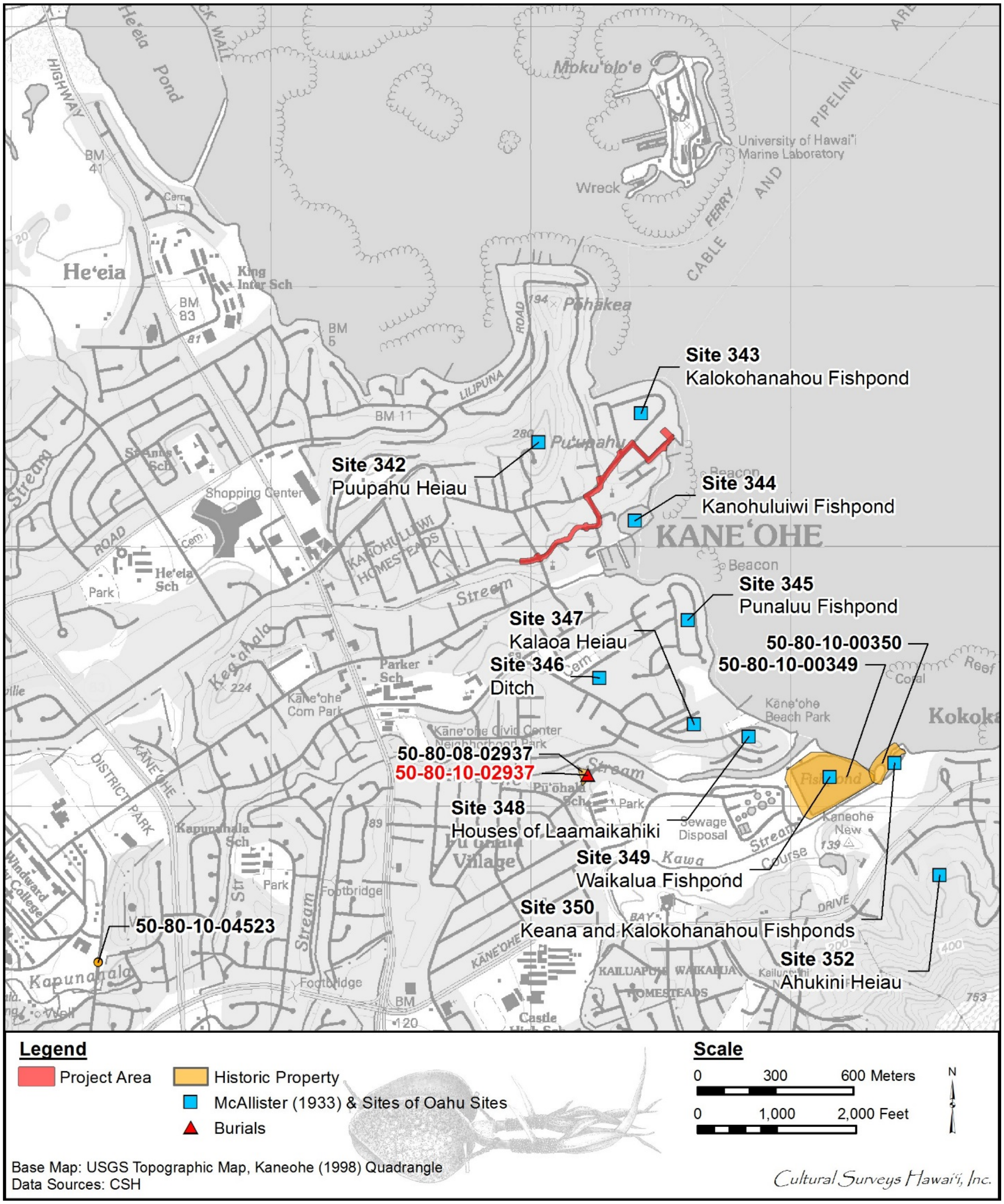



Figure 20. Previously identified archaeological sites in west coastal Kāne‘ohe near the project

Table 2. Previous Archaeological Studies in Kāne‘ohe near the Project Area

| Source | Study | Location | Results |
|---|---|---|---|
| McAllister 1933 | Sites 342–352 | Island-wide | Identified ten sites near project area within Kane‘ohe Ahupua‘a, five fishponds, three *heiau*, ditch, and chief's house cluster (SIHP # 50-80-10-342-352) |
| Kurashina et al. 1986 | Reconnaissance survey | Nani Pua Gardens II Subdivision | Identified several sites, including two lithic scatters, former rice field and taro field with stone retaining wall, historic house foundation, two stone platforms, and Italian prisoner-of-war camp, Kane‘ohe rice mill, and SIHP # 50-80-10-2937 (Hawaiian habitation site). Preliminary test excavations conducted at SIHP # -2937. Pre-Contact artifacts, post-Contact artifacts, and charcoal recovered |
| Clark and Riford 1986 | Archaeological salvage excavations | Nani Pua Gardens II Subdivision | Salvage excavations at Bishop Museum site 50-Oa-G5-101 (SIHP # 50-80-10-2937), pre-Contact Hawaiian habitation site; two human burials and additional fragmentary remains found; reports $^{14}C$ date of AD 1070-1405; substantial discussion of lithic finds |
| Hammatt and Borthwick 1989 | Inventory survey and subsurface testing | Bay View Golf Course | No significant findings within eight trenches, excavated at 50-100 ft intervals; each trench averaged 7.5 m long and 230-240 cm deep (to water table) |
| Department of the Army 1991 | Field inspection | Keaahala Military Reservation | No surface features noted; background research indicates area may never have been used by military |
| Hammatt et al. 1992 | Inventory survey | Castle Hills access road | No surface features noted; historic bottles recovered from one test excavation |
| Duncan and Hammatt 1992 | Archaeological monitoring | Castle Hills access road | During monitoring, one archaeological site recorded, SIHP # 50-80-10-4523; included historic trash pit with bottles and probable water trough |
| Stride et al. 1994 | Inventory survey | Coral Gardens | No cultural remains noted during excavation of eight backhoe trenches |
| Dashiell 1995 | Preservation plan | Waikalua Loko Fishpond | Recommended preserving, restoring, and maintaining fishpond; establishment of interpretive program also recommended |

| Source | Study | Location | Results |
|---|---|---|---|
| Perzinski and Hammatt 2000 | Inventory survey | Kāneʻohe Civic Center playground parking lot | No surface features noted; only fill material noted in excavations |
| Sinoto and Titchenal 2010 | Archaeological assessment | Kāneʻohe-Kailua Force Main | Pre-construction testing and/or monitoring recommended |
| Sinoto and Dashiell 2011 | Archaeological monitoring | Bay View Golf Course | During monitoring of 125 linear-ft sewer line replacement, fill observed to 5.54 m below surface |

Though John Bell pointed out the exact site of this division line, no evidence of the ditch remains; but the idea of such a barrier is worthy of note.

**Site 347** Kalaoa Heiau, Waikalua, Kāneʻohe.

This heiau was located on an elevation to the left of the road leading to the Kāneʻohe municipal camping grounds just beyond lane which leads to the coral gardens. Nothing remains of the heiau, the stones having been used in the construction of the mill. The *heiau* was built by Laʻamaikahiki, according to John Bell, who took me to the site.

**Site 348.** Site of the houses of Laamaikahiki [a chief], Waikalua, Kāneʻohe.

. . . On the southeast side of the Trask home is an oval pile of rocks, 20 feet long, 15 feet wide, and 3 feet high, with a great amount of coral scattered throughout. . . A similar pile of coral and stone, though much smaller, is found on the other side of the house. The sands in front of the place are known as Naonealaa and were tapu [tabu] to the commoner when the alii lived there.

On this same elevation Laamaikahiki wanted to build his heiau, Kalaoa (Site 347), but he was advised by his kahuna to place it considerably farther from the chief's houses, for the women of the household would be too close to the sacred inclosure tapu to them. . . . Naonealaa is listed by Thrum . . . as a heiau.

**Site 349**. Waikalua fishpond, adjacent to Waikalua, Kāneʻohe.

The rebuilding of the pond has been completed. The wall was 1420 feet long, of waterworn basalt 3 to 4 feet high but somewhat wider. The pond covers 11 acres.

**Site 350**. Two ponds, Kailua side of Waikalua.

The pond in use is said to be Keana with an area of 3.5 acres. According to Bell, the name of the other is Kalokohanahou. (See Site 343). Its wall is broken. Both were built of waterworn basalt. The dirt-filled wall of Keana is wide enough for trees to grow on it.

**Site 352.** Ahukini heiau, Keana (now known as Kokokahi), Kāneʻohe

A small structure, 70 by 127 feet, built on the top of an elevation 1200 feet from the sea. The ground slopes away from the heiau in all directions. The only features remaining are the low walls, unusual because they are built of stones a few inches in size. Here and there at the bottom larger stones have been used, and at a few places the wall stands 1 foot in height, but most of the remains are scattered for it is very easy to the cattle to disturb the small stones . . . There appears to have been only this one platform, which was dirt-paved, though on the end toward the mountains there are many scattered stones, also small, which may, at one time, have been used for paving a small area. When the drums at this heiau were beaten they could be heard over Kaneohe, but not just on the other side of the low ridge in Kailua. [McAllister 1933:177–179]

## 3.2 Modern Archaeological Surveys

### 3.2.1 Proposed Nani Pua Gardens II Subdivision Project

In 1986, the Bishop Museum conducted archaeological salvage excavations of site G5-101 (SIHP # -2937) within TMK: [1] 4-5-030:043 (Clark and Riford 1986). This pre-Contact Hawaiian habitation site is within the Nani Pua Gardens II Subdivision and was identified during archaeological investigations by the Bishop Museum in 1986 (Kurashina et al. 1986). The 1.7-acre parcel is bordered on the north and east by Kāneʻohe Stream.

Preliminary investigations revealed a surface layer with lithic artifacts and a buried cultural layer. Additional sites recorded in the area included two lithic scatters (Site 50-Oa-G5-100), a former rice field and taro terrace (Site 50-Oa-G5-104), an Italian prisoner-of-war camp, and the Kaneohe Rice Mill. Subsurface testing recovered a relatively early radiocarbon date of AD 1070-1405. A large assemblage of lithic artifacts suggested the historic property was primarily used by "craftsman specializing in the manufacture of stone tools, primarily adzes" (Clark and Riford 1986:110). Two human burials, discovered in a fully extended position, lacked cultural material. Additional fragmentary remains were encountered in the context of pre-Contact basalt artifacts (Clark and Riford 1986:45, 104). Clark and Riford (1986:110) concluded the historic property housed craftsmen specializing in the production of stone tools, primarily adzes.

### 3.2.2 Keaahala Military Reservation

In 1990, the Department of the Army (1991) conducted a field inspection of a 21.64-acre inland parcel. This parcel was formerly part of the Keaahala Military Reservation, which was established in 1914 as an artillery range. The Governor requested the return of this property in 1928 as it was not being used. Most of the land was returned to the Hawaiian government, and the land was used for a Territorial Mental Hospital, which became the present Hawaiʻi State Hospital (Department of the Army 1991:Supporting Documents). During the field visit, no evidence of the existence of any buildings, structures, or debris related to the Keaahala Military Reservation were observed, and a review of documents indicated the area may never have been used by the military (Department of the Army 1991:2).

### 3.2.3 Castle Hills Access Road Monitoring

In 1991, CSH conducted an inventory survey for the 500 m Castle Hills access road, located approximately 2 km inland of the present project area (Hammatt et al. 1992). One test excavation was dug on the north side of Kapunahala Stream. Modern bottles were found in the top stratum, possibly incorporated into the soil from recent disturbance, such as plowing. In 1992, CSH (Duncan and Hammatt 1992) monitored all grubbing and grading for the road. One archaeological site was recorded, SIHP # -4523. The site had two features, an historic trash pit with bottles dating to the late 1800s and a cement box, possibly a water trough for livestock (Duncan and Hammatt 1992:29).

### 3.2.4 Waikalua Road, Kāneʻohe Bay Project

In 1993, CSH conducted an archaeological inventory survey within 3.2 acres along the shoreline of Kāneʻohe Bay at Waikalua Road, near Punaluʻu Fishpond (Stride et al. 1994). Research indicated a high probability that the project area had been a traditional Hawaiian settlement. The property was also the location of Coral Gardens resort hotel from 1915 to 1940. Eight backhoe trenches were excavated to determine the presence or absence of cultural deposits. No cultural material or human remains were observed during the survey or backhoe testing other than modern trash. No further archaeological work was recommended for the project.

### 3.2.5 Bay View Golf Course Archaeological Survey and Assessment

Hammatt and Borthwick (1989) conducted an archaeological survey and assessment of the 90-acre Bay View Golf Course. Background research indicated over 40 Land Commission Awards (LCA) granted for this area traditionally used for taro planting and aquaculture within three fishponds along Kāneʻohe Bay. Modern development of the area including the golf course, sewage treatment plant (Kaneohe WWPTF), surrounding residential subdivisions, and flood control projects, had caused extensive modifications of the land.

Waikalua Loko Fishpond and Waikalua Fishpond were the only two archaeological features found within the project area. Waikalua Loko Fishpond has been a continuously functioning fishpond since pre-Contact times. Waikalua Fishpond was in poor condition due to mangrove intrusion, but still showed an intact seawall. Both fishponds were recommended for preservation. Archaeological monitoring during initial clearing and grading was also recommended.

Subsurface testing was conducted between Kāneʻohe and Kāwā Streams in a strip of undeveloped pasture between Kānʻeohe WWPTF and the Bay View Golf Course on City and County land. The area was thought to be the only possibly undisturbed portion of the floodplain within the project area. The trench was located just west of the western boundary of the Kaneohe WWPTF.

Eight trenches were excavated at 50-100 ft (15.2-30.5 m) intervals with each trench averaging 7.5 m long and 230-240 cm deep (to the water table). Both sides of the trenches were examined for cultural materials and features as well as changes in stratification. A soil profile description was made for each trench and samples of all subsurface deposits were collected. Elevation rise from Trench 1 to Trench 8 was approximately 1 m.

Neither cultural materials nor features were observed within the backhoe trenches. The former *ʻauwai* shown on early maps was not discerned in the profiles of any of the trenches, nor was there any indication of earthen field boundaries. Only “the original ponded, gleyed sediments associated with former taro/rice planting” was found beneath approximately 60-120 cm of fill (Hammatt and Borthwick 1989:40). No terracing or buried cultural material was observed. Archaeological monitoring was recommended during initial grubbing and grading of the property due to the possibility of subsurface cultural material associated with *lo‘i* cultivation.

### 3.2.6 Waikalua Loko Fishpond Preservation Plan

Dashiell (1995) prepared a preservation plan for the Waikalua Loko Fishpond prior to the mid-1990s expansion of Bay View Golf Course. Two major components of the plan were proposed:

1. Preservation, restoration, and maintenance of the pond based on its present [1995] construction features, environment, and configuration. Actual operation of the pond could take place at any time, dependent on the desires of the owner and the WLFPS [Waikalua Loko Fishpond Preservation Society].
2. Interpretation program, which at a minimum may consist of a booklet and a self-guided tour along the public access route. Under the purview of the WLFPS, additional components of the interpretation program could be added, such as an interpretive center. The interpretive program was proposed to educate students or visitors to Hawai‘i. The possibility that Windward Community College may be interested in establishing some sort of effort was also proposed. [Dashiell 1995:10]

### 3.2.7 Kāne‘ohe Civic Center Playground Parking Lot

The archaeological inventory survey of the proposed Kane‘ohe Civic Center Playground Parking Lot (Perzinski and Hammatt 2000) involved a surface field survey and limited subsurface testing. There were no pre-Contact or early historic structures visible in the project area. Some walls and rock mounds associated with the drainage canal from Kāne‘ohe Stream were noted at the boundaries of the project area. One test excavation was placed near the canal. All of the soil was a fill material, and it was concluded that intensive land-altering activities had significantly changed the original soil structure of the area.

### 3.2.8 Kāne‘ohe-Kailua Wastewater Conveyance Alternative Project

Sinoto and Titchenal (2010) prepared an archaeological assessment for an alternative conveyance route of the Kāne‘ohe-Kailua Wastewater Conveyance and Treatment Facilities (WWTP). That project involved the construction of a force main and installation of “nearly 10,000 linear feet of jacketed pipeline” that extended beneath Kāne‘ohe Bay (Sinoto and Titchenal 2010:i). Either micro-tunneling or open trenching was planned for a two segments, a 1,000 linear ft (304.8 m) segment leading to the Kāne‘ohe WWPTF and a 2,500 linear ft (762 m) segment leading to the Kailua WWTP. No subsurface testing was undertaken as two alternatives were proposed for the project.

Sinoto and Titchenal (2010) recommended “pre-construction spot testing” in the Kailua WWPTF segment if open trenching was planned. If micro-tunneling was planned, pre-construction of the “jacking pit or other access point localities” was recommended. Monitoring was recommended during open trenching of the Kāne‘ohe WWPTF segment due to the presence of the Waikalua Loko Fishpond wall, and the presence of a “manmade embankment.”

Additionally, “a buffer zone of roughly 30 feet shall be established along the land-based perimeter of Waikalua-loko Fishpond to prevent inadvertent intrusions and damage to the structural components of the fishpond” (Sinoto and Titchenal 2010:54).

### 3.2.9 Bay View Golf Course/YMCA Sewer Line Rehabilitation Project

Sinoto and Dashiell (2011) conducted archaeological monitoring for the Bay View Golf Course/YMCA Sewer Line Rehabilitation Project. The location of the sewer line is described as “on the grounds of the existing Bay View Golf Course immediately south of Kāwā Stream and Waikalua-loko Fishpond” (Sinoto and Dashiell 2011:1).

The project entailed open trenching for 125 ft (38.1 m) to replace approximately 1,600 ft (487.7 m) of existing sewer line. The trench measured 10 ft (3.05 m) wide and 15-16 ft (4.6-4.9 m) deep. Trenches contained “vast amounts of fill materials including imported soils and some organic detritus such as *hau* and mangroves to fill marshy areas during original pipeline installation followed by golf course construction” (Sinoto and Dashiell 2011:6).

# Section 4 Results of Field Inspection and Recommendations

## 4.1 Field Inspection

The fieldwork component for this historical resources study was conducted on 9 December 2013 by CSH archaeologists Constance R. O'Hare, B.A. and David W. Shideler, M.A. This fieldwork consisted of a limited field inspection of the water line area to identify any surface archaeological features, and to investigate and assess potential impact to historic properties. The only surface historic structure noted during the field inspection was the Kalokohanahou Fishpond wall, which has already been designated SIHP # 50-10-10-343.

The field inspection began at the Kahanahou Pump Station (Figure 21) at the coast at the end of Kahanahou Place. A remnant of the old Kalokohanahou Fishpond stacked-rock wall is still evident beneath a dense cluster of *naupaka* (*Scaevola taccada*) to the east of the pump station at the western shore of a private boat harbor (Figure 22 through Figure 24).

The field inspection continued by driving down Kahanahou Place to the intersection with Kahanahou Circle to the west and then down Kahanahou Circle to its junction with Lilipuna Place (Figure 25 through Figure 28). Sewer manholes along this route were noted not only on the edges of the residential roads, but also in the center of the roads. At the east end of Lilipuna Place is the northeast end of the private residential section that does not have a road, as shown in Figure 29 through Figure 31. To access the southwest end of this private property it was necessary to take an alternate route to the junction of Makahīʻō Street and Wailele Road. The end of the private property section, shown in Figure 31, is an open southwestern sloping area. The project area continues along Makahīʻō Street a short distance past the junction with Wailele Street (Figure 32).

## 4.2 Summary and Recommendations

Only one historic property, the remnants of a stacked stone wall for Kalokohanahou Fishpond was noted during the field inspection. The plans for the wastewater improvements include excavation near the wall (in Kahanahou Place in the interior of the former fishpond, see Figure 22 for relationship) but do not include any modifications to this wall.

Historical research indicates that this area was used intensively in the mid-nineteenth century for taro cultivation (see Figure 8), as ponded fields and perhaps dryland gardens were placed adjacent to both sides of an old ʻ*auwai* (irrigation ditch) that extended to the coast. Thus, there may be subsurface cultural deposits and/or burials associated with the habitation and agricultural use of the land beneath the modern surface.

Based on the long, serpentine nature of the project area and this study's results that emphasis the extensive land modification and the seemingly low likelihood of intact cultural deposits in any specific location, an archaeological inventory survey of the project area (per the requirements of HAR §13-276) does not appear warranted for development within the project area. CSH does however recommend an archaeological monitoring program with an archaeological monitor to be present during all subsurface excavations greater than 12 inches deep that are needed for the project. This will ensure any subsurface cultural deposits and/or burials as maybe present can be identified. A monitoring program of on-site archaeological


Figure 21. Kahanahou Wastewater Pump Station, eastern end of project area, view to northwest (CSH photograph)

Figure 22. Kahanahou Place, view southwest from Pump Station entrance; Kalokohanahou Fishpond wall remnant beneath *naupaka* hedge at left side of road (CSH photograph)

Figure 23. Kalokohanahou Fishpond wall remnant covered by *naupauka* (CSH photograph)

Figure 24. Kalokohanahou Fishpond stacked stonewall remnant beneath *naupauka* (CSH photograph)

Figure 25. Kahanahou Circle, view southeast back to Kahanahou Place (CSH photograph)

Figure 26. Kahanahou Circle (front section) and Lilipuna Road (back section), view southwest toward junction with Lilipuna Place; note manhole in center of roadway (CSH photograph)

Figure 27. Lilipuna Place, view west-southwest towards private property between Lilipuna Place and Wailele Road (CSH photograph)

Figure 28. Lilipuna Place, view northwest toward the elevation of Puʻu Pahu (left background), former location of Puʻupahu Heiau; note manhole in left lane (CSH photograph)

Figure 29. Private property between Wailele Road and Lilipuna Place, western section, view to east-northeast (CSH photograph)

Figure 30. Private property between Wailele Road and Lilipuna Place, central section, view to east-northeast (CSH photograph)

Figure 31. Private property between Wailele Road and Lilipuna Place, eastern section, view to east-northeast (CSH photograph)


Figure 32. Junction of Wailele Road and Makahī‘ō Street, western end of project area, view to west; note manhole in center of roadway (CSH photograph)

monitoring is recommended for all ground disturbance conducted within the project area below the existing ground surface to facilitate the identification and treatment of any historic properties oand/or burials that might be discovered during project construction. Any departure from this will require consultation with and written concurrence from SHPD.

If deemed necessary by the SHPD, it is possible that one or more archaeological inventory survey test excavations could be placed in the open area of the private property area near Wailele Street (Figure 33) in an area of former LCAs. These test excavations could reveal the soil stratigraphy, search for any remains of the old *ʻauwai* (ditch) shown on historic maps, and reveal habitation remains in the vicinity of LCA 10447 and 8456 (Figure 34).


Figure 33. Aerial photograph showing the location of the project area and two possible testing areas near Wailele Street (Google Earth 2013),

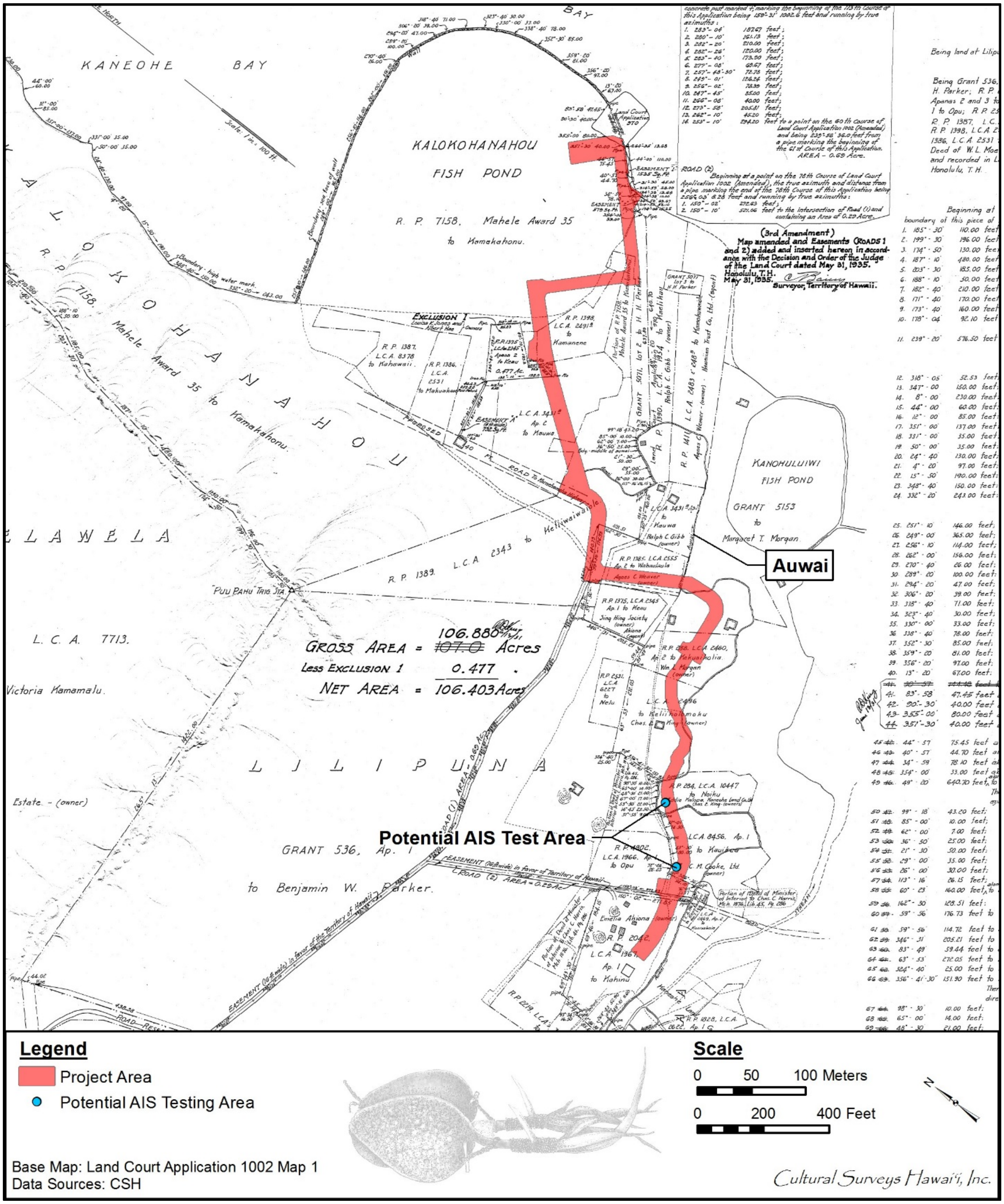



Figure 34. 1931 map of land acquisition by the Kaneohe Land Company, Ltd., showing possible text excavation locations for the project area near the *‘auwai* within LCA 10447 and LCA 8456 (King 1931)

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# Appendix A Land Commission Award Testimony in Vicinity of Project Area

## No. 35 M.A., Kanakahonu

No. 7181, Kamakahonu

N.R. 299-300v5

Hear ye, ye Land Commissioners: Here are my lands, given me by Kamehameha III.

Nunulu, Ahupuaʻa, Kohala, Hawaii.
Kaiholena, Ahupuaʻa, Kohala, Hawaii.
Kamooiki, Ili, Waikiki, Kona, Oahu.
Kalokohou, ʻIli, Kaneohe, Koolaupoko, Oahu.

That is my share, from the Royal Palace. All the poʻalimas of these lands are for me. That is my claim.

KAMAKAHONU

N.T. 312v10

No. 7181, Kamakahonu, 31 August 1853

Kamakahonu's lands in Mahele Book.
Kalokohanahou ili of Kaneohe, Koolaupoko, Oahu.
Kamooiki ili of Waikiki, Kona, Oahu.
Numelu ahupuaa, Kohala, Hawaii
Kaiholewa ahuuaa, Kohala, Hawaii.

TRUE COPY

A.G. Thruston, Clerk

[Award 35 M.A.; R.P. 7158; Kalokohanahou Kaneohe Koolaupoko; 1 ap.; 52.54 Acs; no. 7181 not awarded]

# No. 1954, Kalaikau

**N.R. 305v3**

To the Land Commissioners: I, the undersigned, hereby state my claim for land at Kāne‘ohe in the ‘lli of Kalokohuluiwi. There are sixteen lo‘i, a kula and a house, bounded on the east by the sea, on the north by the lands Laakuaa, on the west, the land of Keliiwaiwaiole, on the south, the land of Kamokuwaiole.
KALAIKAU X His mark
December 17, 1847

**F.T. 451v14**
Helu 1954, Kalaikau, See 458 page

Makuakane, hoohiki‘ia, Ua ‘ike au i kona aina ma Kāne‘ohe, Ko‘olaupoko.

‘Āpana 1. 16 lo‘i kalo & pāhale ma ka ‘ili o Kanohuluiwi.

Panei na palena:
Mauka, ka ‘ili o Lipuna
Ko‘olauloa, ka ‘ili o Kalokohou
Makai, he kahakai
Kailua, ka mo‘o ‘āina o Mokuwaiole.

No Puhalaha mai kona aina i ka wa e ola ana o Liliha, mamua i ka M.H. 1839. A ua mau kona noho ma malaila, ‘A‘ole mea keakea.

**N.T. 458v14**
No. 1954 Kalaikau, claimant, from page 451

Makuahine, the witness, says the land is in the ‘ili of Kanoholuiwi, 16 taro patches.

No. 1. 16 taro patches and house lot. It is bounded:
Mauka, the ‘ili Lipuna
Koolauloa, the ‘ili Kalokohau
Makai, sea beach
Kailua, taro land of Makuwaiole.

His land is from Puhalahua in the time of Liliha. No one has ever disputed his title.[Award 1954; R.P. 1390; Kawaihae Kāne‘ohe Ko‘olaupoko; 1 ‘āp.; 1.67 Acs]

**No. 1966, Opu**

**N.R. 309v3**

Greetings and Peace to the Land Commissioners: I hereby state the boundaries of my land at Kaneohe in the ‘ili of Owaikapoki, consisting of four lo‘i. On the east is a pond, on the north is the land of Kahuaia, on the west is the land of Hoomaulu, on the south is the land of Malia. One lo‘i is at Waiape, one is at Wailele, a house with two planted trees.
OPU
December 18, 1847

**F.T. 99v11**
No. 1966, Opu

Kumuhonua Hoohikiia, Ua ike au i kona aina ma Kaneohe, Koolaupoko

Apana 1. 4 loikalo ma ka ili o Waikapoki
Apana 2. 1 loikalo ma ka ili o Waiape
Apana 3. 1 loikalo ma ka ili o Wailele
Apana 4. Pahale ma ka ili o Wailele

Apana 1.
Mauka, ko Hoonaula aina
Koolauloa, ka aina o Malia
Makai, loi poalima a me ka loi o Kahuaia
Kailua, kahawai o Wailele

Apana 2.
Mauka, ko‘u aina
Koolauloa, ko Pahia aina
Makai, ko Kapaula aina
Kailua, ko‘u aina

Apana 3.
Mauka, ko Kauikea aina
Koolauloa, pela no
Makai, pela no
Kailua, ko Koe(ill)aakaia, a me ka loi poalima

Apana 4.
Mauka, alanui Aupuni
Koolauloa, kula o Lipuna
Makai, pela no
Kailua, kula o Wailele

No Wahineino mai kona aina i ka wa o Liliha mamua o ka M.H.1839. Apana 2, no Paha mai i ka M.H.1840. Apana3, 4, no Nanikea mai i ka M.H.1845, a ua mua kona noho ana aole mea keakea.

Kaenaakaia Hoohikiia, ua like ko maua ike

**F.T. 58v11**
No. 1966, Opu

Kumuhonua, says under oath, I know claimant’s land. It is in Kaneohe.

No. 1 is 4 lois in Waikapoki.
No. 2 is 1 loi in Waiape.
No. 3 is 1 loi in Wailele.
No. 4 is a house & lot in Wailele.

No. 1 is bounded:
Mauka by Hoomaulu’s kalo land
Koolauloa by the ili of Wailele
Makai by Kahuia’s kalo land & a poalima
Kailua by the creek of Wailele.

No. 2 is bounded:
Mauka by Kumuhonua’s kalo land
Koolauloa by Pahia’s kalo land
Makai by Kapaula’s kalo land
Kailua by Kumuhonua’s kalo land.

No. 3 is bounded:
Mauka by Kauikea’s kalo land
Koolauloa by Kauikea’s kalo land
Makai by Kauikea’s kalo land
Kailua by Kunakaia & a poalima.

No. 4 is bounded:
Mauka by the road
Koolauloa by upland of Lipuna
Makai by upland of Lipuna
Kailua by Wailele.

The kalo land in Waikapoke was given to claimant by Wahineino in the time of Liliha. The kalo land in Waiape was given by Peha in the year 1840. The kalo land and house lot in Wailele was given by Kauikea in 1845. Claimant has had them in peace to the present time.

Kuaikolia, testifies to the truth of the above statements.

[Award 1966; R.P. 4902; Waiape Kaneohe Koolaupoko; 1 ap.; .19 Ac.; Waikapoki Kaneohe Koolaupoko; 1 ap.; .29 Ac.; Wailele Kaneohe Koolaupoko; 3 ap.; 1.57 Acs]

**No. 1967, Kahinu**
**N.R. 309v3**

Greetings and Peace: I hereby state the boundaries of my land in Kaneohe in the ‘ili of Kailipaa, consisting of seven lo‘i. On the east is a pali, on the north is the land of Kala, on the west is a kula, on the south is the land of Kuaana. There are two houses with a big fence. One lo‘i is in the ‘ili of Waikapoki.
KAHINU
December 18, 1847

**F.T 66v11**
No. 1967, Kahinu

Kekuahani, Hoohikiia, Ua ike au i kona aina ma Kalaepaa 6 loi kalo, a hookahi loi ma Waikapoki a me ka pahale iloko o Waikapoki a me Wailele, Kaneohe Koolaupoko.

6 loi kalo ma ~~Waikapoki~~ Kalaepaa
Mauka, ko Kuaana aina
Koolauloa, ko Kala aina
Makai, ko Puupuu aina
Kailua, pela no

1 loi kalo
Mauka, ko Keliiholomoku aina
Koolauloa, ko Kala aina
Makai, ko Kauikea aina
Kailua, kahawai o Wailele

Pahale
Mauka, ko Kula aina
Koolauloa, ko Kanehoalani & Keliiholomoku pahale
Makai, ka alanui Aupuni
Kailua, ko Kauikea ainaua paa hapa i ka pa, 2 aoao i paa

No‘u aku kona aina i ka M.H. 1836, a na noha oia malaila a hiki i keia wa, aole mea keakea

Kumuhonua Hoohikiia, Ua like no ko maua ike me ka Kekuahani i hai ae nei, a ua oiaio kana hoike ana.

**F.T. 3v11**
No. 1967, Kahinu

Kekuahane, sworn says, I am a son of Kaneohe and know the claimant’s land. It consists of six lois in the Ili of Kalaepaa, Kaneohe, and one loi adjoining these six lois, but in the Ili of Waikapoki. Also a House lot partly in Waikapoki and partly in Wailele.

The piece of 6 lois is bounded:
Mauka by Kuaana's lois
Koolauloa by the Wailele Creek
Makai by Puupuu’s lois
Kailua by Puupuu’s lois.

No. 2 (one loi) is bounded:
Mauka by Keliiholomoku’s lois
Koolauloa by Kala’s land
Makai by the Ili of Wailele
Kailua by Wailele Creek.

No. 3 (House Lot ) is bounded:
Mauka by the kula of Waikapoki
Koolauloa by Kanehoalani’s house lot
Makai by the government road
Kailua by the kula of Wailele, Kauikea’s land.

The claimant received these lands from me 14 years since, and has possessed them ever since in peace.

Kumuhonua, sworn, says, I am a son of Kaneohe and know the land of claimant. The testimony of Kekuahane is true.

[Award 1967; R.P. 2042; Kalaepaa Kaneohe Koolaupoko; 1 ap.; 2.22 Acs]

# No. 2343, Keli‘iwaiwai‘ole

**N.R. 460v3**

To the Land Commissioners, Greetings: I hereby state my claim for land in the ‘ili at Kokokohou in Kāne‘ohe, Island of Oahu. 1 mo‘o, 18 taro lo‘i, 2 taro lo‘i adjoining the mo‘o of Makuakane, 1 lo‘i adjoining with the lo‘i of Kahawaii, 1 kula adjoining Kikiwelawela. My house claim is in the same ‘ili. I got it in the year 1841.
KELIIWAIWAIOLE X his mark

**F.T. 36v14**
Helu 2343, Keli‘iwaiwaiole, See 165 page

Kapule, ho‘ohikiia, Ua ike au I kona aina ma ka ili o Kalokohou ma Kaneohe.

‘Āpana 1. 16 lo‘i me kahi kula
‘Āpana 2. 2 loi.
‘Āpana 3. kula.
‘Āpana 4. pāhale.

‘Āpana 1:
Mauka, aina o Keliiholomoku
Koolauloa, aina o Kauwa
Makai, moo o konohiki
Kailua, aina o Laahanu.

‘Āpana 2:
Mauka, ‘āina o Makuakane
Ko‘olauloa, kahawai
Makai, loko poalima
Kailua, aina o Kapala.

‘Āpana 3:
Mauka, pali o Kekiwelawela
Ko‘olauloa, kula o Kauwa
Makai, kai
Kailua, kula o Makuakane.

‘Āpana 4:
Mauka, Kahuahale o Keau
Ko‘olauloa, kula o Kalokohou
Makai, ‘auwai me ka ‘āpana mua
Kailua, pāhale o Kauwa & Wahaulaula.

No Kamakahonu mai kona aina I ka M.H. 1843. Ua noho me ka maluhia. Aole mea keakea.

Kahinu, hoohikiia, Ua oiaio no.

**F.T. 165v14**
No. 2343, Keli‘iwaiwai‘ole, claimant, from 36 page

Kapule, sworn say, claimant land is in the ‘ili Kalokohou at Kāne‘ohe & is as follows:

No. 1. 16 lo‘is taro
No. 2. 2 lo‘i taro.
No. 3. Upland.
No. 4. House lot.

No. 1 is bounded:
Mauka by the ‘ili of Lipuna
Ko‘olauloa by the taro land of Kauwa
Makai by a poalima
Kailua by taro land of Lahanu.

No. 2 is bounded:
Mauka by the taro land of Makuakane
Ko‘olauloa by the taro land of Kahawaii
Makai by fish pond
Kailua by the taro land of Kapela.

No. 3 is bounded:
Mauka by high hill
Ko‘olauloa by upland of Kauwa
Makai by sea beach
Kailua by potato patch of Makuakane.

No. 4 is bounded:
Mauka by the house lot of Keau
Ko‘olauloa by upland of Kalokohou
Makai by a river
Kailua by the house lot of Wahaulaula.

Claimant land is from Kamakahonu in the year 1843 and has had it in peace.

Kahinu, sworn, testifies to the truth of the above statement.

[Award 2343; R.P. 1389; Kaimihana Kaneohe Ko‘olaupoko; 1 ‘āp.; 6.09 Acs]

**No. 2345, Keau,**

**N.R. 461v3**

To the Land Commissioners, Greetings: I hereby state my claim for land in the 'ili of Kalokohou in Kaneohe, Island of Oahu. There are 4 taro lo'i together in one place, one kula adjoining a kula of Kahawaii. My house claim is in this one 'ili. I acquired my interest before the law was published.
KEAU X, his mark

**F.T. 15v14**
Helu 2345, Keau, continued page 149

Makuakane, hoohikiia, Ua ike au Ikona mau aina ekolu mau Apana ma ka ili of Kalokohou ma Kaneohe.

Apana 1 4 loi ili of Kalokohou.
Apana 2 kula ili of Kalokohou.
Apana 3 Kulanahale ili of Kalokohou.

Apana 1:
Mauka, na loi o Kauwa
Koolauloa, no loi o Kapela
Makai, loko Poalima
Kailua, aina o Manene.

Apana 2. Ua puni I ke kula o he konohiki ma na aoao a pau.

Apana 3:
Mauka, Ili of Lipuna
Koolauloa, kula o Kipuna & Kalokohou
Makai, Kulanahale o Keliiwaiwaiole
Kailua, Ili o Kanohuluiwi.

No Kumeheua mai kona aina I ka wa o Kamakahonu oia ka M.H. 1841 aole mea keakea ia ia.

Kahawaii, hoohikiia, Ua oiaio kana.

**F.T. 148-149v14**
No. 2345, Keau, claimant, from 15 page

Makuakane, sworn say, I know claimant's land is in the ili of Kalokohou, Kaneohe.

No. 1 is 4 taro patches.
No. 2 is a piece of upland, a potatoe field.
No. 3 is a house lot.

No. 1 is bounded:
Mauka by the taro land of Kauwa
Koolauloa by the taro land of Kapela
Makai by the fish pond
Kailua by the taro land of Manene.

No. 2 is bounded: On all sides is the upland of Kalokohou. It is a small potatoe field.

No. 3 is bounded:
Mauka by the upland of Kipuna.
Koolauloa by the upland of Lipuna & Kalohohou
Makai by house lot of Keliiwaiwaiole
Kailua by ili of Kanohouluiwi.

Claimant received his land from Kumeheua about the year 1841. No one disturbed claimant in his possessing the above land.

Kahawaii, sworn, testifies to the truth of the above.

[Award 2345, R.P. 1375, Kaopulolia Kaneohe Koolaupoko; 2 ap.; 1.09 Acs]

# No. 2460, Kekuaikolia, December 16, 1848

**N.R. 509v3**

To the Land Commissioners, Greetings: I, the one whose name is below, hereby state my land claim, in the ʻili of the konohiki, Nahalelaau. On the north is a poʻalima, on the east is a stream, on the south is the land of Maikaipohu, on the west is a pali. There is also a house claim.
KEKUAIKOLIA
Lipuna, Kaneohe Oahu

**F.T. 99v11**
No. 2460, Kekuaikolia

Kumuhonua hoʻohikiia, Ua ike au i kona ʻāina ma Kāneʻohe, Koʻolaupoko

ʻĀpana 1. 5 loikalo ma ka ʻili o Wailele
ʻĀpana 2. Pahale ma ka ʻili o Lipuna

ʻĀpana 1.
Mauka, ka aina o Nakahulua
Koolauloa, pali o Waiape
Makai, ka aina o Pahia a me ka loi poalima
Kailua, kahawai o Kaneʻohe

ʻĀpana 2.
Mauka, kula o Lipuna
Koolauloa, pela no
Makai, ka auwai
Kailua, pela no

No Nahalelaau mai kona ʻāina i ka M.H.1844, a ua mau kona noho ana a keia manawa,ʻ aʻole mea keakea

No Keliʻiholomoku mai ka Apana 2; aka, ua noho mua kana poe makua malaila ma ka wa o Kamehameha I, a ua mau ko noho ana malaila, ʻaʻole mea keakea

Kukona hoʻohikiia, Ua like pu ko maua ike me ko Kumuhonua

**F.T. 57v11/B>**
**No. 2460, Kekuaikolia**

Kumuhonua, sworn says, claimant's land is in the ili of Waiape and his house in ili Lipuna.

No. 1 is 5 kalo patches in Waiape.

No. 2 is a house lot in Lipuna.

No. 1 is bounded:
Mauka by Nakahuelua's kalo land
Koʻolauloa by the pali of Waiape
Makai by Pehia's kalo land & a poalima
Kailua by Kaneohe Creek.

No. 2 is bounded:
Mauka by upland of Lipuna
Koʻolauloa by upland of Lipuna
Makai by a small brook
Kailua by a small brook.

Claimant's title to the kalo land is from Nahalelaʻau or his agent, Peha, in the year 1844 and has had it undisturbed from that time. His house lot he received from is ancestors, and is confirmed by Keliʻiholomoku, the konohiki.

Kukona testifies to the truth of the above statement**.**

[Award 2460; R.P. 288; Lipuna Kāneʻohe Koʻolaupoko; 1 ʻap.; .88 Ac.]

**No. 2491B, Kamanene**

**No. 2471, Kamanene**
**N.R. 514v3**

To the Land
Commissioners: I, the one whose name is below, hereby state my claim in the ʻili of Lokohou, in Kamakahonu. On the north is the stone wall, on the east is a poʻalima, on the sough is a kula moʻo, on the west is the land of Kumeheua. I also have a kula. I got this land in the time before the publishing of the law.
KAMANENE
Kaopulolia, Kaneohe, Oahu, December 18, 1847

**F.T. 17v14**
Helu 2417!, Kamanene, Continued page 150
[should be 2471]

Kuaikolia,
hoohikiia, Ua ike au i kona aina ma ka ili of Kalokohou. Elima loi one ke kula a hiki aku i kahi loi 1. E pili ana me ka Poalima ma Kaneohe nei.

Mauka, aina o Kauwa
Koolauloa, aina o Keau
Makai, lokoia poalima
Kailua, moo poalima.

Nau aku kona aina, no Kamakahonu mai koʻu i ka M.H. 1844. Ua noho me ka maluhia. Aole mea keakea.

Kauwa, hoohikiia, Ua oiaio kona hoike ana.

**F.T. 150v14**
No. 2471, Kamanene, Claimant, from page 17

Kekuaikolia, sworn, say claimant's land is in the ili of Kalokohou.

It is bounded:
Mauka by the taro land Kauwa, Kumupali
Koolauloa by the taro land Kauwa, Keau
Makai by fish pond
Kailua by the poalima land of Kalekohou.

His land was given him by myself in the year 1844. No one has disturbed him.

Kauwa, swear to the truth of the above.

[Award 2491B; R.P. 1398; Kalokohanahou Kaneohe Koolaupoko; 1 ap.; 1 Ac.; no document yet located for 2491B]

# No. 2496, Keliihelemoku

**N.R. 525v3**

To the Land Commissioners, Greetings: I hereby state my claim for land in the ʻili at Lilipuna in Kaneohe, Island of Oahu, consisting of 1 moʻo. The boundaries are: On the east, the poʻalima, on the south, the land of Puhulu, on the west, my kula, on the north, the land of Kamanu. My house claim and my kula claim are adjacent to Puhalahua's, and also with Kamakahonu's. Here is this claim: I have 4 poʻalima loʻi and 1 poʻalima kula, which I got before the law was printed.
KELIIHELEMOKU

**F.T. 13v14**
Helu 2496, Keliiholomoku, See page 147

Wahaulaula, hoʻohikiia, Ua ʻike au I kona ʻāina ma ka ʻili o Lipuna ma Kaneohe nei, mai ka moʻoʻaina a he kula a me ke Kahuaahale.

Mauka, ko Puluhi me ke kula o Lipuna
Koʻolauloa, kula o Lipuna
Makai, ʻIli of Kanohouluiwi
Kailua, Owau.

Ua komo na loi poalima e 4 o he konohiki maloko. No Kinau mai kona aina I ka manawa o Kinau he `lii kiaana, aole mea keakea.

Makuakane, hoʻohikiia, Ua oiaio kona.

**F.T. 147v14**
No. 2496, Keliiholomoku, claimant, from 13 page.

Wahaulaula, sworn say, claimant's land is in the ili Lipuna. It is a Mooaina.

No. 1 is bounded:
Mauka by the taro land of Puluhi & the upland of Lipuna
Koʻolauloa by the upland of Lipuna
Makai by the ʻili of Kanohouluiwi
Kailua by my land.

Witness says there are two patches included in the above, but claimant has had there is claims [sic] is from Kinau in the time of Kinau before 1839.

Makuakane testifies that the above is true.

[Award 2496; R.P. 289; Lilipuna Kāneʻohe Koʻolaupoko; 1 ap.; 2.27 Acs]

# No. 2555, Wahaulalula

**N.R. 553v3**

To the Land Commissioners, Greetings: I hereby state my claim for land in the ‘ili of Waikapoki, in Kaneohe, Island of Oahu, consisting of 1 mo‘o. The boundaries are: on the south, the land of Kumuhonua; on the north, the pali; on the east, the land of Waikapoiki; on the west, the land of Keliihelemoku. One kula adjoins the kula of Puhalahua. I got this claim before the law was published.
WAHAULAULA X, his mark

**F.T. 17v14**
Helu 2555, Wahaulaula, Continued page 150

Keliiholomoku, ho‘ohikiia, Ua ‘ike au I kona aina ma ka‘ ili Waikapoki ma Kāne‘ohe.
Kulanahale ma Kanohuluiwi

‘Āpana 1. Mo‘o‘āina one ka kula o Waikapoki.
‘Āpana 2. Kulanahale ma Kanohuluiwi.

‘Āpana 1:
Mauka, ko‘u aina
Koolauloa, ko‘u aina
Makai loko o Kanohuluiwi
Kailua, loko o Waikapoki.

‘Āpana 2:
Mauka, kula o Lipuna
Ko‘olauloa, kula o Kalokohou
Makai, kulanahale o Kauwa
Kailua, ‘auwai o Lipuna.

No Alapai mai ka ‘Āpana mua I ka M.H. 1844. Nona Koa mai ka ‘Āpana 2. Ia wa no aole mea keakea ia ia.

Kauwa, ho‘ohikiia, Ua oiaio na mea a Keliiholomoku I hai mai nei.

**F.T. 150v14**
No. 2555, Wahaulaula, Claimant, from page 17

Keli‘iholomoku, sworn, says I know claimant's land. It is in the ‘ili of Waikapoki.

No. 1 taro land & a little upland.
No. 2 House lot.

No. 1 is bounded:
Mauka by my taro land
Koʻolauloa by my taro land
Makai by the fish pond of Kanohouliwi
Kailua by the fish pond of Kanohouliwi.

No. 2 is bounded:
Mauka by the upland of Lipuna
Koʻolauloa by the upland of Kalokohou
Makai by house lot of Kauwa
Kailua by brook of Lipuna.

Claimant's land is from Alapai in the year 1844, the house lot is from Nakoa, given recently in 1844. He has had it in peace up to this time.

Kauwa, sworn, say the above is true.

[Award 2555; R.P. 1385; Waikapoki Kaneohe Koʻolaupoko; 1 ʻāp.; .893 Ac.]

# No. 3431B, Kauwa (Kaule)

**Helu 3431B, Kauwa (Kaule) See page 157, No. 4244B**
**F.T. 27v14**

Ko‘ohikiia, ka mea kuleana a ‘ōlelo mai la ua ho‘okomo au. I ko‘u kuleana a ua kakau ia e Kamali‘i o Kaauwai a ua lilo ku‘u kapaha ia lākou. ‘A‘ole nae puka mei nei, ua haule ma Honolulu paha. Ma ka Hale Hoona.

Kuaikalia, hoohikiia, Ua ike au I kona aina ma ka ili o Kaluakau ma Kaneohe he 11 loi me na kumu ulu elua a me kahi kula.

‘Āpana 1. 11 lo‘i & ulu me kula Kalokohou.
‘Āpana 2. Pāhale ma Kanohuiwi.

‘Āpana 1:
Mauka, Mo‘o Keliiwaiwaiole
Ko‘olauloa, Mo‘o Keliiwaiwaiole
Makai, Mo‘o Manene
Kailua, Mo‘o poalima.

‘Āpana 2:
Mauka, pāhale o Wahaulaula
Ko‘olauloa, ‘Ili o Kalokohou
Makai, pāhale o Mokuwaiole
Kailua, ‘Auwai o Kanohuiwi.

No Kamakahonu mai ka ‘āpana mua I ka wā o Liliha no Puhalahua mai ka ‘Āpana 2 ia wā. ‘A‘ole mea keakea.

Pa, ho‘ohikiia, Ua oiaio na ‘ōlelo.

**F.T. 157v14]**
[No. 3431B], Kauwa, claim not found, This claim is awarded under No. 3431B, page 27
[Listed under No. 4244B!]

Kauwa, sworn, say he sent his claim to the Land Commission. It is not found among the claims. He paid for the writing to an individual who came from Honolulu to take the claims.

Kauaiholeia, sworn, says I know the land of claimant in the ‘ili of Kalokohou.

No. 1 is bounded:
Mauka by the taro land of Keliiwaiwaiole

Ko‘olauloa by the taro land of Keliiwaiwaiole
Makai by the taro land of Manene
Kailua by a poalima taro patches [sic].

No. 2 is bounded:
Mauka by the house lot of Wahaulaula
Koolauloa by ‘ili of Kalokohou
Makai by house lot of Mokuwaiole
Kailua by a brook.

Claimant's land is from Kamakahonu in the time of Liliha. The house lot is from Pualahua. No one has disturbed the claimant to the present time.

Pa testifies to the truth of the above.

[Award 3431B; Kalokohanahou Kaneohe Koolaupoko; 1 ‘āp.; 1.998 Acs]

# Appendix F

Special Management Area Determination Letter

City and County of Honolulu Department of Planning and Permitting, March 2010

2010/ELOG- 449

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

MUFI HANNEMANN
MAYOR

CRAIG I. NISHIMURA, P.E.
DIRECTOR

COLLINS D. LAM, P.E.
DEPUTY DIRECTOR

RECEIVED '10 MAR -3 P3:04
DEPT OF PLANNING AND PERMITTING
CITY & COUNTY OF HONOLULU

WW.P10-046

March 3, 2010

MEMORANDUM

TO: DAVID K. TANOUE, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

FROM: for CRAIG I. NISHIMURA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

SUBJECT: KAHANAHOU WASTEWATER PUMP STATION UPGRADE PROJECT
SPECIAL MANAGEMENT AREA (SMA) USE PERMITS

We are requesting your concurrence that the above mentioned project is exempt from the SMA Use permit.

The Kahanahou Wastewater Pump Station Upgrade Project has been initiated by the Department of Environmental Services to upgrade/replace pumps, piping, mechanical and electrical equipment, emergency power system, structures, ventilation system, and miscellaneous site improvements. The wastewater pump station site is identified by TMK: 4-5-047:95 (See enclosed plan).

It is our understanding that repair and maintenance of appurtenant structures such as sewer pump stations are exempt from SMA Use permits. The scope of this project will be limited to upgrading the sewer pump station. Upon completion of project, all adjacent ground features disturbed during construction will be restored to its original or better condition.

If you have any questions or require additional information to make your determination, please feel free to call Roy Tamashiro of the Wastewater Division at 768-8760

I hereby concur with the SMA exemption for Kahanahou Wastewater Pump Station Upgrade Project.

David K. Tanoue, Director Date
Department of Planning & Permitting

Enclosure

FILE

DEPARTMENT OF PLANNING AND PERMITTING
**CITY AND COUNTY OF HONOLULU**
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
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CITY AND COUNTY OF HONOLULU
STATE OF HAWAII

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

2010/ELOG-449(AA)

March 10, 2010

**MEMORANDUM**

TO: CRAIG I. NISHIMURA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

ATTENTION: WASTEWATER DIVISION

FROM: DAVID K. TANOUE, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

SUBJECT: SPECIAL MANAGEMENT AREA DETERMINATION
KAHANAHOU WASTEWATER PUMP STATION UPGRADE PROJECT
45-13 KA HANAHOU PLACE - KANEOHE
TAX MAP KEY: 4-5-47: 95

This responds to your request, received on March 3, 2010, for information on the Special Management Area (SMA) use permit requirements to upgrade an existing wastewater pump station facility in the SMA.

The project will entail miscellaneous site improvements, and the repair and/or replacement of pumps, piping, mechanical and electrical equipment, emergency power system, structures, and ventilation system within an existing building. The project site is in the SMA; however, we confirm that the project will not require an SMA use permit pursuant to Sections 25-1.3(2)(D) and (M), Revised Ordinances of Honolulu. The proposed work is not expected to have any significant environmental or ecological effect on the SMA.

The project is subject to the environmental compliance law of Chapter 343 HRS. The applicant indicates that the project is exempt pursuant to Exemption Class #2 (Item 7) of the Department of Environmental Services Comprehensive Exemption List.

If you have any questions, please contact Ann Asaumi of our staff at 768-8020.

DKT:nw

**Comprehensive Exemption List**
**for the**
**City and County of Honolulu**
**Department of Environmental Services**

HISTORICAL NOTE

This exemption list for the Department of Environmental Services was reviewed and concurred upon by the Environmental Council on May 17, 2012.

GENERAL NOTE

Section 343 of the Hawaii Revised Statues (HRS) authorizes the Environmental Council to establish procedures to exempt specific types of action from the need to prepare an environmental assessment because the action will have minimal or no significant effect on the environment.

The following types of projects will not be exempt:

1. Projects requiring detailed analysis as provided in an environmental assessment under §343-5. These include, but are not limited to, places listed on the Federal or State registers of historic places.

2. Projects in statutorily defined areas, including but not limited to: critical habitats, special management areas, special design districts, registered view planes or scenic corridors, wet lands, sanctuaries, special habitats, shoreline areas, tsunami inundation areas, or other designations; except where the work is eligible for exemption and there is no negative impact on the conditions that define these areas.

3. Major projects without an Environmental Impact Statement (EIS); an Environmental Assessment with a Finding of No Significant Impact (EA/FONSI); or major projects that were never presented at a public meeting concerning site selection, master plan report, or any phase of incremental construction.

4. Major projects without a program to encourage public input into the design or siting of the project.

Pursuant to HAR Section 11-200-8 (B), all exemptions under the classes in this section are inapplicable when the cumulative impact of planned, successive actions of the same type, in the same place, over time, is significant, or when an action that is normally insignificant in its impact on the environment may be significant in a particularly sensitive environment, as expressed in #2 above.

Pursuant to the administrative rules promulgated under authority of Section 343-6(7) of the Hawaii Revised Statutes (HRS), specifically Section 11-200-8; the Department of Environmental Services has determined that the following types of actions, where they fall within the given classes of action, shall generally be exempt from the preparation of an environmental assessment.

Exemption Class #1:

Operations, repairs or maintenance of existing structures, facilities, equipment or topographic features involving negligible or no expansion or change of use beyond that previously existing.

1. Clearing and grubbing
2. Construction staging areas, temporary
3. Drainage structures (e.g., culverts, outlets, inlets)
4. Earth berms, drainage swales, and stream banks
5. Equipment installations, including but not limited to pumps; motors; electrical transformers, cabinets, panels, and vaults; power, light, and telephone pole systems; heating, ventilation, and air conditioning (HVAC); supervisory control and data acquisition (SCADA); irrigation controllers; telephone stations; emergency electrical generators; and cathodic protection systems
6. Essential utilities, including but not limited, to wastewater systems, drainage systems, water systems, electrical systems, communication systems, SCADA systems, and fuel systems, except where a State Department of Health permit is required
7. Existing individual wastewater systems (cesspools, septic tanks, aerobic units)
8. Existing public facility structures, facilities, or equipment involving negligible or no expansion or change of use beyond that previously existing
9. Existing topographical features involving negligible or no expansion or change or use beyond that previously existing (e.g., maintenance dredging including dewatering; stream bank restoration; maintenance of vegetated and/or lined swales, wet ponds, and/or other water quality features in parks and golf courses)
10. Exterior stems and stairways
11. Fencing, curbing, walls, and gates
12. Fumigation and treatment of buildings for termites, cockroaches, ants, vermin, and other pests using pesticides registered by the State Department of Agriculture and the United States Environmental Protection Agency (EPA)
13. Landfill erosion control
14. Landfill gas and leachate system
15. Landscaping
16. Maintenance/storage sheds
17. Minor underpinning
18. On-site street cleaning
19. Operations, repairs or maintenance actions for compliance with Occupational Safety and Health Administration (OSHA) requirements
20. Painting of existing buildings
21. Pavements (and striping, as needed), including but not limited to, roadways, driveways, parking lots, walkways, bikeways, jogging paths, or multi-use pathways
22. Planter boxes
23. Refuse collection schedule changes
24. Reroofing or roofing
25. Retaining walls and embankment/slope and erosion repairs
26. Roadways and right-of-way within the confines of a wastewater treatment plant, a wastewater pump station, or a landfill
27. Security lighting for public grounds, structures, and parking lots
28. Signs, posts, flag/banner poles
29. Temporary storage of construction equipment and materials on street remnant properties
30. Trash compactors
31. Trash enclosures and litter containers

32. Wastewater Force Mains (FMs) and associated appurtenances (including but not limited to, air relief valve, flow tube, gate valve, manual air relief valve or air bleeder, check valve, blow off valve, testing station)
33. Wastewater lines (mains and laterals)
34. Wastewater outfalls
35. Wastewater Pump Stations (WWPSs)
36. Wastewater spills
37. Wastewater Treatment Plants (WWTPs)
38. Operation of City vehicles on existing City, State and private roads and roadway easements, including cars, trucks and trailers, but excluding operations that result in significant traffic impacts.
39. Loading, delivery and unloading operations for liquid and solid materials to and from vehicles at existing wastewater treatment plants and pump stations, but excluding operations that add nuisance odors at the property lines.
40. Loading, delivery and unloading operations for municipal solid waste and/or recyclable materials to and from vehicles at landfills, waste-to-energy facilities, transfer stations, convenience centers, and disposal, processing or recycling facilities. “Municipal solid waste” is defined in accordance with Hawaii Revised Statutes section 342G-1. “Recyclable materials” are defined in accordance with Revised Ordinances of Honolulu section 9-1.2.

<u>Exemption Class #2</u>

Replacement or reconstruction of existing structure and facilities where the new structure will be located generally on the same site and will have substantially the same purpose, capacity, density, height, and dimensions as the structure replaced.

1. Accessible ramps and handrails
2. Bridge replacement
3. Bollards and vehicular access barriers
4. Clearing, grading, and grubbing
5. Drainage structures (e.g., culverts, outlets, inlets)
6. Earth berms, drainage swales, and stream banks
7. Equipment installations, including but not limited to pumps; motors; electrical transformers, cabinets, panels, and vaults; power, light, and telephone pole systems; heating, ventilation, and air conditioning (HVAC); supervisory control and data acquisition (SCADA); irrigation controllers; telephone stations; emergency electrical generators; and cathodic protection systems
8. Essential utilities, including but not limited, to wastewater systems, drainage systems, water systems, electrical systems, communication systems, SCADA systems, and fuel systems, except where a State Department of Health permit is required
9. Existing individual wastewater systems (cesspools, septic tanks, aerobic units)
10. Existing public facility structures, facilities, or equipment involving negligible or no expansion or change of use beyond that previously existing
11. Existing topographical features involving negligible or no expansion or change of use beyond that previously existing (e.g., reconfiguration of paved parking lots to redirect drainage flow to vegetated areas, demolition and/or regarding areas to provide storm water detention for water quality)
12. Exterior stems and stairways
13. Fencing, curbing, walls, and gates
14. Footbridge

15. Fuel tank modification, repair or replacement in compliance with Federal and State regulations and with concurrence of the State Department of Health
16. Fueling stations
17. Fumigation and treatment of buildings for termites, cockroaches, ants, vermin, and other pests using pesticides registered by the State Department of Agriculture and the United States Environmental Protection Agency (EPA)
18. Guardrails
19. Landfill erosion control
20. Landfill gas and leachate system
21. Landscaping
22. Maintenance/storage sheds
23. Pavements (and striping, as needed), including but not limited to, roadways, driveways, parking lots, walkways, bikeways, jogging paths, or multi-use pathways
24. Planter boxes
25. Replacement or reconstruction actions for compliance with Occupational Safety and Health Administration (OSHA) requirements
26. Retaining walls, embankment/slope, swale, and/or erosion control replacement and reconstruction
27. Roadways and right-of-way within the confines of a wastewater treatment plant, a wastewater pump station, or a landfill
28. Sanitary sewer line modification or replacement in generally the same alignment, or an adjacent parallel alignment, and with the same diameter pipe.
29. Sanitary sewer line rehabilitation, including linings, inserts and coatings applied to existing pipelines and manholes.
30. Sanitary sewer line replacement, with a pipe that is no larger than the next largest nominal diameter size than the existing pipe, in generally the same alignment, or an adjacent parallel alignment, due to the need to increase to a minimum diameter standard for maintenance purposes or to accommodate wet weather peak flows. For the purposes of this item, increasing to the next largest nominal diameter size is considered to be a minor change, and is substantially the same dimensions. Upsizing to larger diameter pipe to service new facilities or structures is precluded.
31. Sanitary sewer relief line, in an adjacent parallel alignment, due to the need to accommodate wet weather peak flows or to restore flow capacity decreased by defect in the existing sewer.
32. Sanitary sewer relief line, in an adjacent parallel alignment, to restore flow capacity for a section of existing sewer that experienced loss of capacity from original design.
33. Sanitary sewer temporary bypass incidental to sewer line rehabilitation, modification, or replacement.
34. Security lighting for public grounds, structures, and parking lots
35. Signs, posts, flag/banner poles
36. Trash compactors
37. Trash enclosures and litter containers
38. Vegetated and/or lined swales, wet ponds, or other water quality features in parks, golf courses, or other recreational areas
39. Wastewater facility/structures (to include, but not be limited to, manholes, junction boxes, tanks, incinerators, etc.)

<u>Exemption Class #3</u>

Construction and location of single, new, small facilities or structures and the alteration and modification of the same and installation of new, small, equipment and facilities and the alteration and modification of same, including but not limited to:

a. Single-family residences less than 3,500 square feet not in conjunction with the building of two or more such units;
b. Multi-unit structures designed for not more than four dwelling units if not in conjunction with the building of two or more such structures;
c. Stores, offices, and restaurants designed for total occupant load of 20 persons or less per structure, if not in conjunction with the building of two or more such structures; and
d. Water, sewage, electrical, gas, telephone, and other essential public utility services extension to serve such structure or facilities; accessory or appurtenant structure including garages, carports, patios, swimming pools, and fences; and acquisition of utility easements.

1. Accessible ramps and handrails
2. Acquisition of utility easements
3. Auxiliary generators for emergency use
4. Bollards and vehicular access barriers
5. Carports
6. Cathodic protection of pipelines and equipment
7. Clearing, grading, and grubbing
8. Comfort facilities at public facility properties
9. Community recycling bin program expansion, limited to not more than a total bin footprint of 1,000 square feet within the same site.
10. Construction and location of a single, new, small public facility structure, including but not limited to those intended for recreational, meeting, administration, maintenance, operations, and safety and protection (e.g., police, fire, emergency medical, and wastewater spill response) less than 3,500 square feet in floor area not in conjunction with the building of two or more such units
11. Construction of ball wash facilities for golf courses
12. Construction of concrete pads and roofs at existing fueling stations
13. Construction of concrete pads and roofs for heavy equipment areas at selected maintenance facilities
14. Construction of small vehicle wash equipment for recycling water at select City facilities
15. Construction of roofs over existing outdoor showers at select park sites to allow connections to the wastewater system
16. Construction of vehicle wash facilities for golf carts
17. Construction or installation of an underground fuel tank with a maximum capacity of 4,000 gallons at fire and police stations
18. Construction or installations of cesspools that require State Department of Health and Board of Water Supply approvals
19. Creation of temporary staging areas during periods of City and County construction
20. Earth berms and drainage swales
21. Equipment installations, including but not limited to pumps; motors; electrical transformers, cabinets, panels, and vaults; power, light, and telephone pole systems; heating, ventilation, and air conditioning (HVAC); supervisory control and data acquisition (SCADA); irrigation controllers; telephone stations; emergency electrical generators; and cathodic protection systems

22. Essential utilities and new, small equipment, including but not limited to wastewater systems, drainage systems, water systems, electrical systems, communication systems, and irrigation systems
23. Expansion of existing groundwater monitoring wells
24. Expansion of existing landfill gas and leachate systems expansion (e.g., pipelines, flares, vacuumed/condensate/leachate pumps, monitoring wells, etc.)
25. Expansion of existing wastewater pump station and force main facilities (e.g. additional pumping equipment, pipe and appurtenances) within the existing footprint.
26. Extensions, modifications, or additions to existing buildings and new, small equipment less than 3,500 square feet in floor area not in conjunction with the building of two or more such additions
27. Facility improvements to comply with Federal and State requirements with concurrence with the State Department of Health (e.g., National Pollutant Discharge Elimination System (NPDES) requirements such as covered truck parking, surface water diversions swales, permanent structural Best Management Practices (BMPs), etc.)
28. Fencing, curbing, walls, and gates
29. Field office
30. Installation and construction of flare screens, safety barriers, guardrails, energy attenuators, and other appurtenances designed to protect the motoring public
31. Landscaping
32. Loading areas
33. Maintenance/storage sheds
34. Minor street widening and improvements within existing or future City and County street rights-of-way
35. Minor modification of incinerator as directed by EPA or other authorized governmental agencies
36. Modifications of existing facilities to conform to Federal, State and local regulations or codes as directed by authorized governmental agencies
37. Modifications at energy facilities to comply with Federal and State requirements with concurrence with the State Department of Health (e.g., pollution control equipment)
38. Pavements (and striping, as needed), including but not limited to roadways, driveways, parking lots, walkways, bikeways, jogging paths, or multi-use pathways
39. Pedestrian bridges within public facility properties
40. Planter boxes
41. Recycling collection bins
42. Retaining walls, except within the shoreline area
43. Security lighting of public grounds, structures, and parking lots
44. Sewer Improvement District project
45. Sewer lateral extension, involving the extension of an existing lateral to a new property line for road improvement projects or for existing laterals that were inadvertently installed short of the property line
46. Sewer manholes with or without concrete apron to accommodate pumper trucks (septage receiving station)
47. Sewer service installation for existing residential properties, including:
    a. The construction of a sewer lateral from an existing sewer main located in an easement or street right-of-way to the abutting property line of lots without sewer service
    b. The construction of additional laterals or the replacement of existing laterals to accommodate other utility lines or to facilitate connections from house sewer connection on the premise to laterals

c. The extension of an existing sewer main together with a lateral to serve lots without sewer service in areas where no significant environmental or historical resources exist

48. Sidewalks and covered walkways
49. Signs, posts, and flag/banner poles
50. Steps and stairways
51. Storm drain line extensions within wastewater treatment plant, wastewater pump station, refuse transfer station, and landfill sites
52. Storm drain line modifications
53. Trash compactors
54. Trash enclosures and litter containers
55. Utility connections (electrical, gas, water, wastewater)
56. Water tanks, not more than 75,000 gallons in capacity, developed to serve individual public facility needs

Exemption Class #4

Minor alterations in the conditions of land, water, or vegetation.

1. Berms
2. Chemical control of vegetation using herbicides and pesticides registered by the State Department of Agriculture and the EPA
3. Clearing, grubbing, or grading of less than 100 cubic feet within existing parks and public facility property boundaries
4. Ground improvements (e.g. driveways, parking areas, walls, sidewalks, etc.)
5. Landscaping and sprinkler system
6. Lining short sections of stream banks for erosion control and slope stability
7. Removal of unhealthy trees that endanger life or property and non-significant trees
8. Shoulders

Exemption Class #5

Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource.

1. Basic data collection, research, experimental management, and resource evaluation activities that do not result in a serious or major disturbance to an environmental resource, including but not limited to, archaeological surveys, bioassays, biological and ecological studies and surveys, chemical and bacteriological laboratory analysis, fish surveys, fresh and saline water sampling and analysis, industrial waste sampling and analysis, monitoring device installation, oceanographic surveys, receiving water monitoring programs, recycling wastewater and wastewater reuse studies, sediment studies and surveys, storm water runoff sampling and analysis, stream studies and surveys, topographical surveys, virus studies and surveys, exploratory soil boring, reconnaissance, testing, or data recovery

Exemption Class #6

Construction or replacement of minor structures accessory to existing facilities.

1. Accessible ramps and handrails

2. Air conditioning enclosures
3. Construction field offices, temporary
4. Drinking fountains
5. Guard shacks
6. Hose bibbs
7. Emergency generator structure
8. Exterior lighting
9. Heating ventilation and air conditioning (HVAC) systems for existing wastewater treatment plant, pre-treatment plant, lift station, and pump station buildings
10. Lighting of driveways, streets, and roadways
11. Maintenance/storage sheds
12. Outdoor showers
13. Pedestrian bridges within public facility properties
14. Planter boxes
15. Portable buildings for temporary use of 5 years or less
16. Relocation of buildings within existing facilities
17. Retaining walls, except in shoreline areas
18. Security lighting
19. Signs
20. Solar water heating systems that include exterior solar collectors, nonreflective panels, and storage tanks not greater than 120 gallons each, and associated accessories
21. Steps and stairways
22. Trash compactors
23. Trash enclosures and litter containers
24. Underground fuel tanks and dispensers, except where a State Department of Health permit is required
25. Ventilation and odor control systems for existing wastewater treatment plant, pre-treatment plant, lift station, and pump station buildings
26. Water tanks, not more than 75,000 gallons in capacity, to serve existing facilities

<u>Exemption Class #7</u>

Interior alterations involving things such as partitions, plumbing, and electrical conveyances.

1. Interior alterations and renovations to wastewater treatment plant, pre-treatment plant, lift station, and pump station buildings, including but not limited to partitions, doors, counters, cabinets, shelving, plumbing, electrical systems, heating ventilation and air conditioning (HVAC) systems, ventilation and odor control systems, and electrical conveyances

<u>Exemption Class #8</u>

Demolition of structures, except those structures located on any historic site as designated in the national register or Hawaii register as provided for in the National Historic Preservation Act of 1966, Public Law 89-665, 16 U.S. C. Sec. 470, as amended, or Chapter 6E, HRS.

1. Demolition of structures at wastewater treatment plant and pump station locations, except those structures located on any historic site

<u>Exemption Class #9</u>

Zoning variances except shoreline setback variances.

1. Zoning variances of wastewater facility properties, except shoreline setback variances

Exemption Class #10

Continuing administrative activities including, but not limited to, purchase of supplies and personnel-related actions.

1. Acquisition, but not improvement of property, for public use (including easements) and minor subdivision and consolidation of parcels necessary for acquisition of property for public use (including rounding corners and minor street widening)
2. Subdivision/consolidation of public lands to facilitate their transfer between the City and State for continuing public use without change in existing land use
3. Continuing government administrative activities, including but not limited to purchase of supplies and personnel-related actions
4. Operation of initial or continuing public programs consistent with established land use (for example, but not limited to, stream debris clean-ups, storm drain stenciling, beach debris clean-ups)