FINAL

North Shore Regional Wastewater Alternatives Plan

Prepared for

City and County of Honolulu

February 29, 2012

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List of Abbreviations

ATUs	aerobic treatment units
BOD	biological oxygen demand
BOD_5	biochemical oxygen demand
CC&Rs	covenants, conditions, and restrictions
CIP	Capital Improvement Program
City	City and County of Honolulu
CPA	Capita Per Acre
CTAHR	College of Tropical Agriculture and Human Resources
CWG	Core Working Group
DOH	Department of Health
DPP	Department of Planning and Permitting
ENV	Department of Environmental Services
FWS	free water surface
GIS	Geographic Information System
gpcd	gallons per capita per day
gpd	gallons per day
HOA	Homeowners' Associations
LUO	Land Use Ordinance
MBR	membrane bioreactor
mgd	million gallons per day
Mg/L	milligrams per liter
NSRWWAP	North Shore Regional Wastewater Alternatives Plan
NSSCP	North Shore Sustainable Communities Plan
O&M	operation and maintenance
PUC	Public Utility Commission
PUD	Public Utilities District
R1	highest quality of reclaimed water
RGF	Recirculating pea gravel filters
RME	responsible management entity
SBR	sequencing batch reactor
SIRWA	Southern Iowa Regional Water Authority
STEG	Septic tank effluent gravity
STEP	Septic tank effluent pumps
TSS	total suspended solids
UIC	underground injection control
UPC	Uniform Plumbing Code
USEPA	United States Environmental Protection Agency
UV	ultraviolet light
VF	vertical flow
WD	water district
WERF	Water Environment Research Foundation
WMD	water management district
WW	Wastewater
WW 101	"Wastewater 101"
WWTF	Wastewater Treatment Facility

Executive Summary

The community of the North Shore Region on the island of Oahu prides itself on the area's abundant land and aquatic resources along with its rural character and rich culture. These attributes are what draw millions of visitors to the area each year, bringing much needed tourism revenue to help support the local economy. Since the closing of the Waialua Sugar Plantation in 1996, the region has sought to revitalize itself into a sustainable community where commerce, tourism, and agriculture can flourish while upholding the community's commitment to "Keep the Country, Country."

The City and County of Honolulu (City) Department of Environmental Services (ENV) regularly performs status reviews of wastewater management for the established regions on Oahu. The outcome of this review process is a plan for future wastewater improvements with the primary goal of protecting human health and the environment. Currently, the City provides wastewater treatment for only a small portion of the North Shore region. The majority of the region's wastewater is handled by private onsite systems, many of which are old and deteriorating cesspools that have been in service for over 50 years. In addition, regulations governing cesspools have become much stricter as cesspools have been disallowed for most any expansion or new construction. Through cesspools, contaminants typically found in wastewater can migrate to the groundwater where they can find their way to streams and shorelines, posing potential health risks to terrestrial and aquatic environments and human populations as well. Environmental sampling and analysis data on soil and water in the North Shore region are very scarce, especially when trying to find indicators of wastewater contamination. Regardless of this lack of data, it is important to develop a wastewater plan that provides feasible alternatives that can move the region closer to its vision of sustainability, and to identify the types of wastewater infrastructure that could be a long-lasting foundation to the type of planned growth that is expected to occur in the next 20 years and beyond.

Because of concerns for public and environmental health, the City retained the services of Brown and Caldwell to evaluate alternatives for wastewater collection, treatment, and disposal for the North Shore region. For the purposes of this project the North Shore Region encompasses areas within the North Shore Neighborhood Board (No.27) boundaries, from Kaena Point to Waialee Gulch. The planning period under consideration is 20 years, through the year 2030.

- Supplemental Waialua-Haleiwa Facilities Plan, June 1996
- Waialua-Haleiwa Facilities Plan, September 1987
- North Oahu Facility Plan, March 1985

None of the past plans were fully embraced by the community and, in general, recommendations from the plans have not been implemented.

This North Shore Regional Wastewater Alternatives Plan (NSRWWAP) is intended to update and revise previous wastewater planning efforts for the region. As a departure from the typical planning approach, this planning effort sought to first understand the values and long term vision of the North Shore community by seeking guidance from its most active residents, business owners, and other important stakeholders. These community leaders made up the Core Working Group (CWG) which became an essential part of the project team and helped to develop a set of technical wastewater treatment alternatives that are consistent with these values.

The Community Engagement Process

When recruiting members for the CWG, the project team sought to achieve a diversity of interests and geographic coverage. The make-up of the CWG was intended to allow the project team to work with three segments of the community:

- **Individual stakeholders with unique interests** – This includes people who live, operate a business, or conduct a cultural or social activity in the region, landowners, and elected officials who represent the affected areas;
- **Organizations and agencies** – This includes the Neighborhood Board, various community associations, environmental and cultural organizations, and other organized groups; and
- **General public** – Both tax and rate payers are included in this group, as well as those who may have an interest in the project but are not connected to any organization.

The purpose of the community engagement process of the NSRWWAP was to maximize the opportunity for community values to shape recommendations for regional wastewater treatment alternatives. The interaction between the CWG and the technical project team was critical to fulfilling this goal. The technical team provided technical expertise and information to the CWG to support informed discussion and decision making. The results of the CWG's deliberations served as planning input and guidance for the project team to integrate into recommended alternatives.

Technical Assessment

Wastewater flows for the North Shore Region were divided into 3 categories: Residential, Commercial, and Institutional. Using the City's current wastewater design standards in conjunction with population estimates from the City Department of Planning and Permitting (DPP) and land acreage for existing and projected commercial and institutional parcels, the following future wastewater flow rates were calculated in Table ES-1:

Table ES-1. Summary of Estimated Wastewater Flowrates for 2030

Sub-district	Residential	Commercial	Institutional	Total (GPD)
Mokuleia	188,000	299,597	0	487,597
Waialua	271,440	361,979	37,600	671,019
Haleiwa	371,920	632,359	6,150	1,010,429
Kawailoa	388,720	103,029	0	491,749
Sunset/Pupukea	531,040	117,116	10,875	659,031
Region Total	1,751,120	1,514,080	54,625	3,319,825

The sub-districts were divided into logical service areas in a way that made them suitable for smaller, decentralized wastewater solutions, since that was the direction the CWG indicated would be best in maintaining the community's values and interests.

The technical team also researched background regional characteristic data for the North Shore that included climate, soils and geology, ground/surface/coastal water quality, and threatened species habitat to name a few.

Recommended Alternatives

The plan identified 10 conceptual alternatives to handling wastewater that range the full gamut of cost, size, and complexity. The technical team utilized the CWG input and technical assessment information to determine which of these conceptual alternatives where better suited for a given service area.

As a result of this process, a decentralized approach to wastewater management is proposed, which is a departure from traditional metropolitan regional wastewater management and past planning efforts. Decentralized wastewater management is defined as the collection, treatment and reuse or disposal of wastewater from individual homes, clusters of homes, isolated communities, industries, or institutional facilities, as well as portions of existing communities at or near the point of generation. Decentralized systems lend themselves to rural, spread-out, communities particularly where the geography makes it difficult to collect and treat at centralized facilities.

The plan identified alternatives for managing decentralized wastewater systems where entities like homeowner associations, private maintenance companies, established management districts or municipal agencies can be responsible for regulatory compliance, operation and maintenance.

For areas where water reuse or treatment improvements were deemed necessary, the following conceptual alternatives were recommended for the North Shore Region:

- Upgrade Cesspool Systems with Septic Tank Addition – for remote or isolated areas where sewering multiple parcels for treatment at a single plant would be unfeasible due to cost or space limitations.
- Neighborhood Cluster Systems with Injection Wells – for areas where sewering multiple parcels for treatment and disposal at a single plant is feasible, but opportunities for reuse are not.
- Neighborhood Cluster Systems with Reuse (irrigation) – for areas where sewering multiple parcels for treatment and disposal at a single plant is feasible, and opportunities for reuse are present.
- Upgrade Existing Private/Municipal Wastewater Treatment Systems – for areas that are currently served by treatment systems that may have the capacity to serve additional parcels or may have potential for upgrading to produce reclaimed water for reuse.
- Sewer Commercial/Residential Areas for Treatment/Water Reuse (small WWTFs) – for larger areas that generate higher volumes of wastewater that could be treated and reused for beneficial purposes.

The first step to moving forward with this plan would be to evaluate the various management entity options discussed in Section 5 and determine which options are feasible and appropriate for the specific service areas and treatment recommendations identified in Section 8. Establishment of a strong management entity is the backbone of a successful regional decentralized treatment program. Collaboration between the local community, City and State regulatory agencies, and potentially private companies will be required to determine the best framework for management and financing.

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Section 1
Introduction

This NSRWWAP is intended to update and revise previous wastewater planning efforts for the region. For the purposes of this project the North Shore Region encompasses areas within the North Shore Neighborhood Board (No.27) boundaries, from Kaena Point to Waialee Gulch. Previous wastewater plans include:

- Supplemental Waialua-Haleiwa Facilities Plan, June 1996
- Waialua-Haleiwa Facilities Plan, September 1987
- North Oahu Facility Plan, March 1985

None of the past plans were fully embraced by the community and, in general, recommendations from the plans have not been implemented. The NSRWWAP took a new approach towards wastewater planning for the community – the CWG.

1.1 The Core Working Group - A Foundation of Community Values

Wastewater issues have historically been a source of debate and frustration for North Shore residents. The majority of the region's wastewater is handled by individual onsite systems, namely cesspools that have experienced structural failure or have exceeded their capacity. In most cases, cesspools are banned from serving any building expansion or new construction due to their lack of adequate treatment and potential harm to the environment. The City's previous wastewater studies mentioned above sought to address the issue of aging cesspools and develop wastewater recommendations throughout the region. However, despite these previous efforts, the timing and method of wastewater treatment/improvements were never agreed to and finalized. The North Shore has a diverse population that embodies sometimes conflicting values and ideas for the region's future. The need for an engineered approach to address wastewater demand must be balanced by environmental concerns and an intense desire to protect the rural character of the region. Past planning efforts in the region have not produced tangible results, in large part because of a lack of support by key community interests.

Meeting these challenges was the basis for the community engagement process used in this NSRWWAP. The process was unique in terms of the level and role of community involvement and its focus on community values. Traditional infrastructure planning usually involves planners, engineers, and other experts assessing the conditions and needs in a given locale, and then developing technical solutions to meet a set of technical requirements. The community that is being planned for is often brought in late in the process after a proposed plan has been developed; and the form of community interaction usually involves one or more public meetings in which attendees are presented the proposed plan and asked for their reactions. While plans formulated in this manner may be sound from an engineering standpoint, they may not fully account for the priorities and special characteristics of an area and its residents.

For this NSRWWAP, the project team began with no preconceptions of outcomes in terms of recommended wastewater management alternatives for the North Shore region. Instead, a diverse representative CWG of community leaders was convened at the very beginning of the planning process. This CWG worked hand-in-hand with the project team through all planning stages. The intention behind this approach was to create a set of technically sound planning recommendations that reflects the North Shore community's values and priorities. The City ENV endorsed this high level of community-

engagement and included the CWG process in the original scope of work for the planning contract, which included two community engagement consultants on the project team.

Developing the CWG was done carefully over a three month period. In considering the CWG's representational needs, the project team sought to achieve a diversity of interests and geographic coverage, i.e., individuals who could interact and communicate with a broad range of constituencies in the North Shore region. The make-up of the CWG was intended to allow the project team to work with three segments of the community:

- **Individual stakeholders with unique interests** – This includes people who live, operate a business, or conduct a cultural or social activity in the region, landowners, and elected officials who represent the affected areas;
- **Organizations and agencies** – This includes the Neighborhood Board, various community associations, environmental and cultural organizations, and other organized groups; and
- **General public** – Both tax and rate payers are included in this group, as well as those who may have an interest in the project but are not connected to any organization.

The CWG was designed to have balanced representation from all three segments from both interest and geographic perspectives. CWG members were encouraged to discuss the project with their peers so that their participation reflected the interests of their groups.

Interviews were conducted with potential CWG members to ascertain their level of interest and to seek names of other possible participants. The expectations for participation -- the ability to support the interests of the North Shore region as a whole and willingness to do the work -- were shared with all candidates. This organizing effort resulted in 25 community representatives accepting invitations to serve as the NSRWWAP Core Working Group. With the CWG in place, the planning effort began.

The purpose of the community engagement portion of the NSRWWAP was to maximize the opportunity for community values to shape recommendations for regional wastewater treatment alternatives. The interaction between the CWG and the project team was critical to fulfilling this goal. The project team provided technical expertise and information to the CWG to support informed discussion and decision making. The results of the CWG's deliberations served as planning input and guidance for the project team to integrate into recommended alternatives. Tentative recommendations were then reviewed and vetted by the CWG. Significant efforts were made to ensure that the North Shore community's values and priorities, as represented by the CWG, flowed through to the recommended wastewater alternatives. These efforts included:

- Close coordination of the CWG process with the work of the technical team;
- Presenting an introductory description of wastewater technology and management practices (Wastewater 101) and the ongoing sharing of relevant information;
- Obtaining CWG consensus on guiding principles as an expression of community values that must be reflected in the plan's recommendations;
- Ensuring NSRWWAP consistency with the North Shore Sustainable Communities Plan;
- Review and consideration of the Kamehameha Schools North Shore Master Plan;
- Conducting a vision-based, scenario planning activity to gauge members' knowledge levels and to expand CWG thinking about possible wastewater management strategies;
- Using an objective comparison (pairwise comparison) exercise to allow the group to formulate a ranked set of criteria that were then used by the project team to evaluate wastewater treatment alternatives;
- CWG review of an array of possible wastewater strategies;

- CWG feedback on community data assembled by the project team, including current and projected land use and wastewater flows by sub-district;
- CWG input on potential wastewater reuse opportunities;
- Conducting a CWG review of proposed alternatives for each of the five North Shore sub-districts to gauge whether these proposals were appropriate from a community values perspective;
- Scheduling CWG meetings to best accommodate members' busy schedules;
- Obtaining CWG involvement in an information sharing/input gathering meeting for the North Shore community; and
- Seeking CWG consensus in support of the final version of the NSRWWAP.

The project team strove from the outset to develop a positive and mutually supportive working relationship with the CWG. The CWG responded with a willingness to engage that was impressive, to say the least. The result of their efforts is a unique wastewater alternatives plan that considers the values and needs of North Shore residents. This comprehensive plan is not a typical "one size fits all" infrastructure plan, but a menu of options tailored to complement each sub-district's environmental and cultural resources while meeting the demand for effective wastewater management. The members of the CWG are to be commended for their commitment of time, energy, knowledge, and wisdom to the process.

1.2 Report Contents

This report is organized into the following sections:

Section 1. Introduction provides a brief description of the project and its purpose.

Section 2. Community Engagement Process describes the teaming effort that this project implemented with active members of the North Shore community. This process was critical in guiding the recommended wastewater alternatives in a way that maintains the culture and reflects the values of the region.

Section 3. Assessment of Future Development and Population Growth analyzes the projected population growth and describes areas that are planned for future sustainable development as outlined in the North Shore Sustainable Communities Plan and other similar planning efforts.

Section 4. Evaluation of Wastewater Flows and the Wastewater Collection System provides an estimate of future wastewater flows for the region by sub-district and defines potential service areas for wastewater collection and treatment.

Section 5. Analysis of Wastewater Management Alternatives discusses options for managing wastewater systems that can be handled by public or private entities or potential public-private partnerships.

Section 6. Analysis of Wastewater Treatment Alternatives provides a "toolbox" of various treatment alternatives that can vary in size and complexity. Different technologies are covered in detail, including estimated costs and applicability to the North Shore.

Section 7. The Wastewater Planning Process explains the methodology used behind developing the various wastewater alternatives, including using technical tools such as geographic information system (GIS) and non-technical tools such as the CWG input.

Section 8. Recommended Alternatives describes the process for recommending various alternatives for each sub-district.

References include a list of all resources cited throughout this plan.

Appendices include supporting project data that were used in developing this plan, and are described as follows:

Appendix A - Review of Wastewater Facility Regulations, Standards and Guidelines summarizes the regulatory framework affecting wastewater systems in Hawaii.

Appendix B - North Shore Regional Characteristic Data includes background information for the North Shore for the following features:

- Climate
- Geology and Soils
- Groundwater
- Surface Water
- Coastal Water
- Threatened and Endangered Plants & Critical Habitats
- Air Quality and Noise
- Historic Sites
- Population & Socioeconomic Conditions

Appendix C - Water Quality and Water Quality Management Issues contains information on previous sampling efforts and locations of knows contamination on the North Shore.

Appendix D - Community Engagement Process Supporting Documentation includes summaries of all meetings and that took place and work products produced as part of the community effort for this plan. A list of the Core Working Group team and each member's affiliation is also presented.

Appendix E - Alternative Funding Sources includes a description of private and public funding sources that may be available for implementing wastewater solutions on the North Shore.

Section 2

Community Engagement Process

2.1 Introduction

The purpose of the NSRWWAP was to address concerns relating to the region's reliance on aging cesspools and to update ENV's wastewater plan for the region. Earlier plans for the region have not resulted in infrastructure projects actually being implemented, due in part to the lack of community support for previously proposed plans. This planning effort represented an opportunity to develop a plan more suited to the community and to set the stage for future improvements.

The NSRWWAP process was designed from the outset to include a major community engagement component to ensure that community values were incorporated in wastewater plans for the North Shore. The project therefore brought together a broadly-based CWG of community leaders, a project team comprised of Brown and Caldwell as the technical consultant including two community engagement sub consultants, and ongoing participation and support from ENV. The CWG's role was outlined in the first meeting as follows:

- Provide balanced representation of geographic areas, varied sectors, and community leadership
- Receive technical presentations and develop a common knowledge base
- Develop planning process elements, i.e., community values and guiding principles, weighted evaluation criteria, and input on alternatives
- Review and comment on recommendations, and
- Bring in the community's voice via members' networks and affiliations.

The planning process was a collaboration that drew on the CWG's knowledge of and sensitivity to the North Shore region's values, culture, and concerns; and the project team's expertise in wastewater infrastructure planning. The resulting plan addressed how the North Shore's wastewater needs should be handled over the next 10 to 15 years.

The overall goals of the CWG process were to:

- Create a transparent, permeable membrane between the Core Working Group and the project team to allow for a mutual exchange of information and input;
- Encourage recommendations to emerge from the process and not from a set of preconceived ideas or desired outcomes; and
- Generate sound and informed community input that would go far beyond what is possible from the usual public information and input gathering meetings.

The benefits of this approach were: a) a greater opportunity for community consensus to guide planning and decision making; b) an informed and educated community; and c) a better planning product in the form of recommendations that enjoy broad community support.

2.2 Organization of the Core Working Group

CWG diversity was essential to ensure that key stakeholders and interests from the North Shore community would be represented in the planning process. Broad representation was also important from the standpoint of gathering a wide range of perspectives and ideas. Community engagement

consultant Leland Chang conducted a round of 29 key informant interviews to gather information about wastewater-related issues and concerns on the North Shore and to identify potential participants for the CWG. A list of interviewees and notes from these interviews are included as Appendix D-1.

Representation on the CWG was sought from varied sectors, including: financial services, churches, social and community services, large landowners, environmental groups, business, young businesspersons who were taking over from their parents' generation, real estate, the Native Hawaiian community, agriculture, ocean recreation, seniors, education, civic and political leaders, and healthcare. An effort was also made to ensure a balance of interests and geographic coverage. Participants needed to be able to keep the best interests of the whole North Shore community in mind; provide links to vital networks and constituents; and invest the time and energy needed to attend meetings and complete assignments. Twenty-nine community members accepted ENV's invitation to participate on the NSRWWAP CWG.

2.3 Major NSRWWAP Process Elements

The overall NSRWWAP planning framework involved coordinating and integrating a series of community engagement activities and objectives with the wastewater infrastructure planning process employed by the Brown and Caldwell technical team. Interactions were designed to enable the technical team to share information and expertise to support informed discussion and decision making by the CWG; and to elicit CWG input on community values, issues, and priorities that could be used to guide each planning product developed by the team. Table 2-1 illustrates the relationship between CWG meeting objectives and technical team planning responsibilities.

Table 2-1. CWG Meeting & Technical Team Planning Relationship

CWG Meeting – Objectives	Technical Team Objectives
CWG I – orientation to WW planning and the community engagement process; mission and guiding principles; introduction to scenario planning	
CWG II – continue orientation; refine guiding principles; education; preliminary scenarios development; homework questionnaire	Wastewater 101 (general wastewater treatment fundamentals); existing conditions (quantity, quality, location, topography)
CWG III – strategies and alternatives brainstormed for each scenario	Projected conditions - future needs and design capacity
CWG IV – re-orientation following 18-month break; recent events affecting planning; update scenario planning; initial discussion of evaluation criteria	Regional data and other related planning information; define CWG-identified criteria
CWG V – pairwise comparison activity to prioritize evaluation criteria	Regional data and other related planning information; conceptual alternatives (toolbox);
CWG VI – input and reactions to conceptual alternatives; input on preliminary Haleiwa recommendations	Weigh and rank alternatives; preliminary recommended alternatives for Haleiwa sub-district
CWG VII – input and reactions to preliminary sub-district recommendations	Review of alternatives selection process (how community values flow into selection of alternatives); recommended alternatives for remaining four regional sub-districts
CWG VIII – continue review of recommended alternatives; future community interaction with City and County; implementation priorities	
Public Meeting to present recommendations and obtain feedback	Refine alternatives; phasing of implementation; financing considerations
CWG IX – Review final report; closing comments from members and team	Finalize report

2.3.1 Education and Information

There was a significant and ongoing investment in providing the CWG with sufficient technical information and understanding of the complex issues surrounding wastewater management

approaches, regulatory requirements, regional planning data, and alternative technologies. This heavy emphasis on education was aimed at developing a well informed CWG that would be able to fully engage in discussion, decision making, and the public's/community's understanding of issues and recommendations. "Wastewater 101" (WW 101) topics that were covered included:

I. Science of Wastewater Treatment
   A. What is Wastewater
      i. Gray water – water from kitchen, laundry, and shower areas
      ii. Black water – water from toilet flushes
      iii. Also includes commercial sources like restaurants
      iv. It does not include storm water or outside wash water
   B. Why Treat Wastewater
      i. Protect public health and the environment (near shore waters)
      ii. Protect drinking water quality
      iii. Protect groundwater quality
      iv. Make beneficial reuse of water
      v. Avoid surface water pollution
   C. Harmful Constituents in Wastewater
      i. Pathogens
      ii. Toxics
      iii. Solids
      iv. Organics
      v. Nutrients
   D. Disposal Methods
      i. Cesspools
      ii. Septic tanks and leach fields
      iii. Injection wells
      iv. Below ground reuse
      v. Above ground reuse
      vi. Ocean or lake outfall
   E. Regulatory Framework
      i. U.S. EPA – primary authority over nation's water programs
      ii. Hawaii State Dept. of Health – local entity responsible for regulating wastewater treatment, disposal, and reuse
      iii. City & County of Honolulu – owns, operates, and maintains municipal wastewater facilities within the County
II. What Wastewater Systems Exist on the North Shore
   A. Study in 1992 estimated 3,152 cesspools in the North Shore, with about 40% failing
   B. Since then, some have upgraded to septic tank – leach field systems
   C. 31 private wastewater treatment systems on the North Shore
      i. 19 in Waialua
      ii. 6 in Haleiwa
      iii. 6 in Sunset/Pupukea

D. One City and County treatment facility, the Paalaa Kai WWTP – constructed in 1980, serving 314 homes

III. Alternative Technologies
   A. Collection Systems
      i. Conventional sewers
      ii. Small diameter collection systems
      iii. Pressure and vacuum sewers
   B. Treatment Technologies
      i. Gray water treatment systems
      ii. Septic tanks
      iii. Textile biofilters
      iv. Membrane bioreactors (MBR)
      v. Small community systems
      vi. Example of decentralized system – Stonehurst Wastewater System (Martinez, CA)
      vii. Natural systems
         1. ponds/lagoons
         2. constructed wetlands
         3. soil adsorption systems
         4. soil aquifer treatment
IV. Management Approaches
   A. Existing Systems Can be Sustained by Good, Consistent Management
   B. Homeowner Awareness and Education
   C. Onsite Management Districts
   D. County Service Areas
   E. EPA Management Models

2.3.2 Ground Rules

At its first meeting on October 9, 2007, the CWG agreed to abide by the following ground rules to ensure a fair, transparent, and efficient process:

- The group is advisory to the project team.
- There should be a collaborative and collegial interaction between the CWG and the project team. Consensus will be used as much as possible. The consensus question will not be, "Is everyone happy with the decision?", but rather, "Is there anyone who can't live with it?"
- Neutral facilitation - Leland's role is to facilitate productive interaction; not to take sides or advocate for any position on an issue.
- The public is welcome to attend CWG meetings. CWG members will have a chance to discuss an item until all have had a chance to contribute; then those in the audience who wish to comment will be recognized.
- Meeting summaries will be provided to serve as a record of CWG deliberations.
- Efforts will be made to bring absent members up to speed. However, discussions held at a meeting will not be repeated at subsequent meetings.
- There should be open sharing of information. The project team will provide all CWG members with the same information at the same time. Leland requested that CWG members also adopt

this practice when they want to share information with other CWG members. There were no objections to this.

- Meetings will start and end on time.

2.3.3 Guiding Principles

A CWG-approved statement of guiding principles reflecting the community's values was developed. CWG members were asked to express what they cherished most about the North Shore at the first CWG meeting. This input, along with input from the key informant interviews, was shaped into a draft statement that was discussed, revised, and adopted with the consensus of the CWG at its second meeting.

North Shore Regional Wastewater Alternatives Plan Guiding Principles
Final - November 21, 2007

The following are statements of principles that were used as guidance in the development of the NSRWWAP. These statements describe qualities of the plan that would best serve the interests of the people and communities of the North Shore region.

The North Shore Regional Wastewater Alternatives Plan:

A. Protects the health and safety of people living in and visiting the North Shore region;

B. Provides for the protection of the North Shore environment, including the land, air, fresh water, and ocean;

C. Promotes options for increasing conservation, reclamation, and reuse of wastewater;

D. Remains consistent with and supports the values of the North Shore Sustainable Communities Plan (NSSCP), including its policies on growth and infrastructure; is aligned with sub-regional growth as defined in the Community Development Plans in the NSSCP; and is reconciled with the latest approved revision of the NSSCP signed into law on May 3, 2011;

E. Follows a technically sound process and considers the full range of potentially appropriate alternatives for the collection, treatment, reuse, and disposal of wastewater in the region;

F. Meets or exceeds regulatory requirements pertaining to wastewater collection, treatment, reuse, and disposal;

G. Incorporates a transparent, open, and inclusive process that seeks full community participation;

H. Demonstrates sensitivity to the particular needs and conditions existing in the various communities and sub-regions within the North Shore region;

I. Considers both the economic feasibility of the recommended wastewater alternatives and the affordability of recommended alternatives to end users; and is sensitive to affordability for various groups, including senior citizens and people with low income (low-income being defined as up to 140% of median household income); and

J. Provides a strong foundation for implementation within a reasonable cost and timeframe; and explores options and opportunities for financing of recommended alternatives.

2.3.4 CWG Homework

Homework was typically assigned at the end of CWG meetings, usually involving preparation for the next session. Following CWG II, members were asked to comment on five substantive and process-related topics:

- The quality of WW 101 and additional information desired
- Three most important factors in wastewater planning for the NS region

- Observations of failing or faulty wastewater infrastructure on the North Shore
- Geographic areas in greatest need of upgrades to wastewater infrastructure
- Motivational factors that would make North Shore residents and businesses want to upgrade their current method of wastewater treatment.

Members' comments, which guided project team thinking regarding special need areas and other implementation issues, are provided in Appendix D-2.

2.3.5 Scenario Planning and Strategies Brainstorm

Scenario planning is a method used by public and private organizations to visualize various future possibilities and plan ways to achieve these futures. Typical planning efforts are based on forecasts, whereby futures are extrapolated based on current conditions. In this project, "backcasting" was used whereby participants started with a future and discussed how these futures would be achieved. Participants were not asked to determine whether these scenarios are desirable or achievable. Rather, they were asked to think about 1) how these scenarios were achieved and, 2) what were problems along the way that presented challenges to the community and the City.

Scenario planning was used to both stretch the imaginations of CWG members as to what might be possible and desirable wastewater futures and actions; and to assess the group's level of understanding of the management and technical aspects of developing wastewater approaches and infrastructure. The CWG's input was used to create a series of four different scenarios of the North Shore's desired wastewater management future. Out of this input, the following four scenarios were created:

1. Ahupua`a Vision

In 2025, the North Shore Wastewater system embodies the concepts and principles of the ahupua`a:

- A Native Hawaiian system of land division and resource management based on self-contained and geographically bounded areas from the mountain to the sea
- Full community responsibility and involvement in protecting the resources in the area and using resources in a sustainable way
- Rules for proper behavior regarding the use and protection of resources (kapu)
- Living in harmony with nature
- Highest value on protection of water resources as essential to life
- A holistic view of resource management in the area, of which wastewater management is an integral part
- The system serves the area's ahupua`a in its regional distribution of services and facilities and environmentally sustainable practices.

2. Maximum Water Reclamation

By 2025, reclaimed water is commonly used to irrigate and sustain diversified agriculture, landscaping of public and private property, and industrial uses. Further, the community is actively exploring ways to increase the use of reclaimed water.

3. Minimum Financial Burden on Homeowners and Businesses

By 2025, the necessary upgrades and improvements to the North Shore Wastewater System were achieved with the least possible amount of financial hardship on North Shore homeowners and businesses. For comparison purposes, the typical residential sewer fee is about $71 per month plus $3.00 per 1,000 gallons over the base 2,000 gallon per month allowance (July 2011 rates). The cost of

properly maintaining a residential cesspool is estimated at $100 per year (Gonzales, Ed – Gecko Enterprises).

4. Zero Tolerance for Negative Environmental Impacts

In 2025, The North Shore's wastewater systems, facilities and equipment do not contribute in any way to the degradation of the area's land, waters, and air; and meet all related Federal, State and County regulations. Further, the community is strongly encouraged to protect and restore the environment in matters related to the wastewater system.

Working in small groups, CWG members were asked to brainstorm as many strategies as possible to achieve each of the four scenarios. The resulting strategies and actions to achieve each scenario would: a) indicate the degree of community support for possible vision and goal statements; b) suggest strategies and implementing actions that can be explored in greater depth for possible inclusion in the plan; and c) raise questions and issues that need to be addressed in the planning process. Questions used to guide the brainstorming activity included:

- What are all the things that could be done to move the North Shore closer to this scenario?
- What are possible strategies to achieve success?
- For the strategies you have identified, what are specific actions to carry out those strategies?
- Are there partnerships that could help bring about this scenario?
- How could other County, State of Federal agencies help to make this scenario possible?
- How can the private sector be engaged?
- What technological solutions could be used?
- Are there general approaches to take in developing necessary infrastructure?

The results of the strategy brainstorm are provided in Appendix D-3. The input allowed for categorization of ideas and suggestions into four major areas: community education; incentives and disincentives; regulations, mandates, monitoring and enforcement; and technologies, systems, and alternative approaches and strategies.

2.3.6 The NSRWWAP Process Returns from Hiatus

Due to funding constraints, the NSRWWAP process was suspended for 18 months beginning in March, 2008. The project was to be funded jointly by the City and the State. The City funded the first half of the project but at the half-way point the State retracted its funding (in part, due to budget issues). The City then had to obtain funding on their own to complete the project. Following ENV's successful effort to secure supplemental project funding, CWG members were informed by letter in late September, 2009 that the planning process would be restarted.

Attempts were made to contact all CWG members. A solid majority were willing to continue their participation. Continuing members included: Marianne Abrigo; Laura Figueira; Judy Fomin; Kalani Fronda; Ed Gonzales; John Hirota; Susan Lau; Joe Lazar; Bob Leinau; Michael Lyons; Susan Matsushima; Reed Matsuura; Antya Miller; Kathleen Pahinui; Edith Ramiscal; Randy Rarick; Warren Scoville; Mark Takemoto; and Ron Valenciana.

Declining were: Jeffrey Alameida; Cathy Aoki; Diane Anderson; T. Dilcher; Josh Heimowitz; and Marianita Lopez. Gerry Meade and Jimmy Awai, had passed away during their CWG tenure. Kalani Fronda from Kamehameha Schools continued to represent Native Hawaiian interests. Mark Takemoto (formerly from Castle and Cooke) remained on the CWG as a representative of Pioneer Hi-Bred; and Garrett Matsunami joined the CWG representing Castle and Cooke.

The 18-month break in the process posed a challenge for regaining momentum with the CWG. Also, during the layoff, the state's overall economy had taken a major turn for the worse, which could have had an effect on the group's thinking and priorities regarding future wastewater plans. Definitely cost was a key concern. CWG IV was the point of departure for the second phase of the planning process, and the meeting was used to apprise the CWG of what had been done to date, the current status of the project, and plans for the remainder of the planning process. A reorientation summary (Appendix D-4) and supporting materials were distributed and discussed. The group was asked to provide input on any developments during the 18-month hiatus that might have a bearing on wastewater planning for the region. Also at this meeting, the CWG revisited the scenario planning activity from CWG III and provided additional comments and suggestions. It was both gratifying and a relief to find that the interest and energy level of CWG members had survived the hiatus fully intact.

2.3.7 Development and Ranking of Evaluation Criteria

At its fourth meeting, the CWG identified a range of criteria that could be used to evaluate the efficacy and desirability of wastewater management alternatives that could potentially be deployed in the region. Prior to CWG V, the technical team refined the suggested criteria by providing definitions. The resulting criteria list is shown below.

Table 2-2. Evaluation Criteria and Definitions

Cost of system(s)	The cost to design and construct new treatment facilities
Minimum negative environmental impact	The type and extent of harm to the environment or ecology are minimized
Simplicity of design	A facility's design minimizes operations and maintenance requirements
Wastewater reuse	A facility's wastewater recycling potential is maximized
Visual impact	A facility's visual compatibility with surrounding properties is maximized
Facility footprint	The land required for facility implementation
Treatment capacity	The maximum amount of wastewater that can be handled by a facility
Green design	Incorporating specific design features into a facility to increase sustainability and energy efficiency
Expandability	The ability to increase a facility's treatment capacity with minimal time and cost
Life expectancy	The useful life of a facility
Soil compatibility (percolation)	The soil's ability to accommodate wastewater effluent disposal
Employment	The labor required to operate and maintain facilities
Decentralized systems	Smaller facilities tailored to localized service areas throughout the region
Odor control	Design, operations and maintenance features that minimize odors
Compliance	Enforcement of applicable regulatory standards
Funding opportunities	Eligibility for a variety of funding sources that would reduce financial burden on the City and ratepayers
Rate impacts	The cost impact to sewer rate payers to cover wastewater systems operations, maintenance and CIP costs
Tax incentives	City programs to encourage residents to upgrade their wastewater systems
Cost to tax payers	Non-sewer fee, public financing of wastewater system design and construction

A pairwise comparison activity was introduced at CWG V. This technique allows a group of individuals to develop a collective ranking of multiple options by comparing each option to the remaining options and stating a preference. Thus, subjective criteria can be compared and weighted, resulting in an objective rank for each of the criteria. The group was briefed on the pairwise exercise and given spreadsheets to

use in completing the exercise. The completed spreadsheets were tabulated with the results shown below.

Table 2-3. Final Pairwise Evaluation Criteria Comparison Results (in ranked order according to average scores)

64.6	Compliance
62.1	Odor control
61.5	Soil compatibility (percolation)
59.3	Life expectancy
58.9	Treatment capacity
57.7	Minimum negative environmental impact
56.5	Wastewater reuse
55.2	Decentralized systems
54.9	Cost to tax payers
53.7	Rate impacts
52.5	Expandability
50.8	Tax incentives
49.9	Cost of system(s)
49.7	Funding opportunities
49.5	Green design
49.2	Simplicity of design
47.4	Facility footprint
46.2	Visual impact
45.5	Employment

In reviewing these results with the CWG, one member commented that this exercise involved a certain amount of subjectivity regarding the relative importance of the criteria when compared to each other. The project team noted that pairwise is intended to assist groups in ranking preferences, which fall squarely into the realm of the subjective. The team further responded however, that the pairwise results serve as a guide to assist in the development of recommended alternatives, which will be reviewed by the CWG. The CWG would be able to comment on the acceptability of the recommended alternatives; and consensus support for the recommendations would be an indicator that the overall process had been sound.

2.3.8 Ranking of Wastewater Alternatives

Pairwise comparison provides a method for integrating the criteria ranking scores with those of an alternatives rating exercise to produce a prioritized inventory of alternatives. The technical team rated each of ten wastewater management alternatives (discussed in Sections 5 and 6) in terms of how well they met each criterion. Each alternative received a score of 1, 2, or 3, depending on its ability to satisfy the various criteria. These scores were then multiplied by each criterion's weighted average; and the results were summed to produce a total score for each of the ten alternatives. This method of evaluating the wastewater management alternatives according to the weighted criteria produced the following set of ranked alternatives.

Ranked Alternatives Based on Pairwise Evaluation Using Weighted Criteria

1. **Alternative 2:** Form Onsite Maintenance District (described in Section 5)
2. **Alternative 3:** Upgrade Onsite Systems with Gray Water Separation
3. **Alternative 6:** Neighborhood Cluster Systems with Reuse (Irrigation)
4. **Alternative 8:** Sewer Commercial Areas for Treatment/Water Reuse (small wastewater treatment facilities [WWTFs])
5. **Alternative 5:** Neighborhood Cluster Systems with Injection Wells
6. **Alternative 9:** Sewer Each of the 5 Areas of North Shore for Treatment and Reuse/Disposal (sub-regional WWTFs)
7. **Alternative 4:** Upgrade Cesspool Systems with Septic Tank Addition
8. **Alternative 10:** Sewer the Entire North Shore Region for Treatment and Reuse/Disposal (Regional WWTF)
9. **Alternative 7:** Upgrade Existing Private/Commercial Wastewater (WW) Treatment Systems
10. **Alternative 1:** No Action

CWG Review of Recommended Alternatives for the Five North Shore Sub-districts

CWG members received and discussed the technical team's recommended alternatives for the Haleiwa sub-district at CWG VI. At CWG VII, the CWG reviewed the recommended alternatives for the Mokuleia, Sunset/Pupukea, Kawailoa, and Waialua sub-districts. The CWG's feedback can be found in the summaries of these two meetings. How these recommendations were developed is discussed in Section 7 of this report. From a community engagement standpoint, the CWG expressed a high level of satisfaction with the integration of community input, ranked alternatives, and regional data (including projected future wastewater needs) that produced the recommended alternatives for each sub-district.

This plan was finalized upon receiving comments on the draft report after CWG VII and the Community Meeting discussed in Section 2.3.9. CWG VIII was anticipated as a project closeout meeting to present the final plan to the CWG and to discuss post-project next steps.

2.3.9 NSRWWAP Community Meeting

A community meeting was held on Wednesday, August 31, 2011 at the Waialua Community Association in Haleiwa. This meeting allowed the project team to share the recommendations that had been developed for each of the region's five sub-districts with the broader North Shore community; and to solicit questions and comments about the draft plan.

Presenters included Peter Ono and Darin Izon from Brown and Caldwell; and Tim Houghton, representing the City's Department of Environmental Services. Project community engagement consultant Leland Chang served as facilitator. Fifteen community members participated in the meeting, which was announced at the July Neighborhood Board 27 meeting and noticed via an article and an advertisement in the North Shore News. Seven of those attending were members of the CWG.

Discussion included topics relating to: the types of population data used; the pros and cons of a centralized system; consideration for private providers of restroom facilities to the public; water quality standards and levels of treatment; chemicals of concern relating to septic systems; and how implementation of the plan is envisioned to occur. Summary notes from the discussion appear in Appendix D. In general, the presentation and the draft plan were well received, with people expressing appreciation for the approach and the direction taken in the plan.

The following sections discuss the technical approach to the NSRWWAP process, which culminate with the plan's recommendations for wastewater alternatives.

Section 3

Assessment of Future Development and Population Growth

This section discusses projected growth and development for the North Shore Region through the year 2030. Each sub-district within the North Shore region was evaluated for current and future land use, population, and planned development.

3.1 Population Projections

For this study, the 2007 Socioeconomic Projections for 2000-2035 obtained from the City's DPP (DPP, 2007) was used to develop future population estimates for the North Shore Region. Designated areas of projected development for each sub-district were taken from DPP's latest revision to the 2000 North Shore Sustainable Communities Plan which was signed into law on May 3, 2011. Other planning efforts considered in this plan that pertain to future development within the region include DPP's 2005 Waialua Town Master Plan and the Kamehameha Schools 2011 North Shore Plan.

It should be noted that the NSRWWAP does not attempt to determine areas of potential future development for the region. Rather, the objective is to estimate future wastewater generation and develop feasible alternatives to provide effective wastewater treatment for these estimates, using the projected, planned growth that has already been established through the planning documents mentioned above.

Table 3-1 shows the residential population estimates through the year 2030 for the North Shore Region by sub-district. The sub-districts of Mokuleia, Waialua, and Kawailoa are actually forecasted to decrease in population during the 30-year study period shown. Only the Haleiwa and Sunset Beach/Pupukea sub-districts are expected to increase in population. This is partly due to the community's vision of keeping the region rural in nature with the majority of available land being preserved for agriculture and natural resources. The phrase "Keep the country, country" has represented the region's philosophy ever since the Waialua Sugar Company was threatened with closure throughout the 1990's (and was subsequently closed in 1996) and symbolizes the region's stance on development in the area. DPP maintains the North Shore Region Rural Boundary as shown in Figure 3-1. Lands mauka of this line are planned for agriculture and other open space resources, thereby discouraging development from occurring outside of these areas.

Table 3-1. North Shore Region Residential Population Projections

Sub-District	Actual Population	Projected Population					
	2000	2005	2010	2015	2020	2025	2030
Mokuleia	2,345	2,350	2,340	2,338	2,329	2,338	2,328
Waialua	3,386	3,393	3,354	3,329	3,298	3,288	3,267
Haleiwa	4,366	4,376	4,441	4,499	4,551	4,625	4,649
Kawailoa	3,930	3,939	3,915	3,907	3,891	3,899	3,888
Sunset Beach/Pupukea	4,353	4,363	4,976	5,505	5,993	6,329	6,638
North Shore Region Total	18,380	18,421	19,026	19,578	20,062	20,479	20,770

Source: DPP Socioeconomic Projections, Nov. 2007

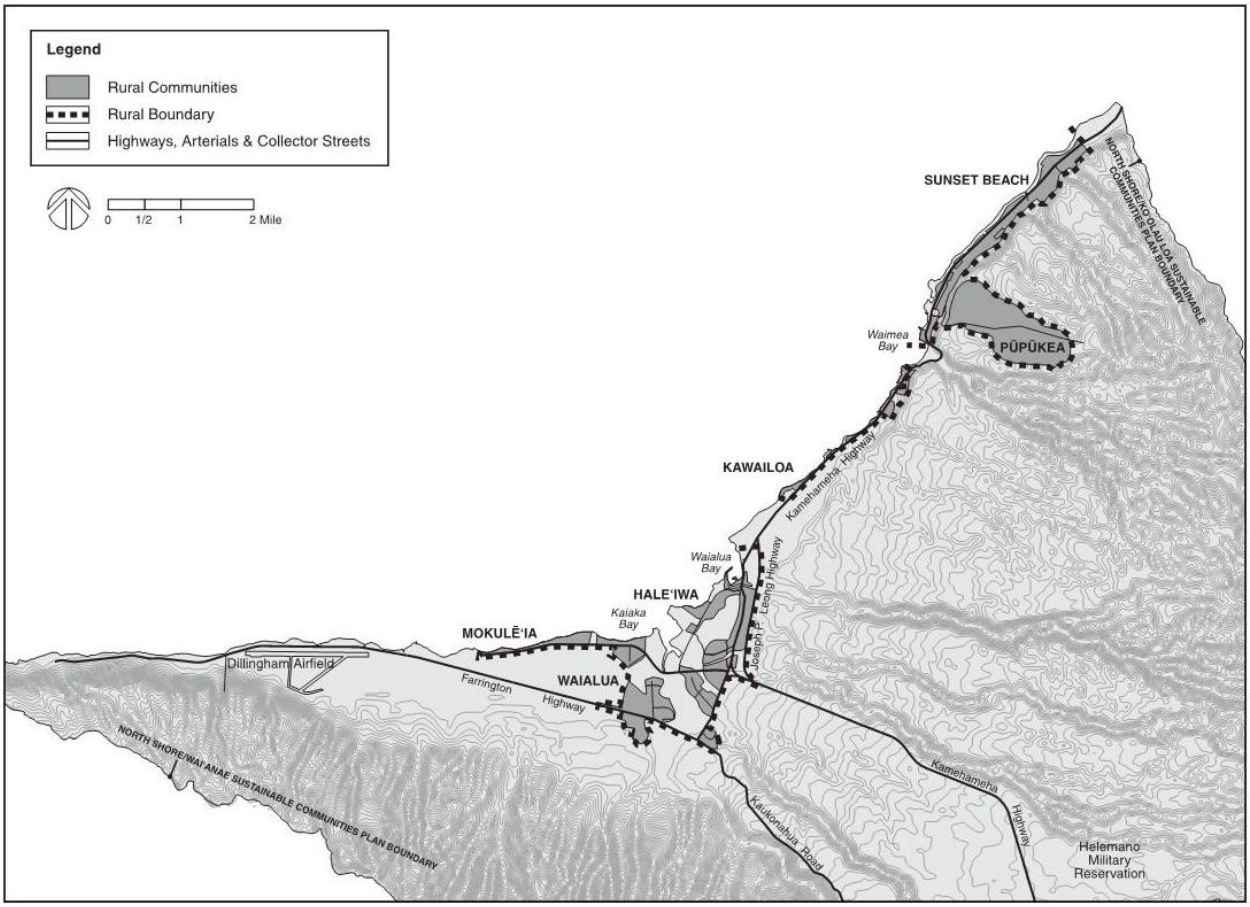

Figure 3-1. North Shore Region Rural Boundary

Source: North Shore Sustainable Communities Plan, May 2011.

3.2 North Shore Sub-Districts

The sub-district boundaries used in the NSRWWAP correspond with census tract and neighborhood board boundaries. Each North Shore sub-district is discussed in detail below.

3.2.1 Mokuleia Sub-District

The Mokuleia sub-district boundaries are shown in Figure 3-2. This sub-district contains the smallest population of the five sub-districts that make up the North Shore region. According to the Socioeconomic Projections, the estimated number of households in the Mokuleia sub-district for the year 2010 was 891, with an estimated resident population of 2,340. For the year 2030, the projected population is 2,328 with 930 total households.

There is a small amount of commercial activity in Mokuleia, including hang glider and skydiving attractions at Dillingham Airfield, organized group events at the YMCA Camp Erdman and the Episcopal Church's Camp Mokuleia, the Hawaii Polo Club and School, Mokuleia Landscape & Nursery, and other agricultural enterprises.

The vast majority of land, roughly 7,800 acres, within the Mokuleia sub-district is made up of the Waianae mountain range, and the steep slopes coupled with restrictive land zoning protect much of the area from development. Other large portions of Mokuleia are made up of agricultural land owned by Oahu's large agricultural land owners including Castle & Cooke, Dole Foods, and Pioneer Hi-bred. It should also be noted that most of the land in this sub-district falls outside (mauka) of the rural boundary. Therefore, the expansion and development potential for this area is very limited, and planning efforts have worked to keep the Mokuleia sub-district in its present form.

3.2.2 Waialua Sub-District

The Waialua sub-district boundaries are shown in Figure 3-3. This sub-district contains the second smallest population within the North Shore region. According to the DPP Socioeconomic Projections, the estimated number of households in the Waialua sub-district for the year 2010 was 1,035, with an estimated resident population of 3,354. For the year 2030, the projected population is 3,267 with 1,058 total households.

For much of the 1900's, Waialua was the center of the region's sugar industry. At its peak in the mid-1970's the Waialua Sugar Co. produced approximately 80,000 tons of sugar per year on 12,000 acres (CTAHR 1999). However, the years leading up to the closing of sugar operations in 1996 were characterized by the loss of thousands of jobs in the region. The end of large-scale sugar production on the North Shore had a direct influence on the population numbers presented in Table 3-1.

Since then, planning efforts have been conducted to guide the direction of Waialua's future. The latest of these efforts is the 2005 Waialua Town Master Plan developed by DPP, Group 70 International, and Friends for Waialua. Conceptual ideas for revitalizing the town include renovating the existing town center, expanding small business opportunities at the old sugar mill site, and developing small clusters of infill residential housing adjacent to existing residential locations to coincide with the additional jobs that future new business ventures could create. The plan strictly complies with the rural boundary shown in Figure 3-1, and proposes that any future growth be confined to locations immediately adjacent to existing residential or commercial areas. The goal is to maintain Waialua as a small, country town with a limited amount of commercial activity revolving around its town center.

Figure 3-2. Mokuleia Sub-District Boundary

Source: State of Hawaii GIS System.

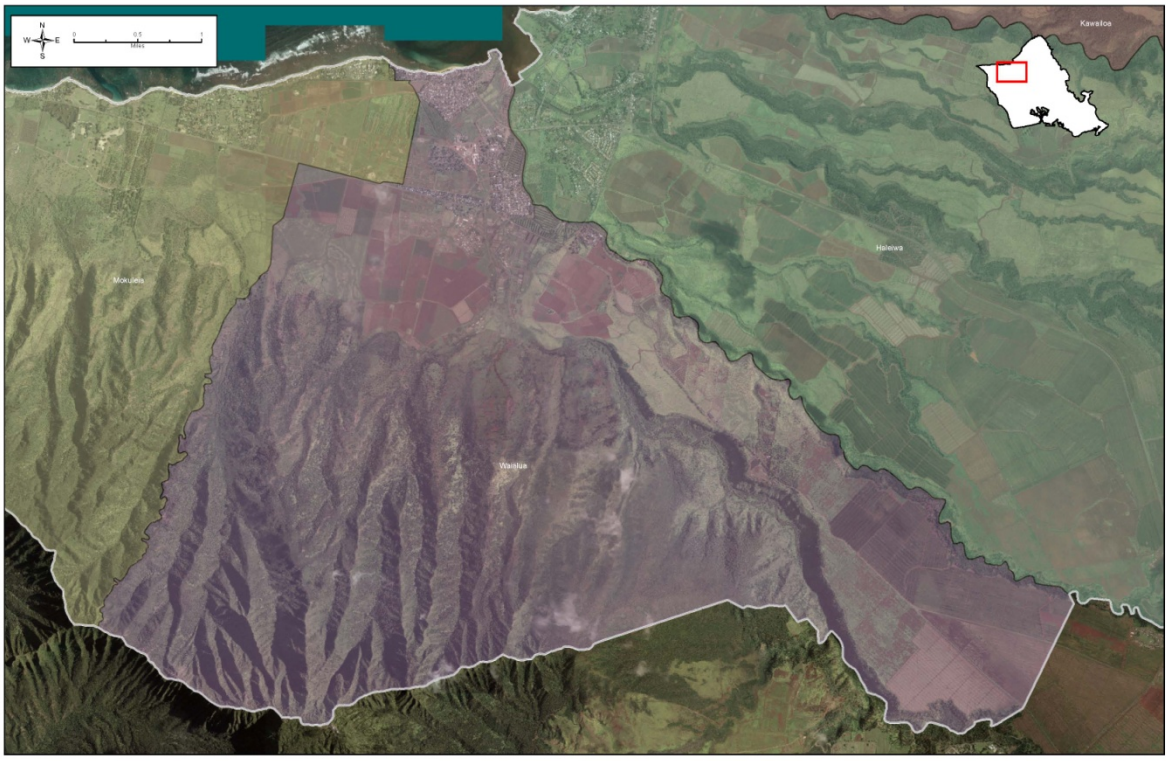

Figure 3-3. Waialua Sub-District Boundary

Source: State of Hawaii GIS System.

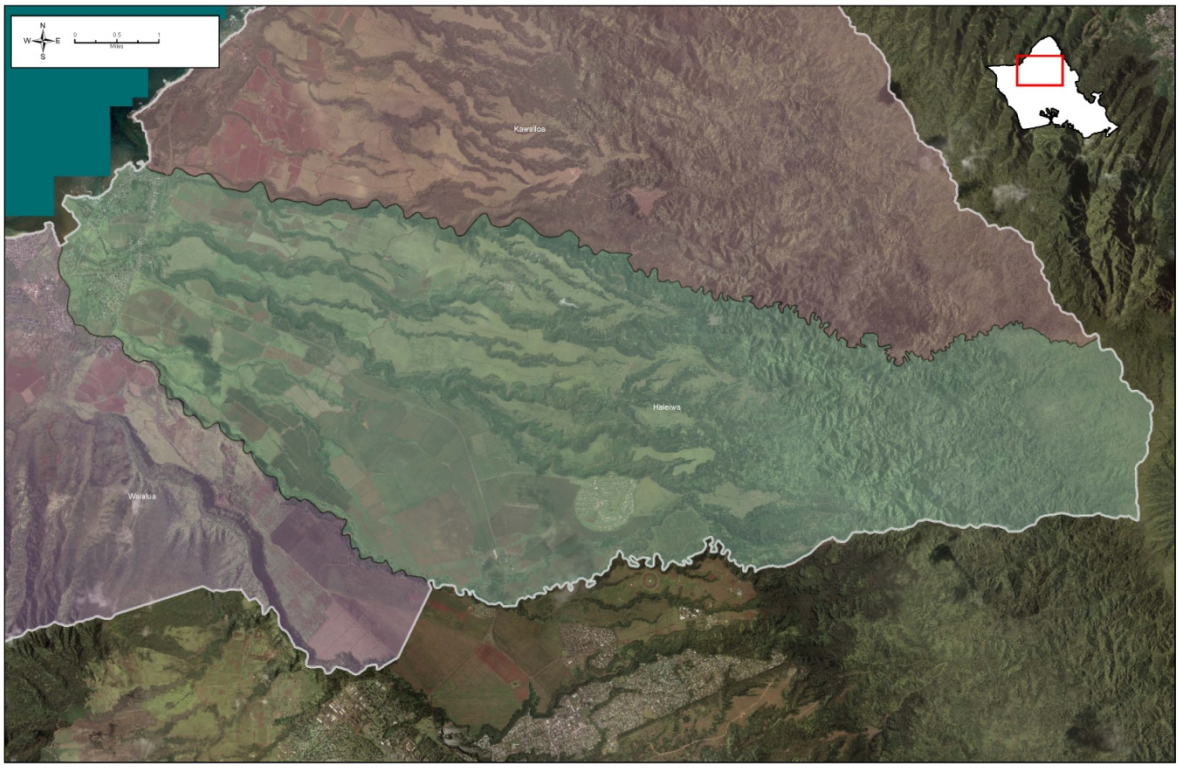

Figure 3-4. Haleiwa Sub-District Boundary

Source: State of Hawaii GIS System.

3.2.3 Haleiwa Sub-District

The Haleiwa sub-district boundaries are shown in Figure 3-4. Haleiwa is known as the "Gateway to the North Shore." There is a diverse mix of residential and commercial development along with schools, public parks, and agriculture. Residential population projections for the Haleiwa sub-district estimate 1,331 households and 4,441 people in 2010. These numbers increase to 1,460 households and 4,649 people in 2030

Since the closing of sugar operations, Haleiwa Town has sought to revitalize itself by improving infrastructure and planning for sustainable growth while keeping the original country town charm that existed during the days of the sugar plantations. The outdoor recreation industry – particularly surfing – brings millions of visitors through the North Shore every year, and current planning efforts aim to capture and increase revenue coming into the region while implementing controlled, smart growth guided by the NSSCP.

Kamehameha Schools has recently completed its North Shore Plan which involves the future use of some 26,000 acres of land that Kamehameha Schools owns within the North Shore region. Figure 3-5 shows conceptual plans for Haleiwa Town along Kamehameha Highway.

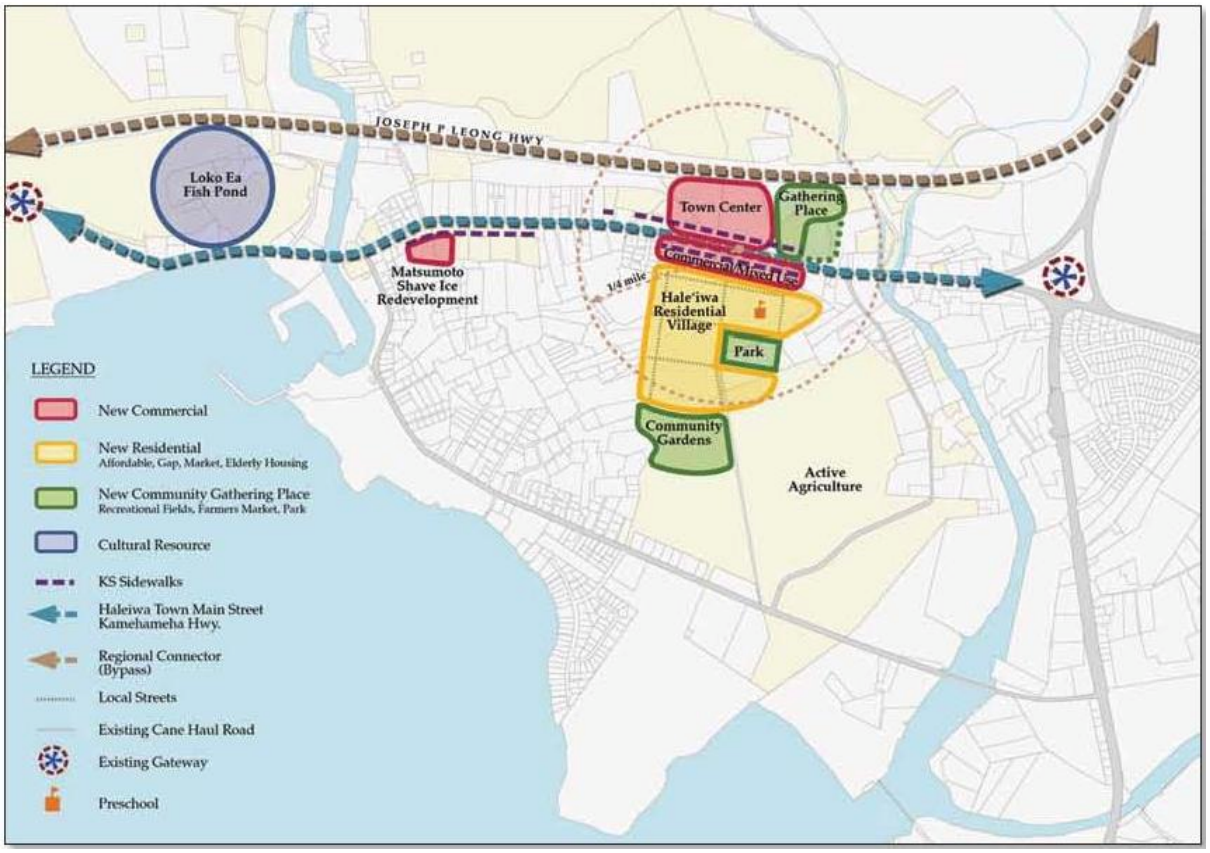

Figure 3-5. Kamehameha Schools' North Shore Plan in Haleiwa Town

Source: IMUA Magazine, Fall 2008.

Kamehameha Schools' North Shore Plan includes about 350 affordable and gap-group residential housing units, the addition of 50,000 to 100,000 square feet of commercial space at the Haleiwa Town Center, and renovation of the existing Matsumoto Shave Ice building which includes an additional 10,000 square feet of retail space.

3.2.4 Kawailoa Sub-District

The Kawailoa sub-district boundaries are shown in Figure 3-6. This sub-district extends from the Anahulu Stream in Haleiwa Town to the Waimea Stream at Waimea Bay. Residential and commercial developments are confined to a narrow band along the coastline due to the steep topography formed by the Koolau Mountain Range. Residential population projections for the Kawailoa sub-district estimate 1,307 households and 3,915 people in 2010. For 2030, the estimated number of households increases to 1,366 while the population decreases to 3,888.

Kamehameha Schools' North Shore Plan includes developing roughly 40 homes on 14 acres in the existing Papailoa subdivision, and approximately 70 homes on 32 acres in the Kapaeloa area near Waimea Bay. According to discussions with DPP and in accordance with the NSSCP updates and revisions adopted into law on May 3, 2011, the population estimates in Table 3-1 do consider the build out of these areas.

3.2.5 Pupukea/Sunset Beach Sub-District

The Pupukea/Sunset Beach sub-district boundaries are shown in Figure 3-7. This sub-district extends from the Waimea Stream at Waimea Bay to an area just north of the Crawford Senior Home at Waialee. Similar to the Kawailoa sub-district, the topography limits most residential and commercial development

to areas along the coastline. The exception is the residential development along Pupukea Road which navigates the steep terrain and climbs over 750 feet between the lower coastal area at Kamehameha Hwy and the upper reaches of the development at Sunset Ranch. Residential population projections for this sub-district estimate 1,816 households and 4,976 people in 2010. For 2030, these numbers increase to 2,424 households and 6,638 people.

The University of Hawaii once used the Waialee Livestock Research Farm as part of its program within the College of Tropical Agriculture and Human Resources (CTAHR). However, it has ended its operations at the site with the intent of moving the program to a location on the Windward side of Oahu. Ownership of the Waialee Livestock land was transferred to the State Department of Land and Natural Resources. It is not yet known what the State has planned for these lands. Section 7 will discuss the potential for a portion of this area to serve as a treatment location for wastewater generated in the Sunset Beach area.

Figure 3-6. Kawailoa Sub-District Boundary

Source: State of Hawaii GIS System.

Figure 3-7. Pupukea/Sunset Beach Sub-District Boundary

Source: State of Hawaii GIS System.

Section 4

Evaluation of Wastewater Flows and the Wastewater Collection System

This section discusses the process used to estimate current and future wastewater flows for the North Shore region. It also presents the methodology of defining logical wastewater service area boundaries within each sub-district that were used to develop alternatives for collection, treatment and disposal/reuse.

4.1 Basis of Flow Projections

To develop the estimated average wastewater flow from each area, the City's – Design Standards of the Department of Wastewater Management, Volume 1 (July 1993) were used to first estimate equivalent populations or average flows based on residential dwelling type or commercial land use. Table 4-1 shows the wastewater planning estimate guidelines contained in the design standards.

Table 4-1. Wastewater Design Standards: Per-Capita Density Factors

Residential Dwelling Type	Persons Per Dwelling Unit
Single- or Multi- Family	4
Apartment	2.8
Land Use (Wastewater Source)	**Planning Guidelines**
Central Business	300 CPA
Community Business	140 CPA
Neighborhood Business	40 CPA
Resort	400 CPA
Apartment (high density)	390 CPA
Apartment (medium density)	250 CPA
Apartment (low density)	85 CPA
General Industry	100 CPA
Waterfront Industry	40 CPA
School	25 gpcd
Hospital or similar institution	200 gpcd

CPA = Capita Per Acre

gpcd = Gallons Per Capita Per Day

Source: City and County of Honolulu – Design Standards of the Department of Wastewater Management, Volume 1 (July 1993)

Once the equivalent population (per capita density) was determined for a given wastewater source, an average per capita wastewater flow of 80 gpcd was applied unless otherwise provided. Wastewater generated for the North Shore Region was assigned to one of the following three categories:

1. Residential (single- and multi-family houses; apartments; condominiums)
2. Commercial (stores, restaurants, offices, etc.)
3. Institutional (Schools)

4.2 Residential Wastewater Flows

The population projections shown in Table 3-1 coupled with the per capita generation rates shown in Table 4-1 were used to estimate existing and future residential wastewater flow rates for the region. These values are presented in Table 4-2.

Table 4-2. Estimated Current and Future Residential Wastewater Flows

Sub-district	Projected Residential Population		Estimated Avg. Daily Wastewater Flow (gpd)	
	2010	2030	2010	2030
Mokuleia	2,340	2,328	187,200	186,240
Waialua	3,354	3,267	268,320	261,360
Haleiwa	4,441	4,649	355,280	371,920
Kawailoa	3,915	3,888	313,200	311,040
Pupukea/ Sunset Beach	4,976	6,638	398,080	531,040
Total	19,026	20,770	1,522,080	1,661,600

4.3 Commercial Wastewater Flow

Commercial wastewater flows for each sub-district were estimated by taking the land area of known commercial properties and applying the City's planning guidelines from Table 4-1. For large properties that contain small building structures and a majority of open space (i.e. Dillingham Airfield in Mokuleia), the total area was reduced to a smaller percentage to avoid estimating overly conservative wastewater flow rates. The City's planning guidelines include varying capita per acre estimates depending on the type of commercial activity (e.g. neighborhood versus community business). To account for tourist populations, a higher capita per acre estimate was used for the more frequented areas of Haleiwa and Pupukea/Sunset Beach. The estimated commercial wastewater generation for each sub-district is contained in Table 4-3.

Table 4-3. Estimated Current Commercial Wastewater Flows

Location/Description	TMK	Acres	Capita/Acre	Total Capita	Avg WW Flow/Capita (gpcd)	Avg Daily WW Generation (gpd) @ 80 gpcd
Mokuleia Sub-district						
Dillingham Airfield	68014001	52.0	40 [(a)]	2080.0	80	166,400
YMCA of Honolulu	69004003	10.4	40	416.0	80	33,280
YMCA of Honolulu	69004004	9.8	40	390.1	80	31,210
Camp Mokuleia	68003008	3.2	85	267.8	80	21,420
Fish Enterprises	68009020	1.8	40	72.0	80	5,760
Mokuleia Beach Colony	68009001	6.1	85	519.1	80	41,528
Mokuleia Total	--	83.2	--	3745.0	--	299,597
Waialua Sub-district						
Industrial Property	67001062	24.8	100	2475.9	80	198,072

Table 4-3. Estimated Current Commercial Wastewater Flows

Location/Description	TMK	Acres	Capita/Acre	Total Capita	Avg WW Flow/Capita (gpcd)	Avg Daily WW Generation (gpd) @ 80 gpcd
Waialua Town Center	67016033	0.3	140	37.2	80	2,976
Waialua Town Center	67016001	2.1	140	291.9	80	23,352
Waialua Town Center	67016002	0.2	140	28.7	80	2,296
Waialua Town Center	67001053	3.2	140	450.5	80	36,042
Waialua Town Center	67016038	0.4	140	61.6	80	4,928
Waialua Town Center	67016034	0.2	140	21.2	80	1,696
Gas Station / Food	67002011	0.4	140	54.9	80	4,390
Store	67005083	0.4	40	17.6	80	1,411
Store	67005084	0.3	40	11.0	80	883
Waialua District Park	67001044	9.0	40	361.8	80	28,941
United Church of Christ	67002026	1.2	140 [(a)]	162.4	80	12,992
Pioneer Hi-Bred	67002032	5.5	100 [(a)]	550.0	80	44,000
Waialua Total	--	47.9	--	4524.7	--	361,979
Haleiwa Sub-district						
Paa Laa Kai Store & Bakery	66032105	0.2	40	9.0	80	723
Oils of Aloha	66032107	0.3	40	11.4	80	915
Dole	66018039	0.3	N/A [(b)]	4.0	80	320
HECO	66018037	1.0	N/A [(b)]	4.0	80	320
Shops/Shrimp Trucks	66018020	0.5	40	20.7	80	1657
7-11 Parking/Shrimp Trucks	62007015	0.5	140	71.1	80	5690
7-11 Store	62007013	2.2	140	306.5	40	12258
Commercial Bldg (Shops)	62007017	0.5	140	63.7	80	5096
Gas Station	62007034	0.5	140	65.4	80	5230
Commercial Bldg (Shops)	62007035	0.4	140	57.4	80	4592
Parking	62007031	0.3	140	42.0	80	3360
Service Garage	62007009	0.3	140	40.0	80	3203
Shops (currently unused)	62007020	0.4	140	62.4	80	4995
McDonald's	66017029	0.7	40	29.8	80	2,387
Buddhist Mission	66017001	0.8	40	30.9	80	2,472
Shops	66017043	0.2	40	6.7	80	534
Shops	66017031	0.1	40	4.7	80	374
USPS/Other Commercial	66017033	1.2	40	47.2	80	3,779
Shops	62006018	0.2	40	6.9	80	554
Shops	62006017	0.2	40	9.2	80	739
Shrimp Trucks	62006011	0.9	140	127.9	80	10,232

Table 4-3. Estimated Current Commercial Wastewater Flows

Location/Description	TMK	Acres	Capita/Acre	Total Capita	Avg WW Flow/Capita (gpcd)	Avg Daily WW Generation (gpd) @ 80 gpcd
Waialua Comm. Assoc.	62006013	2.1	140	287.0	80	22,960
Shops/Eatery	62006012	3.1	40	123.8	80	9,904
North Shore Marketplace	62005034	2.2	140	309.8	80	24,786
North Shore Marketplace	62005025	0.7	140	91.3	80	7,302
North Shore Marketplace	62005003	2.2	140	307.3	80	24,584
North Shore Marketplace	62005007	0.5	140	63.6	80	5,085
Shops (partial area only)	66009001	0.2	80	15.2	80	1,216
Offices/Shops	62005016	0.2	140	29.4	80	2,352
Office (partial area only)	62005033	0.1	80	4.4	80	353
Shops	66009024	0.2	140	30.9	80	2,475
Shops/Eatery (partial area only)	62005020	0.1	140	12.1	80	967
Shops/Eatery (partial area only)	62005015	0.1	140	12.1	80	969
Shops	62005032	0.2	140	30.2	80	2,419
Shops/Eatery	62005027	0.2	140	23.4	80	1,870
Historic Court House	66009023	1.1	20	21.3	80	1,702
Haleiwa Shopping Center	66009019	1.3	140	185.9	80	14,874
Grocery Store	62005012	0.7	140	94.4	80	7,549
Haleiwa Shopping Center	66009014	0.4	140	61.6	80	4,928
Haleiwa Shopping Center	66009020	0.3	140	44.1	80	3,528
Grocery Store/Huli Huli Chicken	62005011	0.7	140	92.7	80	7,414
Haleiwa Shopping Center	66004001	3.4	140	469.9	80	37,594
Offices/Shops	62005009	0.7	140	91.3	80	7,302
Surf Shop	62005021	0.3	140	40.7	80	3,259
ACE Hardware	62005008	0.8	140	115.6	80	9,251
Protestant Church	62005005	1.1	140	158.6	80	12,688
Haleiwa Shopping Center	66004020	0.4	140	50.5	80	4,043
Haleiwa Shopping Center	66004021	1.1	140	154.3	80	12,342
Shops	66004018	0.1	140	18.6	80	1,490
Shops	66004017	0.2	140	33.3	80	2,666
Shops	66004028	0.3	140	45.4	80	3,629
Shops	66004016	0.2	140	22.0	80	1,758
Shops	66004015	0.2	140	32.1	80	2,565
Shops	66001001	0.1	140	15.0	80	1,198
Shops	66001030	0.2	140	29.7	80	2,374
Abrigo Properties (office)	66001031	0.3	140	48.3	80	3,864

Table 4-3. Estimated Current Commercial Wastewater Flows

Location/Description	TMK	Acres	Capita/Acre	Total Capita	Avg WW Flow/Capita (gpcd)	Avg Daily WW Generation (gpd) @ 80 gpcd
Gas Station	66001033	0.3	140	48.0	80	3,842
Office	62012029	0.2	140	21.8	80	1,747
Haleiwa Joes Overflow parking	62012030	0.3	140	36.4	80	2,912
Haleiwa Joes	66001034	0.8	140	105.1	80	8,411
City corp. yard	62012015	4.1	20	82.3	80	6,583
Shops	62012034	0.2	140	32.1	80	2,571
Hawaiian Telcom	66021011	0.1	40	5.6	80	452
Youth Services Assoc.	66013011	1.6	40	63.3	80	5,062
Shops/Fire Station	66013002	0.4	40	14.9	80	1,195
Shops/Fire Station	66013003	0.3	40	13.8	80	1,102
Baptist Church/Preschool	66013021	1.5	40	59.9	80	4,794
Japanese Mission	66006010	0.6	40	25.1	80	2,004
Japanese Mission	66006003	0.3	40	10.9	80	869
Japanese Mission	66006004	0.2	40	9.7	80	778
Offices	66003014	0.3	40	13.8	80	1,102
Offices	66003028	0.3	40	13.2	80	1,056
Offices	66003013	0.4	40	14.8	80	1,185
Haleiwa Total	--	49.5	--	4757.7	--	368,359
Kawailoa Sub-district						
Shops	62003036	0.5	140	64.3	80	5,141
Shops?	62003037	0.5	140	71.7	80	5,734
Surf and Sea Shop	62003039	0.1	140	12.2	80	974
Jameson's Gift Shop	62003014	0.5	140	75.7	80	6,059
Vacant land/Ranch Land	61005014	26.6	40 [a]	1064.0	80	85,120
Kawailoa Total	--	28.2	--	1287.9	--	103,029
Pupukea/Sunset Beach Sub-district						
Roman Catholic Church of Hawaii	59004013	5.5	40	220.3	80	17,622
Kava Roots food	59011056	0.1	40	4.8	80	381
Surf Store and Board RenTal	59011017	0.4	40	17.1	80	1,370
Foodland/Starbucks	59011016	1.8	140	257.0	80	20,563
Food	59011034	0.3	140	36.1	80	2,890
Food	59011033	0.3	140	41.2	80	3,293
Sunset Fire Station	59004029	0.5	40	20.7	80	1,654
Gas Station	59011027	0.3	40	12.8	80	1,021
Gas Station	59011026	0.3	40	10.1	80	806
Sunset Beach Christian Church	59008007	0.5	40	21.4	80	1,709

Table 4-3. Estimated Current Commercial Wastewater Flows

Location/Description	TMK	Acres	Capita/Acre	Total Capita	Avg WW Flow/Capita (gpcd)	Avg Daily WW Generation (gpd) @ 80 gpcd
Hawaiian Tel bldg.	59008006	0.2	40	6.9	80	550
Sunset Chevron Gas Station	59013020	1.0	40	40.2	80	3,219
Food	59014016	0.2	40	8.0	80	643
Food/ Restaurant	59016014	0.3	140	47.2	80	3,774
Intelsat Global Service Corp	59006029	1.2	40	48.0	80	3,840
Intelsat Global Service Corp	59006031	0.1	40	4.0	80	320
GE American Communications	59006028	1.1	40	44.0	80	3,520
Center	58001007	8.7	40	348.0	80	27,840
Crawford's Convalescent Home	58001051	3.3	85	276.3	80	22,100
Pupukea/Sunset Beach Total	--	26.1	--	1464.0	--	117,116

[a] *Total parcel area was reduced for wastewater generation estimate.*

[b] *Estimated wastewater flow was assumed to be equivalent to one single-family home.*

It should be noted that the commercial wastewater flow estimates presented in Table 4-3 represent existing conditions. This plan did not speculate as to future commercial growth in the region other than what has already been considered in other planning documents (e.g., Kamehameha Schools' North Shore Plan and revised NSSCP); the assumption being that growth beyond what has already been identified will be limited. Figure 3-2 indicated planned commercial expansion around the existing North Shore Marketplace along Kamehameha Highway. Based on this plan, the area of commercial expansion was determined to be roughly 11 acres. Using the "Central Business" category from Table 4-1, this translated to a total of 3,300 people which resulted in an average wastewater flow of about 264,000 gpd. This value was added to the estimated current flow for Haleiwa sub-district to yield the future estimated commercial wastewater flows.

In keeping in line with the NSSCP, it is apparent that no significant commercial growth is planned for the region, and the rezoning of existing agricultural lands to accommodate development is not consistent with the long-term vision of the North Shore community. In the future, if significant commercial development does take place within the region, more detailed studies would need to be performed to assess the impact on future wastewater flow estimates and whether the treatment, disposal, or reuse recommendations made in this planning effort are sufficient and appropriate to accommodate the increased loading.

4.4 Institutional Wastewater Flows

For this study, the institutional category is made up of public and private schools. Any dedicated preschools or day care facilities were included as commercial entities. The equivalent population planning guidelines for schools can be found in Table 4-1. Table 4-4 below summarizes the North Shore region's schools and their estimated wastewater flows.

Table 4-4. Estimated Current Institutional Wastewater Flows					
Sub-district	School	Current Estimated Enrollment	Current Estimated Staff/Faculty	Total Capita	Avg Daily WW Generation (gpd) @ 25 gpcd
Waialua	St. Michael's School	249	32	281	7,025
	Waialua Elementary	536	60	596	14,900
	Waialua High & Intermediate	540	87	627	15,675
Haleiwa	Haleiwa Elementary	200	46	246	6,150
Pupukea/Sunset Beach	Sunset Beach Elementary	384	51	435	10,875
	Totals	1909	276	2185	54,625

Only future commercial or institutional growth which has already been planned was included in this study. The commercial and institutional wastewater flow estimates in Table 4-3 (plus the Kamehameha Schools North Shore Plan commercial expansion) and Table 4-4 were used to estimate commercial and institutional wastewater flows in the year 2030. The total estimated wastewater generation for the North Shore region can be found in Table 4-5. It should be noted that the residential flow rates listed in this table are derived using the highest population estimates for each corresponding sub-district between the years 2010 through 2030. Because some sub-district populations are projected to decrease, the design residential flow rates are based on the period with the highest estimated wastewater generation. The higher flow values were used because wastewater treatment facilities must be sized to accommodate the worst case flows.

Table 4-5. Summary of Estimated Wastewater Design Flowrates				
Sub-district	Residential	Commercial	Institutional	Total (gpd)
Mokuleia	188,000	299,597	0	487,597
Waialua	271,440	361,979	37,600	671,019
Haleiwa	371,920	632,359	6,150	1,010,429
Kawailoa	388,720	103,029	0	491,749
Sunset/Pupukea	531,040	117,116	10,875	659,031
Region Total	1,751,120	1,514,080	54,625	3,319,825

4.5 Wastewater Collection System

The only public wastewater collection system in the North Shore region serves the Paalaa Kai subdivision of Waialua (Haleiwa Sub-district). The wastewater from this subdivision flows by gravity to the City and County's Paalaa Kai WWTP. The system services 308 lateral connections. The original design capacity of the wastewater treatment plant is 140,000 gpd. The average flow treated in 2007 was 87,000 gpd.

Figures 4-1 through 4-5 illustrate conceptual service areas for year 2030 build out conditions that may be assigned to the various sub-districts and provides the estimated average daily flow for each service area. Some general rules of thumb that were used to define service areas are as follows:

- Limit residential service areas to (+/_) 50 units – this represents a typical wastewater flow limit for small community cluster treatment systems;
- Follow logical boundary lines when possible. This includes major streets, streams, and parcel elevation;
- Separate residential areas from commercial/industrial areas when possible;

- Parcels should be contiguous with each other.

Beach parks were specifically excluded from any potential service area in Figures 4-1 through 4-5, and estimated wastewater flows were not calculated. The number of visitors that frequent the beach parks along the North Shore vary greatly depending on the location and the season. The project team felt a more thorough analysis of wastewater generation was required in order to develop a reasonable estimate of future flows for these beach parks. The amount of effort required for such an analysis would be unique to the specific beach park, and may be more suitable for a City agency to conduct.

Depending on the type of treatment recommended for each service area in Figures 4-1 through 4-5, a collection system may need to be installed to combine flows from multiple users and transport the wastewater to a designated treatment point. Various treatment technologies will be presented in Section 6, and the recommended alternatives for treatment will be discussed in Section 8.

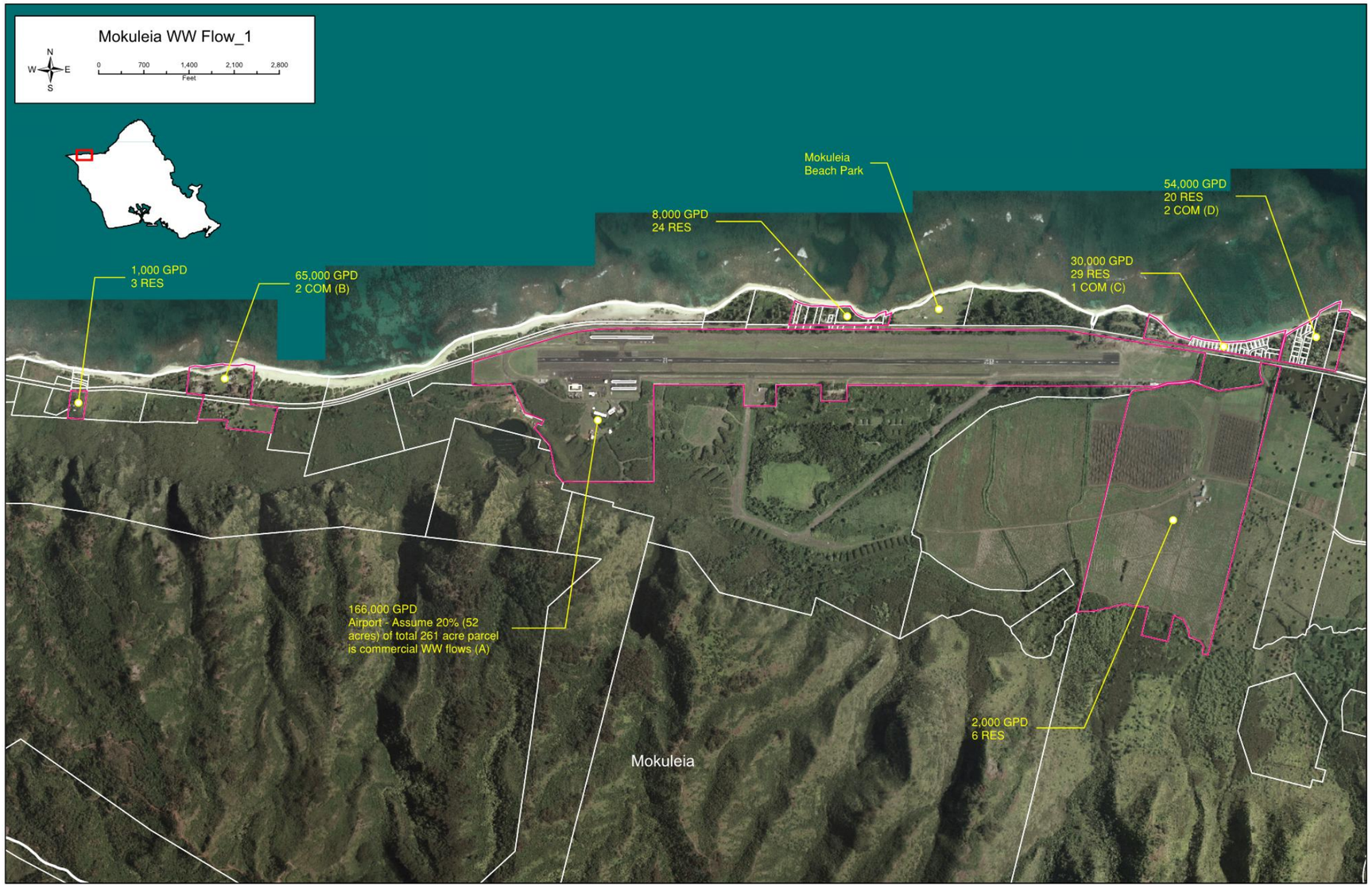

Figure 4-1a. Mokuleia Wastewater Service Areas and Corresponding Average Daily Flow

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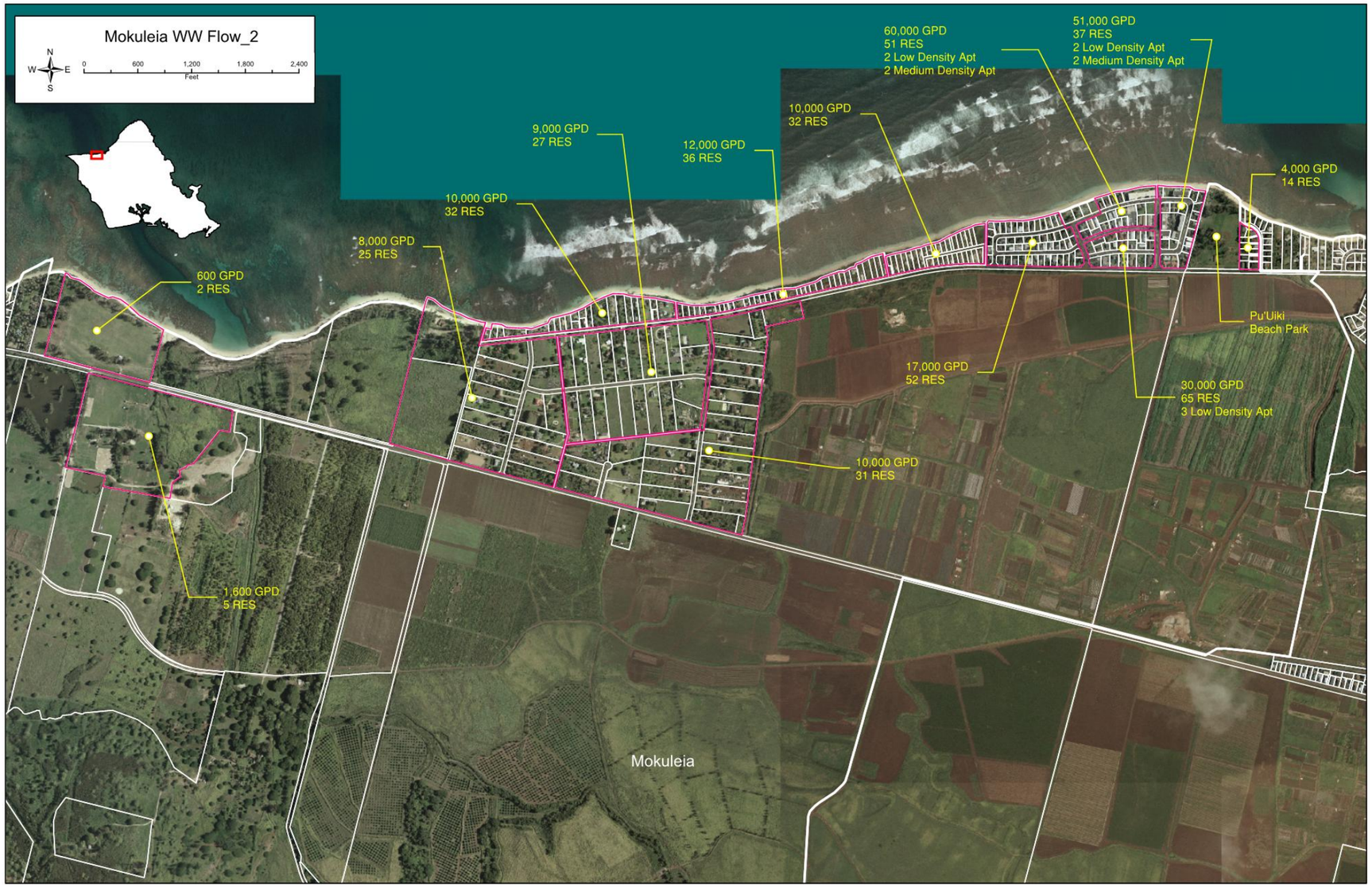

Figure 4-1b. Mokuleia Wastewater Service Areas and Corresponding Average Daily Flow (Cont'd)

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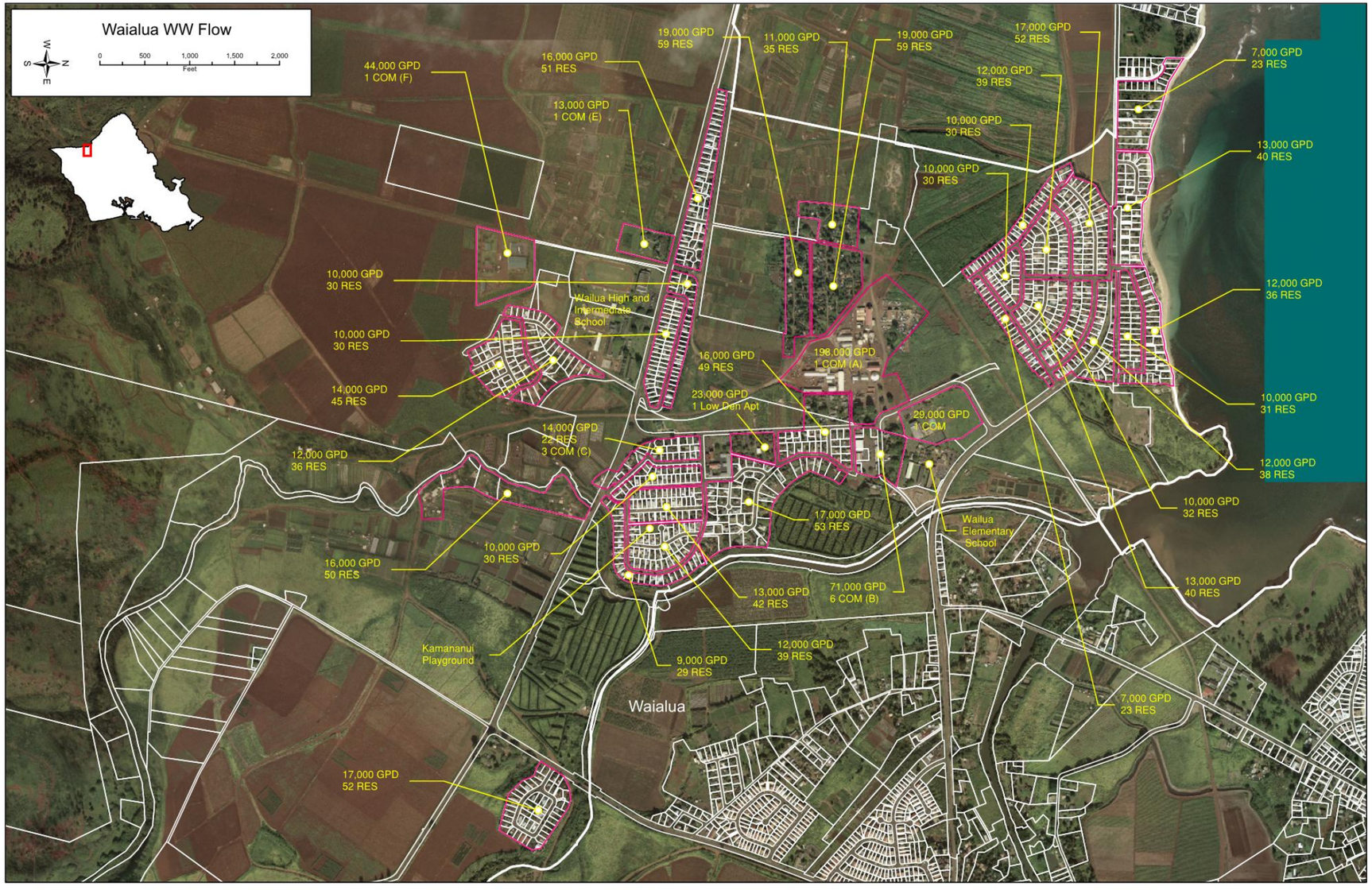

Figure 4-2. Waialua Wastewater Service Areas and Corresponding Average Daily Flow

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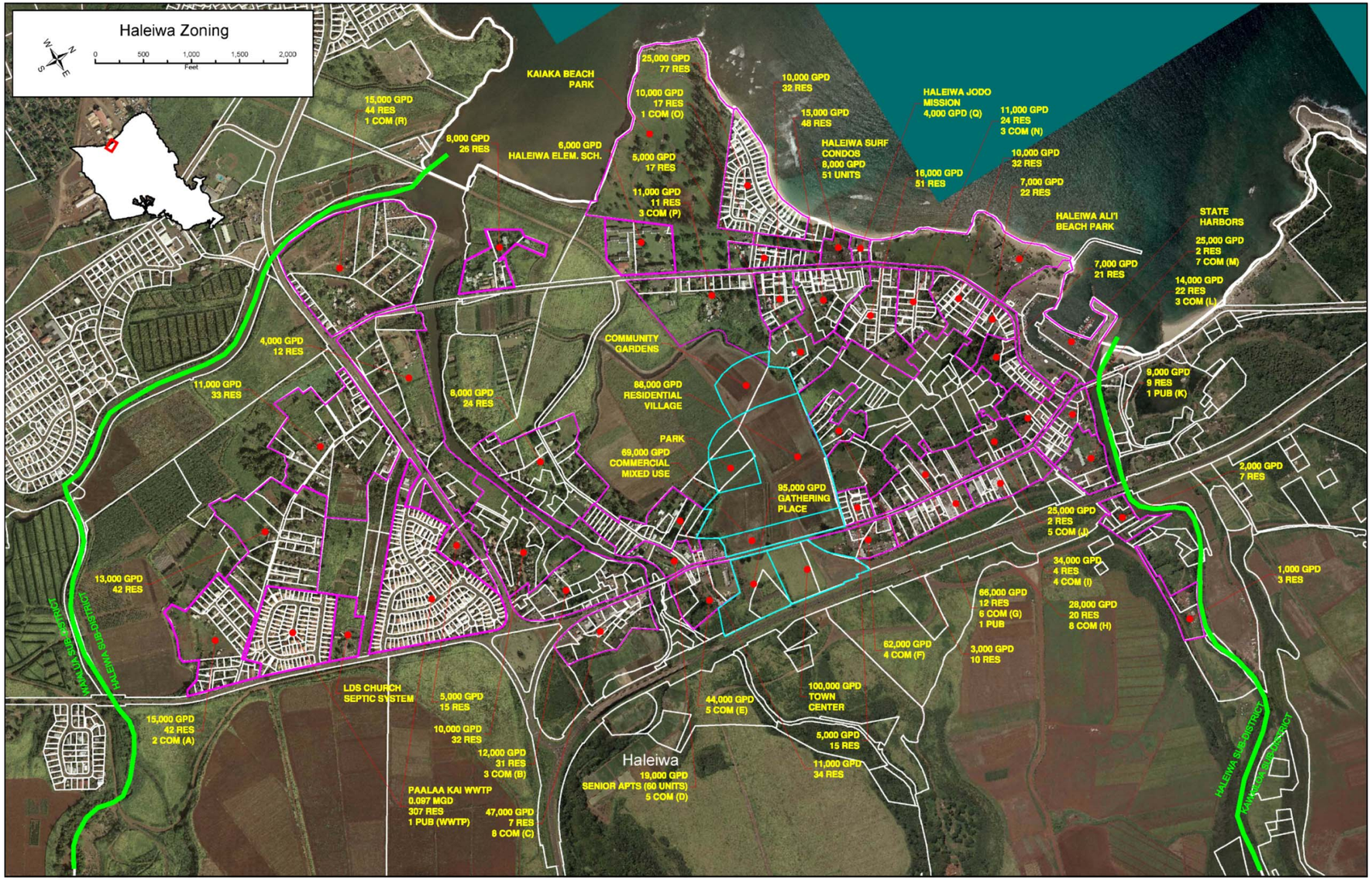

Figure 4-3. Haleiwa Wastewater Service Areas and Corresponding Average Daily Flow

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Figure 4-4a. Kawailoa Wastewater Service Areas and Corresponding Average Daily Flow

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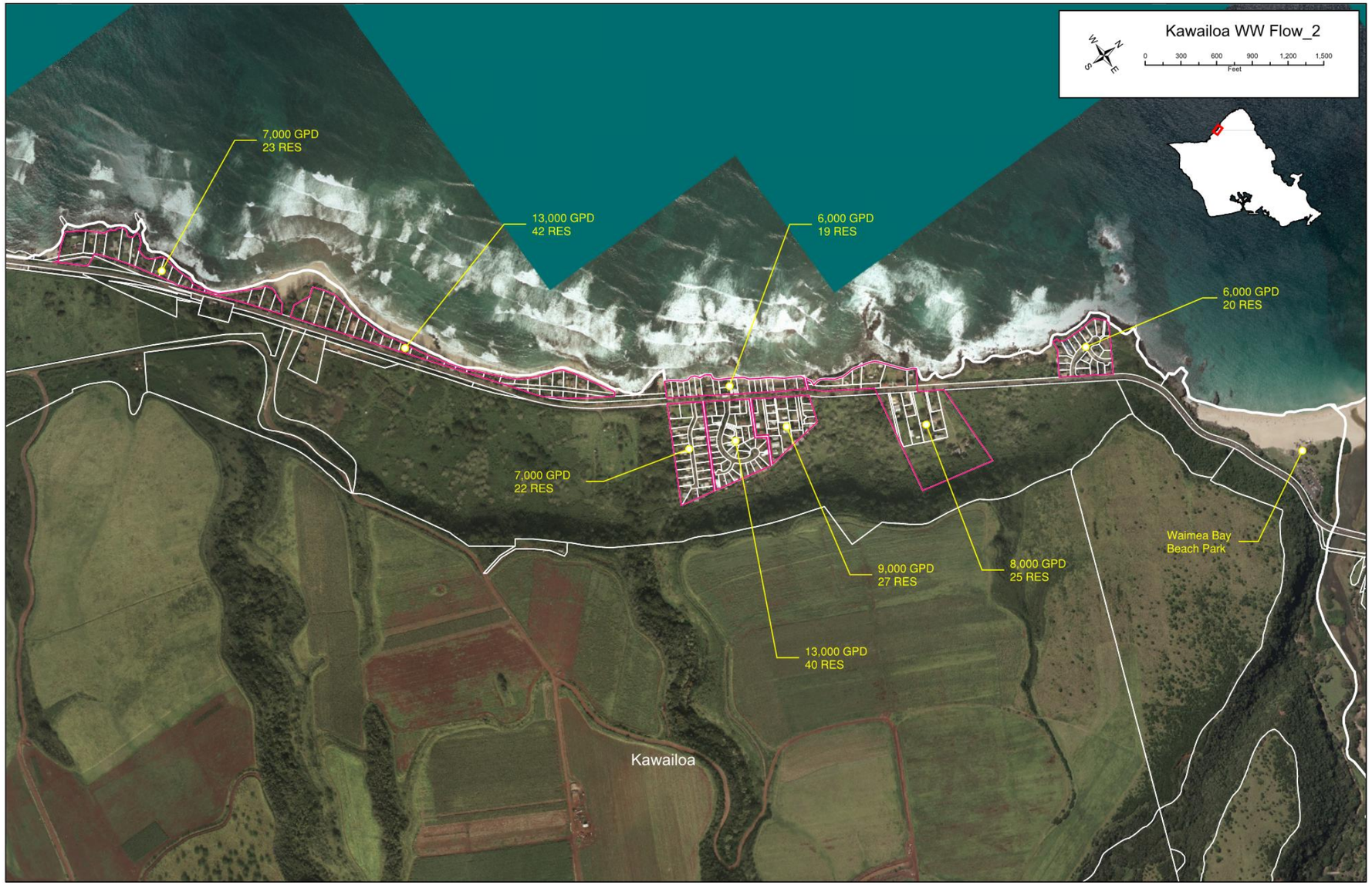

Figure 4-4b. Kawailoa Wastewater Service Areas and Corresponding Average Daily Flow (Cont'd)

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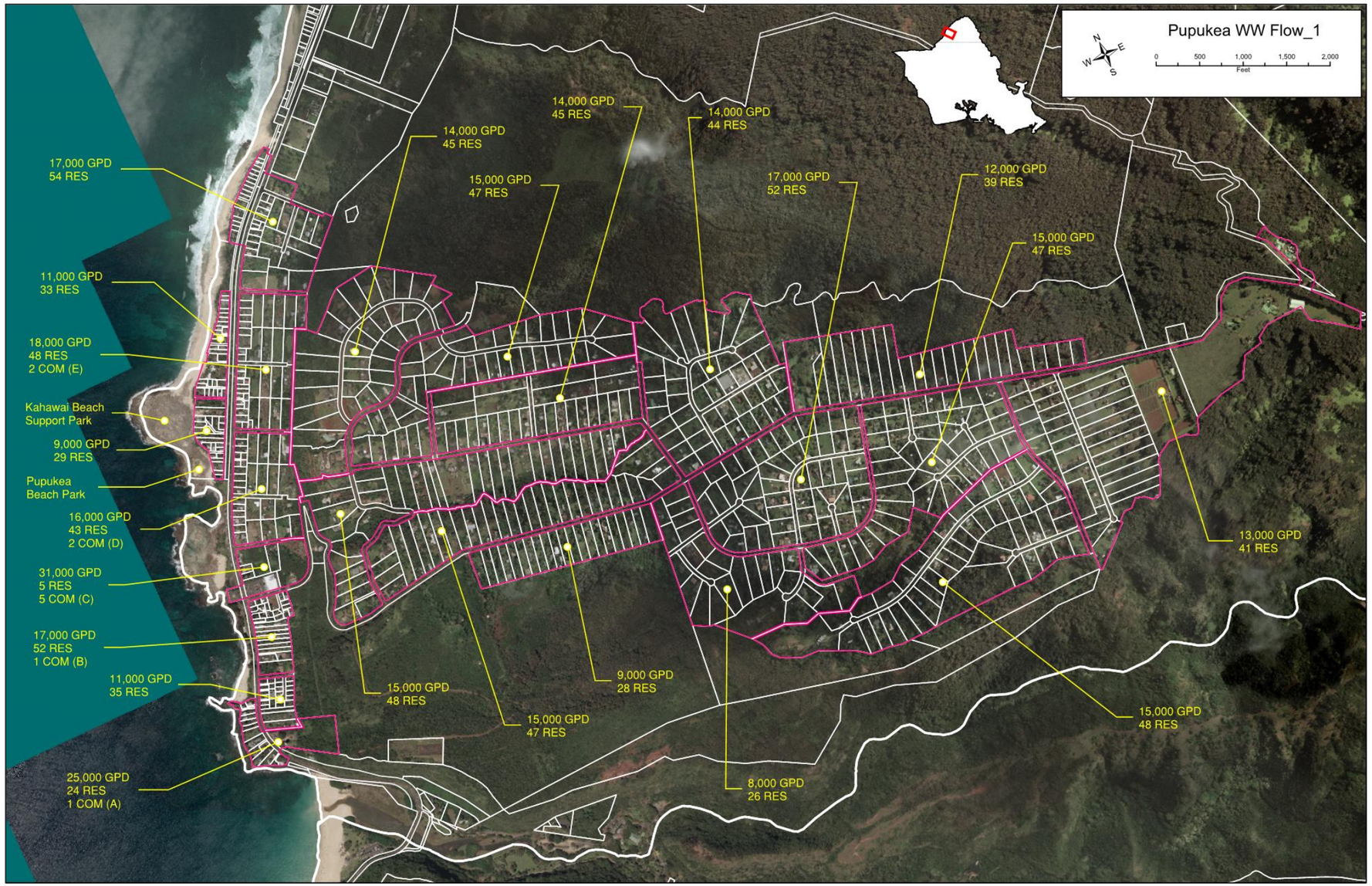

Figure 4-5a. Pupukea/Sunset Beach Wastewater Service Areas and Corresponding Average Daily Flow

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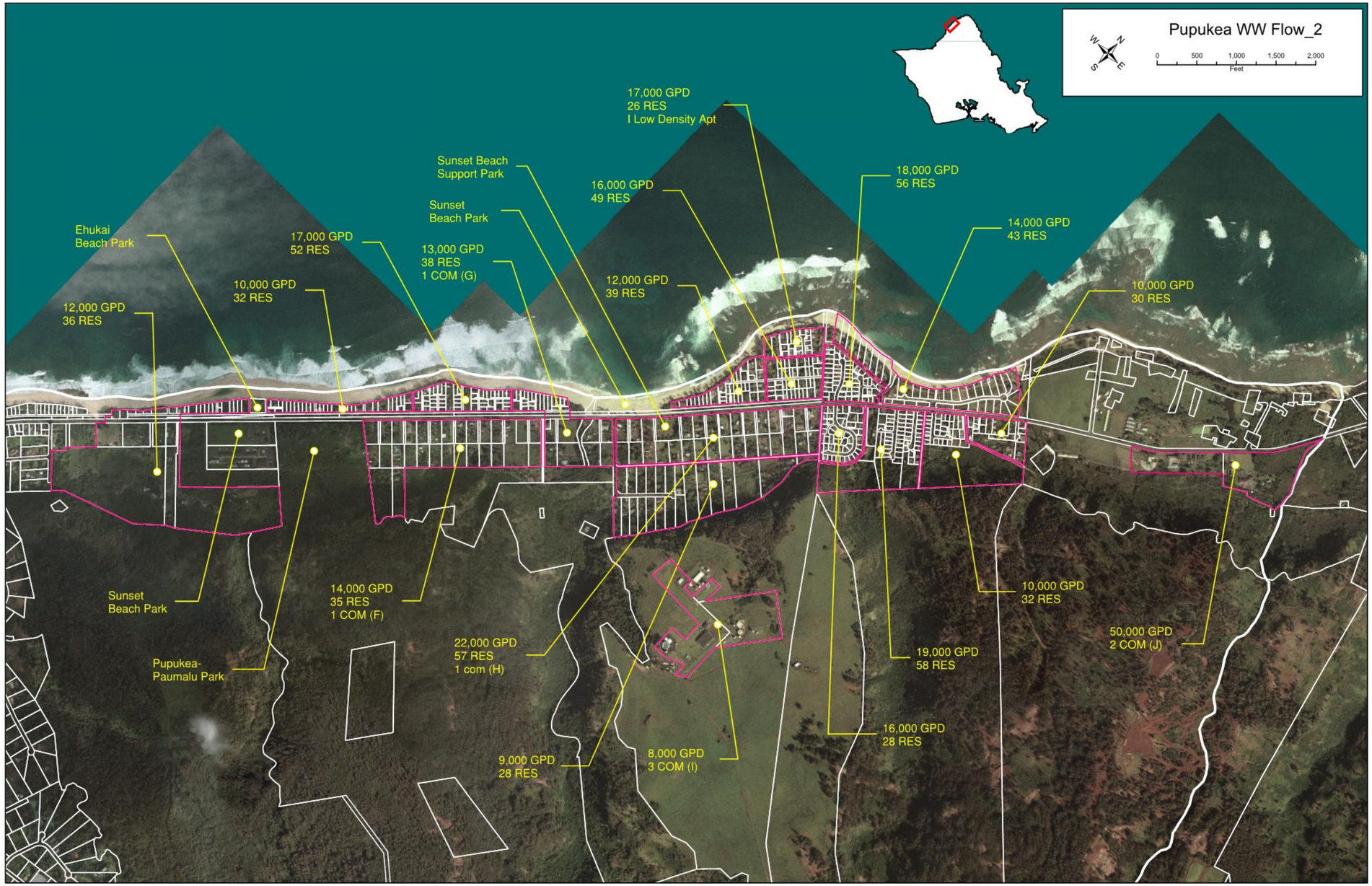

Figure 4-5b. Pupukea/Sunset Beach Wastewater Service Areas and Corresponding Average Daily Flow

Section 5

Analysis of Wastewater Management Alternatives

Regional wastewater management alternatives are discussed in this section. The purpose of presenting management options is to address the issue of implementation and oversight with regard to wastewater solutions for the region, by presenting various management alternatives. Past wastewater planning efforts recommending centralized treatment did not receive community support, and through the CWG work it became apparent that the North Shore's residents and business owners more closely identify with a decentralized approach to wastewater collection, treatment, and disposal. However, the biggest challenge to a decentralized system is the management of that system, which must ensure that wastewater collection, treatment, and disposal are properly designed, constructed, and maintained, in order to protect public health and the environment. The establishment of a strong management entity is the backbone of a successful regional decentralized treatment program.

On Oahu, most people associate wastewater management with a public, municipal entity such as the City. However, management of wastewater infrastructure, particularly decentralized systems can be handled in other ways such as by private entities, and on various levels of responsibility. On Oahu the principal types of wastewater management are:

- Sewer collection, treatment and disposal or reuse by the City
- Private systems
- Public Utility Commission (PUC) controlled private collection, treatment and disposal or reuse
- Public-private partnerships

Decentralized wastewater management is defined as the collection, treatment and reuse or disposal of wastewater from individual homes, clusters of homes, isolated communities, industries, or institutional facilities, as well as portions of existing communities **at or near the point of generation**. All wastewater systems require permits from the State of Hawaii Department of Health (DOH). Private onsite systems range from individual home systems to condominiums or small package plants. Developments with private wastewater systems operate under the authority of the PUC. An example of this type of system is Turtle Bay Resort.

5.1 Onsite Wastewater Management Entities

Onsite wastewater systems can be managed by a wide range of management entities at different service levels. In this section the advantages and disadvantages of management levels and governance structures are described and discussed. Five examples of onsite management districts are compared to illustrate how these districts have been developed and how they have been operated.

The United States Environmental Protection Agency (USEPA) has defined five levels of onsite management models. As the complexity and level of management control increases, the concept of responsible management entity (RME) was developed to describe how onsite systems are planned, designed, operated, repaired, and monitored.

Homeowner Awareness Model (Model 1). In this model, information is provided to the local property owners on the proper way to operate, maintain, and repair individual onsite systems. This model is adequate where treatment methods are limited to conventional septic tank and leach field systems that require relatively little owner attention. The regulatory authority mails maintenance reminders to owners at appropriate intervals (USEPA, 2003).

Maintenance Contract Model (Model 2). EPA recommends Model 2 where more complex system designs are used to overcome physical or zoning restrictions on conventional systems. For example, engineered systems to overcome slowly permeable soils, high groundwater, or limited infiltration area, may require contract maintenance with trained operators. The objectives of this model build on the Homeowner Awareness Model by ensuring that the property owners develop and maintain maintenance contracts with trained operators.

Operating Permit Model (Model 3). EPA recommends Model 3 under circumstances where the sustained performance of onsite treatment systems is critical to protect public health and water quality. Under this model limited-term operating permits are issued to the property owner, which are renewable if the owner demonstrates that the onsite system is in compliance with the terms and conditions of the permit. In subareas where it is appropriate to use conventional onsite system designs, the operating permit may only require routine maintenance and periodic inspection.

RME O&M Model (Model 4). EPA recommends Model 4, the Responsible Management Entity (RME) Operation and Maintenance (O&M) Model where large numbers of onsite and cluster systems must meet specific water quality requirements. The operating permit is issued to the RME instead of the property owner to provide greater assurance of performance compliance. For a service fee the RME takes responsibility for O&M of the onsite and cluster systems.

RME Ownership Model (Model 5). Model 5 is a variation on Model 4, with the difference being that ownership of the onsite system is no longer with the property owner. The RME owns, operates, and manages the onsite systems in a manner similar to the City owning its centralized wastewater treatment plant.

5.1.1 Governance Structure Types

There are at least five different types of governance structures that can be used to manage onsite wastewater systems (Water Environment Research Foundation [WERF], 2007). The five are:

1. Water, Wastewater or Other Special Purpose Districts
2. County or Municipal Government
3. Privately Owned RMEs
4. Cooperatives
5. Homeowners' Associations (HOA)

Wastewater or Special Purpose District. A special purpose district is a single purpose political subdivision developed specifically to take responsibility for a service, such as wastewater, drinking water, solid-waste disposal or electricity. Such districts are used in some states for ownership or management of decentralized wastewater systems. Many different types of district may fit in this category, including utility authorities, public utility districts, onsite wastewater districts and fire districts. Such districts are sanctioned by state law. Districts can be independent of another local government unit, or the district may be a combination of county, township, or municipal government. Some districts may be responsible to local officials, while others have elected or appointed governing boards. The advantages and disadvantages of these districts are presented in Table 5-1 (WERF, 2007).

Table 5-1. Wastewater or Special Purpose Districts	
Advantages	Disadvantages
Often already established in growing urban areas, so has potential to provide continued service and accountability	Authority to own or manage distributed systems varies among states
Fees can be collected via property taxes as part of local government	Limited service area restricts growth in customer base
Billing processes and systems in place	Board turnover or micromanagement may impact operations
Strong means for dealing with non-payment	Varying access to governmental financing options
Defined service areas protect the customer base from competition	Changes in local politics may impact operations
Governing board or committee can focus on big picture	Steep learning curve for traditional wastewater authorities, who may be resistant to adopting newer alternative decentralized technologies
Potential to issue tax exempt revenue bonds and apply for state and federal money	

County or Municipal Government. In Hawaii, the State DOH implements its onsite wastewater regulations. In other states, local government agencies (such as county health departments), are responsible for the implementation of state-level rules for the design, siting, and installation of individual onsite wastewater systems. Some local governments, usually through the enactment or enforcement of local ordinances in addition to state rules, administer ongoing O&M programs or implement requirements that are more-stringent than state regulations to address local conditions. The advantages and disadvantages of having county or municipal government manage onsite maintenance districts are described in Table 5-2.

Table 5-2. County or Municipal Government	
Advantages	Disadvantages
Government entities generally already exist	Authority to own or manage distributed systems usually does not exist
Staff may already be knowledgeable about technologies	Staff may be resistant to alternative technologies and management approaches
Potential to issue tax exempt revenue bonds and apply for state and federal money	Education of policy makers and key staff may be required
Burden of upgrade costs rests with property owner	Local politics or budgetary constraints may impact operations
Fee collection and billing mechanisms in place	Staff has multiple responsibilities that create a direct conflict of interest between its permitting and management functions
Provides continued service and accountability	

Privately Owned RME. A privately owned RME or service provider is a separate legal entity apart from its owners, created under state law. Most existing privately owned utilities are publicly regulated, for-profit corporations that provide the public with an essential commodity or service. Such businesses are granted certain monopoly rights in the form of certificated service areas. The prices and means by which services are delivered are highly regulated by public utility commissions under state laws. The advantages and disadvantages of privately-owned RMEs are presented in Table 5-3 (WERF, 2007).

Table 5-3. Privately Owned RME and Service Providers	
Advantages	Disadvantages
Limited liability	Significant cost and time to incorporate
Full control of system design, installation, operations and management activities	Subject to costly and time consuming rate/territory cases before public utility commissions
Can grow very large	Often must "sell" the idea to regulators and public utility commissions
Guaranteed service area (as granted by public utility commissions, within state boundaries)	Owned assets (e.g., land for dispersal sites) may have little resale value
Provides for good accountability	Difficult to take business entity across state lines

Cooperatives. Cooperatives are independent, democratically governed utilities owned by the members they serve. They are governed by a board of directors elected from the membership. The board sets policies and procedures that are implemented by the cooperatives' professional staff. Membership in cooperatives is usually voluntary. Cooperatives have a long history of supplying electricity to rural areas (www.nreca.com). Advantages and disadvantages of cooperatives are presented in Table 5-4 (WERF, 2007).

Table 5-4. Cooperatives	
Advantages	Disadvantages
In some cases, unlimited service areas	Board turnover or micromanagement may impact operations
Established cooperatives adding wastewater to their services already have existing administrative systems	Limited or no access to governmental financing options
Governing board or committee can focus on big picture	Members can leave cooperative
Tax-exempt, provided 85% of revenue comes from members	Steep technical learning curve for co-op starting to provide wastewater services.
	Limited service areas
	Subject to PUC rate approval in many states

Homeowners Associations. A HOA is a legal entity. It is generally a non-profit corporation created by a real estate developer for the purpose of managing and selling homes in a subdivision or planned community. Property owners are required to join the HOA when they purchase property in the development. The HOA enforces covenants, conditions, and restrictions (CC&Rs) and manages the common amenities of the development. HOAs are governed by boards made up of volunteers from the development who are elected by owners at annual meetings. Like municipal governments, HOAs may have the power to provide services, regulate activities, levy assessments, and impose fines. For wastewater systems the role of the HOA is usually to ensure that adequate O&M occurs, either through an RME or a competent service provider. The bylaws of HOAs, however, rarely provide the detail needed for adequate management of a developments' decentralized wastewater system. The advantages and disadvantages of homeowners associations to manage onsite districts are presented in Table 5-5 (WERF, 2007).

Table 5-5. Homeowner's Associations	
Advantages	Disadvantages
Easy for developers to create	Usually reliant on volunteers with limited experience or knowledge in wastewater
Can continue indefinitely	Board members may have competing responsibilities and limited interest
Board of homeowners sets rates	Limited recourse for substandard installations once developer leaves
Tax-exempt	Volunteer board must manage contractors
	Sinking funds for major repairs often not established or inadequate
	Weak legal means for enforcing fee collection
	Poor accountability
	Can dissolve, leaving no one for regulators to enforce against

Examples of Onsite Management Districts

Examples of Onsite Wastewater Management Districts are presented in Table 5-6, including location, the group that initiated the district, legal structure, and year established. Five examples of onsite districts are further described in the following paragraphs.

Table 5-6. Examples of Existing RME Business Structures			
Name	Initiator	Legal Structure	Year [(a)]
Water, Sewer, and Other Special Purpose Districts			
Mobile Area Water & Sewer Services, Alabama	Authority staff	Special purpose district	1999 (1952)
Loudon Water, Virginia	Authority staff	Special purpose district	1958
Otter Tail WMD, Minnesota	Local citizens	Special purpose district	1984
Stinson Beach WD, California	Local citizens	Special purpose district	1970
Crystal Lakes W&S Association, Colorado	Local residents in response to state mandate on water use association	Private homeowners assn.	1995
Southern Iowa Regional Water Authority, (SIRWA), Iowa	SIRWA, HD sanitarian, local RD staff	Regional water authority	1975
Lake Panorama WMD, Iowa	Private owners' association and County Board of Health	Special purpose district	1980
Paradise WMD, California	Town officials	Special purpose district	1993
Washington Island UD, Wisconsin	Town officials, local residents	Special purpose district	1996
Warren Village, Vermont	Local citizens	Special purpose district	1999
County and Municipality Governments			
Newnan Utilities, Georgia	County commission	Municipal utility	2006
Charlotte County HD, Florida	County officials, local residents	County government	1991
Cayuga County HD, New York	Local citizens	County government	1994

Table 5-6. Examples of Existing RME Business Structures			
Name	Initiator	Legal Structure	Year [(a)]
Broad Top Township, Pennsylvania	Municipal officials, local residents	Township government	~1995
Private Companies			
Adenus Utilities Group, Tennessee	Company owner/management	For-profit corporation	1994
EcoCheck, Inc., Minnesota	Company owner/management	Private corporation	2002
Applied Water Management, Inc., New Jersey	Company owner/management	Private corporation	1984
Non-Profit Sewer Cooperative			
Ozark Clean Water Company, Missouri	Local business persons	Non-profit sewer co-op	2003
Rural Electric Cooperative			
Connexus WaterWays, Minnesota	Not clear from existing info	Non-profit electric co-op	2000
Tribal Authority			
Tohono Oodham Utility Authority, Arizona	Tribal authority and Bureau of Indian Affairs	Tribal authority	1975

Stinson Beach, CA. Stinson Beach is located in Marin County California just north of the Golden Gate Bridge and San Francisco Bay. It was developed in the late 1800s using onsite leachfield systems for wastewater treatment and disposal. In 1961, a survey by the County Health Department found that existing onsite systems constituted a public health hazard and the Stinson Beach County Water District was formed in 1962 to provide sewerage services for the area (Crites and Tchobanoglous, 1998). A bacteriological survey of the local creek found high coliform organism counts and led to a ban on the use of onsite systems. Nine engineering studies were conducted to determine what should be done to correct the situation. In each case the proposed plans were rejected because of local opposition or the failure of the plans to meet regulations (Crites and Tchobanoglous, 1998).

The Onsite Wastewater Management District was formed in 1978 under new state legislation. The District has a wide range of rules and responsibilities including planning, design review, inspection, permitting, monitoring and reporting. Many onsite systems have been upgraded over the years. There were 672 discrete onsite systems in Stinson Beach in 1998 ranging from pressure dosed leachfields to intermittent sand filters. The District regulates the permitting, development, design, and repair of the onsite systems and monitors both surface water and groundwater.

Sea Ranch, CA. The Sea Ranch residential community features some of the most exclusive real estate in the country. A total of 1,500 homes sit on 2,500 lots on rugged, rocky land that hugs the California coastline for about 10 miles on either side of the famed Highway 1 in Sonoma County, CA. Picturesque views, abundant wildlife, and the feeling of "getting away from it all" are some of the reasons that draw scores of weekend and holiday residents. Officials with the Sea Ranch Association estimate that only 600 of the community's homes are lived in by full-timers—and because more than 1,200 of the community's homes rely on onsite septic systems, the high number of part-time residents can cause serious wastewater problems.

The Sea Ranch is unique because its residents are served by a combination of centralized and decentralized sewer services. The 600 homes here that aren't connected to onsite septic systems are instead served by one of two wastewater treatment plants owned by the Sonoma County Water Agency. The staffers at the Sea Ranch Association Water Co. are contracted by the county to maintain and

operate the wastewater treatment plants. The community's central treatment plant can handle 27,000 gallons of water per day, while its north one can take 160,000 gallons daily. The ranch uses treated water from the north sanitation zone to irrigate its golf links. It uses treated wastewater from the central plant for irrigation.

The Sea Ranch Onsite Waste Disposal Zone, which is a special district, is responsible for record keeping, routine inspections, operating permits, abatement/enforcement, water quality monitoring, reports, and public education. Homeowners are responsible for the design, construction, operation, and maintenance of their systems.

Paradise, CA. The Town of Paradise has a population of 27,000 all served by decentralized treatment systems. The town started as a retirement community and then became a bedroom community to the city of Chico. Spread across 18 square miles of foothills, the community cherishes its rural atmosphere. Several attempts to develop centralized sewers were defeated. After the 1992 sewer plan was defeated, an onsite zone became the means for Paradise to manage all the wastewater systems in town (Pinkham, Magliaro and Kinsley, 2004).

Through the Onsite Wastewater Management Zone, the town (1) requires operating permits for all new and existing systems; (2) adopted design criteria, including special regulations for large systems and innovative systems; set up variance and enforcement procedures; and established a monitoring program. Paradise also established a program of initial and periodic operational evaluation of all onsite systems by private evaluators.

Georgetown Divide PUD, CA. Georgetown Divide Public Utilities District (PUD) serves the area of El Dorado County, California known as Auburn Lake Trails. This Sierra Nevada foothill subdivision is located on 2,500 acres. Many of the lots are marginally suitable for onsite disposal of septic tank effluent. In 1971 the District was formed in response to environmental concerns about water quality. The original intent was for the District to be an interim entity until sufficient housing density made conventional sewering feasible (Crites and Tchobanoglous, 1998). However, because of the increasing cost of centralized sewering, improvements in onsite treatment and disposal technology, and changing philosophy regarding onsite systems as being acceptable wastewater infrastructure, the District continues to provide initial site inspection, design, management, periodic system inspection, and educational and environmental surveillance services to onsite disposal system customers.

When onsite wastewater disposal systems were proposed, it was discovered that many of the 1,800 lots had issues with limited soil depth, high seasonal groundwater, and unfavorable topographic conditions. An initial soils investigation, involving over 4,000 soil profiles and 6,000 percolation tests were conducted so that onsite disposal systems could be designed to overcome the physical restrictions. The District inspectors work with the individual site contractors and homeowners during the process of location, design, and construction of individual onsite systems. The District maintains a database of site conditions and enters new systems into the database including design criteria and inspection reports. The District can also enforce compliance under the public utilities governance.

Charlotte County, FL. Charlotte County is on the gulf side of Florida to the south of Saratoga. The availability of some 200,000 affordable quarter-acre lots led to rapid growth in the 1970s to the 2000 population of 140,000 (Pinkham, et al., 2004). Roughly half the lots have access to water distribution, but the original developers only provided sewer service to a smaller portion of the lots.

In 1993 the county prepared a master sewer plan with an estimated wastewater service cost of $462 million. Public reaction was overwhelmingly negative and the county stopped the project.

In 1997 the county took an alternative approach. It enacted a variety of growth management policies. It developed "mini" sewer expansions in certain areas, established a water quality monitoring program, developed an ordinance to require advanced treatment (aerobic treatment units or ATUs) or density-

reducing lot combinations for small and water-front lots, and created a septic system management program. Under the ordinance, operating permits and service contracts with licensed maintenance companies are required for all ATUs. The ATU ordinance met with initial resistance from realtors and builders who thought its cost would hurt their business, but is now largely accepted.

5.2 Wastewater Management for North Shore

5.2.1 Onsite Management Alternative

For the Onsite Entity alternative for North Shore, the Homeowner Awareness Model (Model 1) or the Maintenance Contract Model (Model 2) may be an appropriate place to start on the continuum of onsite management options. With these options an entity other than the State DOH would be responsible for management of onsite wastewater systems within specified district boundaries.

Potential services that the entity might provide include:

- Water quality monitoring
- Inspections and permits
- Location, design and construction approvals
- Education
- Database management.

Private Entities

Laie is an example of a public-private partnership arrangement. The Laie Water Company provides water service to the residents of Laie. The wastewater system developed by Hawaii Reserves is now operated by the City and County under the public-private partnership. The partnership is an interim agreement until land ownership details are resolved, at which time the City will both own and operate the wastewater system.

City and County of Honolulu

The City provides wastewater service to publicly-owned wastewater collection treatment and disposal systems on Oahu. Properties that are within 400 ft of sewer systems operated by the City must connect to the public sewer system.

5.2.2 NO ACTION Alternative

The no-action alternative would involve leaving the wastewater management as it currently is, in the hands of the individual property owner or resident with regulation provided by the State DOH.

Applicability to the North Shore Region. The five regions would have the same issues with wastewater treatment and disposal. There would be little or no opportunity for water recycling or reuse in the region.

Cost Implications. No new costs would be incurred. The current costs of repair and pumping as needed would continue.

Environmental Implications. No change to the negative effects the current wastewater treatment and disposal systems are having on the environment. As discussed in Appendix C it is believed that there is some amount of environmental degradation occurring at some sites.

Section 6

Analysis of Wastewater Treatment Alternatives

Two essential elements of a successful regional wastewater treatment system are management and implementation. Management options were described in Section 5, and this section describes and evaluates potential wastewater treatment alternatives which could be implemented in the North Shore region.

6.1 Alternatives Development Methodology

A comprehensive list of wastewater treatment technologies was developed and is referred to as the "Toolbox". The list is presented in Table 6-1. The reason for including such a broad list of potential alternatives was to develop a comprehensive array of potential treatment methods that could be applied to existing conditions and also incorporated into future planning and implementation steps. The Brown and Caldwell team did not have preconceived treatment technologies in mind and was open to considering different treatment methods depending on the community values provided by the core working group. The list of alternatives in the Toolbox was developed by determining the most appropriate technologies for the North Shore from a wide array of feasible technologies. Table 6-1 is not meant to be an all inclusive list of technologies, as others may be available either now or in the future that could be considered for the North Shore Region.

Table 6-1. Toolbox of Collection, Treatment and Disposal Technologies

Category	Applicable Technologies
Water Use Reduction	Water conservation devices Gray water separation
Non-Discharging Systems	Incinerating toilets Composting toilets Vault toilets and holding tanks
Individual Onsite Systems	Septic tanks and cesspools Septic tanks and leachfields Septic tanks and bottomless sand filters Septic tanks and pressure dosed absorption beds Septic tanks and drip irrigation Septic tanks and evapotranspiration beds
Collection Systems	Conventional gravity sewers Pressure sewers (grinder pumps) Septic tank effluent pumps (STEP) Septic tank effluent gravity (STEG) Vacuum sewers
Cluster Systems	Recirculating gravel filters Advantex biofilters Glendon biofilters

Table 6-1. Toolbox of Collection, Treatment and Disposal Technologies	
Category	Applicable Technologies
	Package aerobic systems Trickling filters
Natural Treatment Systems	Ponds Constructed wetlands Living Machines
Centralized Treatment Systems	Activated sludge Membrane bioreactors Sequencing batch reactors Trickling filters Moving bed bioreactors
Tertiary Filters and Disinfection	Rapid sand filters Cloth filters Fuzzy filters Membrane filters Chlorination Ultraviolet (UV)
Reuse	Landscape irrigation Crop irrigation Groundwater recharge Industrial cooling Dust control Car washing
Land Discharge	Rapid infiltration Seepage pits Injection wells

6.1.1 Applicability to the North Shore Region

The neighborhoods on the North Shore have varying needs for wastewater management and varying opportunities for water recycling and reuse. As a result, the approach taken has been to consider multiple alternatives for each of the five sub-districts. In considering each alternative, the wastewater treatment needs and opportunities for each region and for portions of each region were considered independently. Community values and the input from the CWG were reflected in the nature of the alternatives considered to be appropriate.

6.1.2 Level of Evaluation Detail

The two previous Facilities Plans provided specific recommendations and costs. The scope of this study was to consider and evaluate multiple alternatives at the planning level for future implementation. As such no detailed designs are provided.

6.2 Upgrading Onsite Systems with Gray Water Separation

Homes that discharge all wastewater directly into cesspools may experience failure (required pumping twice a year or more than twice a year) resulting from overloading or clogging. To reduce flows and loads on the cesspools one method of flow reduction is to separate the gray water (sinks, showers, and laundry) from the rest of the household wastewater.

6.2.1 System Layout/Schematic

Gray water is water from non-toilet and non-kitchen sources and accounts for 60 to 80 percent of household wastewater. The DOH allows separation of this gray water from the toilet and kitchen wastewater (black water) and subsurface disposal of the gray water. The DOH has published guidelines for gray water separation (ref). This alternative would provide relief to failing cesspools where excess flow is the cause of failure. This alternative is shown schematically in Figure 6-1. The treated gray water can be used to provide subsurface irrigation to trees, shrubs, vines and flowers.

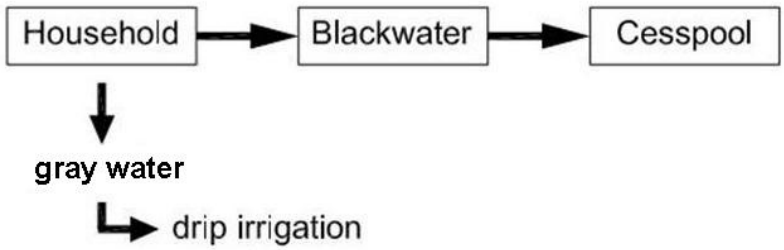

Figure 6-1. Gray Water Diversion from a House to a Backyard Drip Irrigation System

6.2.2 Applicability to the North Shore Region

It is not uncommon for rural residents to practice gray water separation from black water. In these cases residents typically run a hose from their laundry area out to the backyard and use the water to irrigate grass, shrubs or trees. As of April 2009, all four counties in the state are waiving the portions of the Uniform Plumbing Code (UPC) which previously prohibited the use of gray water, in order to allow the use of washing machine wastewater to be used for subsurface irrigation. These waivers apply only to areas not serviced by a publicly owned sewer system. The DOH will be the regulatory agency responsible for the gray water systems located in areas not serviced by publicly owned sewer systems. The Counties will retain regulatory responsibility for the areas serviced by their sewer systems. DOH *"Guidelines for the Reuse of Gray Water"* are posted on their website.

6.2.3 Cost Implications

Costs vary with the type and sophistication of the separation, holding and disposal system. Reported costs range from $3,000 to $8,000 plus the plumbing changes within the residence.

6.2.4 Environmental Implications

Reducing the flow of household wastewater into a cesspool would have a positive environmental impact. If the guidelines are followed there would be no adverse health effects from diverting and reusing treated gray water. The guidelines address the potential for some soaps to adversely effect some vegetation.

6.3 Upgrading Cesspool Systems with Septic Tank Addition

In this alternative, a new septic tank would be added between the residence and the cesspool. The septic tank removes settleable solids, and reduces biological oxygen demand (BOD), as well as some portion of the nutrients and pathogens. For those residences with cesspools that have problems accepting the solids from the household, this alternative would prolong the useful life of the cesspool. The cesspools would, by definition, become seepage pits in the regulatory context. Solids would be trapped in the septic tank, which would require periodic pumping.

6.3.1 System Layout/Schematic

In this alternative, a new septic tank would be added between the residence and the cesspool. The septic tank removes settleable solids, and reduces BOD, as well as some portion of the nutrients and pathogens. For those residences with cesspools that have problems accepting the solids from the household, this alternative would prolong the useful life of the cesspool. The cesspools would, by definition, become seepage pits in the regulatory context. Solids would be trapped in the septic tank, which would require periodic pumping.

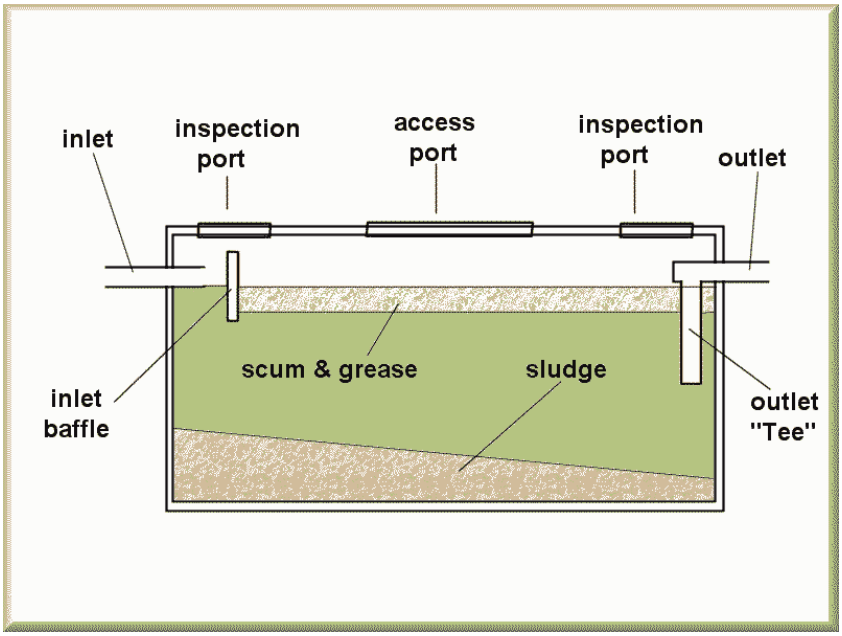

Figure 6-2. Septic Tank for Residential Wastewater Treatment prior to a Seepage Pit

6.3.2 Applicability to the North Shore Region

Given the widespread prevalence of individual cesspools on the North Shore, this alternative would be applicable throughout the region, depending on site-specific soil conditions.

6.3.3 Cost Implications

The cost of septic tank addition would range from $5,000 to $15,000 depending on the number of bedrooms served and the accessibility of the lot to install the septic tank.

6.3.4 Environmental Implications

The environmental implications of this alternative would be to reduce the solids loading to the disposal system, thereby extending the useful life of the onsite systems. Additional implications would include reduced groundwater degradation down gradient of the seepage pits due to reduction of solids, nutrients and pathogens.

6.4 Neighborhood Cluster Systems with Injection Well Disposal

6.4.1 Description of Alternative

In this alternative the wastewater is collected from a number of residences and conveyed to a small wastewater treatment plant. A variety of collection, treatment and disposal/reuse options from the toolkit can be used with cluster systems.

6.4.2 System Layout/Schematic

Cluster systems involve collection of wastewater from a number of homes to a location where treatment and disposal or reuse is practical. The number of homes needed or desired is not fixed and depends on housing density and can range from 4 to over 40. An example of the collection of wastewater is shown in Figure 6-3.

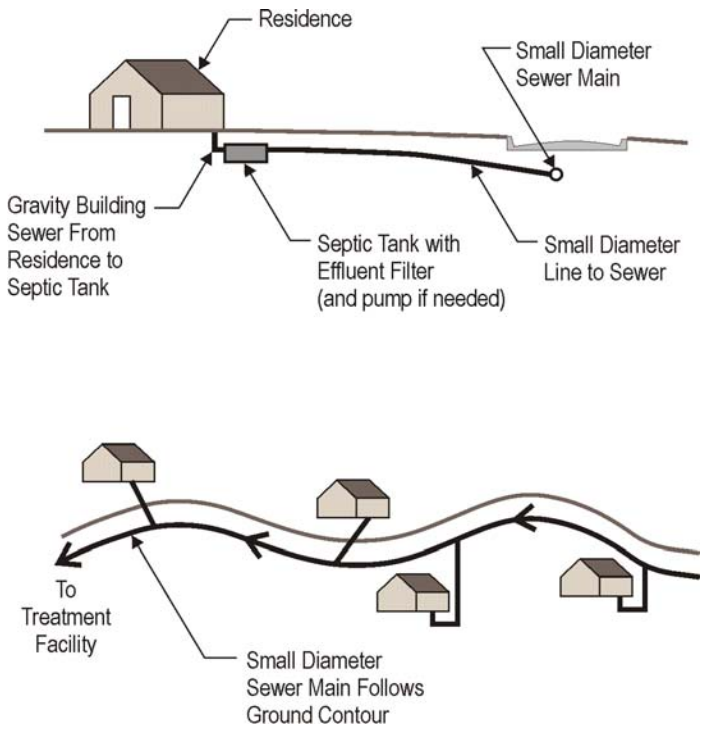

Figure 6-3. Septic tanks intercept household wastewater, remove solids, and allow the effluent to be collected to a treatment facility

After collection and conveyance, the wastewater is treated, in this case using a recirculating gravel filter. Recirculating pea gravel filters (RGF) are a relatively simple, but effective means to treat wastewater from small communities. RGFs have been used to treat flow rates up to 1.0 million gpd. RGFs typically produce a nitrified effluent that contains less than 10 milligrams per liter (mg/L) of biochemical oxygen demand (BOD_5) and total suspended solids (TSS) (Crites and Tchobanoglous, 1998).

A schematic diagram of a RGF is shown in Figure 6-4. A septic tank is used to capture settleable and floatable solids. The septic tank effluent enters a recirculation tank. A dosing pump is used to apply wastewater in small doses to the top of the filter. The wastewater is treated as it percolates through the pea gravel media. A network of drainage piping collects the water at the bottom of the filter and returns it to the recirculation tank. A floating ball recirculation valve controls the return flow back to the recirculation tank or to the effluent disposal or reuse system. The dosing pump timer settings and recirculation tank volume are designed so that wastewater will typically flow through the filter for treatment an average of three to five times before being discharged. A RGF system requires approximately 5 acres of land area per million gallons per day of treatment capacity. An example of a RGF system in use within a decentralized wastewater system can be found at the Stonehurst subdivision, located near Martinez, California (Crites, et. al. 1997).

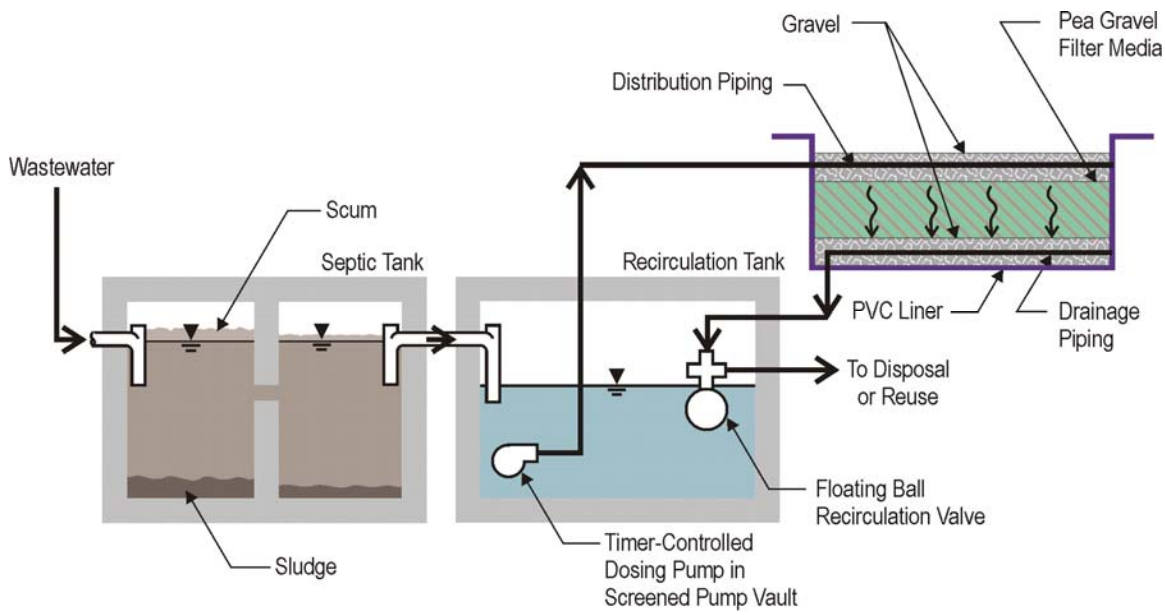

Figure 6-4. Recirculating Gravel Filter for Treatment of Septic Tank Effluent

Effluent from the RGF is typically chlorinated for disinfection prior to discharge to the injection well.

6.4.3 Applicability to the North Shore Region

Neighborhood cluster systems featuring septic tanks followed by RGF and then discharge to injection wells would be applicable to all of the sub-districts, particularly to dense housing between the State DOH underground injection control (UIC) line and the ocean where treated wastewater injection above the groundwater table is acceptable.

6.4.4 Cost Implications

Typical costs for RGF systems are $15,000 to $30,000 per household. The loading rates are based on hydraulic loading, so the costs are somewhat linear with increased flow (larger clusters). Including the septic tank, chlorination and construction of injection wells would bring the unit cost up to $26,000 to $50,000.

6.4.5 Environmental Implications

Receiving water quality will be improved as the result of secondary treatment and disinfection prior to groundwater discharge. The potential for localized contamination of streams and beaches will be diminished.

6.5 Neighborhood Cluster System with Reuse

In this alternative, like the previous alternative, the wastewater is collected from a number of residences and conveyed to a small wastewater treatment plant. However, a higher level of treatment is employed which allows the potential for reuse of the treated effluent instead of disposal. A variety of collection, treatment and reuse options from the toolkit can be used with cluster systems. In this case the use of textile filters followed by drip irrigation is selected for illustration.

6.5.1 System Layout/Schematic

Biotextile filters are a variation of the proven RGF technology described above. Biotextile filters will typically produce a nitrified effluent having less than 15 mg/L BOD_5 and TSS. Figure 6-5 is a schematic

diagram of a biotextile filter system, which is very similar to the RGF technology shown in Figure 6-4. As shown in Figure 6-5, wastewater is first treated in a septic tank to remove settleable and floatable solids. Septic tank effluent flows into a recirculation tank, where it is pumped to the biotextile filter "pod" and distributed at the top of the filter media. The filter media consists of vertical sheets of non-woven synthetic textile. The wastewater is treated by attached growth micro-organisms as it percolates through the filter media. The wastewater is applied in many small doses throughout the day to increase the hydraulic detention time within the filter media. Drainage piping collects the water at the bottom of the filter and returns it to the recirculation tank. A floating ball recirculation valve automatically controls the return flow back to the recirculation tank or to the leachfield for disposal. The dosing pump timer settings and recirculation tank volume are designed so that wastewater will typically flow through the filter for treatment an average of three to five times before being discharged.

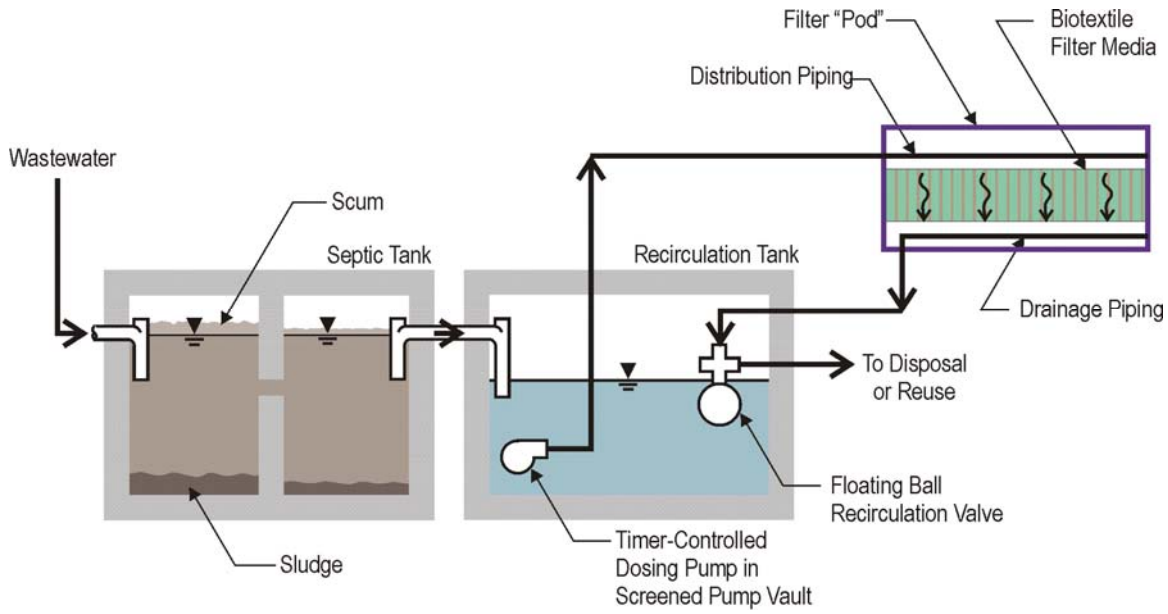

Figure 6-5. Biotextile Filter for Treatment of Septic Tank Effluent

Effluent from the biotextile filter would be used to irrigate landscape, parks and playgrounds using subsurface drip irrigation because without filtration and disinfection the water would be classified as R3 (the lowest quality of three defined reuse classes). Subsurface drip irrigation technology has advanced to the point where high-quality effluent can be reused to irrigate landscaping. A typical subsurface drip irrigation system consists of drip irrigation lines spaced two feet apart and buried 6 to 10 inches below the soil surface. The drip emitters are spaced two feet along the drip lines. Subsurface drip irrigation systems are designed to apply water at or below the infiltration rate of the soil to preclude surfacing of the water. Periodic chlorination of the drip lines is required to avoid emitter-clogging growths (Crites and Tchobanoglous, 1998). A subsurface drip irrigation system restricts public access to treated wastewater.

6.5.2 Applicability to the North Shore Region

In the following chapter there are a number of parks identified that could be irrigated with recycled water using subsurface drip irrigation.

6.5.3 Cost Implications

Costs for this alternative are similar to those for the previous alternative using RGF and injection wells.

6.5.4 Environmental Implications

Receiving water quality will be improved as the result of secondary treatment and disinfection prior to water reuse. The potential for localized contamination of streams and beaches will be diminished. In addition, potable water supply can be conserved if the landscape is currently irrigated with potable water.

6.6 Upgrading Existing Private or Municipal Wastewater Treatment Systems

In this alternative the twenty or so existing private wastewater treatment plants would be upgraded to produce tertiary disinfected water (R1 – the highest quality of three defined reuse classes) for water reuse.

6.6.1 System Layout/Schematic

The schematic for the additional treatment is shown in Figure 6-6.

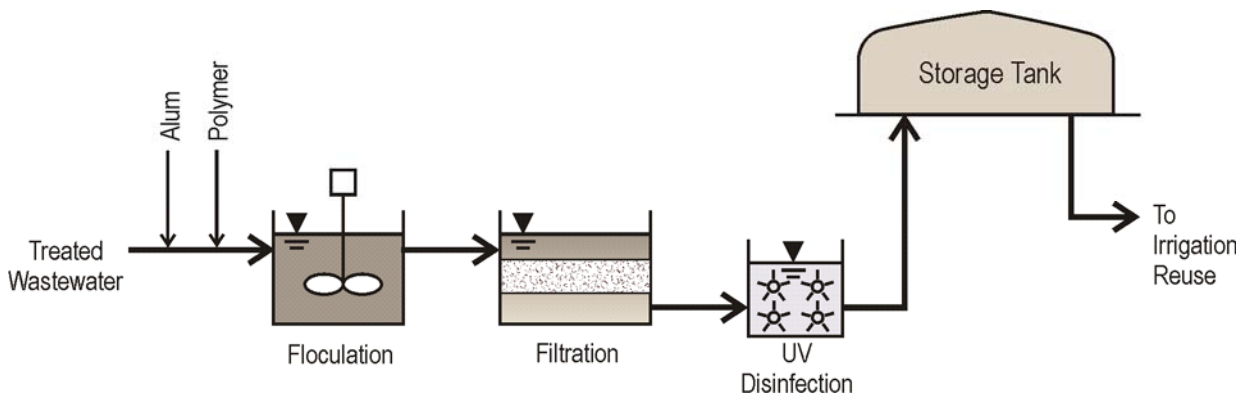

Figure 6-6. Treatment plant schematic for upgrading existing secondary treatment to produce R1 disinfected tertiary recycled water

Figure 6-6 is a schematic diagram of the processes required to produce R1 recycled water suitable for unrestricted use. Unrestricted use includes sprinkler irrigation of parks, playgrounds, school yards, streetscape, and residential landscaping. As shown in Figure 6-6, coagulants such as alum (aluminum sulfate) and polymer are mixed with effluent from a secondary treatment process in a flocculation tank. The flocculation process combines small particles in the wastewater together into larger particles that can be removed in sand or multi-media filters. The filtered water is then disinfected using UV. Chlorine in the form of chlorine gas or liquid sodium hypochlorite may also be used to disinfect the recycled water, however, a chlorine contact tank must be provided. Recycled water storage should be provided because the diurnal demand patterns for recycled water generally do not match recycled water production rates.

6.6.2 Applicability to the North Shore Region

The existing private wastewater systems are primarily in the areas of high density condominiums. In most cases, effluent reuse opportunities are rather limited due to their location. An exception could be the City's wastewater system at Paalaa Kai.

6.6.3 Cost Implications

The construction cost for an upgrade using rapid sand filtration and disinfection for a 1 million gallons per day (mgd) size would be approximately $2 per gallon. Operating costs would be approximately $100,000/yr.

6.6.4 Environmental Implications

The environmental implications include an improvement in localized receiving water quality and a potential reduction in potable water use.

6.7 Sewering Commercial Areas for Treatment and Reuse (Small WWTFS)

In this alternative the wastewater from commercial areas would be collected, treated, and effluent reused locally. A typical system would consist of gravity sewers from each establishment to a small, local treatment plant, such as a membrane bioreactor (MBR), and an effluent reuse system such as sprinkler irrigation of parks, playgrounds, trees or agricultural crops.

6.7.1 System Layout/Schematic

A current leading treatment process the membrane bioreactor (MBR), is often considered as a technology for decentralized treatment because it can produce a very high quality recycled water with a facility that has a small footprint. The MBR utilizes “membranes” with very fine pores (microfiltration or ultrafiltration) in place of gravity settling (secondary clarifier) to remove the solids from the liquid stream. Other steps in the treatment process scheme are similar to the extended aeration activated sludge process, with some additional requirements (much finer screening requirements and anoxic process zones) to protect the membranes and enhance separation. Figure 6-7 presents a schematic diagram of a MBR process.

An advantage of the MBR process is a relatively small footprint is required – less than 0.5 acres per million gallons per day of treatment capacity. Small flow rates can be accommodated by using manufactured “package” MBR treatment plants. The process requires greater energy use and greater operational and maintenance complexity than the other secondary treatment processes described above. Effluent from an MBR system is of a very high quality with respect to suspended solids and turbidity and typically requires only disinfection to produce tertiary treated R-1 recycled water according to DOH reuse guidelines.

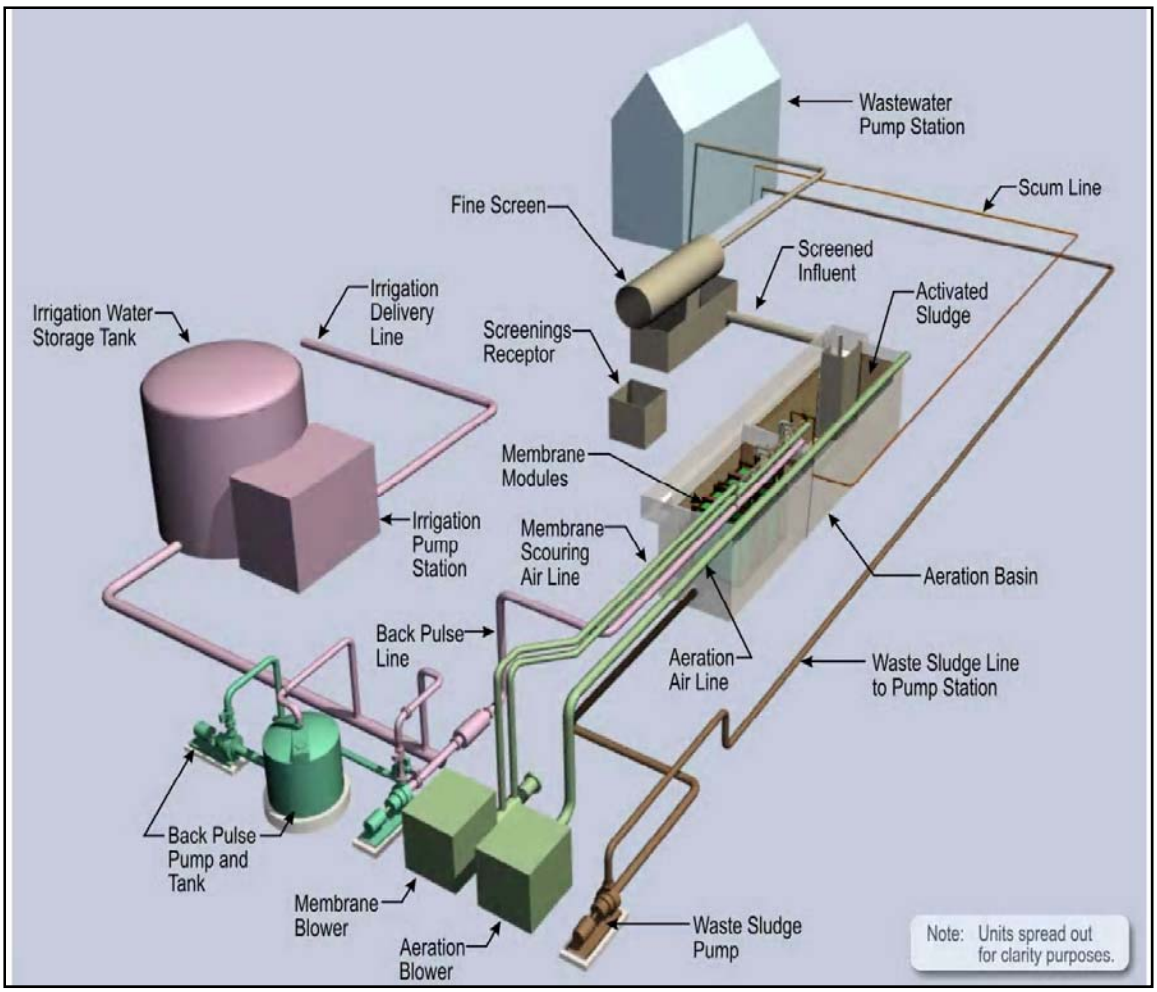

Figure 6-7. Membrane Bioreactor for Tertiary Treatment

6.7.2 Applicability to the North Shore Region

The commercial area in Haleiwa would be a suitable application for this alternative in the North Shore region, due to the compact footprint and high quality effluent produced.

6.7.3 Cost Implications

The construction costs for an MBR system would cost between $10 and $20 per gallon. Operating costs for a 1 mgd system would cost approximately $1.4 million/yr.

6.7.4 Environmental Implications

Environmental implications would include localized impacts on traffic and businesses during construction, improved receiving water quality, and reduced need for potable water for irrigation.

6.8 Sewering Sub-Districts for Treatment and Reuse (Sub-Regional WWTFS)

6.8.1 Description of Alternative

In this alternative each of the five sub-districts would be served by a sub-regional treatment plant with water reuse during periods of high irrigation demand and subsurface disposal during periods of low

irrigation demand. Each sub-district would have its own sewer system collecting residential and commercial flows for treatment at a given sub-district plant. Treatment could be accomplished using the MBR in the previous alternative, constructed wetlands, or other suitable technology.

6.8.2 System Layout/Schematic

To illustrate the potential use of constructed wetlands for some of the sub-districts, two types of constructed wetlands are discussed: free water surface wetlands and vertical flow wetlands. The free water surface (FWS) wetlands require the most land, require primary pretreatment, and would require filtration and disinfection prior to producing R1 water for reuse.

Constructed wetlands are engineered wastewater treatment systems that are based on the use of emergent wetland vegetation. In free water surface wetlands the emergent vegetation is flooded to a depth of 4 to 18 inches, as illustrated in Figure 6-8. The wastewater is treated as it flows through the wetland by bacteria attached to the submerged vegetation, as well as by physical and chemical processes. Typical vegetation in free water surface wetlands includes cattails, reeds, sedges, and rushes. A FWS wetland system usually consists of multiple channels constructed over an impermeable liner or low-permeability compacted soil (Crites and Tchobanoglous, 1998).

In addition to secondary wastewater treatment functions, free water surface wetlands can be designed and used for tertiary effluent polishing while providing a community amenity for bird watching, hiking, jogging, etc. Constructed wetlands designed for these purposes generally have a greater percentage of open water areas to attract waterfowl and to create a visually appealing environment. An excellent example of this is located in Arcata, California, where an attractive tertiary treatment wetland is highly valued by the local community.

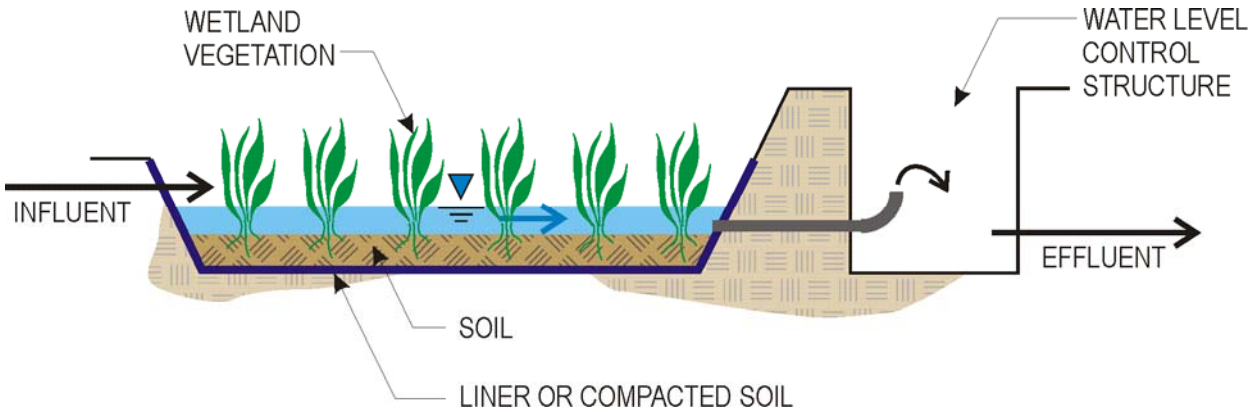

Figure 6-8. Free Water Surface Constructed Wetland

The second type of constructed wetlands is the vertical flow wetlands. These vertical flow (VF) wetlands require less land area and produce a higher quality of effluent. VF wetlands are a variant of RGF technology. The concept is illustrated in Figure 6-9. Influent that has received at least primary settling is introduced into a recirculation tank, where it is mixed with water that has already been treated in the wetland. A dosing pump intermittently sends water from the recirculation tank to a distribution piping network located on the surface of the wetland. The applied water percolates vertically through the wetland's pea gravel media. Wetland vegetation growing in the media improves the aesthetics of the packed-bed filter while supplying a small amount of oxygen to bacteria in the pea gravel media via the plant roots. Water is collected at the bottom of the wetland cell and returned to the recirculation tank. A recirculation valve in the tank controls the effluent flow.

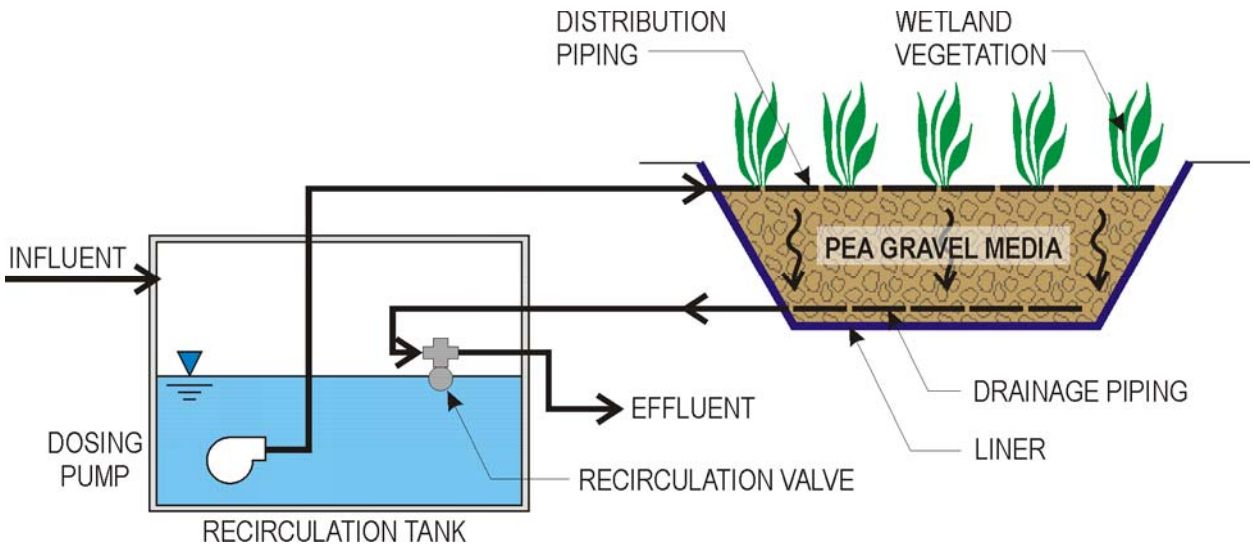

Figure 6-9. Vertical Flow Wetlands for Secondary Treatment

If this type of wetland is used, the pretreatment is primary treatment, such as a septic tank. Tertiary filtration, using either intermittent sand filters or rapid sand filters will produce an effluent that can be disinfected to R1 reuse standards.

6.8.3 Applicability to the North Shore Region

Constructed wetlands or other suitable secondary treatment options from the toolbox could be used to treat the sub-district flows prior to reuse or disposal. The 1996 Hydro Resources Facilities Plan proposed two sub-regional facilities that featured ponds and wetlands. The advantages are the relatively low cost of construction and operation. The disadvantage is the land area needed.

6.8.4 Cost Implications

Costs can range from $3 to $4 per gallon for constructed wetlands up to $7 to $12 per gallon for sequencing batch reactors (Salveson, et al., 2010). Sewering typically costs 4 to 5 times more than treatment and disposal. A rough estimate of the capital cost for piping is $38 per inch diameter per lineal feet of pipe (Honolulu Board of Water Supply, 2011c). For example, the installed cost of 1000 feet of 8 inch diameter pipe would be approximately $304,000.

6.8.5 Environmental Implications

Implications for subregional sewering and treatment/disposal or reuse include disruption of transportation corridors and businesses. Positive environmental impacts could include reduced shoreline pollution and improved water quality of receiving waters.

6.9 Sewering the Entire Region for Treatment and Disposal/Reuse (Regional WWTFS)

6.9.1 Description of Alternatives

The final and most centralized of all alternatives would be to collect all the wastewater from the sub-districts into one place, treat it to secondary or tertiary quality, and reuse it for a variety of purposes including landscape irrigation, agricultural crop irrigation, creation of wetlands or combination of these opportunities.

6.9.2 System Layout/Schematic

The previous Facilities Plans provided examples of centralized treatment and disposal/reuse.

6.9.3 Applicability to the North Shore Region

Because this alternative ranked lowest of all alternatives for achieving the goals of sustainability and community values, it is the least applicable of all the alternatives.

6.9.4 Cost Implications

The 1996 Facilities Plan provided a cost estimate of over $90 million for collection, treatment and reuse/disposal. The predicted operating cost was over $400,000/yr for a flow of 1.4 mgd (Hydro Resources International, 1996).

Environmental Implications for regional sewering and treatment/disposal or reuse include disruption of transportation corridors and businesses. Positive environmental impacts could include reduced shoreline pollution and improved water quality of receiving waters.

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Section 7

The Wastewater Planning Process

This chapter discusses the planning process and technical tools used to match the various service areas described in Section 4 to the most feasible treatment alternatives discussed in Section 6. Prior wastewater planning efforts conducted in 1987 (Belt Collins, 1987) and 1996 (Hydro Resources, 1996) for the Waialua-Haleiwa areas focused on centralized subregional treatment to handle urban wastewater, while the more rural areas were recommended to continue with existing disposal systems, the majority of which were cesspools.

The 1987 Belt Collins study recommended a single secondary treatment plant based on a sequencing batch reactor (SBR) treatment process with effluent chlorination. Final effluent was recommended to be discharged to an ocean outfall with no provisions for water reuse.

The 1996 Hydro Resources study recommended two regional treatment facilities providing tertiary treatment based on oxidation pond and constructed wetlands treatment followed by slow sand filtration and UV disinfection. This effluent would be of R-1 quality and was recommended for reuse by irrigation or for disposal by rapid infiltration.

For this planning effort, it should be noted that the study area encompassed the entire neighborhood board boundary and was not limited to the urban Waialua-Haleiwa areas as was the case for the other planning efforts. However, this plan does adhere to the designated areas of future growth as defined in the North Shore Sustainable Communities Plan. The intent of this report is to provide different approaches to wastewater management that can serve as guidance for future planning and specific projects within the region. Section 6 presented a toolbox of various alternatives that represent a full spectrum of size, cost, and complexity. The current planning process considered a number of aspects to develop the most feasible alternative to apply to a given service area as defined in Section 4. The following is a description of these criteria and how they were used as tools to develop the alternatives.

7.1 Community Engagement

This study included a Community Engagement effort in which members of the North Shore community that represent, and are active in various community interests, were asked to help establish the direction of the current planning process. The purpose of this CWG was to help identify the fundamental values of the community for the planning team and to provide insight as to how wastewater management can incorporate those values while blending cohesively into the long-term vision of the region. The project team utilized this guidance in developing alternatives for the various service areas throughout the region. Details of the outcomes from the Community Engagement effort are presented in Section 2.

7.2 Related Studies

7.2.1 North Shore Sustainable Communities Plan

The NSSCP is developed by the City DPP. The purpose of the plan is to clearly define the direction of land use and growth in the region, which ultimately influences City Land Use Ordinance (LUO) and Capital Improvement Program (CIP) issues. The NSSCP, combined with the equivalent plans for the other seven defined geographic regions of the island, are the guiding documents for Oahu's development. The NSSCP is reviewed and revised accordingly every five years. The most current revision to the 2000

NSSCP was approved and adopted into law on May 3, 2011. Regarding wastewater management, the current revision of the NSSCP established the following guidelines:

- "Use reclaimed water for irrigation and other uses, where feasible, in accordance with the Guidelines for the Treatment and Use of Recycled Water (May 15, 2002) by the State DOH and the No Pass Line established by the Honolulu Board of Water Supply. A "wetlands" treatment system could serve as wild bird refuges that could also be used as a picnicking area and/or children's fishing park.
- Replace outdated individual cesspools with septic tanks and individual wastewater systems. Consider public programs or policies to support private conversion efforts.
- Discourage new residential, commercial or school uses in close proximity to wastewater treatment facilities where odors will be prevalent.
- Identify appropriate areas and technologies for future wastewater facilities that maintain the rural character and are proportionate to future population projections.
- Do not permit an ocean outfall in the North Shore area."

A goal of the NSRWWAP was to define and recommend alternatives for wastewater management that would be consistent with the long-term vision of the North Shore region as described in the NSSCP.

7.2.2 Waialua Town Master Plan

The Waialua Town Master Plan developed in 2005 was a planning effort initiated by the non-profit organization "Friends for Waialua." It sought to document the community's vision for Waialua Town after the end of sugar production and the closing of the Waialua Sugar Mill in 1996.

The NSRWWAP utilized the Waialua Town Master Plan to determine where future residential, commercial or industrial expansion might take place. It also helped identify areas of potential wastewater effluent reuse.

7.2.3 Kamehameha Schools North Shore Plan

In 2008, Kamehameha Schools completed its North Shore Plan which outlines the future use of some 26,000 acres of Bishop Estates land within the region, much of which was formerly leased for sugar production. The NSRWWAP utilized the Kamehameha Schools North Shore Plan to determine types of growth and future areas of development, in order to estimate wastewater generation quantities and identify potential areas of wastewater effluent reuse.

7.3 Wastewater Regulations, Standards, and Guidelines

A review of the wastewater regulatory framework that exists in Hawaii was conducted for the North Shore region. Appendix A contains applicable information pertaining to wastewater collection, treatment, and disposal. This information was reviewed to ensure that any recommendations made in this plan remained consistent with the current regulatory framework, particularly in regards to reclaimed water use and effluent disposal.

7.4 Technical Tools

There are a number of technical tools that were used to establish and evaluate various characteristics of the North Shore region. Following is a description of these tools and the kinds of information that was obtained by their use.

7.4.1 Regional Characteristic Data

Appendix B contains the following regional data for the North Shore:

- Climate
- Geology and Soils
- Groundwater
- Surface Water
- Coastal Water
- Threatened and Endangered Plants & Critical Habitats
- Air Quality and Nose
- Historic Places
- Population & Socioeconomic Conditions

In addition, Appendix C discusses water quality and water quality management issues in the North Shore Region. This information was used by the project team to obtain a broader understanding of the region and assist in developing recommendations for potential sites for treatment, disposal, or reuse.

7.4.2 Geographic Information System

A GIS is a geospatial software that uses various tools to capture, manage, and analyze data associated with a geographic location. GIS geodatabases from the State of Hawaii and from the City were used. The following GIS feature classes were used in the map generation and data analysis.

State of Hawaii GIS

- Agricultural Lands of Importance – includes land area and type of agricultural designation.
- Conservation Districts – includes district area size, district type and zone.
- Critical Habitats – designated critical habitats for various species, includes designated area name and species name.
- Elevation Contours – displays contours per 5 feet of elevation change.
- Parks (State) – includes park name and size.
- Rainfall – approximate rainfall volume throughout Hawaii.
- Soils – includes soil type and attributes.
- SMA – special management areas, includes area size.
- Streams – includes length, name, and type
- Threatened and Endangered Plants – includes area size and affected concentration/density.
- Underground Injection Control (UIC) – displays regulated UIC boundary where underground injection is and is not permitted.
- Wells – includes well permit number, well name, owner, type, depth, flow capacity and flow rate.
- Wetlands – represents extent, size, location and type of wetlands and deepwater habitats in Hawaii.

City and County of Honolulu GIS

- Aerial Imagery – satellite aerial image of the island of Oahu.
- Flood Zones- includes flood zone type and area.
- Neighborhood Board – includes the various Oahu board districts and sub-districts.

- Parks (CITY) – includes park name and size.
- Treatment Plants – includes information of municipal and private wastewater treatment plants and its capacity and service area.
- Streets – Oahu streets and roads, street names, owner.
- Parcels – tax map key, parcel area.
- Zoning – includes land use designation and type.

7.4.3 Parcel and Zoning Information

The DPP website http://gis.hicentral.com/ was also used for data collection. The DPP website is an online interactive GIS web map and data service which provides detailed information of specific parcels. This detailed information includes parcel property boundaries, size, zoning, land use, and ownership.

7.4.4 Map Generation

Using the described data sources above, GIS maps were generated to show the North Shore region and its geographic properties. As stated earlier, these maps assisted in identifying and/or eliminating areas of potential wastewater treatment or effluent reuse.

Section 8

Recommended Alternatives

In this section the recommended wastewater alternatives for the North Shore are presented and discussed. As stated in Section 2, the alternatives that were developed in this planning effort were evaluated and ranked by the CWG as follows:

Alternative #2 – Form Onsite Maintenance District

Alternative #3 – Upgrade Onsite Systems with Gray Water Separation

Alternative #6 – Neighborhood Cluster Systems with Reuse (Irrigation)

Alternative #8 – Sewer Commercial/Residential Areas for Treatment/Water Reuse (Small WWTFs)

Alternative #5 – Neighborhood Cluster Systems with Injection Wells

Alternative #9 – Sewer Each of the Five Sub-districts of the North Shore for Treatment and Reuse/Disposal (sub-regional WWTFs)

Alternative #4 – Upgrade Cesspool Systems with Septic Tank Addition

Alternative #10 – Sewer the Entire North Shore Region for Treatment and Reuse/Disposal (Regional WWTF)

Alternative #7 – Upgrade Existing Private/Commercial Wastewater Treatment Systems

Alternative #1 – No Action

One guiding principle that the CWG emphasized throughout the process was the promotion of water reuse to encourage sustainable practices and agricultural growth. Therefore, determining potential reuse areas throughout the region was a major factor in recommending the alternatives for wastewater management for each sub-district. Depending on the specific service area being analyzed, one alternative may be more suited for wastewater treatment than another even though it may have ranked lower in the list above.

It should be noted that consideration of alternatives geared toward reuse by irrigation should include pumping and piping costs in future feasibility analysis. In the following figures that show potential areas for reuse, consideration was given only to those areas that were relatively flat compared to the point of wastewater generation to try to limit the amount of pumping and piping that would be required to transmit the water for irrigation.

8.1 Mokuleia Sub-District

As stated in Section 3, the Mokuleia Sub-district has the smallest population of the North Shore region's five sub-districts and is not envisioned to experience much growth over the study period. Figure 8-1.a and 8-1.b show potential areas of reuse that were identified for this sub-district. There were 686 total acres identified for reuse, with 11 of those acres representing Mokuleia Beach Park and the other 675 acres representing private agricultural lands.

8.1.1 Recommended Alternatives

The recommendation for the Mokuleia sub-district involves a combination of two alternatives:

- Alternative #4 – Upgrade Cesspool Systems with Septic Tank Addition
- Alternative #6 – Neighborhood Cluster Systems with Reuse (Irrigation)

Figures 8-2.a and 8-2.b highlight the areas that are recommended for these two wastewater management alternatives.

There are a few pocket areas where the installation of septic tanks is recommended to upgrade or replace existing cesspool systems (Alternative #4). These areas appear to be remote while having sufficient land available to accommodate a septic tank (and leach field if necessary). In fact, one of the areas highlighted for Alternative #4 is the YMCA Camp Erdman, which had already installed a septic tank system in 2005 to comply with the DOH large-capacity cesspool replacement regulations.

The bulk of the wastewater generated in the residential areas of the Mokuleia sub-district can potentially be treated and reused to irrigate the agricultural lands shown in Figures 8-1.a and 8-1.b. This area is described as being between Waialua Beach Road, Crozier Drive, and Farrington Hwy. The total estimated average day wastewater generation from this area is about 220,000 gpd. Installing neighborhood cluster systems with reuse (Alternative #6) was recommended in order to maximize the amount of wastewater effluent going to reuse and eliminating cesspools especially along the shoreline areas where smaller residential lot sizes can prohibit the addition of septic tanks. The exact number and location of cluster system treatment locations is not defined at this time. However, with the ample amount of agricultural land available in this area, identifying suitable reuse locations should be easy, particularly if agreements are made with the private land owners (e.g. Castle & Cooke, Pioneer HiBred, etc.) that would give them first preference to receive the wastewater effluent for reuse.

8.2 Waialua Sub-District

The long-term vision for Waialua as described in the Waialua Town Master Plan is for the town to represent the industrial center of the North Shore region focused around the old sugar mill site while maintaining its small, country-town atmosphere. As Figure 8-3 shows, there are approximately 350 acres of potential reuse area that could be irrigated without requiring significant pumping.

8.2.1 Recommended Alternatives

The recommendation for the Waialua sub-district involves a combination of three alternatives:

- Alternative #2 – Form Onsite Maintenance District
- Alternative #6 – Neighborhood Cluster Systems with Reuse (Irrigation)
- Alternative #8 – Sewer Commercial/Residential Areas for Treatment/Water Reuse (Small WWTFs)

Figure 8-4 shows the recommended wastewater management alternatives for the Waialua sub-district. Small residential areas with limited parcel sizes that are both somewhat remote and a considerable distance from the UIC line were recommended to maintain existing wastewater systems (likely cesspools although we recommend eventual upgrade/replacement at least to a septic system) and incorporate an onsite maintenance district (Alternative #2) to assist (and require) residents in maintaining these systems properly. The existing Mill Camp area was also recommended to implement Alternative #2 since it is considered plantation housing that Dole provides for its former sugar workers and their families. While residents still live in Mill Camp, it is uncertain as to what Dole has planned for this particular area in the long-term.

The more dense residential areas in Waialua were recommended for neighborhood cluster systems with reuse (Alternative #6). Many of these areas are adjacent to streams or coastlines that currently threaten water quality because of potential low-quality discharges from cesspools.

The old sugar mill and town center areas are recommended for Alternative #8 which involves sewering commercial areas for treatment and reuse. The estimated average daily wastewater generation at potential build-out of these industrial/commercial areas is about 230,000 gpd. It is possible that a small treatment facility that serves the old sugar mill and town center areas can also accommodate some residential wastewater from adjacent properties as well, in order to reduce the number of cluster systems serving residential developments.

8.3 Haleiwa Sub-District

With Haleiwa being the hub of commercial activity in the North Shore region, and with Kamehameha Schools planning to develop additional residential and commercial property in the Haleiwa Town area, an opportunity exists for collecting a large portion of the wastewater generated in the region and treating it for reuse on agricultural lands. Figure 8-5 shows that there is potentially around 350 acres available for reuse in and around the Haleiwa Town area.

8.3.1 Recommended Alternatives

The recommendation for the Haleiwa sub-district involves a combination of four alternatives:

- Alternative #4 – Upgrade Cesspool Systems with Septic Tank Addition
- Alternative #6 – Neighborhood Cluster Systems with Reuse (Irrigation)
- Alternative #7 – Upgrade Existing Private/Commercial Wastewater Treatment Systems
- Alternative #8 – Sewer Commercial/Residential Areas for Treatment/Water Reuse (Small WWTFs)

The majority of the Haleiwa Town area is recommended for Alternative #8 which involves sewering commercial areas for treatment and reuse. According to Figure 8-6, about 850,000 gpd of wastewater can be collected and treated for reuse in the Haleiwa Town area.

Residential areas to the south of Helemano Stream which are not sewered for treatment by the Paalaa Kai WWTP are recommended for neighborhood cluster systems with reuse (Alternative #6). It is recommended that the Paalaa Kai WWTP be upgraded (and slightly expanded) to provide tertiary treatment to produce an R-1 quality effluent which will facilitate reuse, and also expand the collection system to allow a few adjacent parcels to connect to the system (Alternative #7).

A small handful of parcels along the sub-district boundary with Pupukea/Sunset Beach mauka of the Haleiwa Bypass Road were recommended for septic tank addition only (Alternative #4) due to their isolated location.

8.4 Kawailoa Sub-District

Due to the proximity of steeper slopes from the Koolau Mountain Range, there is not much potential for significant water reuse in the Kawailoa sub-district. Figure 8-7 shows roughly 50 acres may be available for reuse application.

8.4.1 Recommended Alternatives

The recommendation for the Kawailoa sub-district involves a combination of three alternatives:

- Alternative #4 – Upgrade Cesspool Systems with Septic Tank Addition
- Alternative #6 – Neighborhood Cluster Systems with Reuse (Irrigation)
- Alternative #8 – Sewer Commercial/Residential Areas for Treatment/Water Reuse (Small WWTFs)

Figure 8-8.a includes the recommendation that the Papailoa area have a neighborhood cluster system with reuse that could potentially be used to irrigate a portion of the proposed area shown in Figure 8-7. Commercial activities at this site could potentially increase future reuse opportunities depending on the type of commercial operations that are performed there. Currently, the site is home to Alluvion, Inc. – a horticultural business that could potentially reuse a high quality effluent for its operations. If commercial operations expand at this location in the future, it may be desirable to implement a treatment system that could collect wastewater from both this commercial area and the Papailoa subdivision (Alternative #8) in order to increase the amount of reclaimed water available for irrigation.

Residential areas further north of Papailoa up to the sub-district boundary are recommended for septic tank replacement of any existing cesspool systems, utilizing the existing cesspool for disposal (Alternative #4). A preferred alternative for this area would be to install cluster systems. However, a narrow corridor between the ocean and steep slopes of the Koolau Mountain Range, coupled with limited available land may make identifying a treatment facility location difficult. Future feasibility studies for treatment solutions should include a more detailed analysis of these alternatives.

8.5 Pupukea/Sunset Beach Sub-District

Similar to the Kawailoa sub-district, the Pupukea/Sunset Beach sub-district is largely made up of steep slopes formed by the Koolau Mountain Range. Most of the existing residential and commercial development in this sub-district is located along Kamehameha Hwy with the exception of the residential development that sits at the higher elevations along Pupukea Road. Because of the terrain and the amount of existing development, there are limited opportunities for reuse. Figure 8-9 shows about 160 acres of land at the former UH CTAHR Waialee Livestock site that could potentially be available for, and benefit from, water reuse for irrigation.

8.5.1 Recommended Alternatives

The recommendation for the Pupukea/Sunset Beach sub-district involves a combination of 3 alternatives:

- Alternative #4 – Upgrade Cesspool Systems with Septic Tank Addition
- Alternative #6 – Neighborhood Cluster Systems with Reuse (irrigation)
- Alternative #8 – Sewer Commercial/Residential Areas for Treatment/Water Reuse (small WWTFs)

Figures 8-9 and 8-10 show the recommended alternatives for the Pupukea/Sunset Beach sub-district. The majority of parcels in this sub-district are recommended for the addition of septic tanks for wastewater treatment and reuse of the cesspool for disposal of septic tank effluent (Alternative #4). For the development along Pupukea Road, this appears to be the most feasible alternative because the average parcel size there should be large enough to accommodate the addition of a septic tank, but not meet the space requirements for a leach field.

Some areas immediately along Kamehameha Highway however, may have difficulty accommodating the addition of a septic tank to fit within existing property boundaries. For these areas, a more suitable approach with regard to water quality would be to install neighborhood cluster systems (Alternative #6) or even a small sub-regional plant to accommodate all the wastewater from along Kamehameha Highway within this sub-district (Alternative #8). Lack of available land and the cost of installing a sub-regional collection, treatment and disposal system, however, should be considered in assessing the feasibility of this option.

In addition to serving as a potential site for reuse, the former Waialee Livestock property also presents a possible location for a treatment facility. Figure 8-10.b indicates the residential and commercial

properties that could potentially be served by a treatment facility at this site. As stated previously, the cost of expanding the collection system to properties south of this area would be rather high because many of these areas are a mile or more away from the Waialee site, and sewer mains would likely be installed within the public right-of-way, potentially causing traffic, trenching, and repair issues.

The Turtle Bay Resort's Kuilima WWTP is located about 5 miles northeast of the former Waialee Livestock site. While this represents a considerable distance to convey wastewater from the Sunset Beach area for treatment, discussions with resort representatives indicate that the treatment plant currently has excess capacity, and they would be willing to explore the possibility of treating wastewater from the Sunset Beach area. The treatment plant is privately owned by Turtle Bay Resorts and operated by Aqua Engineers. According to the 2004 Hawaii Water Reuse Survey and Report, the plant was built in 1994 and treats 250,000 gpd and produces R-2 quality effluent. This effluent is blended with brackish water to form a 30% to 40% recycled water concentration prior use for golf course irrigation at the resort. The resort absorbs the cost of recycled water production, and therefore does not pass the cost on to golf course operations. As brought up during discussions with a resort representative, an additional incentive for the construction of a force main that would convey wastewater from Sunset Beach to the Kuilima WWTP includes the potential to extend the bike path from Sunset Beach with a leg to Turtle Bay Resort to help alleviate traffic in the area. The force main project could potentially be included with a sewer collection system installation, where costs could be spread among various interested parties.

8.6 Next Steps

Previous wastewater plans recommended a one or two centralized treatment plant approach to sewer the majority of the North Shore Region, which did not receive the community's support. With the recommended alternatives contained in this plan – guided by direct collaboration with some of the community's most active members in the CWG – the region is not confined to a single solution that would require difficult planning and effort to implement. The decentralized approach allows implementation to occur at different times for different areas, and the more critical locations can be given higher priority.

The community views treated wastewater as a resource and clearly favors reuse whenever possible, with the hope that this resource can be used beneficially – especially in supporting agriculture. Since the Haleiwa sub-district generates the bulk of the region's wastewater, it seems appropriate to give this area more focused attention in the near-term especially since changes are already occurring to implement some of the North Shore's planned growth. Kamehameha Schools will soon be executing its plans to revitalize its North Shore properties, with the bulk of the activity occurring right in Haleiwa Town. This presents an opportunity for collaboration with the possibility of a combined wastewater system to meet the goals described in this plan. With a diverse mix of residential, commercial, recreational, and agricultural components, the Haleiwa sub-district could become a model for decentralized wastewater solutions in a way that will not only protect public health and the environment but also enhance the commercial, agricultural, and cultural value of the area as well.

The most important point that this plan emphasizes is that the establishment of a strong management entity is the backbone of a successful regional decentralized treatment program. The first step to moving forward from this plan would be to evaluate the various management entity options discussed in Section 5 and determine which ones are feasible and appropriate for the specific service areas and treatment recommendations identified in Section 8. This will require collaboration between the local community, City and State regulatory agencies, and potentially private companies as well. This type of collaboration can also assist in identifying various sources of funding, such as those listed in Appendix E. Improving the wastewater landscape of a region as vast as the North Shore undoubtedly presents some difficult challenges. However, utilizing decentralized treatment alternatives coupled with the right management program will at least allow the region to move toward that goal one area at a time.

Figure 8-1.a Mokuleia Sub-District Potential Areas for Reuse

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Figure 8-1.b Mokuleia Sub-District Potential Areas for Reuse (Cont'd)

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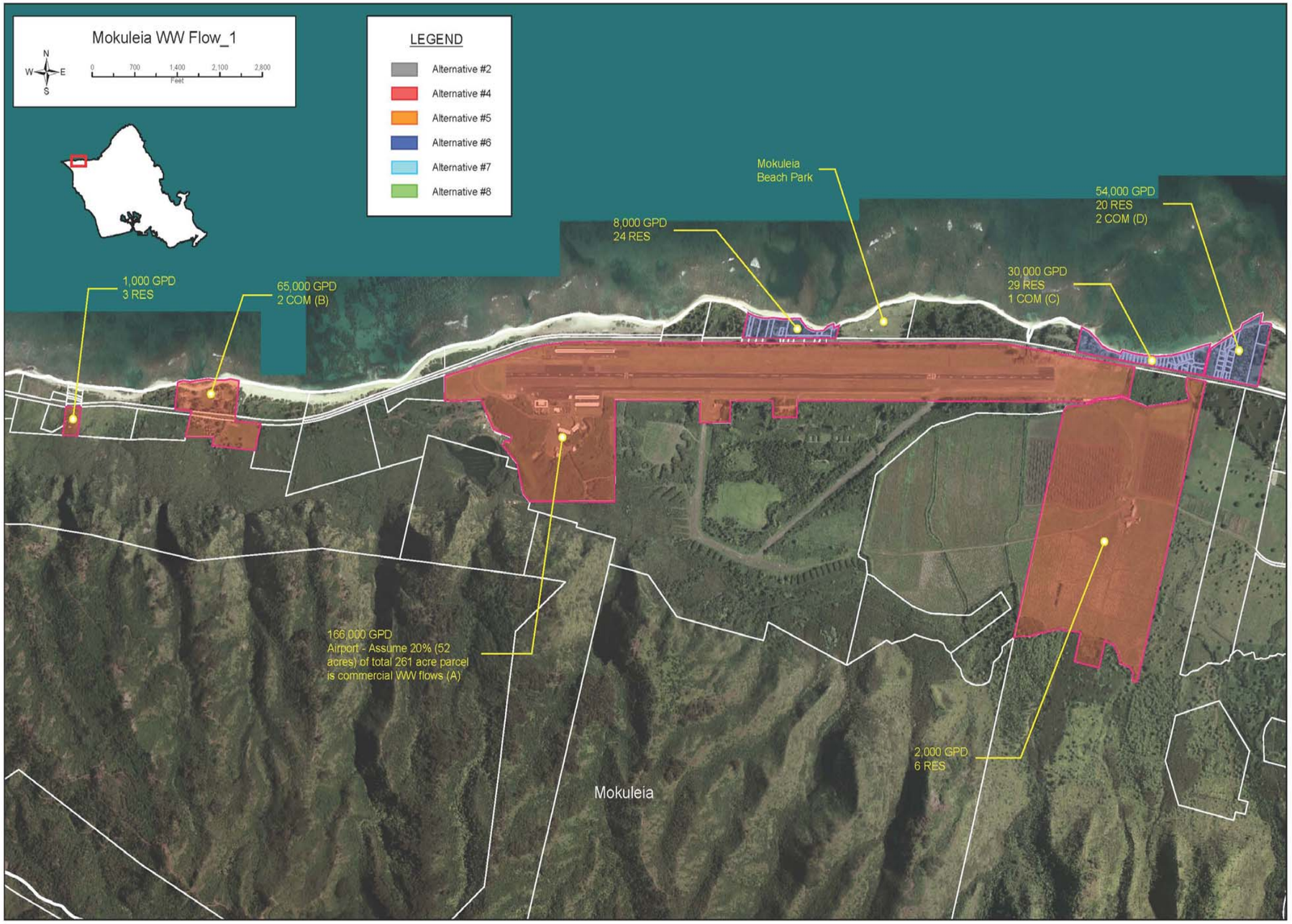

Figure 8-2.a Mokuleia Sub-District Wastewater Management Recommendations

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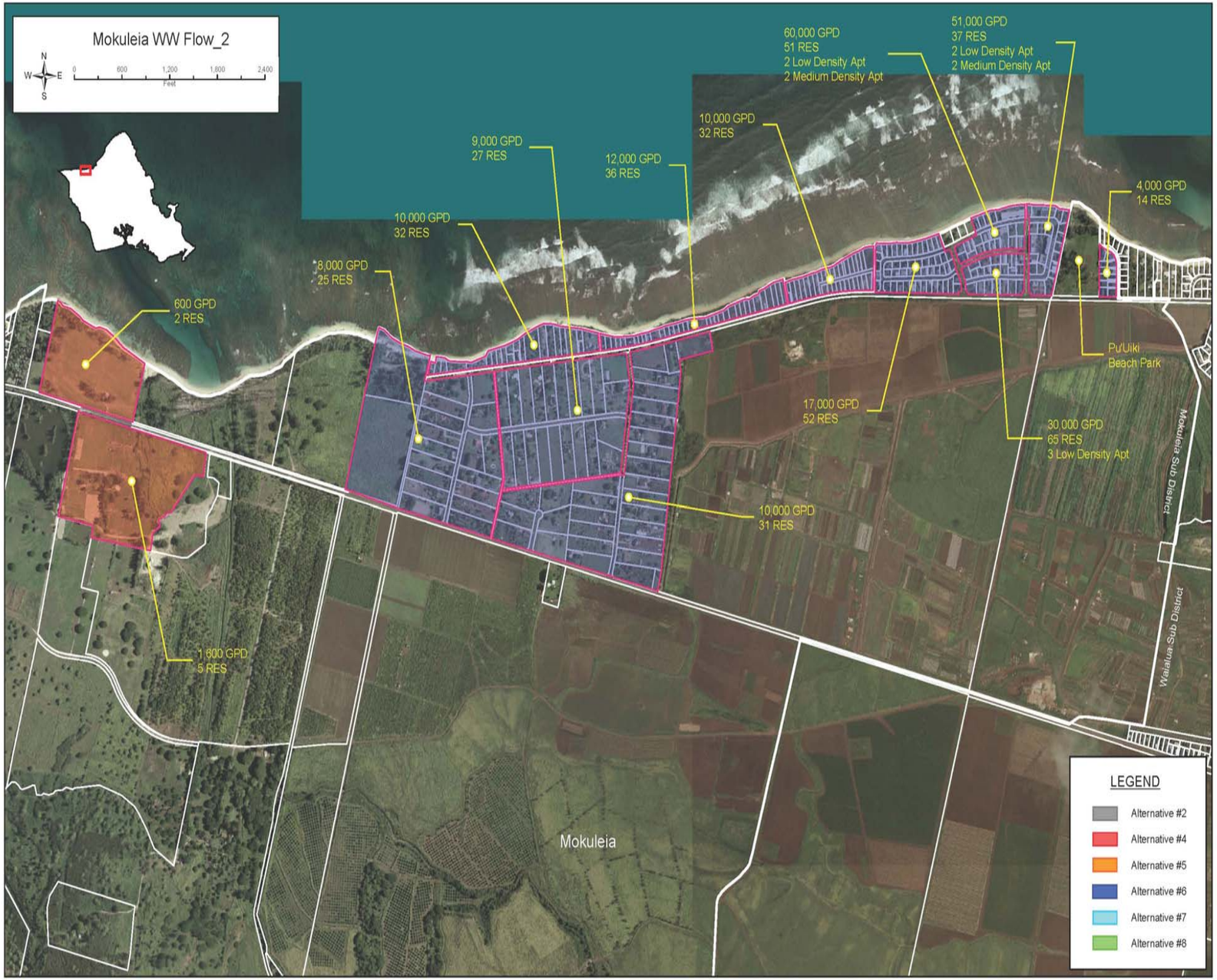

Figure 8-2.b Mokuleia Sub-District Wastewater Management Recommendations (Cont'd)

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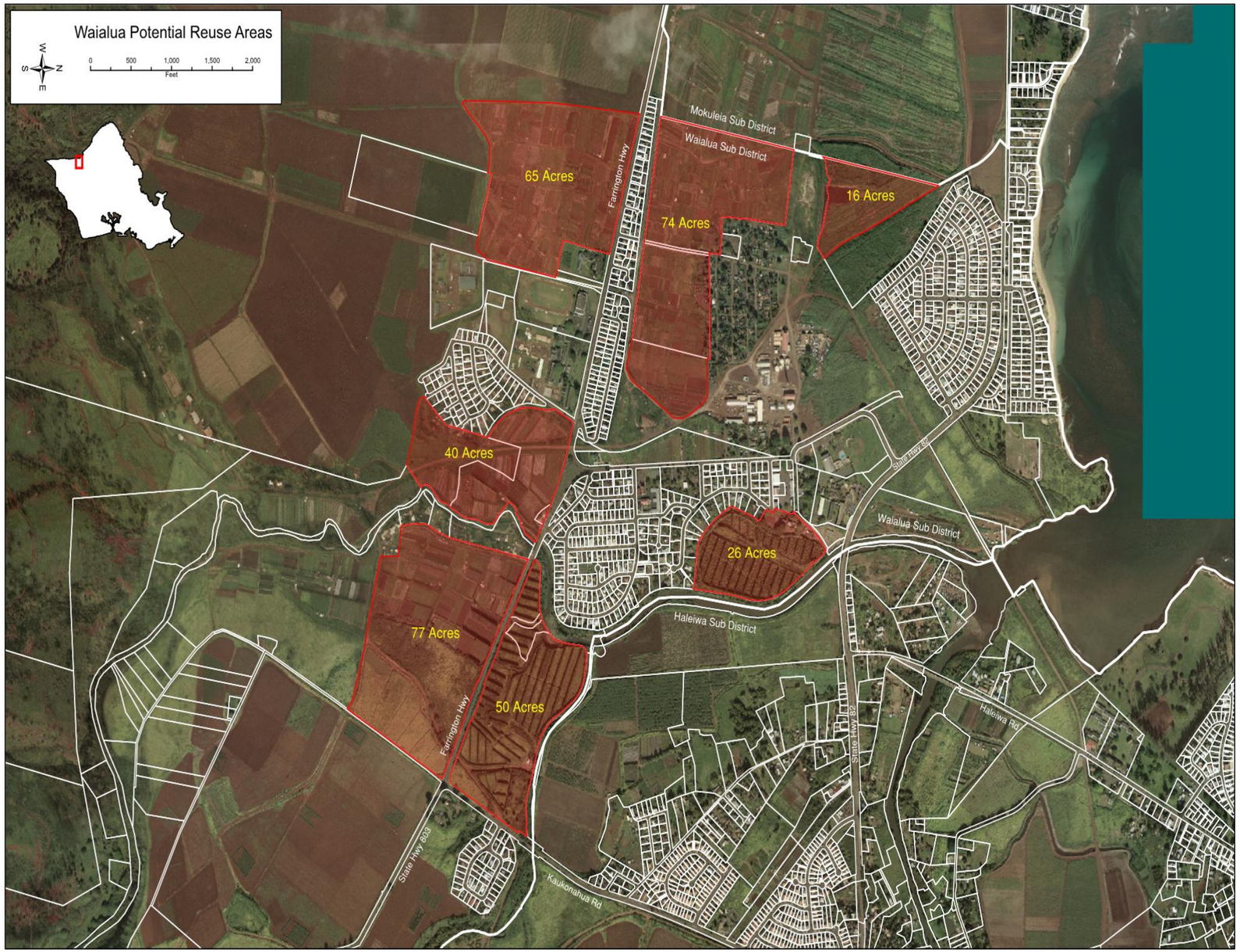

Figure 8-3 Waialua Sub-District Potential Areas For Reuse

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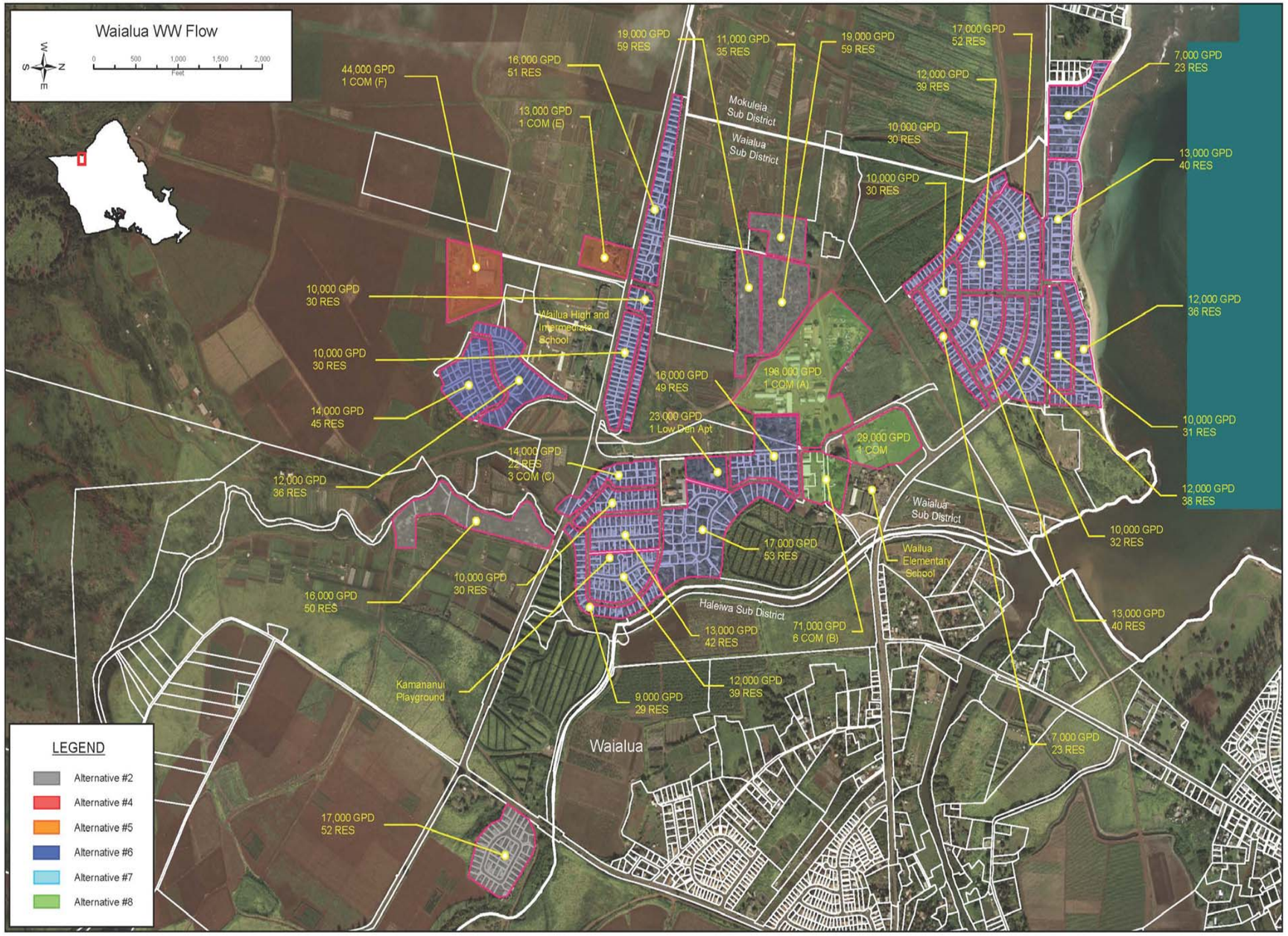

Figure 8-4 Waialua Sub-District Wastewater Management Recommendations

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Figure 8-5 Haleiwa Sub-District Potential Areas For Reuse

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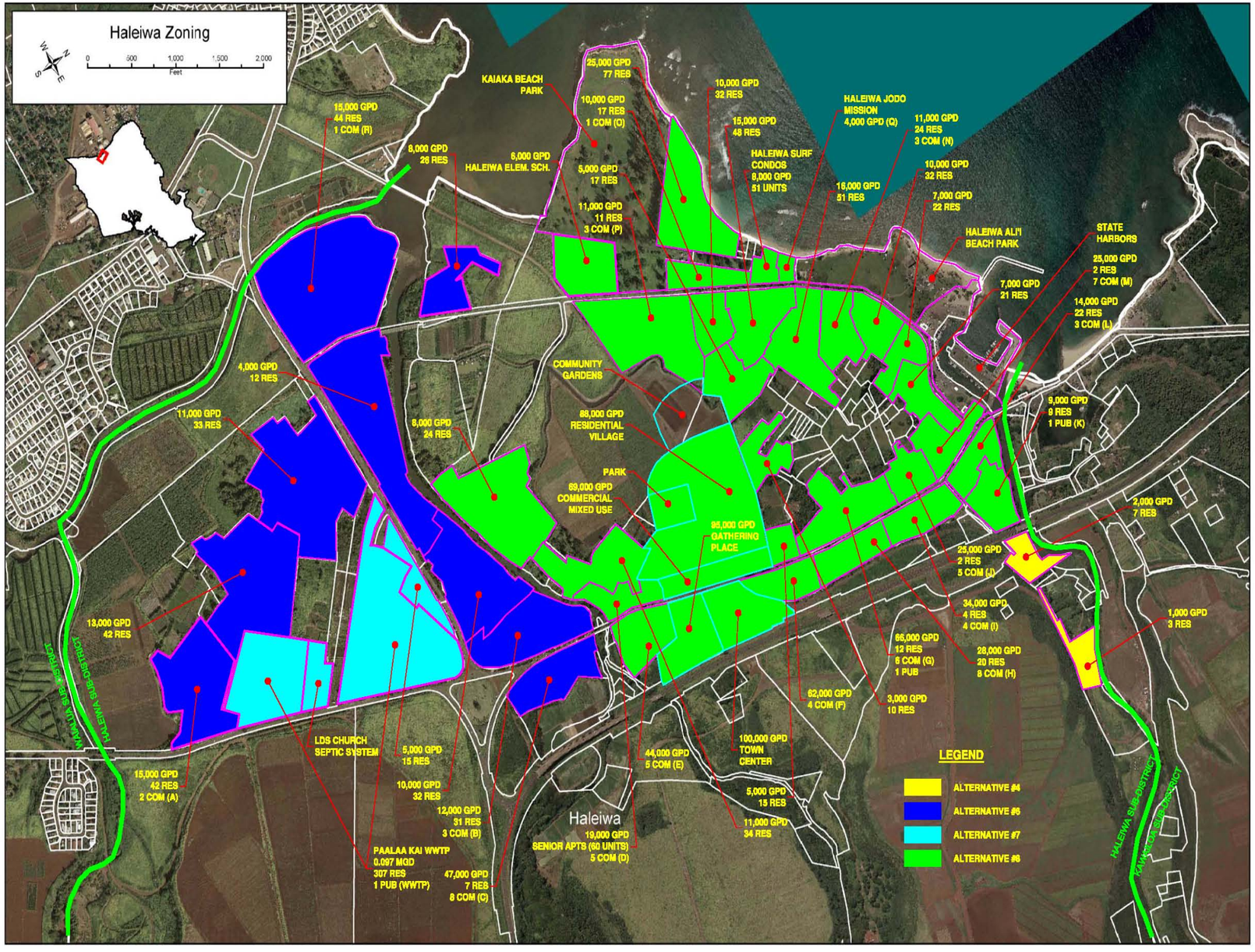

Figure 8-6 Haleiwa Sub-District Wastewater Management Recommendations

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Figure 8-7 Kawailoa Sub-District Potential Areas For Reuse

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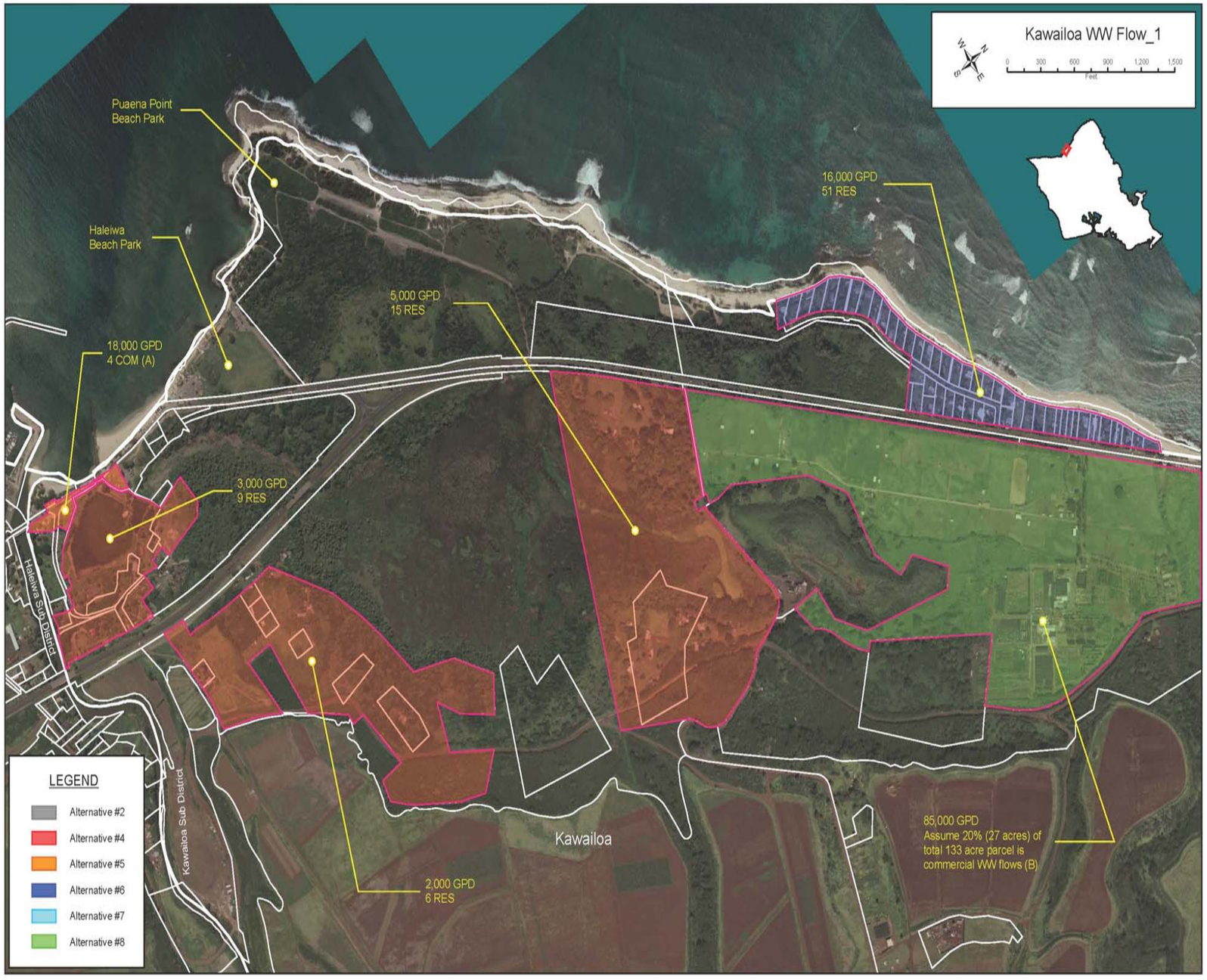

Figure 8-8.a Kawailoa Sub-District Wastewater Management Recommendations

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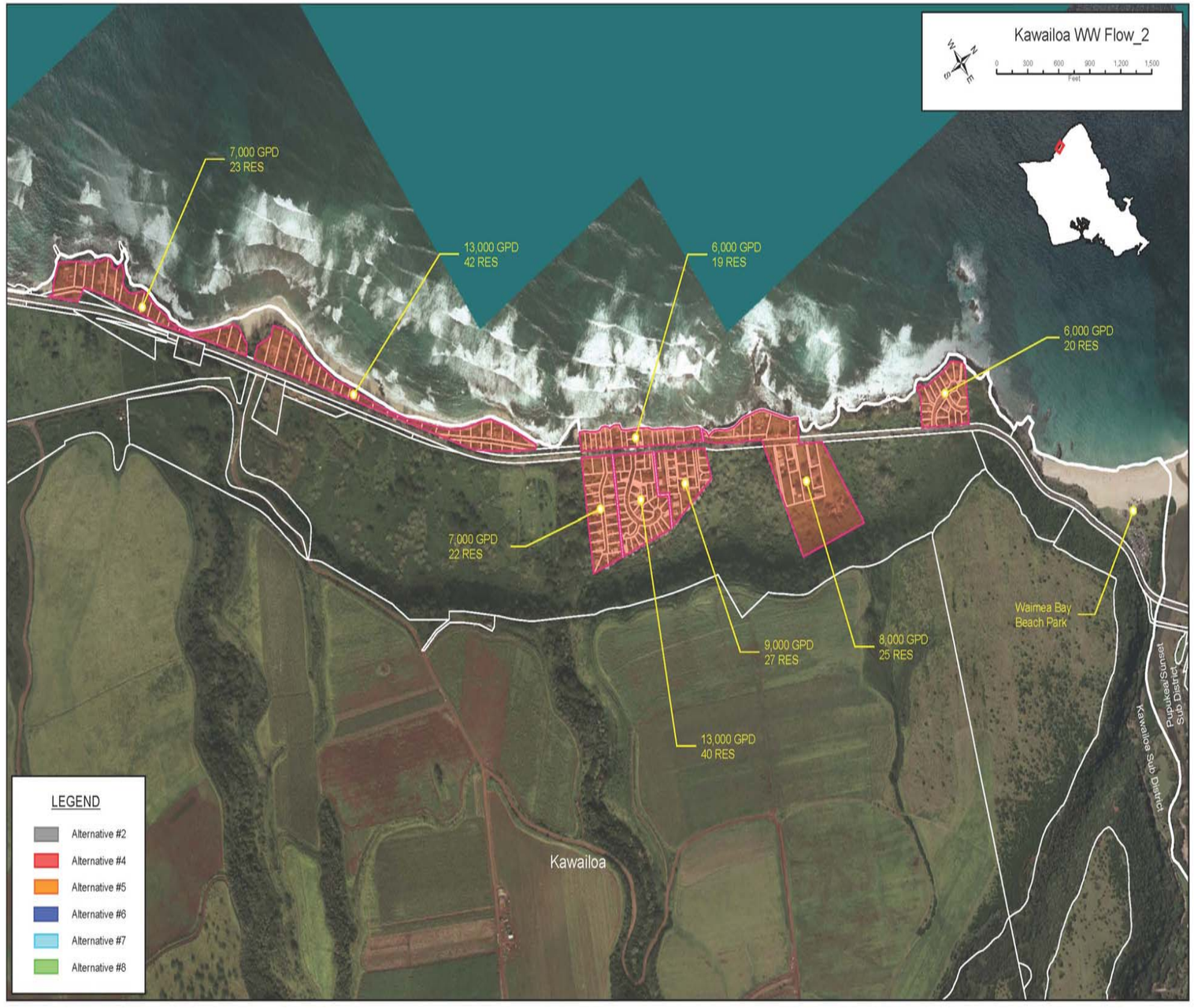

Figure 8-8.b Kawailoa Sub-District Wastewater Management Recommendations (Cont'd)

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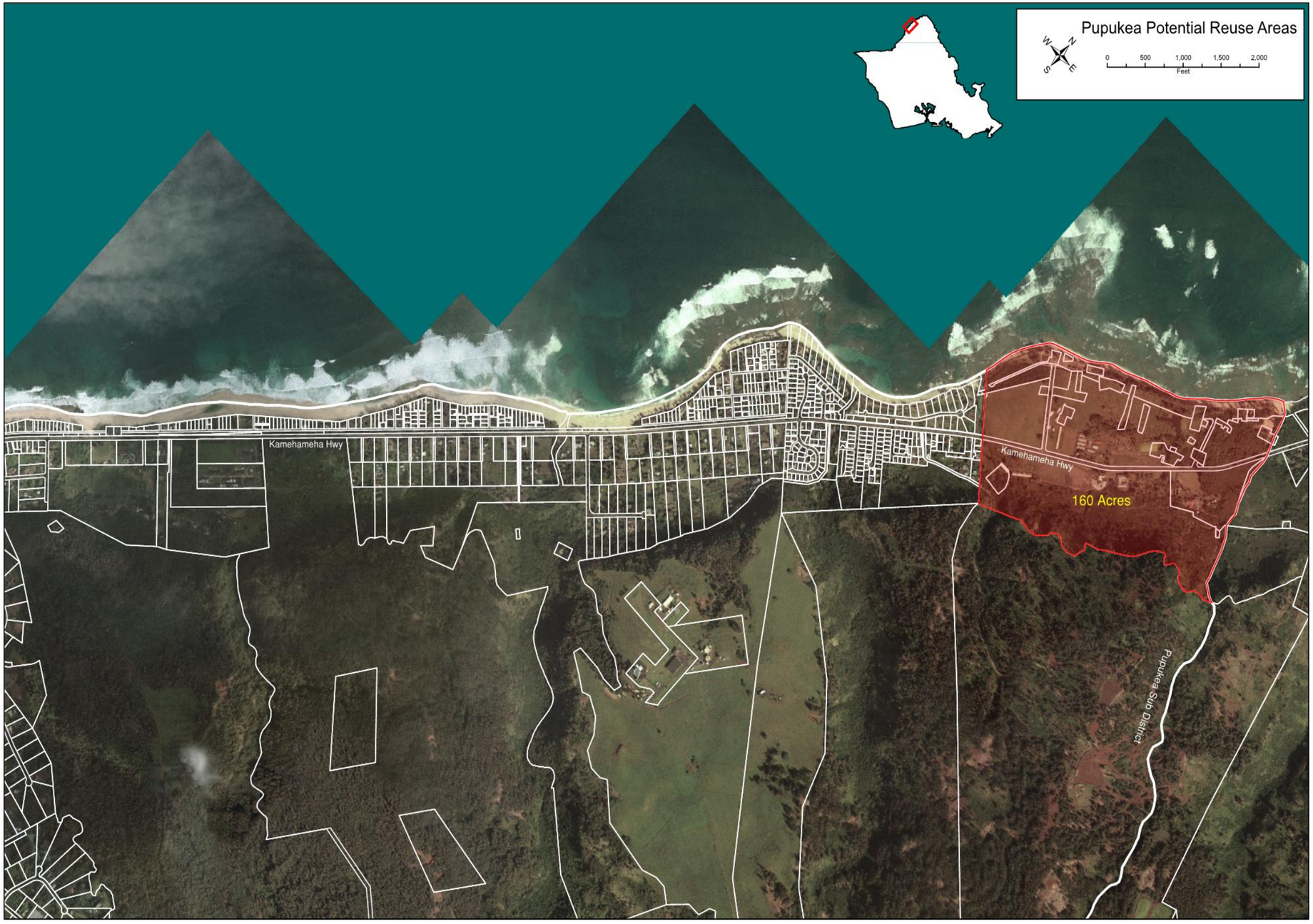

Figure 8-9 Pupukea/Sunset Beach Sub-District Potential Areas For Reuse

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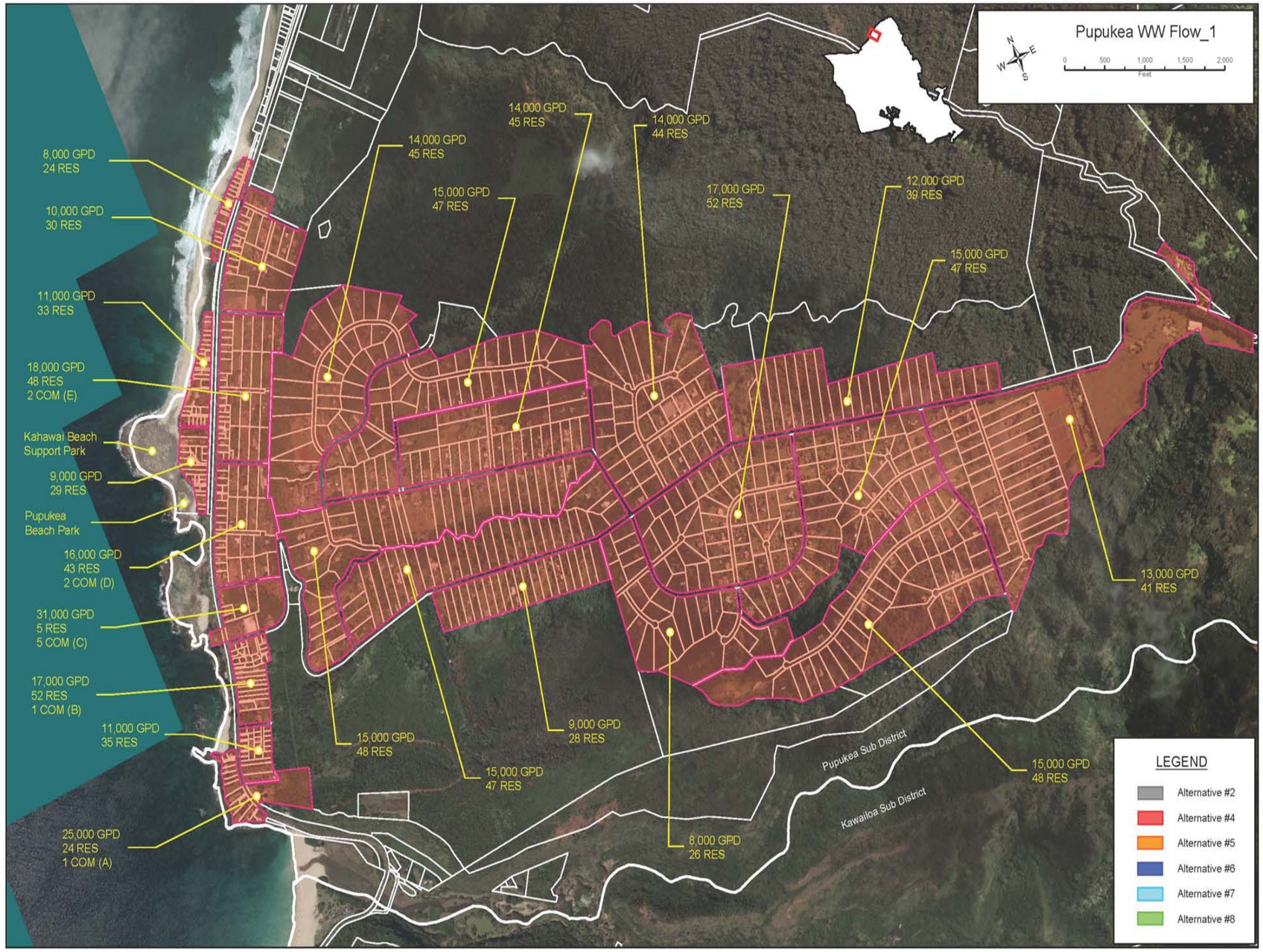

Figure 8-10.a Pupukea/Sunset Beach Sub-District Wastewater Management Recommendations

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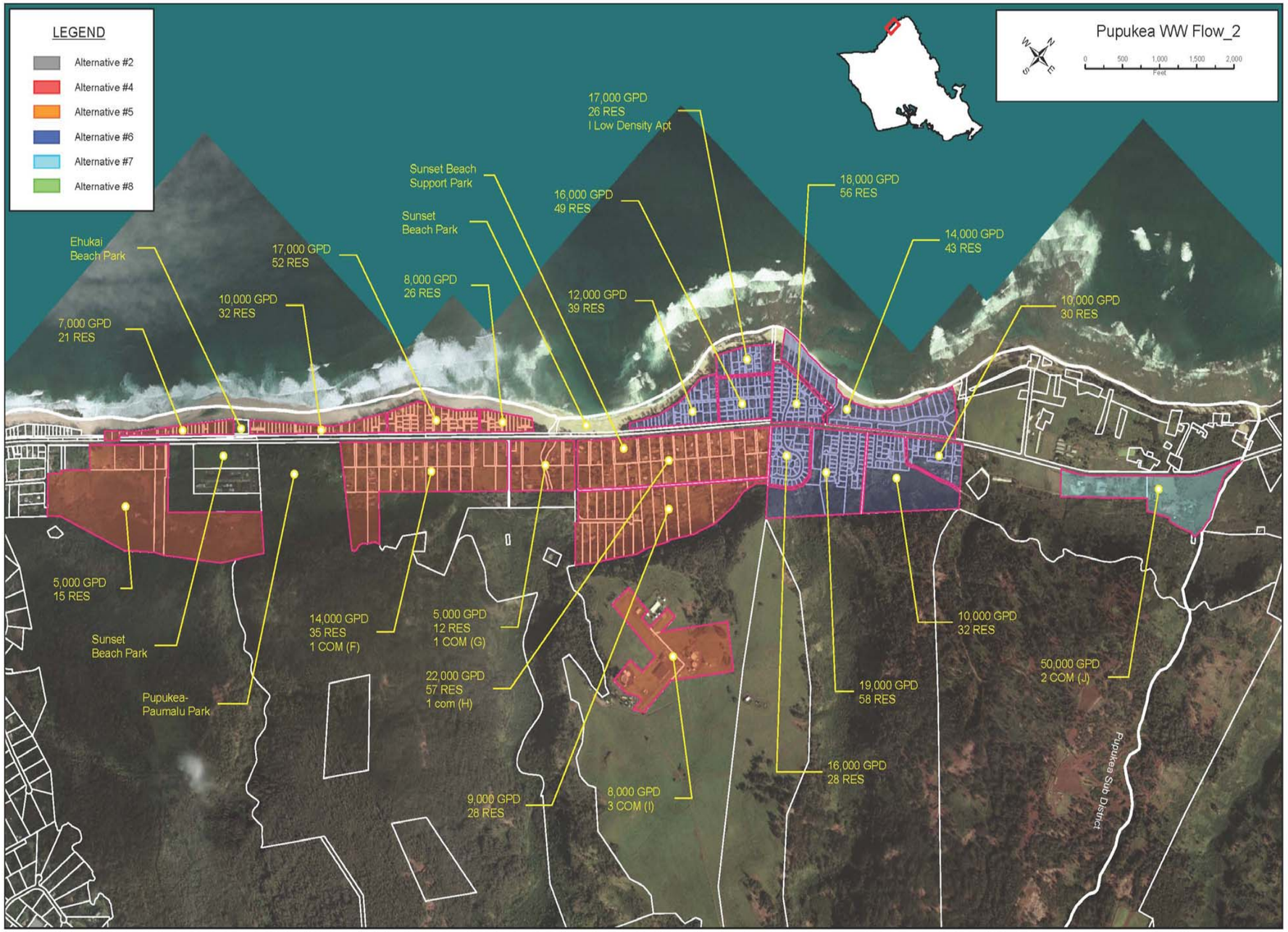

Figure 8-10.b Pupukea/Sunset Beach Sub-District Wastewater Management Recommendations (Cont'd)

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