Prepared by:
AECOM
Honolulu, HI
November 2018

Ka‘elepulu Watershed Water Quality Analysis Planning Study

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List of Acronyms

BMPs	best management practices
CCH	City and County of Honolulu
CWA	Clean Water Act
CWB	Clean Water Branch – State of Hawaii
EPA	U.S. Environmental Protection Agency
DOH	Department of Health – State of Hawaii
GI	Green Infrastructure
HDOT	Hawaii Department of Transportation – State of Hawaii
KBAC	Kailua Bay Advisory Council
LID	Low Impact Development
LIDA	Low Impact Development Approach
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NSPECT	Nonpoint Source and Erosion Comparison Tool
O&M	Operation and Maintenance
PRC	Pollution Runoff Control
RFP	Request for Proposal
ROW	Right of Way
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACE	US Army Corps of Engineers
WQ	Water Quality
WRAS	Watershed Restoration Action Strategy

Executive Summary

Background and Watershed Function

In the mid-1960s, increased residential development on the windward coast of Oahu resulted in the conversion of the historic Kaʻelepulu wetland into Enchanted Lake (Kaʻelepulu Pond). Flood control projects completed in 1966 diverted fresh water that historically flowed through the wetland. The removal of the fresh water inflows and the creation of the Kaʻelepulu Pond altered the historic dynamic equilibrium of the watershed.

Prior to the creation of the open water facility, the wetland fluctuated in size based on the surface water flows and sediment delivered from the watershed. During wet years the wetland grew in size and was able to transport stored sediment to the ocean. During dry periods the wetland would shrink as sediment would accumulate until flows could flush it out to sea. Sounds good, but is there any historical documentation to back this up?

The conversion of the functioning wetland to the pond along with the flood control projects altered the dynamic equilibrium of the system. The configuration of the pond created a longer flow path through the open water resulting in, lower flow velocities and longer travel times. Both factors of which contribute to sediment deposition. The creation of impervious surfaces altered the hydrologic response of the watershed and the composition and volume of sediment.

Since the creation of the Kaʻelepulu Pond the system has been attempting to reach a state of equilibrium where sediment delivered to the pond is balanced by the conveyance capacity of the flows associated with the watershed. Unfortunately, the natural dynamic equilibrium appears to require the pond to fill in until a stable channel is developed. This process is evidenced by the appearance of wetlands at the outfalls of the major channels. Or is the presence of wetlands at the outfalls of major channels an indication of poor sediment controll at construction sites, and debris control from roads and urban settings?

Short of letting Kaʻelepulu Pond develop into a stable system, which would likely eliminate the open water amenity, a program of accounting for the volume of sediment entering the pond is required. The two options available to achieve this goal are:

1. Reduce the volume of the sediment being conveyed by the drainage ways and discharging to the pond.
2. Capture the material in the pond and remove it.

This report details the steps taken to establish an approach working with the community and stakeholders to identify the water quality issues found in the watershed and provide implementable solutions that meet the needs required to maintain and improve the water quality of the Kaʻelepulu Pond.

Stakeholder/Community Involvement

Two stakeholder/community meetings were held as part of the project. The meetings provided a platform to inform the community of the goals of the project and provide information on the progress being made. At each meeting AECOM and CCH provided a Powerpoint presentation detailing the past project efforts, the project findings, and potential paths moving forward.

In turn, the meetings also allowed the community to provide input on their concerns for the health of the Kaʻelepulu Pond and approaches they felt would benefit the water quality within the pond. Discussions between project team and community helped better define the physical and organizational constraints for implementation of preferred projects.

Existing Document Review

Through the years the Kaʻelepulu Pond has been the focus of multiple of studies. Most of the studies were conducted for the local watershed groups, Hui O Koolaupoko or the Kailua Bay Advisory Council. A review of the previous efforts and results provided this project with foundation of information on watershed conditions, issues and pathways to move forward.

These earlier efforts conducted similar watershed investigation and typically provided a list of appropriate best management practices.

Field Observations
Multi-day field reconnaissance was conducted as part of the project. The site visits included watershed conditions during dry and wet periods and allowed the team to document stormwater issues impacting the water quality of Kaʻelepulu Pond.

- Yard debris disposal in drainage channels
- Bare and unprotected soils in neighborhood and along roadways
- Trash and accumulated material in street gutters
- Non-functioning construction site BMPs.

Identification of Stormwater Quality Issues
Based on the findings from the field observations the current stormwater quality issues associated with the Kaʻelepulu Pond were identified based on the land use.

Residential land use makes up largest portion of the Kaʻelepulu Pond watershed. Many of the issues associated with the residential areas can be classified as "housekeeping" issues. Dumping of yard debris and trash was evident throughout the watershed, resulting in the material being flushed into the canals and pond.

Also found in the residential areas were locations with unvegetated soils. This issue was identified on slopes associated with residential yards and along roadways, as well as locations where grass areas were used for vehicle parking, resulting in bare earth. During rain events these unprotected areas provide a sediment source. Along with the exposed soil at existing homes, new construction and remodeling have created freshly disturbed soils. Permitting requirements for erosion control at these sites do not appear to be monitored or strictly enforced.

Conservation lands in the upper watershed above the Kalanianaole Highway receive the most precipitation. Site investigation found the conservation land to be functioning naturally. Most rain appears to infiltrate into the soils and flow subsurface to the streams or the water remains subsurface, perhaps reaching the pond. There are identified locations of small slides that provide a sediment source to streams. This is a natural occurrence and does not appear to be providing unexpected volumes of material.

Agricultural lands are limited to only a few parcels within the watershed. That said, there did not appear to be typical erosion protection farming practices used, such as contour plowing, grass filter strips, or ground cover vegetation.

Commercial properties are mostly found along Keolu Drive, tributary to the pond and Hamakua Drive, tributary to Kawai Nui Canal. The commercial properties represents a small fraction of the overall watershed area but poorly maintained parking lots provide a source for pollutants such as oils and metals.

No mention of large area of poorly maintained streets, or large active construction sites with poor BMPs.

Proposed Conceptual Projects
As promoted in the previous watershed strategy plans reviewed for this effort, community education is suggested as a non-structural approach to addressing water quality issues in the Kaʻelepulu Pond watershed. Working with local schools and Hui O Koolaupoko, educational programs can be established (or strengthened). Along with community education, the CCH should enhance its street sweeping program in the watershed and perhaps the island. During one of the community meetings some residents stated they have never seen a street sweeper in the watershed. Whether true or not, making the street sweeping program more visible to the public provides for less material contribution from the streets and knowledge that CCH is partner in maintaining the water quality of the pond.

Based on the community input and watershed opportunities four projects are recommended within the Kaelepulu Pond watershed. The silt basin modifications and constructed wetlands are associated with specific locations. Green Infrastructure approaches are opportunity based projects that can be implemented throughout the watershed but the project typically require a partnership between CCH and a landowner. The Hydrodynamic Separators can be used within the existing right of way but they may result in the highest capital costs as well as operation and maintenance costs.

Project	Description	Cost
Kapaa Silt Basin Modifications	The Kapaa detention basin is a privately owned facility at the upstream extent of the Keolu Channel. The design and operation of the facility is not documented so it is not known if the facility's design maximizes the benefit of the facility. This project will assess the current facility to determine the effectiveness of the detention facility. Based on the findings there is a potential to modify the facility to more effectively provide water quality improvement impacting the quality of water in the Ka'elepulu Pond.	$ 2,076,400
Constructed Wetlands	It is proposed to have constructed wetlands at the outfall of the channel near Ka'elepulu Elementary School, along the outfalls along Keolu Drive between Akipohe Street and Akea Place, as well as potential modification to existing Ka'elepulu Wetland Bird Preserve to better protect this resource.	$ 761,500
Hydrodynamic Separators	Hydrodynamic Separators (HS) are sediment removal facilities designed into standard manhole configurations. The HS can be used to replace existing manholes and provide sediment removal treatment. The project objective is use HS units at locations where green infrastructure options are limited. The Ka'elepulu Pond project area this would include streets with steep slopes, narrow streets, land owners not willing to collaborate with the City of green infrastructure approaches. The HS have limited flow conveyance capacity so they either need to be placed on stormwater feeder lines or a low flow bypass needs to be constructed.	$ 1,378,800
Green Infrastructure	Green infrastructure (GI) is designed to promote infiltration of stormwater runoff from impervious surfaces. Depending on the location the GI approaches will include rain gardens, flow-through planters, rainwater collection, and cisterns. Each of the GI approaches can be designed to individual properties or larger areas. They can be applied to both residential and commercial locations. The visible nature of the GI treatment approach add aesthetic to the neighborhood and provides for educational interactions between the GI owner their neighbors, particularly if the GI is implemented at local elementary schools.	$ 5,632,300

1.0 Introduction

1.1 Purpose

The Kaʻelepulu Pond (Enchanted Lake) is a privately owned, man-made water body located in Kailua, Hawaii (Figure 1-1). Stormwater infrastructure maintained and permitted by the City and County of Honolulu (CCH) discharges surface runoff into the pond. Sediment build-up and odors in the pond have residents adjacent to the pond concerned about to the water quality associated with the stormwater runoff being discharged to the pond.

Currently, mitigation efforts are being completed at various locations in the watershed. These projects were proposed in the Storm Water Best Management Practices (BMP) Plan for Four Major Outlets at Kaʻelepulu Pond (November 2008). Using the information developed as part of the 2008 report and earlier reports, this project will develop additional potential projects that will address the water quality concerns of the residents and other stakeholders.

But will ignore the primary recommendation of the 2008 report to install filter systems in the four major outlets.

An Ahupua'a approach is used that looks at the health of the entire watershed to identify causes of current water quality issues and how mitigation efforts will impact the health of not only the pond but also the natural processes of the entire watershed. This approach focuses on not only potential structural options but also uses tools that include regulatory changes as well as community education.

1.2 Kaʻelepulu Pond Watershed

The approximately 3,000 acre Kaʻelepulu Pond watershed is located on the windward coast of Oahu. Kaʻelepulu Pond historically existed as a naturally occurring pond, hydraulically connect to the Kawai Nui Marsh. Mapping dated from 1884 indicated an open water area of approximately 190 acres with an additional marsh area of 90 acres. The pond and marsh area had limited connection to Kailua Bay due to natural topography and man-made earthen embankments.

I'd like to see the historical evidence of this....

As the eight time series of photos (Figure 1-2) illustrates, prior to the conversion of Kaʻelepulu Pond from a wetland to the Enchanted Lake, the natural configuration of the open water extent varied. The historic naturally functioning wetland would fluctuate to reflect the hydrologic condition of the watershed that delivered stream flows and sediment. During dry years the wetland may allow more vegetation to get established. Then during wet years the vegetation would slow the stream flows and filter some of the sediment load. The volume of stored material within the wetland would fluctuate, accumulating until a large storm would create runoff conditions with enough energy to convey the sediment to the ocean.

Residential development in the Kaʻelepulu Pond watershed began in the 1960s on the hillsides above the pond. The following series of photos provided by the US Army Corps of Engineers illustrates the time line of the development of the Kaʻelepulu Pond area. The development was named Enchanted Lake with the developer using earth from adjacent hill grading to fill and shape the Lake. The Lake was dredged 15 feet. As part of the Enchanted Lake development agreement the infrastructure, which included storm drains, was deeded to the City with a drainage easement to the pond.

Water in the pond is connected to Kailua Bay through Kaʻelepulu Stream. The mouth of the stream, located in the Kailua Beach Park, is typically blocked by a naturally occurring sand berm. Occasional large storm events naturally remove the bar and allow the water in the pond to flow out to the ocean. Historically the mouth has periodically been dredged to promote drainage of the pond.

A 1966 flood control project diverted fresh water flows to the pond, blocking conveyance from the Kawai Nui Marsh. The Kawai Nui Canal was created to provide conveyance of subsurface and surface flows.

The canal is connected to Kaʻelepulu Stream, so when the sand bar is removed the flows in the canal and the stream flow into Kailua Bay.

The Kaʻelepulu watershed is highly developed, mostly with single family residential, but it also contains commercial and multi-family residential. As with most development, there is the creation of impervious surfaces including: streets, roofs, driveways, and parking lots. Most of the Kaʻelepulu watershed is directly tributary to the pond. The developed commercial core of Kailua is indirectly connected to the pond. Stormwater infrastructure conveys runoff that discharges into the canal that runs along the southern edge of the town. Flows in the canal can either flow north to the Oneawa Canal or into Kawai Nui Canal, then into Kaʻelepulu Stream. Table 1.1 lists land use distribution with the Kaʻelepulu watershed. The impervious area includes structure roofs and parking areas.

FALSE

Table 1.1 Land Use with the Kaʻelepulu Pond Watershed

Pervious	Area (acres)	Impervious	Area (acres)
Bare Land	7.1	Highway	16.1
Cultivated/Grassland	22.6	Street	288.3
Evergreen Forest	565.9	Parking Lot	68.1
Developed Open Space	158.0	Open Water	125.1
Emergent Wetland	26.9	General Impervious (CCAP)	75.7
Forested Wetland	7.2	Roof – Single Family	434.5
Scrub/Shrub Wetland	4.5	Roof - Multi-Family	16.1
R-10 Residential	90.7	Roof - Commercial	23.1
R-7.5 Residential	141.8	Roof - Schools	12.2
R-5 Residential	625.4	Roof - Church	1.8
Scrub/Shrub	304.0	Roof – Misc. Structures: Rec Center, HiDOT, Golf Club House	3.8
Unconsolidated Shore	1.6		
Total Pervious	1955.7	Total Impervious	1064.8

The urbanization of the watershed has led to an increase in surface water entering the pond. The CCH discharges stormwater into the pond through 37 permitting outfall. Another 36 permitted outfalls discharge to Kawai Nui Canal. The water quality of the pond has been adversely impacted by the urban runoff due to an increase is sediment deposition and nutrients like nitrogen and phosphorus. Table 1.2 provides the water quality standards.

Table 1.2 State Water Quality Standards for Ka‘elepulu Stream and Pond (Estuary)

Parameter	Units	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value more than 2% of the time
Total Nitrogen	mg/L	0.2	0.35	0.5
Ammonia Nitrogen	mg/L	0.006	0.01	0.02
Nitrate+Nitrite Nitrogen	mg/L	0.008	0.025	0.035
Total Phosphorous	mg/L	0.025	0.05	0.075
Chlorophyll a	mg/L	0.002	0.005	0.01
Turbidity	N.T.U.	1.5	3	5
Total Suspended Solids (TSS)[1]	mg/L	20[2] 10[3]	50 30	80 55

1. Standards are for streams/ 2. Wet Season criteria/ 3. Dry Season criteria

Figure 1.1 Ka‘elepulu Pond Study Area

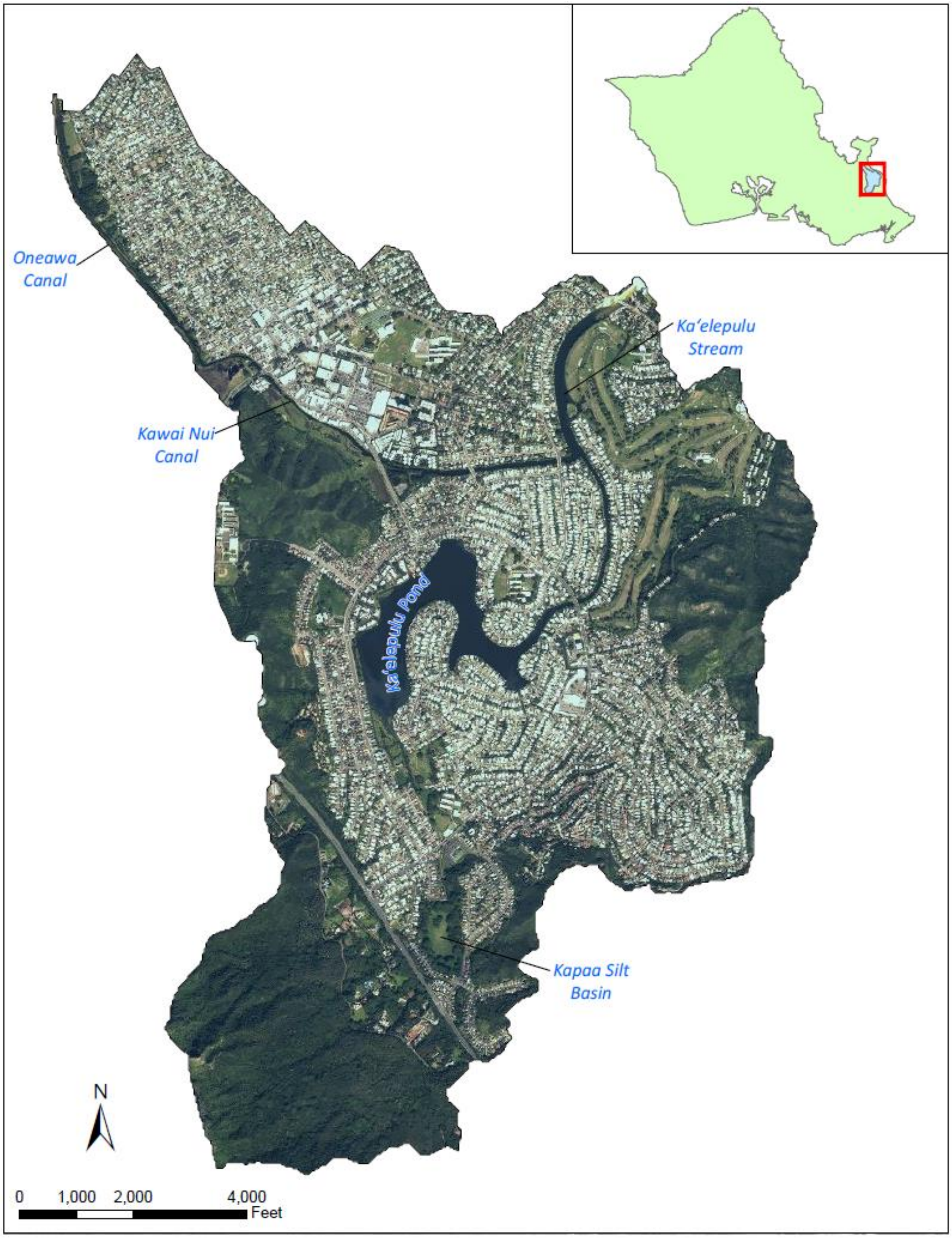
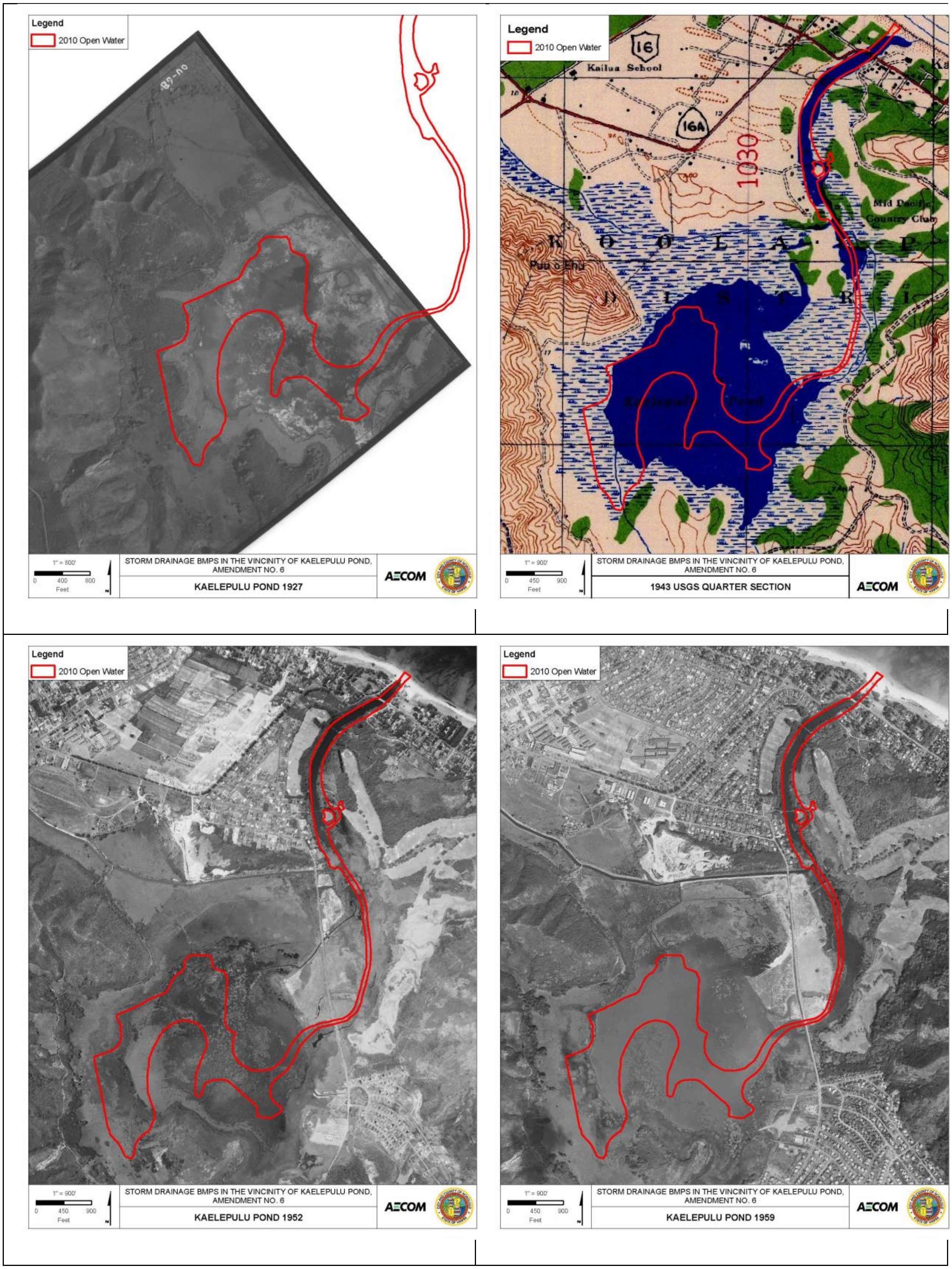
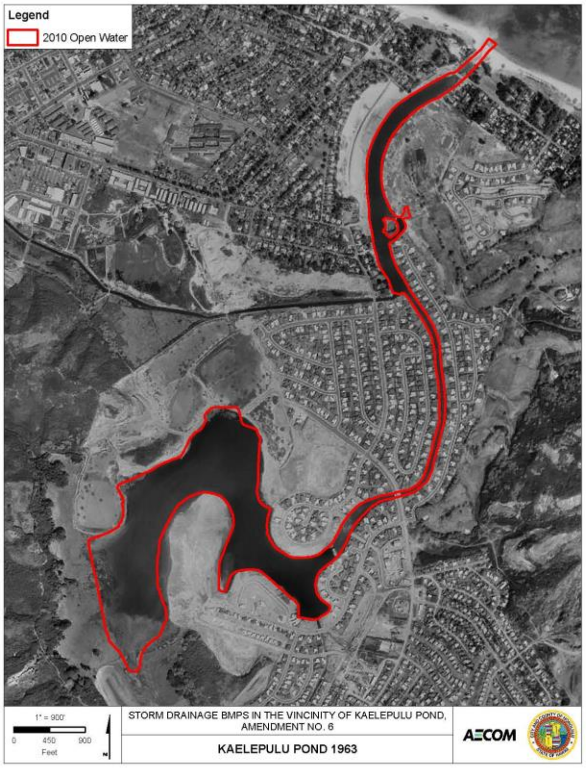
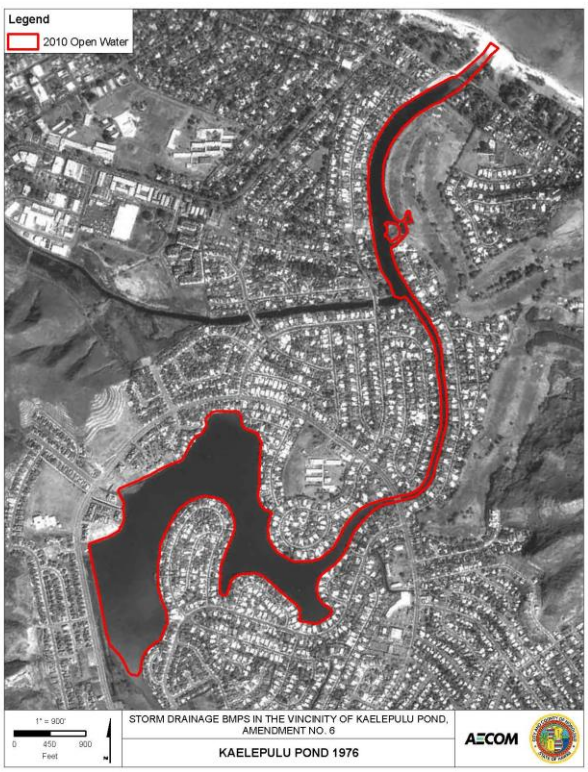


Figure 1.2 Ka‘elepulu Pond Historic Aerials and Maps




Legend
2010 Open Water
1" = 900'
0 450 900
Feet
STORM DRAINAGE BMPS IN THE VINCINITY OF KAELEPULU POND, AMENDMENT NO. 6
KAELEPULU POND 1963
AECOM


Legend
2010 Open Water
1" = 900'
0 450 900
Feet
STORM DRAINAGE BMPS IN THE VINCINITY OF KAELEPULU POND, AMENDMENT NO. 6
KAELEPULU POND 1968
AECOM


Legend
2010 Open Water
1" = 900'
0 450 900
Feet
STORM DRAINAGE BMPS IN THE VINCINITY OF KAELEPULU POND, AMENDMENT NO. 6
KAELEPULU POND 1976
AECOM

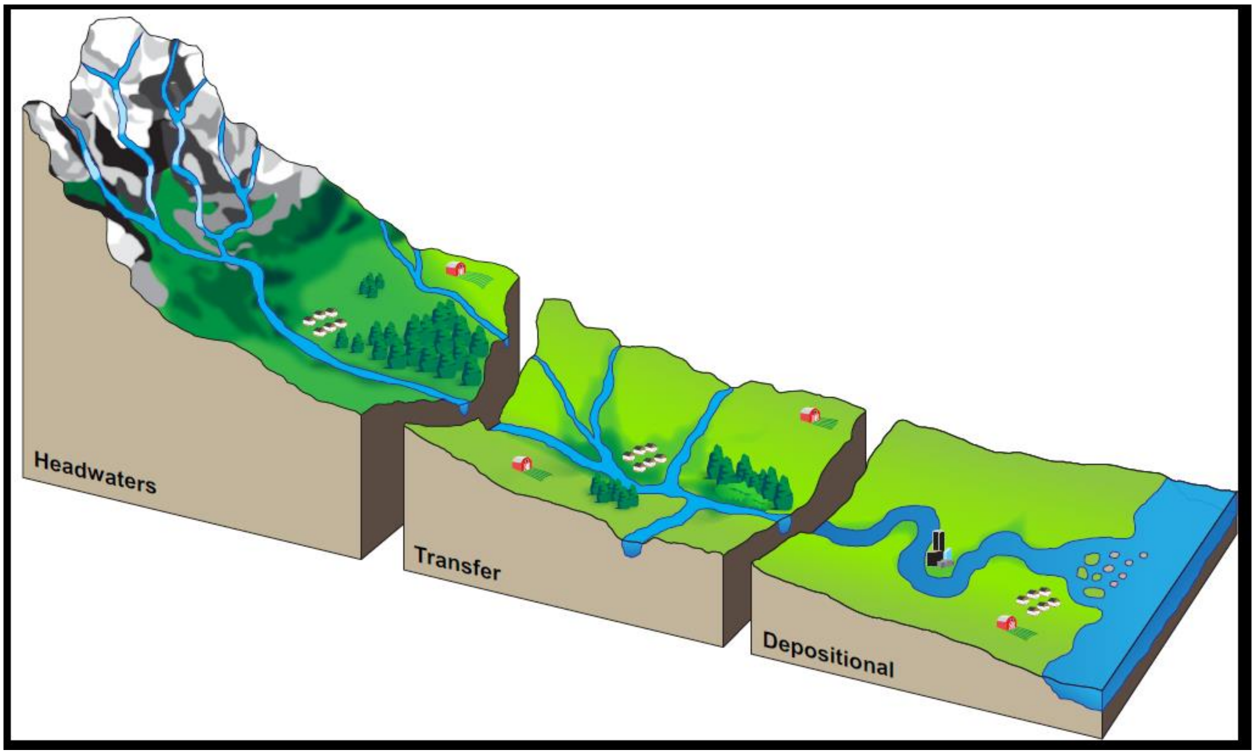

Legend
2010 Open Water
1" = 900'
0 450 900
Feet
STORM DRAINAGE BMPS IN THE VINCINITY OF KAELEPULU POND, AMENDMENT NO. 6
KAELEPULU POND 2010
AECOM

2.0 Watershed Functions

2.1 Watershed Landscape

Degradation of watershed health may result due to a range of natural and human activities. Any change within a healthy watershed may alter the historic and natural functions that shaped and developed the drainage system. Collectively the impact of human activities within a watershed may alter the natural watershed attributes that formed the elements critical to the health of the watershed and stream. When addressing the healthy natural function in a watershed it is important to understand the relationship between the location within the watershed and the natural fluvial functions. Figure 2-1 illustrates the three general fluvial functions reaches in a watershed.

Figure 2.1 Watershed Sedimentation Zones



Each zone is characterized by how it generates and conveys stream flows and sediment. The three zones are described as:

- Headwaters are characterized by steeper topography and stream flowing in V-shaped valleys. Due to the generally steeper terrain associated with the Headwaters it is typically the least populated and developed area of a watershed. This zone generates a majority of the water volume and provides the source of most of the larger sediment material entering the system. There are no broad floodplains in this area so floodplain storage is negligible. The soils are generally porous with high infiltration rates, resulting in minimal surface runoff except during large storm events.

For the Kaʻelepulu watershed, the headwaters are identified as the pali areas upgradient of the Old Kalanianaole Highway as well as the undeveloped slopes surrounding the pond. The undeveloped areas provide sources for sediment typically through small slope failures.

- Transfer zones are the transition reach where larger material is being deposited while finer material is being added, temporarily stored, and transported downstream. The region is characterized by streams with milder slopes and broad valleys. Stream meanders will start to develop in this region.

In the Kaʻelepulu watershed the transition zones can be defined as the areas with residential development located on the steeper slopes. Due to the development and concrete channelization of the historic streams, the transitions zone does not function naturally. The hydraulic conditions of the stream channels and stormwater conveyance pipelines do not provide conditions where transported sediment can be temporarily stored. All materials entering the conveyance system are flushed through.

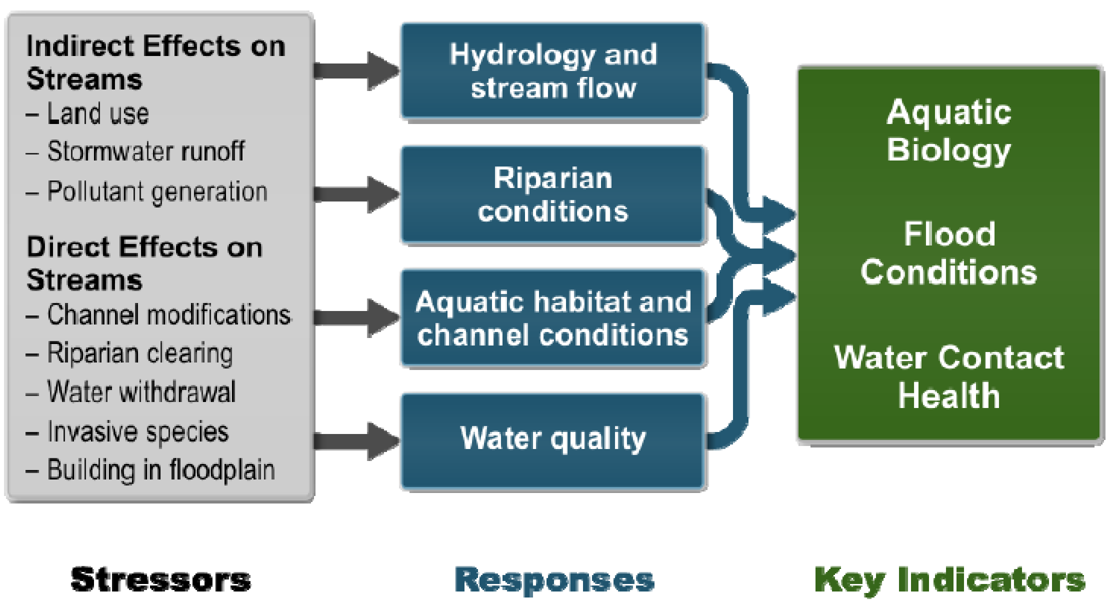
- Depositional zones occur in the lower reaches of the system where channel gradient is low. The stream channels meander across very broad flat valleys. Sediment transported from the upper reaches is accumulated in this reach. During high flow event, the accumulated material is transported out to sea.

The flat, developed areas of the Kaʻelepulu watershed, including the pond itself define the depositional zone. The historic wetland functioned as a sediment capture zone for the material transported from the upper watershed. The conversion of the wetland to the current pond did not alter its location with the watershed, so it continues to function as a depositional zone.

2.2 Watershed Characterization

The health of a watershed can be estimated through a watershed characterization and geomorphic assessment which evaluates watershed health stressors, how the watershed will respond to the stressors and to identify the indicators of watershed health. Figure 2-2 provides the three processes that are important for the watershed characterization and geomorphic assessment: Stressors, Responses, and Key Indicators.

Figure 2.2 Watershed Characterization and Assessment Process (Booth et al, 2005)



Stressors can be described as activities that change the physical nature of the land within a watershed and are defined as Indirect or Direct.

- Indirect – Land use changes, storm water runoff, pollution generation.
- Direct – Channel modification (hydromodification), riparian loss, water use, invasive species, and floodplain encroachment.

Responses are best described as the watershed health constituents affected by the stressors. The responses impact both the watershed hydrology and habitat, both riparian and terrestrial.

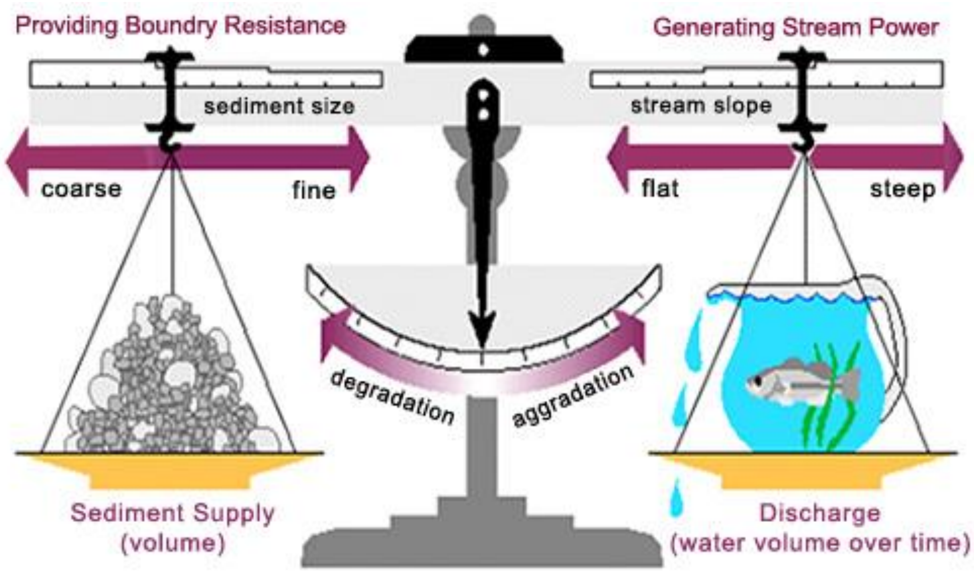
- Hydrology – Changes in peak flows and flood frequency, baseflow, sediment/water quality, and storm water runoff volume.
- Habitat – Changes in riparian condition and stream channel condition affect aquatic and terrestrial habitat, increase in pollutants entering the waterways directly affects aquatic and terrestrial species.

Key Indicators are the signals of watershed health and they focus on geomorphic conditions, flooding impacts, and water quality. For the Ka'elepulu Pond the quality of the water in the pond is impacting not only the aesthetic of the pond but also the aquatic habitat.

2.3 Natural Function of a Healthy Watershed and Stream

In order to understand the interaction between the streams and the land within the study area, it is important to understand the natural dynamics of a stream system. All stream systems exist in a state of "dynamic equilibrium," which refers to a system's ability to maintain a generally consistent balance related to a set of characteristics. Lane (1955) defined this balance in a river system as a relationship between sediment load, sediment size, stream slope, and discharge (Figure 2-3). Any change in one of these parameters will result in a natural adjustment in one or more of the other parameters to balance out the system. If the adjustment is not made, the result will be either degradation or aggradation of the stream.

Figure 2.3 Lane's Dynamic Equilibrium Diagram



For Ka'elepulu Pond, it is important to think of the historic wetland and the current pond as a stream segment. As water flows through the system, the pond functions to convey water and sediment. Historically, the wetland received flows from the current watershed as well as inflows from the Kawai Nui wetland. The creation of the pond created a circuitous flows path through the historic wetland that resulted in the lengthening of the flow path and subsequently making the stream slope flatter. The flood control project that diverted the flows from the Kawai Nui wetland altered the volume of flows that historically entered the wetland.

Based on Lane's diagram (Figure 2-3), the result of changing the channel slope through the wetland/pond is aggradation. Due to the development of the Kaʻelepulu watershed, the increased flows from the additional impervious surfaces may balance out the historic contributing flows from the Kawai Nui wetland. It is also likely the volume of sediment delivered to the pond has increased but the size of the sediment coming off impervious area is generally finer, so that may also balance out the sediment delivery side of the balance in the Lane's diagram.

Overall, the historic wetland and present day pond is located within the watershed landscape to act as a depositional zone. Changes to the watershed through development and flood mitigation have likely added to the parameters that lead to aggradation of a stream channel or in this case the Kaʻelepulu Pond. The existing wetland and accumulated material at the outfalls of the Keolu and Akipola channels provide evidence of this occurrence. Any approaches designed to reduce sediment accumulation within the Kaʻelepulu Pond will need to focus on reducing the volume of sediment entering the pond or controlling the location of sedimentation.

We agree that the pond and channels act as sedimentation basins. But this does not excuse the City for the grossly excessive quantities of sediment, trash, and nutrients they allow to flow through their MS4 into the estuary. Other Cities across the US are meeting this challenge, but the DFM seems to devote much of its energy to avoiding this responsibility.

3.0 Stakeholder Involvement

Historically, impaired water quality was easily attributed to individual sources in a watershed such as factories and water treatment plants. Federal and State regulations addressed individual sources resulting in improved water quality in many rivers and streams. Currently, impacted water quality is less likely to be attributable to individual sources. Non-point sources such as stormwater runoff, account for a larger proportion of impacted water bodies.

When dealing with the mitigation of non-point sources impairing water quality, it is likely that any proposed approach will impact multiple entities (stakeholders) with the watershed. Those impacted may include individual property owners, businesses and public entities. These stakeholders are an integral partner in the development and implementation of best management practices to address water quality issues. The watershed partners are those who will make decisions, those who will be affected by them, and those who can stop the process if they disagree.

Involving stakeholders (EPA, 2012)

- *Builds trust and support for the process and outcome*
- *Shares the responsibility for decisions or actions*
- *Creates solutions more likely to be adopted - builds a consensus.*
- *Leads to better, more cost-effective solutions*
- *Forges stronger working relationships*
- *Enhances communication and coordination of resources*
- *Helps to ensure that any environmental justice concerns are identified at an early stage*

Along with building a consensus, involving stakeholders and the community at large opens the door to funding sources from federal and state agencies

Table 3.1 Ka'elepulu Pond and Watershed Stakeholder List.[1]

Affiliation	Stakeholder Name
Non-Profits/Private	• Enchanted Lake Resident Association • Hui o Koolaupoko • Kukilakila Community Association • Bishop Estate • Enchanted Lake Shopping Center
City and County of Honolulu	• Department of Environmental Services • Department of Facility Maintenance
State	• State of Hawaii Department of Land and Natural Resources • Hawaii Department of Transportation • Department of Health, Clean Water Branch • Department of Education
Federal	• Environmental Protection Agency

Notes 1. Detailed list of Stakeholders containing contact information is located in Appendix 1.

Stakeholder meetings were held to provide a platform for interaction of parties of concern. Two meetings have been held to date.

Meeting 1 – The first meeting was held on Wednesday October 28, 2015, from 6:00 to 8:00 p.m., at the Enchanted Lake Elementary School. The meeting was attended by many members of the home owners association. The meeting provided the project team with the opportunity to discuss the project purpose and goals, efforts conducted to date, and also allowed the community to voice their concerns. The main topic of discussion focused on new development and ineffective sediment/erosion control best management practices. Appendix 1 contains the meeting announcement, attendees list, and meeting minutes.

A discussion following the meeting concluded that the next meeting should take place in February/March and would include HSPF modeling result results as well as potential elements to address sediment loads into the Kaʻelepulu Pond.

Meeting 2 – A follow up meeting was held on Wednesday December 7, 2016, from 6:00 to 8:00 p.m., at the Enchanted Lake Elementary School. The meeting was attended by the community residents and allowed the project team to brief the residents regarding ongoing and future improvement projects, CCH's continuing water quality sampling program and preliminary results to the CCH's watershed modeling efforts intended to help predict the effectiveness of the various BMP and LID solutions. The residents had a variety of comments and concerns that are summarized in Appendix 1 containing the meeting announcement, attendees list and meeting minutes.

Additional stakeholder meetings may be held at the CCH's discretion as the proposed project moves forward from the conceptual phase toward design and implementation.

There were no additional meetings held. I had to file a FOIA in 2024 just to get a copy of this report.

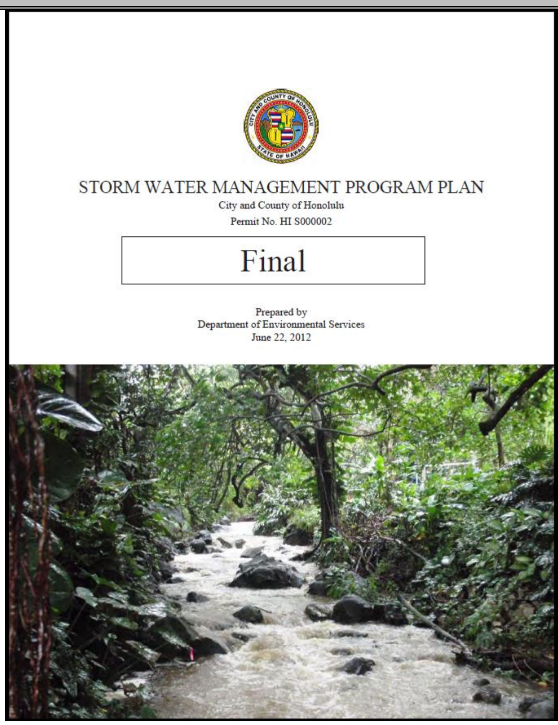
4.0 Existing Document Inventory and Review

4.1 Existing Kaʻelepulu Pond Studies

One of the goals of the Kaʻelepulu Pond stormwater project is to build off existing reports. The water quality issues related to the pond is not a new issue. Similar stormwater issues are found all along the windward coast and all of Oahu. The inventory of existing documents and data was developed using internet search and personal communications with State and county staff as well as local watershed groups. Following is a list of relevant documents with a brief description of the documents contents.

Final STORM WATER MANAGEMENT PROGRAM PLAN

Prepared by Department of Environmental Services June 22, 2012



Document Purpose

The City's SWMPP addresses the requirements and responsibilities related to the discharge of pollutants to and from its MS4 to protect water quality and to satisfy the appropriate water quality requirements of the CWA. This document provides information for each of the following program components:

- Public Education and Outreach
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Storm Water Management
- Pollution Prevention and Good Housekeeping
- Industrial and Commercial Activities Discharge Management

Available On-line at: http://www.cleanwaterhonolulu.com/storm/

Content Related to the Kaʻelepulu Pond

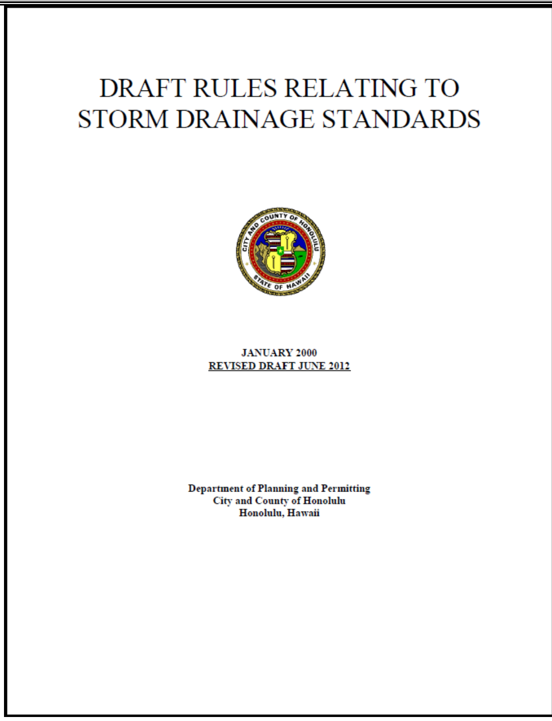
- Responsibilities of the various City and County department related to source areas and stormwater.
- The requirement of public involvement in watershed health issues
- The available programs related to stormwater management
- Regulatory authority related to illicit runoff discharge

Overall Usefulness for Kaʻelepulu Pond Issues

How potential BMP LID within the watershed need to fit within the regulatory requirements of the City and County of Honolulu

Rules Relating to Storm Drainage Standards

Prepared by the Department of Planning and Permitting, City and County of Honolulu, January 2000 (Revised. June 2012)


DRAFT RULES RELATING TO
STORM DRAINAGE STANDARDS

JANUARY 2000
REVISED DRAFT JUNE 2012

Department of Planning and Permitting
City and County of Honolulu
Honolulu, Hawaii

Document Purpose

Present updated storm drainage standard required under the City and County of Honolulu's recently renewed NPDES permit focusing on stormwater runoff quality.

Available on-line at: http://www.cleanwaterhonolulu.com/storm/notices/2013_sds/

Content Related to the Kaʻelepulu Pond

- Design and sizing criteria for both flow and volume based stormwater facilities.
- List of acceptable BMP and LID for under the updated standards.

Overall Usefulness for Kaʻelepulu Pond Issues

The document will help guide the approaches that can be used to improve the quality of stormwater runoff in the Kaʻelepulu watershed. Along with what BMPs and LID are approved for use the document guide the process of development and implementation of stormwater elements.

Ko'olaupoko Urban Sub-Basin Action Plan

Prepared for Hui o Ko'olaupoko, September 2011 (Not available on-line)

Document Purpose

Assess non-point source pollutant and then identify and prioritize mitigation opportunities that attempt to restore the natural function of the watershed's hydrology

Content Related to the Kaʻelepulu Pond

- Lists Kaʻelepulu Stream as impacted for nutrients and turbidity.
- Develops a list of low impact development approaches appropriate for the hydrology of the windward coast of Oahu.
- Provides a list of prioritized project sites with the Kaʻelepulu watershed. Most of the sites are tributary to the stream, not necessarily the pond.
- Overall Usefulness for Kaʻelepulu Pond Issues

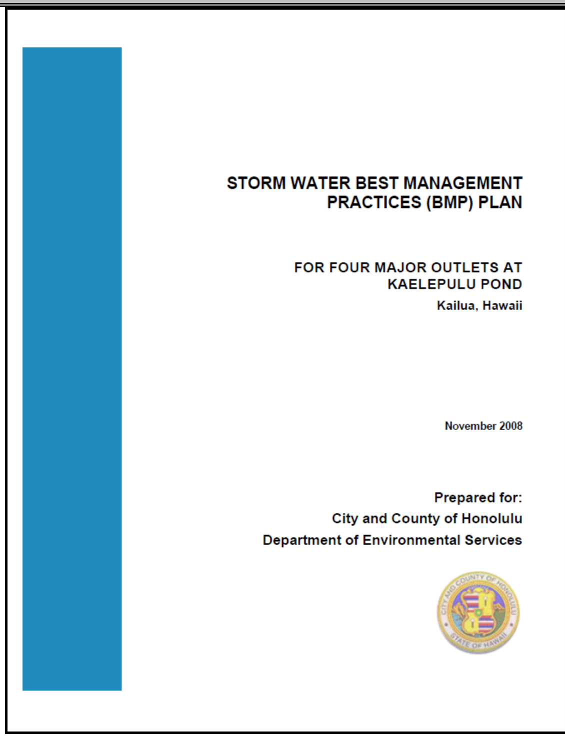
Overall Usefulness for Kaʻelepulu Pond Issues

The report's Low Impact (Green) approaches are a good starting point.

The report provides estimates of the pollutant loadings and reductions for the watershed based on document BMP removal efficiencies. The loading estimates are not based on sampling data specific to Kaʻelepulu Pond.

Storm Water Best Management Practices (BMP) Plan for Four Major Outlets at Ka‘elepulu Pond

Prepared for the City and County of Honolulu, Department of Environmental Services, Nov 2008


STORM WATER BEST MANAGEMENT PRACTICES (BMP) PLAN

FOR FOUR MAJOR OUTLETS AT KAELEPULU POND
Kailua, Hawaii

November 2008

Prepared for:
City and County of Honolulu
Department of Environmental Services

Document Purpose

The report is written to address complaints of sediment build up and odors at Ka‘elepulu Pond through structural (and non-structural) BMPs. Additionally, this report attempts to address gross pollutants issues that were discovered through field investigations and resident interviews within the drainage area.

Available on line: http://www.Ka‘elepulupond.org/bmp/default.htm

Content Related to the Ka‘elepulu Pond

- Ka‘elepulu Pond is listed as an impaired water body on the EPA’s 303(d) list.
- Ka‘elepulu Stream is listed as an impaired water for: turbidity, nutrients, bacteria, and chlorophyll.
- Provides context of the watershed physical characteristics and stormwater collection system, including photographic documentation of the watershed issues and channel conditions.

Overall Usefulness for Ka‘elepulu Pond Issues

Sampling results, photographs and stakeholder/resident concerns will provide direction on assessing and locating potential BMP for implementation.

Again, you ignore the primary reommendation of this study - to install some type of filtration / trash interception devices in each of the four main channels entering the pond.

Oahu Storm Water Management Program Plan

Prepared by the State of Hawaii Department of Transportation, Highways Division, 2007


Oahu Storm Water Management Program Plan

State of Hawaii Department of Transportation
Highways Division

PROTECT
OUR
WATER
MĀLAMA I KA WAI

March 2007

Document Purpose

This document presents the programs and activities that the State of Hawaii Department of Transportation, Highways Division (HDOT Highways) will implement to reduce, to the maximum extent practicable, the amount of storm water containing pollutants entering and discharging from the HDOT Highways municipal separate storm sewer system on Oahu (Oahu MS4).

Available on-line at: http://stormwaterhawaii.com/program_plan/pdfs/plan_march2007.pdf

Content Related to the Kaʻelepulu Pond

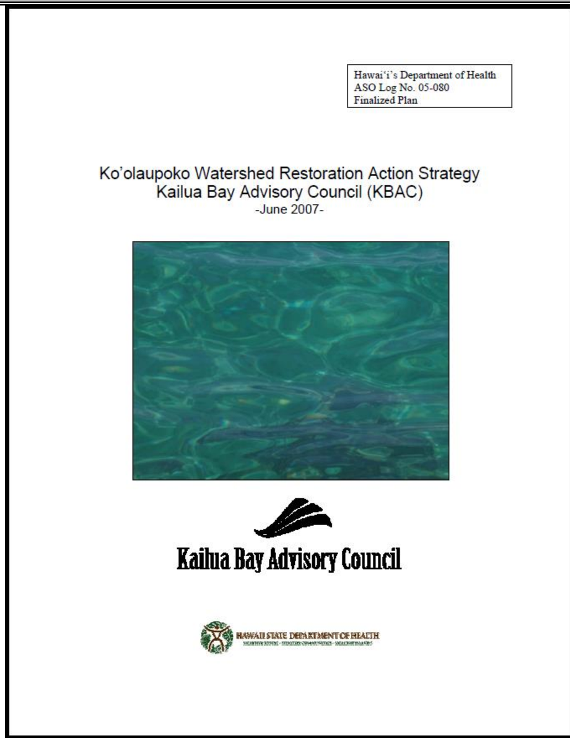
- Approved Best Management Practices for HDOT facilities, including highway alignments, maintenance facilities, and other operational structures.
- Street sweeping schedules for Kalanianaole Highway is set for once every five weeks.
- Identification of four high priority erosional site on the Kalanianaole Highway with the Kaʻelepulu watershed. Estimated total sediment load for the four sites is 538 lb/year.

Overall Usefulness for Kaʻelepulu Pond Issues

The identification of high priority areas within the Kaʻelepulu watershed provides the CCH the opportunity to investigate project teaming efforts that benefit both agencies and the health of the Kaʻelepulu watershed.

Ko'olaupoko Watershed Restoration Action Strategy

Prepared for Kailua Bay Advisory Council (KBAC) June 2007 by State of Hawaii DOH


Hawai'i's Department of Health
ASO Log No. 05-080
Finalized Plan

Ko'olaupoko Watershed Restoration Action Strategy
Kailua Bay Advisory Council (KBAC)
-June 2007-

Kailua Bay Advisory Council

HAWAII STATE DEPARTMENT OF HEALTH

Document Purpose

To serve as a master planning document for the KBAC and provide direction for the implementation of BMPS, restoration, monitoring and education and outreach in the Koolaupoko area windward Oahu. The document is an update of the 2002 WRAS and focuses on activities and approaches designed to address new regulatory requirements, new watershed information, and changes within the watersheds.

Available on-line at: http://huihawaii.org/data_documents/finalwras_june_2007.pdf

Content Related to the Kaʻelepulu Pond

- The Kaʻelepulu Pond has 37 NPDES permitted storm outfalls. Another 36 stormwater outfalls discharge to Kawai Nui Stream and Kaʻelepulu Stream. These numbers may not still be valid.
- Kaʻelepulu Stream is a 303(d) listed stream for nutrients and turbidity. Potential sources include residential fertilizer and pesticide use, animal droppings, wastewater treatment effluent, and urban runoff.
- A TMDL was anticipated to be complete in 2008.
- NSPECT modeling estimate 1.5M kg of TSS is conveyed into Kaʻelepulu Pond.
- Provides Management Measure Recommendations including: public education related to fertilizer and yard waste storage and disposal, street sweeping scheduling, address storm water runoff at a residential lot scale, installation of sediment and trash BMPs for Kalanianaole Highway and major drainage ways entering the lake.

Overall Usefulness for Kaʻelepulu Pond Issues

Provides good overview material related to the Kaʻelepulu watershed. The document does not provide specifics for potential BMPs with relation to types and locations.

Water Quality in Ka‘elepulu Pond - Results and Summary of Sampling from Five Storms.

R.E. Bourke June 2006

No Image Available	**Document Purpose** Provide the details related to the methodology and sampling results for 5 water quality sampling event between January 2002 and March 2006.

Available on-line: http://www.Ka‘elepulupond.org/documents/WaterQuality_Ka‘elepuluPond_7-06.pdf

Content Related to the Ka‘elepulu Pond

- Water quality sampling results taken throughout the entire watershed.
- Potential sources of TSS.
- Outfall locations with sediment accumulations.

Overall Usefulness for Ka‘elepulu Pond Issues

The WQ sampling results, provided later in this section, can be used to compare current project sampling efforts to determine if a consistent TSS loading is found in the watershed or that local conditions have changed potential sources.

Controlling Polluted Surface Water Runoff in the Kailua Watershed – A Guide to Stormwater Best Management Practices. Contractor's Draft (Dec, 2003)

Prepared for Kailua Bay Advisory Council (KBAC) by Tetra Tech-EMI – Not Available On-Line

Document Purpose

Identify and prioritize water quality issues within the Kailua watershed and develop a plan to address these issues with input from the community.

Content Related to the Kaʻelepulu Pond

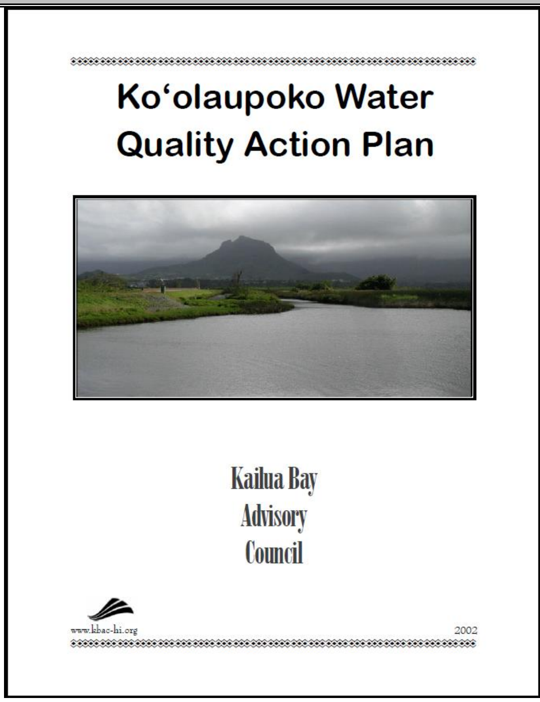
- Catalogue of potential Best Management Practices (BMPs) for addressing stormwater related issues in watershed.
- Aeration and Oxidation System for the addressing WQ in Kaʻelepulu Pond
- Qualitative Construction and O&M costs
- BMP Application Matrix
- Identified the residential area tributary to concrete channel adjacent to Keolu Elementary School as a potential priority area
- Identified Kaʻelepulu Pond as a potential site for demonstration projects related to constructed wetlands and aeration systems

Overall Usefulness for Kaʻelepulu Pond Issues

The report provides a list of potential BMP but does not provide analytical support for their use. Most of the documentation of the BMP is generic in nature. Because of the dense development in the Kaʻelepulu watershed there is likely not available space for implementation of most of the BMPs.

Koʻolaupoko Water Quality Action Plan

Kailua Bay Advisory Council 2002 - Not found on-line


Koʻolaupoko Water Quality Action Plan

Kailua Bay Advisory Council

www.kbac-hi.org 2002

Document Purpose

The Action Plan provides description of the multiple watersheds (ahupua'as) within the Ko'olaupoko region. The plan includes natural, physical and cultural components found in each watershed as well as issues related to the natural health. The document serves a master plan with the purpose of:

- Guiding KBAC's Implementation planning efforts
- Serve as guidance document for local communities to address water quality and natural health of their watersheds
- Meet the State's requirement as a planning document so that federal grant funding opportunities can be used.

Content Related to the Kaʻelepulu Pond

Some relevant broad information related to cultural concerns for the Koolaupoko region.

Overall Usefulness for Kaʻelepulu Pond Issues

Due to the lack of specific data related to Kaʻelepulu Pond or Stream the report can only be used to better understand the overall characteristic of the region.

4.2 Water Quality Sampling Results

Much of the historic sampling data may be institutionally lost as earlier efforts conducted State of Hawaii Environmental Planning Office (EPO) were transferred over the Clean Water Branch (CWB). During the earlier EPO period, many volunteer sampling efforts were conducted and the CWB has used a single sampling location as part of the 303(d) listing. Included in this report are sampling results conducted by Bob Bourke, a resident of the Kaʻelepulu watershed and scientist. His efforts have resulted in sampling data for select storm events. Also provide are limited sampling results from the AECOM 2008 effort. Both sets of data area provided in Appendix 2. Collected and analyzed water quality samples associated with the pond have focused on the constituents shown in Table 1-2. The table lists the water quality parameters as well as the State of Hawaii limits.

- ***Water Quality in Kaʻelepulu Pond – Results and Summary of Sampling from Five Storms. R.E. Bourke. June 2006***
- ***Storm Water Best Management Practices (BMP) Plan – For Four Major Outlets at Kaʻelepulu Pond. AECOM, 2008***

5.0 Ka‘elepulu Pond Field Observations

To better understand the relationship between the current condition in the watershed and the overall health of the Ka‘elepulu watershed multiple site visits were conducted. The purpose of the field reconnaissance was to document stormwater related issues under both dry and wet conditions.

The dry weather site visits allowed the project team to investigate the condition of the watershed in anticipation of a precipitation event. This type of site visit is intended to provide for safe inspection of stormwater inlets, outlet, culverts, stream channels, dry weather flows and existing BMPs. the stormwater infrastructure under safe conditions.

The wet weather visit allows the project team to better understand the drainage characteristics of the various land uses in the study area. This includes observations of flow paths, volume of flows, and appearance of flow related to suspended solids and floatables.

The AECOM project team conducted multiple site visits associated with both wet and dry conditions. Site evaluation sheets were developed and filled out during each of the visits. These are provided in Appendix 3. Photographic documentation was also collected during the site visit.

5.1 Stormwater Management Issues Found in Ka‘elepulu

Photo 5.1 Accumulated Material in Gutters

Throughout the watershed there is evidence that street sweeping is regularly occurring. The road debris accumulated on the down gradient side of the storm inlet reflects the material that has been pushed past the inlet during higher flows. The shown material appears to be larger material loosened from the repaving efforts. It can be assumed a larger volume of material entered the stormwater conveyance system and was deposited in the lower channels.

Photo 5.2 Organic Material in Open Conveyance System

Many of the concrete drainage channels are constructed between two residences. These facilities tend to become dumping grounds for yard debris and other organic material. This photograph illustrates a channel piled with palm fronds and leaves. The relatively large size of the palm fronds increase the chances of material accumulation on grated culvert inlets causing localized flooding

Photo 5.3 Unprotected Bare Road Cuts

The Old Kalanianaole Hwy was cut into the slopes of the hills. Most of the road cuts are bare, with vegetation roots exposed and eroded material accumulated on the shoulder

Photo 5.4 Garbage in Gutters

Throughout the watershed, accumulation of trash was found along roadways, in the gutters, and in the stormwater conveyance system. Eventually the trash along the roads is conveyed into storm inlets and discharged into Kaʻelepulu Pond.

Photo 5.5 Unprotected and Bare Lands

This photograph illustrates bare soils that contribute to the sediment load. Similar patches of unvegetated area are found at many of the school sites within the study area. There is no visual evidence of runoff channelization for most of the site, likely because of the mild slopes, but precipitation impacts will result in elevated concentrations of sediment in the sheet flow runoff.

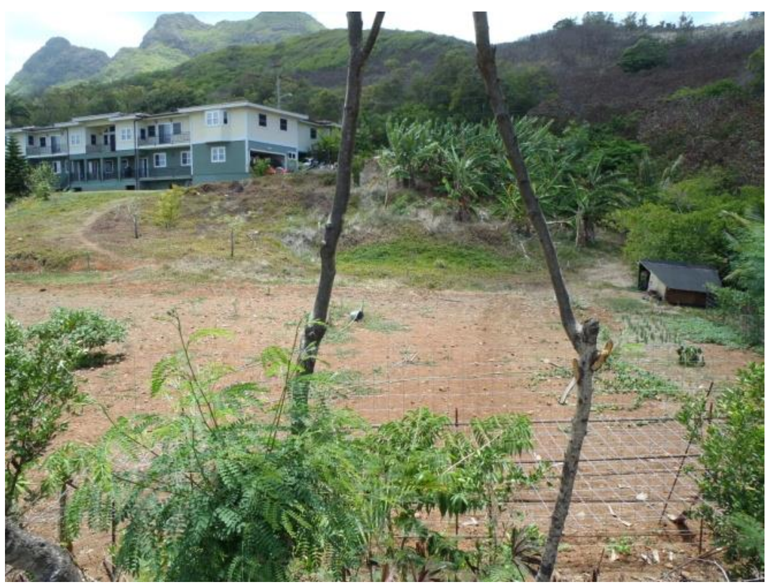


Photo 5.6 Old Kalanianaole Highway

Sediment load in the stormwater gives it a reddish-brown appearance. The source of sediment is likely the bare cut slopes across the road. Accumulated runoff is maintained along the shoulder by the vegetation.

Photo 5.7 Hele Channel at Keolu Drive

The flow in the Hele channel is light brown. At least one barrel of the culverts under Keolu Drive is blocked. It appears the combination of flows from the parking lot drainage and plugged culvert is resulting in the clear water shown along the left bank. The channel upstream of Keolu Drive is much clearer potentially meaning the brown water is backflow from the Pond.

Photo 5.8 Hele Channel at Liku Street

Shallow flow, relatively clear, along the bottom of the channel. The watershed is mostly residential with only a small portion of the Keolu Hills. This photo location is upstream of Photo 5-7. The brown water in Photo 5-7 is either backwater from pond or there is a sediment source between the two sites.

Photo 5.9 Akipola Lined Channel at Keolu Drive

Runoff with less sediment content is entering the channel and mixing with the sediment laden flows.

Photo 5.10 Exposed soil

Residential site on Akipola Street with soil eroding. Sediments and gravels are being washed in to the stormwater system. Rills are forming in the soil, channelizing flows and increasing the rate of erosion.

Photo 5.11 Residential Construction

Akipola Street, unprotected exposed soil is being eroded from the site and entering the stormwater system. Flow in the gutter has high concentration of sediment. Eroded material can be seen in front of the vehicle.

Photo 5.12 Clear Surface Runoff

This photo illustrates clear stormwater runoff flowing in the gutters. This indicated relatively little sediment in the flow.

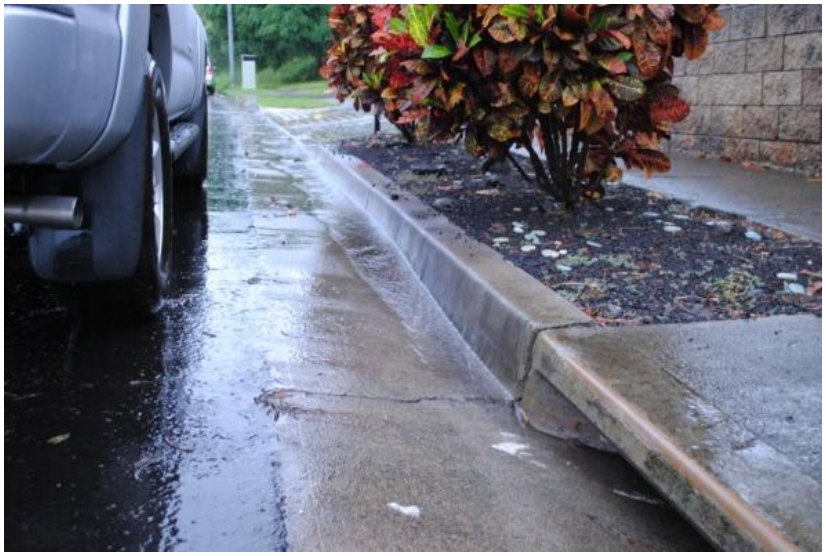


Photo 5.13 Flows Discharging Through a Wall

Based on the amount of flow, it may be assume this pipe is directly connected to the house gutter system. The water drains lower in the wall do not appear to have flow coming out of them.

Photo 5.14 Stream channel conditions upstream of Old Kalanianaole Rd.

The natural stream has flowing water, but due to transmission losses (water entering the soil) the shown stream flow did not reach the culvert under the road.

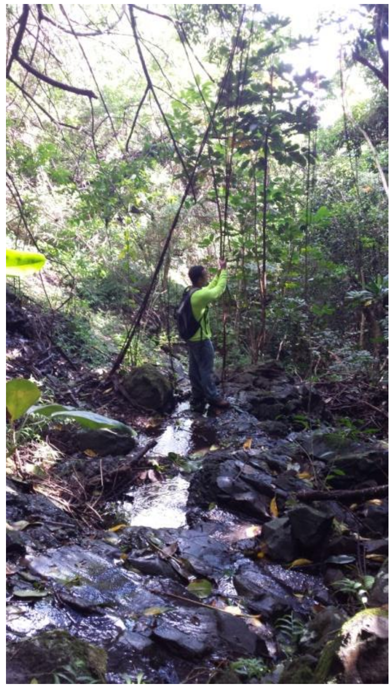


Photo 5.15 Typical sediment found in the stream channel.

Landslides in the upper watershed deliver both fine sediment and larger rocks.

Photo 5.16 Evidence of natural slides

Landslides in the upper watershed are providing sediment input to the unnamed stream reach.

Photo 5.17 Earthen Berm in Kapaa Silt Pond

Kapaa Silt Basin, the vegetated berm between the upper basin and lower basin. The concrete emergency overflow structure is visible at the center-left of the photo. The berm may currently have a breach that limits the facilities ability to function as a sedimentation pond.

6.0 Identification of Stormwater Quality Issue in the Ka‘elepulu Pond Watershed

As mentioned in Section 1.0, the purpose of this report is to build off previous efforts where appropriate and provide new information and approaches to improve the water quality of the Ka‘elepulu Pond. To this end, the report Storm Water Best Management Practices (BMP) Plan for four Major Outlets at Ka‘elepulu Pond (AECOM, 2008) presented the results of storm water quality issues found within the Ka‘elepulu watershed. Chapters 1 and 2 of the 2008 report provide details of the watershed characteristics and water quality issues found. The two chapters, as well as the rest of the report, contain multiple photographs of the storm water elements of the Ka‘elepulu Pond.

6.1 2008 Ka‘elepulu Pond Identification of Stormwater Issues

Water quality in Ka‘elepulu Pond is affect by the runoff from storms, biological activity and nutrient pollutant from the surrounding community (AECOM, 2008). The 2008 report provides a section on stormwater pollutants by land use. A summary of this section is provided:

Residential – approximately 60 percent of the basin is classified as residential. These areas include permeable surface such as landscaped areas, lawns and parks. Impervious surface include roofs, driveways, and streets. The vegetated areas typically allow for all the precipitation to infiltrate except for the larger storm events. The impervious areas generate stormwater runoff for all events that surpass the surface storage volume.

Typical pollutants generated from urban landscapes include nutrients from fertilizer, pesticides, pet and bird waste, oils/grease, metals and sediment. The Ka‘elepulu Pond also has a high level of floatables include trash and yard debris.

Conservation/Preservation – The upper watershed is conservation land and undeveloped. These areas contribute sediment from localized slides and green wastes such a leaves and coconut fronds. The hydrologic characteristics of the upper watershed, including high infiltration rates and stream channel losses, result in runoff from this area only occurring in response to large storms.

Agricultural – Less than 10% of the watershed is agricultural. Typical water quality issues associated with this type of land use include pesticides, fertilizers and sediment. Most of the designated agricultural land is located between the Old Kalanianaole and the Kalanianaole Highway.

Light Industrial/Commercial – approximately 12 acres of this land use category exists in the watershed. The majority of this classification is associated with the Enchanted Lake Center and the area at the intersection of Hele Street and Keolu Drive. A large portion of this land use is impervious surface that includes roofs and parking area. The parking areas are the major source of pollutants caused by the use of automobiles. Runoff carries metals such as copper, zinc, lead, and chromium generated by oils dripping from cars, wearing of brakes, and the breakdown of vehicle tires.

The earlier report (AECOM, 2008) concluded typical runoff into Ka‘elepulu Pond contains urban trash, vegetative and green waste (organic debris), sediment and roadway particles with nutrients and other organic pollutants adhering to the particles. A large portion of the organic debris can be traced to the improper disposal of yard clippings and tree trimming along with wind-blown material such as coconuts and palm fronds.

6.2 Current Kaʻelepulu Pond Stormwater Quality Issues

Based on the field observations conducted with this current effort and presented in Section 5.0 of this report, the following conclusion related to stormwater quality issues associated with Kaʻelepulu Pond are provided for each of the land use classifications:

Residential – The majority of the Kaʻelepulu Pond watershed is residential of variable density. The residential land use includes flat landscape near the pond, as well as steep terrain. Many roof downspouts are directed to discharge onto impervious surfaces and therefore are directly connected to the stormwater conveyance system. Other residences have downspouts discharging into landscaped areas where roof runoff is infiltrated instead of being directed to the pond.

Yard debris was found in many of the open drainage ways. It appears that local residents occasionally discard grass clippings and landscape pruning directly into the open concrete channels and canals throughout the watershed. During rain events, the organic material is flushed through the channels and into Kaʻelepulu Pond.

Bare soil was identified throughout the watershed as a potential source of sediment. In the upper watershed, with steep slopes, some properties appear to have large swaths of un-vegetated soil. In the lower watershed, residents park their vehicles on grassy surfaces, eventually killing the vegetation. The resulting bare soil provides sources for fine sediments.

Residences in the more developed portions of the watershed have created impervious surfaces that cover almost the entire site. This leads to increased stormwater runoff as the once pervious soils are converted to impervious surfaces, reducing the site's capacity to infiltrate rainfall. The residential impervious area is typically used to store vehicles so fluids leaking for the vehicles tend to accumulate and wash away during rainfall events.

New development and redevelopment within the watershed was found at multiple locations. In most cases the construction sites had unprotected exposed soils. Typical best management practices were found but in many cases were not performing as designed or not adequate for the volume of material at the site. During rain events the exposed, loose soil was easily eroded and conveyed with the stormwater runoff in the conveyance system, discharging into Kaʻelepulu Pond.

Conservation/Preservation – This land use is generally in the upper watershed where the heaviest precipitation occurs. The area maintains steep slopes and the soils have high infiltration rates. There is evidence of localized slope failure that supply a finite volume of sediment to the stream. Generally the stream channel themselves appear to be stable, with no visible signs of channel erosion. Evidence suggests that this land use is not a typical continuous supplier of sediment to the stormwater conveyance system.

Agricultural – Limited observations of agricultural land were made in the field. A review of aerial photography of areas designated as Cultivated found portions of land with little or no vegetative cover. No visible evidence of soil washoff, such as sediment accumulation, was identified in drainage ways down gradient of the agricultural areas.

Light Industrial/Commercial – This land use represents a small fraction of the total watershed area. Typically stormwater generated from this land use originates on the rooftops of the commercial buildings and the associated paved parking. Although small in total area, the land use has the potential for high pollutant concentration for oils and metals due to the presence of vehicular traffic and parking. The Enchanted Lake Center parking lot is poorly maintained and does not appear to receive regular street sweeping.

6.3 Major Water Quality Issues within the Ka‘elepulu Pond

Based on the field observations presented in Section 5.0, the greatest influences on the amount of sediment and trash entering the Ka‘elepulu Pond are:

- Exposed soil and construction activities in the watershed. Exposed soil was identified in the residential areas as well as along the Old Kalanianaole Highway and the current highway alignment. For the exposed soils associated with construction activities, the lack of erosion control measures implemented at the sites, are the issue. This typically is associated with new development, existing home remodels, and agriculture. For the exposed soils associated with the roadways, the issue is lack of maintenance required to keep vegetation on the slopes healthy.
- Yard debris and trash disposal. The discarding of yard waste into the stormwater channels appears to be a common practice. This introduces high levels of organic material into the pond. Careless disposal of trash along streets and in parking lots leads to trash being washed in the stormwater system and eventually discharging into the pond

7.0 Conceptual Project Recommendations

7.1 Stormwater Quality Approaches

The stormwater water quality issue in the Kaʻelepulu Pond can be addressed through either Source Control or Structural Approaches. Because of the pond's landscape scale position within the depositional zone, most sediment and pollutants that reaches the Kaʻelepulu Pond will settle within the open water reach. To limit the amount of sediment, pollutants, and trash entering the pond, most materials should either not be allowed to enter the stormwater system or be removed prior to adversely impacting the pond.

Table 7.1 provides definitions of the two approaches to water quality management; Source Control and Structural. The CCH Stormwater BMP manual addresses source controls and includes a long list of practices that can be implemented through regulatory channels. The reader is directed to the City and County of Honolulu's webpage for links to the Stormwater Master Plan (See Section 4). This report focuses on establishing a list of potentially feasible best management practices (BMPs) to address surface runoff quality entering the Kaʻelepulu Pond.

Table 7.1 Definitions of Stormwater Treatment Approaches

Source Control	*The reduction of stormwater runoff, pollutants entering the stormwater system, and the reduction of contact between the two elements.*
Structural	*The mechanical, biological, physical removal of pollutants being transported by stormwater runoff.*

Along with conventional BMPs, low impact development approaches (LIDA) were considered. The benefit of using LIDA is that they are designed to encourage treatment of the smaller, more common storm events through the use of infiltration and less impervious surfaces.

Potential approaches for improving stormwater quality are organized as those available to local residences (Table 7.2) and those available to jurisdictional agencies (Table 7.3). The Residential (landowner) option generally fall under the Source Control while approaches available to jurisdictions, CCH in this case, include both Sources Control and Structural.

Table 7.2 Landowner Approaches for Addressing Stormwater Quality (Source Controls)

Approach	Method
Sidewalk and Driveway Cleaning	Sweep sidewalks and driveways and dispose of sweepings in the trash instead of using hoses or leaf blowers to clean surfaces.
Exposed Soil Repair	Use native vegetation or grass to cover and stabilize exposed soil on lawns to prevent sediment wash off.
Healthy Lawns	Maintain thick grass planted in organic-rich soil to a height of at least 3 inches to prevent soil erosion, filter stormwater contaminants, and absorb airborne pollutants; limit or eliminate chemical use and water and repair lawn as needed

Yard Waste Management	Prevent yard waste from entering storm sewer systems and water bodies by either composting or using curbside pickup services and avoiding accumulation of yard waste on impervious surfaces; keep grass clippings and leaves out of the street.
Low Impact Development Elements	Use green infrastructure elements appropriate to individual sites. Green Infrastructure options are provided later in this section

To implement many of the options available to landowners and residents, the CCH needs to incorporate public involvement and education opportunities. The educational interactions with the public can provide information on the issues impacting the pond as well as how personal actions, such as yard waste disposal, impacts the pond. The Hui O Koolaupoko is a local resource that can partner with CCH to promote watershed health and provide Source Control information to the local population.

Table 7.3 Municipal Approaches for Addressing Stormwater Quality

Approach	Method
Temporary Construction Sediment Control	Implement and encourage practices to retain sediment within construction project area.
Streambank Stabilization	Repair erosion occurring on a streambank of lakeshore and canals in a timely manner.
Better Street and Parking Lot Cleaning	Maintain streets and parking lots frequently and especially in the spring by sweeping, picking up litter, and repairing deterioration; pressure wash pavement only as needed and avoid using cleaning agents.
Storm Sewer System Maintenance	Regularly clean debris from storm sewer inlets, remove sediment from catch basin sumps, and remove any illicit connections to storm sewer systems.
Retro Fitting Existing System	As the study area is already urbanized with little available land for regional facilities, retrofitting the existing stormwater conveyance system is a potential option. Both Gray and Green infrastructure can be incorporated in the watershed.

As the Kaʻelepulu Pond watershed is generally development, with existing stormwater facilities already in place, retrofitting the Kaʻelepulu Pond watershed offers the community the opportunity to incorporate both Green and Gray stormwater elements.

- Green infrastructure is constructed facilities such as green streets, ecoroofs, and rain gardens that capture and manage stormwater with vegetation and soils. The goal of green infrastructure is to restore the natural function of a watershed. Most green infrastructure approaches utilize infiltration through soil to provide either water quality treatment before the runoff enters the stormwater system or to become subsurface flows, basically removing the runoff from the stormwater system.
- Gray infrastructure refers to the color of concrete and ranges from structural facilities, such as pipes, catchbasins, and manholes and include stormwater BMPs; hydrodynamic separators, storage vaults, and ponds designed to attenuate flows. Infiltration is not a major aspect of the treatment.

The following section provides examples of both Green and Gray options appropriate for use in the Kaʻelepulu Pond watershed. Along with description of the stormwater elements, the section also includes basic costs and design considerations.

7.1.1 Vegetative Ground Cover/Lawn Care

Planting appropriate vegetation on sloping surfaces and parking areas will assist in eliminating soil erosion potential. Along with the improved ground cover, proper use of fertilizers should be implemented. Excess fertilizer can lead to increased nitrogen and phosphorus concentrations in stormwater runoff.

7.1.2 Green Roof – Roof Garden

Green roofs are covered with growing media and vegetation that enable rainfall infiltration and evapotranspiration of stored water. The green roof may include an underdrain collection system or an overflow outlet for stormwater releases during large or intense rainfall events.

They are particularly cost-effective in dense urban areas where land values are high where stormwater management costs are likely to be high.

7.1.3 Rainwater Harvesting

Rainwater harvesting systems collect and store rainfall for later use. When designed appropriately, they slow and reduce runoff and provide a source of water. This practice could be particularly valuable in arid regions, where it could reduce demands on increasingly limited water supplies.

Cisterns – Rain collection and reuse can be encouraged by offering prepackage kits for the smaller rain barrels and pre-approved plans for installing cistern.

7.1.4 Rain Garden/Planter Box/flow through Planter

Rain gardens/Planter Boxes are versatile features that can be installed in almost any unpaved space. Also known as bio-retention, or bio-infiltration, cells, they are shallow, vegetated basins that collect and absorb runoff from rooftops, sidewalks, and streets.

Rain Gardens – Implementation of the rain gardens can be done for individual residences/structures, adjacent residences, and neighborhoods. Home owners willing to install rain garden that receive runoff from public right-of-way need to be encouraged through cost assistance ranging from reduced fees, rebates on materials cost, and perhaps labor. Many of the neighborhoods with flat terrain and wide streets would benefit from encouraging the use of rain gardens.

Flow through Planter - The goal is to place a flow through planter at the location of all existing cut street inlet. Knowing this is not possible, the approach for implementation should focus on willing home owners where the facilities can be constructed adjacent to the public right-of-way and also within some private property. In locations with wide streets and neighbor consent, the facilities can be constructed entirely within the public right-of-way.

7.1.5 Permeable/Porous Pavements

Permeable pavements infiltrate, treat, and/or store rainwater where it falls. They can be made of pervious concrete, porous asphalt, or permeable interlocking pavers. This practice could be particularly cost effective where land values are high.

Porous Pavements/Pavers– Along with the downspout disconnect, using porous pavement can reduce stormwater runoff volumes from private residences. The city can encourage the replacement of existing concrete area with porous materials through programmatic rebates and cost reductions.

7.1.6 Downspout Disconnect

This simple practice reroutes rooftop drainage pipes from draining rainwater into the storm sewer to draining it into rain barrels, cisterns, or permeable areas. You can use it to store stormwater and/or allow stormwater to infiltrate into the soil.

Downspout Disconnect Program – This low cost approach redirects roof runoff from impervious areas to pervious areas, allowing for runoff to infiltrate into the soil. The runoff contains not only material accumulated on the roof but once it is discharged to the impervious surface it can transport additional loads accumulated on driveways and gutters. The City and County can offer the materials at little or no cost to home owners to convert the downspout discharge location.

7.1.7 Constructed Wetlands

Prior to development Kaʻelepulu Pond was a functioning wetland. The natural change in stream gradient means transported materials will settle out in the pond. Constructed wetlands will provide a contained area for sediment to accumulate. The delineated areas can then easily be dredged when full.

Constructed Wetlands at Major Outlets – At many of the existing outlets, particularly at canals and large diameter pipes the accumulated material is already creating small emergent wetlands. Implementing constructed wetland at these locations will provide for the material to be contained within a defined area and also allow for access for scheduled removal.

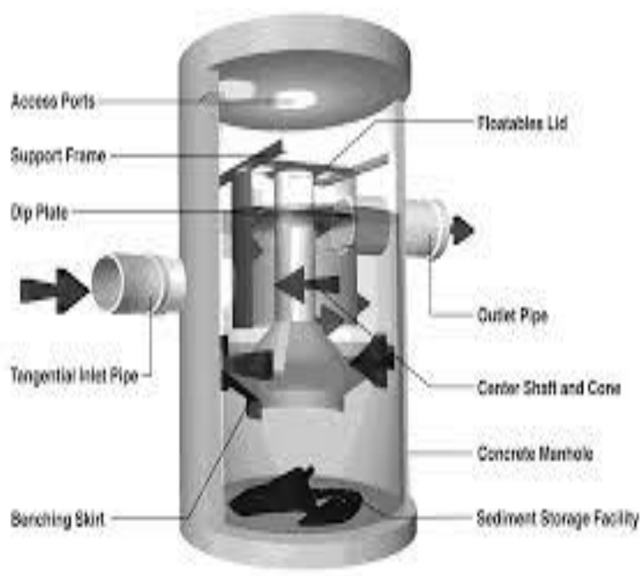
7.1.8 Storm Filter

Stormwater treatment device comprised of one or more structures that house rechargeable, self-cleaning, media-filled cartridges that trap particulates and absorbs pollutants such as dissolved metals, hydrocarbons, nutrients, metals, and other common pollutants found in stormwater runoff.

7.1.9 Vortex Removal - Hydroseparators

Vortechs is a below-ground, engineered stormwater treatment device that combines swirl concentration and flow controls into a single treatment unit. Vortechs is ideal for capturing and retaining trash, debris, sediment, and hydrocarbons from stormwater runoff.

Hydro Separators – When space is a limitation the hydro separators can be retrofitted into the existing stormwater conveyance system. The amount of contributing area defines how many of the units would be required to address the entire Kaʻelepulu watershed. Typically the cost of the unit and installation are higher than the flow through planters so the installation of the hydro-separators should only occur if no other options are available.



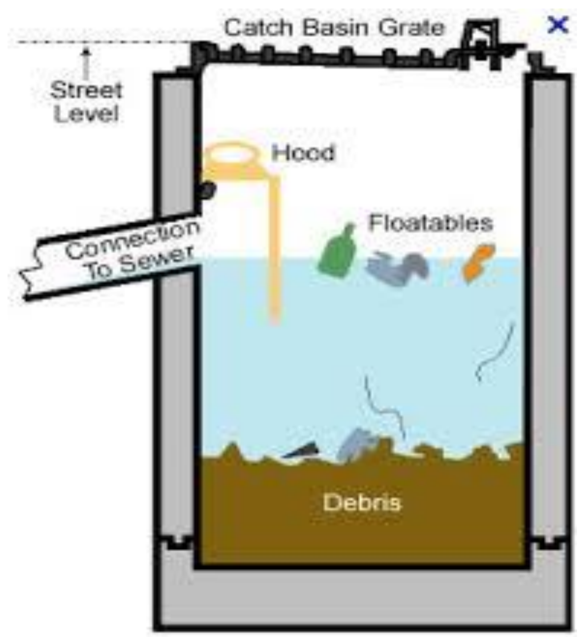
7.1.10 Vaults

A closed detention system is an underground structure, typically a concrete vault or series of large diameter pipes, which temporarily stores stormwater and releases it slowly. They typically are used on sites that do not have space for a pond.

7.1.11 Sumped/Hooded/Screened Catch Basin

A catch basin is an inlet to the storm drain system that typically includes a grate or curb inlet where stormwater enters the catch basin and a sump to capture sediment, debris and associated pollutants. They are also used in combined sewer watersheds to capture floatables and settle some solids.

Catchbasin inserts – the City and County is already installing these units throughout the watershed. The units provide for excellent removal of floatables but are not as effective for removing sediment. They can be used in conjunction with other elements to provide a treatment train but they should not be considered the sole solution.



7.1.12 Detention Basins

Detention basins provide general flood protection and sedimentation. The basins are typically built during the construction of new land development projects. A Retention Basin is design to hold all flows, allowing the pond to drain through infiltration and evaporation. The Kapaa Silt basin (shown in the aerial) acts a detentions basin.

7.2 Costs Associated with Stormwater BMPs

Costs associated with implementing stormwater BMPS are highly variable. Costs can depend on land values, site location, local availability, and knowledgeable contractors. The following costs (Table 7.4) are intended to provide the general range of costs for each of the listed options

Table 7.4 Estimated Cost Associated with Stormwater BMPs

BMP	Estimated Cost	Notes
Roof Garden	\$15-30/ft^2	Not available for all roofs. Structural considerations will need to be made.
Rainwater Harvesting	\$3000-10,000/house	Largest portion of the cost is for the cistern
Rain Garden	\$5-20/ft^2	
Porous Concrete Porous Pavers	\$2-7/ft^2 \$5-10/ft^2	Likely just for driveways and parking areas
Downspout Disconnect	\$5-10/downspout	Cost at Home Improvement Store
StormFilter	\$30,000/Unit	Assumes in public ROW
Vortech	\$16,000-\$20,000/Unit	Assumes in public ROW
Stormwater Vaults	\$72,000/Unit	Assumes in public ROW
Catchbasins	\$4,000 each	Assumes in public ROW
Detention Pond	\$39,000/acre of Impervious	Does not include land cost

The treatment efficiency for each of the BMPs is shown in Table 7.5. The variability of the removal is due to multiple factors associated with design parameters as well as concentration loads. The values should be assumed as guidance toward the removal goal. Post-implementation treatment can be determined through a program of sampling.

Table 7.5 Stormwater BMPs Treatment Efficiencies

BMP	Typical Treatment Efficiency
Roof Garden	reduced runoff volume leads to reduced WQ loads
Rainwater Harvesting	reduced runoff volume leads to reduced WQ loads
Rain Garden	90%
Porous Concrete Porous Pavers	80% - due to reduced runoff volume
Downspout Disconnect	reduced runoff volume leads to reduced WQ loads
StormFilter	60-80%
Vortech Hydro-Separator	60-80%
Stormwater Vaults	40-60%
Catchbasins	25%
Detention Pond	40-60%
Constructed Wetland	90%

The AECOM recommendations assume a regimented street sweeping program and also increased sediment erosion controls during construction.

7.3 Potential Funding Sources

U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Program
http://www.nae.usace.army.mil/Missions/Public-Services/Ecosystem-Restoration-Authorities/

The purpose of Corps ecosystem restoration activities is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. Ecosystem restoration efforts involve an examination of the problems contributing to the system degradation, and the development of alternative means for their solution. The intent of restoration is to partially or fully reestablish the attributes of a natural, functioning, and self-regulating system. Restoration opportunities associated with wetlands, riparian, and other floodplain and aquatic systems are likely to be most appropriate for Corps involvement. Programs through which the Corps can participate in the study, design and implementation of ecosystem restoration projects include:

Section 206, Aquatic Ecosystem Restoration – The purpose of the Section 206, Aquatic Ecosystem Restoration is to give the authority to develop aquatic ecosystem restoration and protection projects that cost effectively improve the quality of the environment, and are in the public interest.

Study Cost	Project Cost
The feasibility study is cost shared 50 percent Federal / 50 percent Non-Federal after the first $100,000 in study costs. The first $100,000 in study cost is Federally funded.	Design and construction costs are 65 percent Federal / 35 percent non-Federal

Section 1135, Project Modifications for Improvement of the Environment – The Section 1135, Project Modifications for Improvement of the Environment provides the authority for the review and modification of structures and operations of water resources projects constructed by the Corps for the purpose of improving the quality of the environment. Projects must be feasible, consistent with the authorized project purposes, and improve the quality of the environment in the public interest. In addition, if a Corps water resources project has contributed to the degradation of the quality of the environment, restoration measures may be implemented at the project site or at other locations that have been affected by the construction or operation of the project, if such measures do not conflict with the authorized project purposes.

Study Cost	Project Cost
The feasibility study is cost shared 50 percent Federal / 50 percent Non-Federal after the first $100,000 in study costs. The first $100,000 in study cost is Federally funded.	Design and construction costs are 75 percent Federal / 25 percent non-Federal

Clean Water Act (CWA) Section 319 Grant Program
https://www.epa.gov/nps/319-grant-program-states-and-territories

The 1987 amendments to the Clean Water Act (CWA) established the Section 319 Nonpoint Source Management Program, which addresses the need for greater federal leadership to help focus state and local nonpoint source efforts. Under Section 319, States, territories and tribes receive grant money that supports a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects.

Clean Water Act Section 319(h) provides funds only to designated state and tribal agencies to implement their approved nonpoint source management programs. State and tribal nonpoint source programs include a variety of components, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and regulatory programs. Each year, EPA awards Section 319(h) funds to states in accordance with a state-by-state allocation formula that EPA has developed in consultation with the states.

Section 319(h) funding decisions are made by the states. States submit their proposed funding plans to EPA. If a state's funding plan is consistent with grant eligibility requirements and procedures, EPA then awards the funds to the state.

The State of Hawaiʻi (State) Department of Health (DOH) Clean Water Branch (CWB) Polluted Runoff Control (PRC) Program's mission is to protect and improve the quality of Hawaiʻi's water resources by preventing and reducing nonpoint source pollution. To achieve this goal, the PRC Program funds implementation projects that control polluted runoff and improve water quality.

Organizations including counties, colleges and universities, State agencies, non-profit entities, watershed groups, for-profit organizations, and environmental groups may submit proposals. Federal agencies can participate in the proposed project, but may not apply for grant funds. Other federal funding or in-kind services from federally funded sources can be used as evidence of federal support for the project.

The level of funding fluctuates by year. For the 2018 Watershed Implementation Project cycle there is approximately $600,000 available for awards from this RFP. There is no minimum dollar amount of funds that can be requested. The amount requested in any proposal budget shall reflect the level of effort, clearly demonstrate anticipated water quality benefits, not exceed 36 months, and shall include non-federal matching funds and/or in-kind funds. For this RFP, the required (non-federal) match and/or in-kind contribution shall be 1:0.25 (i.e., 25%). For example, a request for $400,000 in grant funding requires a minimum of $100,000 of non-federal match.

7.4 Project Recommendations

Large scale improvement to the water quality of Kaʻelepulu Pond will require a large scale effort. Using a combination of public and private approaches will develop the community responsibility to restore and maintain the natural function of the pond. Recommendations presented here focus on the implementation of stormwater elements designed to reduce pollutant loads discharging to Kaʻelepulu Pond.

Not included in the recommendations is the need for improved and continuous public education efforts. The importance of building a sense of community around the protection of the pond is key to a successful stormwater program. Educating the public on the impact of degraded water quality and how simple actions can provide increased benefit is the most cost effective approach to water quality improvements. Some of the recommendations provided include Source Controls that occur at the household level. The Hui O Ko'olaupoko is a great local resource for assisting with public education.

The Source Controls included (Table 7.2) are all elements that can be implemented at a landowner level. The City and County will need to provide guidance and programs that get the residents involved. Included in this effort is having clear processes developed and published along with resources to assist with the implementation.

As most of the Source Control recommendations are based on the public involvement, the impact of actions is not quantifiable. Sources control approaches are typically considered the most cost effective approach because it is easier to limit the pollutant from entering the system than it is to remove the pollutant from the water.

Section 4.0 of this report provides reviews from previous watershed strategies for improving the water quality of the Kaʻelepulu Pond. The recommendation from each of the documents is provided. As shown, community education and green infrastructure are a reoccurring theme in most of the documents.

Project recommendations for this effort are shown in Figure 7-6. Additional information for each of the approaches shown in the figure are provided in the subsequent pages.

Koolaupoko Watershed Restoration Action Strategy (June 2007)

- Education program to inform residents on the proper nutrient and fertilizer use.
- Work with Mid-Pac Golf Course to revegetate along Ka‘elepulu Stream with native plants.
- Implement pilot project to promote green infrastructure including rain barrel/cisterns, permeable pavement, and rain gardens.
- BMP Implementation
- Improve DOT highway storm drains above Kalanianaole Highway to reduce sediment and debris entering the
- Install sediment and trash catchment BMPs on the major drainage ways discharging to Ka‘elepulu pond.

Controlling Polluted Surface Water Runoff in the Kailua Watershed. A Guide to Stormwater Best Management Practices (December 2003)

- Green infrastructure using grass swale and rain gardens for commercial development
- Supplemental Aeration and oxidation systems.
- Riparian buffers
- Constructed Wetlands

Koolaupoko Water Quality Action Plan (2002)

- Community Education programs
- Enforcement of grading and construction permits conditions
- Dredge the Lake
- Increase opening of the mouth of Ka‘elepulu Stream
- Erosion control measures

Koolaupoko Urban Sub-basin Action Plan (September 2011)

- Use of green infrastructure, particularly rain gardens at commercial sites, including Enchanted Lakes Center and the areas associated with Downtown Kailua.
- Green Streets – Project locations were not identified in the document.
- Popoia Road. This rain garden/filtration swale project is already constructed. It serves the street adjacent to Ka‘elepulu Stream upstream of the Lihiwai Road crossing (near Buzz’s Steakhouse).

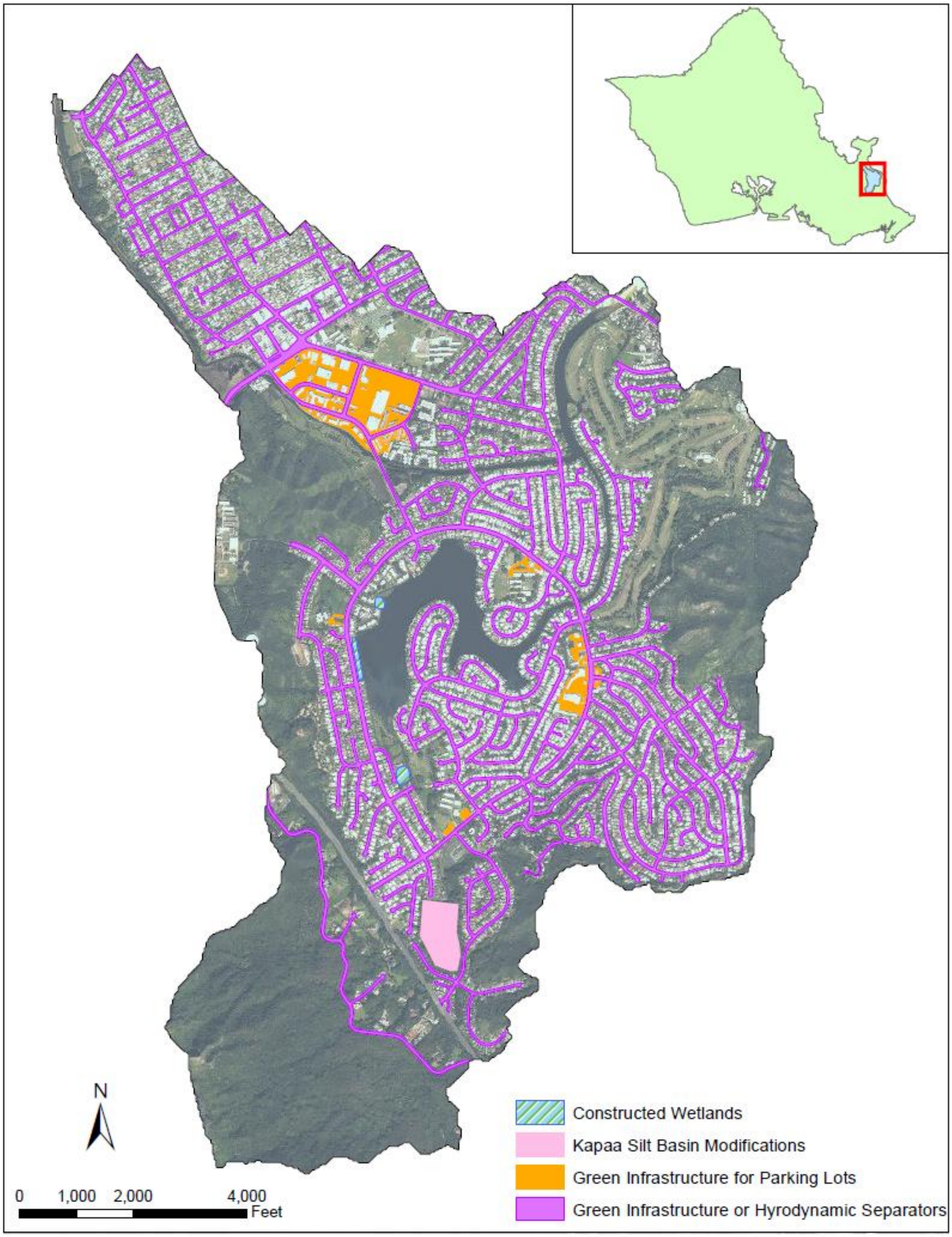
Stormwater Best Management Practices (BMP) Plan for Four Major Outlets at Ka’elepulu Pond (November 2008)

- Installation of Bio Clean Curb Inlet Boxes throughout the watershed – Installation of Curb Inlet Filter Baskets, Completed 2017
- Hydrothane HDPE Trashrack – Retractable Curb Inlet Screens Under Construction, Projected Completion 2019
- Hele Channel Bank Stabilization – Under Construction, Projected Completion 2019
- Kamahele Ditch Bank Stabilization – Completed 2016

For Commercial Areas:

- Downspout disconnect and discharge to vegetated areas
- Catchbasin Filter

Figure 7.6 Potential Project Locations for Ka'elepulu Watershed



7.4.1 Kapaa Silt Basin Modifications

Purpose
Improve sediment retention capacity of the existing facility.

Background and Objective
The Kapaa detention basin is a privately owned facility at the upstream extent of the Keolu Channel. The design and operation of the facility is not documented so it is not known if the facility's design maximizes the benefit of the facility. This project will assess the current facility to determine the effectiveness of the detention facility. Based on the findings there is a potential to modify the facility to more effectively provide water quality improvement impacting the quality of water in the Kaʻelepulu Pond.

Preliminary Scope

1. Research as-built document
2. Survey site to establish stage – storage relationship of existing facility
3. Determine design criteria
4. Develop preliminary design plans
5. Permitting
6. Final design
7. Construction

Participating Agencies

- City and County of Honolulu – Department of Environmental Services
- Department of Land and Natural Resources
- Hawaii Department of Transportation

Collaboration Opportunities

- Private landowner for the pond
- Enchanted Lakes Home Owners Association
- Hawaii Department of Transportation
- Hui O Koolaupoko

Estimated Costs
The costs associated with this project focus on the design and construction. The design will focus on how to modify the configuration of the existing facility to better perform sediment removal. The construction costs will be based on the volume of material to be graded and perhaps removal.

$ 2,076,360. (see Appendix 4)

Reference to Assist in Project Design
This project approach will be based on generally accepted engineering practices and will not require special project design assistance through manuals and software.

7.4.2 Constructed Wetlands

Purpose
Provide sedimentation BMP at the outfalls of concrete channels and storm sewers.

Background and Objective
Historically the Kaʻelepulu Pond was a wetland. Due to flow velocities within the pond, larger sediment is deposited near the outfall of the concrete channels. This is evident by the wetland that has developed and is now maintained at the end of the Keolu Channel. This project approach will provide a defined sediment deposition area that can be regularly monitored and maintained. It is proposed to have constructed wetlands at the outfall of the channel near Kaʻelepulu Elementary School, along the outfalls along Keolu Drive between Akipohe Street and Akea Place, as well as potential modification to existing Kaʻelepulu Wetland Bird Preserve to better protect this resource.

Preliminary Scope
1. Assess gradation of accumulated sediment at each potential project sites
2. Gather bathymetric survey of the potential project sites
3. Develop preliminary design plans
4. Permitting
5. Final design
6. Construction

Participating Agencies
- CCH Department of Environmental Services
- State of Hawaii Department of Land and Natural Resources
- State of Hawaii Department of Transportation
- US Army Corps of Engineers

Collaboration Opportunities
- Enchanted Lakes Home Owners Association
- Hawaii Department of Transportation
- Hui O Koolaupoko

Estimated Costs
$ 761,590. (see Appendix 4)

Reference to Assist in Project Design
EPA – Guiding Principles for Constructed Treatment Wetlands
https://www.epa.gov/wetlands/constructed-wetlands
EPA – A Handbook of Constructed Wetlands
https://www.epa.gov/sites/production/files/2015-10/documents/constructed-wetlands-handbook.pdf

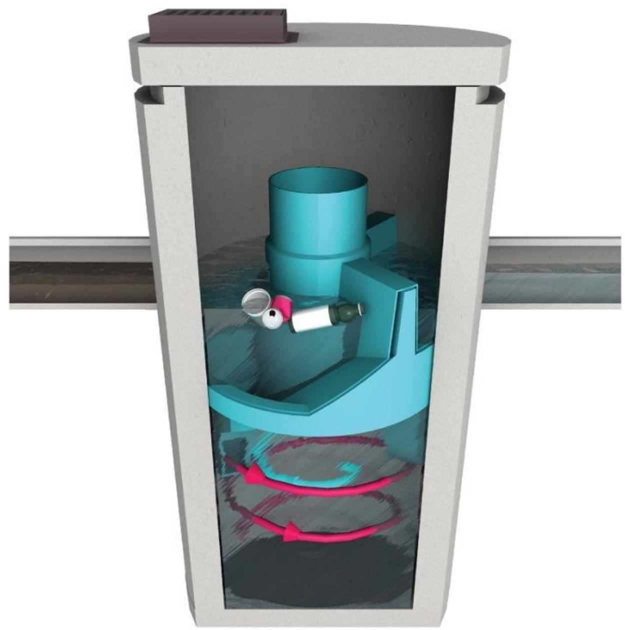
Permitting –
- Hawaii Coastal Zone Management (CZM) concurrence
- Environmental Assessment (EA) Exemption
- National Pollutant Discharge Elimination System (NPDES), Notice of General Permit Coverage
- Department of the Army Permit
- State Historic Preservation Division (SHPD) determination
- State of Hawaii, Department of Health, Section 401 Water Quality Certification (WQC)
- United States Fish and Wildlife Service (USFWS) consultation

7.4.3 Hydrodynamic Separators

Purpose
Provide a gray infrastructure options that can be retro-fitted into the existing stormwater collection system.

Background and Objective
Hydrodynamic Separators (HS) are sediment removal facilities designed into standard manhole configurations. The HS can be used to replace existing manholes and provide sediment removal treatment. The project objective is use HS units at locations where green infrastructure options are limited. The Kaʻelepulu Pond project area this would include streets with steep slopes, narrow streets, land owners not willing to collaborate with the City of green infrastructure approaches. The HS have limited flow conveyance capacity so they either need to be placed on stormwater feeder lines or a low flow bypass needs to be constructed.

Preliminary Scope
1. Obtain as-builts of storm sewer pipes and manholes for each potential project site
2. Develop preliminary design plans
3. Permitting
4. Final design
5. Construction



Participating Agencies
- City and County of Honolulu Department of Environmental Services
- City and County of Honolulu Department of Design and Construction

Collaboration Opportunities
- Enchanted Lakes Home Owners Association

Estimated Costs
$ 1,378,880. (see Appendix 4)

Reference to Assist in Project Design
There are multiple manufacturers of hydrodynamic separators. When the supplier is selected, they will be used as a resources for the design.

Permitting –
1. City and County Construction Permits

7.4.4 Green Infrastructure

Purpose
Incorporate stormwater treatment facilities into the existing urbanized landscape to provide water quality improvements.

Background and Objective
Green infrastructure (GI) is designed to promote infiltration of stormwater runoff from impervious surfaces. Depending on the location the GI approaches will include rain gardens, flow-through planters, rainwater collection, and cisterns. Each of the GI approaches can be designed to individual properties or larger areas. They can be applied to both residential and commercial locations. The visible nature of the GI treatment approach add aesthetic to the neighborhood and provides for educational interactions between the GI owner their neighbors, particularly if the GI is implemented at local elementary schools.

Preliminary Scope
1. Identify landowners willing to participate
2. Gather survey data for the individual project locations
3. Develop preliminary design plans
4. Permitting
5. Final design
6. Construction

Participating Agencies
- City and County of Honolulu Department of Environmental Services

Collaboration Opportunities
- Enchanted Lakes Home Owners Association
- Hawaii Department of Transportation
- Hawaii Department of Education
- Hui O Koolaupoko
- Individual Land Owners

Estimated Costs
$ 5,632,308. (see Appendix 4)

Reference to Assist in Project Design
Hawaii Residential Rain Garden Manual
http://www.huihawaii.org/uploads/1/6/6/3/16632890/raingardenmanual-web-res-smaller.pdf
University of Hawaii Center for Smart Building & Community Design
http://sbcd.seagrant.soest.hawaii.edu/tools-and-resources

Permitting –
1. City and County Construction Permits

8.0 References

AECOM, et al. Storm Water Best Management Practices (BMP) Plan for Four Major Outlets at Kalelepulu Pond, November 2008

Booth, D.B., J.R. Karr, S. Schauman, C.P. Konrad, S.A. Morley, M.G. Larson, and S.J. Burges. In Press. Reviving Urban Streams: Land Use, Hydrology, Biology, and Human Behavior. Journal of the American Water Resources Association.

Lane, E.W. 1955. The Importance of Fluvial Morphology in Hydraulic Engineering, American Society of Civil Engineering, Proceedings, 81, paper 745: 1-17.

Appendix 1 Stakeholder Meeting Materials

Stakeholders Meeting 1 Announcement

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 Ulu`ohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 768-3343 • Fax: (808) 768-3381
Website: www.honolulu.gov

KIRK CALDWELL
MAYOR

ROSS S. SASAMURA, P.E.
DIRECTOR AND CHIEF ENGINEER

EDUARDO P. MANGLALLAN
DEPUTY DIRECTOR

IN REPLY REFER TO:
SWQ 15-099

October 22, 2015

Mr. Greg Colbert, President
Enchanted Lake Residents Association
P.O. Box 1485
Kailua, Hawaii 96734

Dear Mr. Colbert:

Subject: Request to Attend Stakeholders Meeting
Ka'elepulu Pond Water Quality Project

The City and County of Honolulu, Department of Facility Maintenance, Storm Water Quality (SWQ) Branch is hosting a Stakeholders meeting to discuss the Ka'elepulu Pond Water Quality Project. Your attendance and input would be greatly appreciated to ensure a successful project outcome. The meeting will be held on **October 28, 2015, from 6:00 to 8:00 p.m., at the Enchanted Lake Elementary School.** Please RSVP by **Monday, October 26, 2015**.

The goal of the Ka'elepulu Pond Water Quality Project is to assess existing storm water conditions and make recommendations to address sediment build-up and other water quality issues adversely impacting the pond.

Background

In FY14, the SWQ Branch initiated a water quality watershed planning study for the Ka'elepulu Pond area. The intent of the study was to identify the potential sources of the pollutants within the watershed and recommend various Best Management Practice (BMP) improvements that could be feasibly implemented to improve the overall health of Ka'elepulu Pond. As part of the study, the SWQ Branch began a water quality-monitoring program to install, operate, and maintain six (6) water quality-monitoring stations at various locations throughout the watershed to test for water quality constituents such as Total Suspended Solids, Ammonia Nitrogen, Nitrate-Nitrite Nitrogen, Total Phosphorous, and Enterococci. These stations were

Mr. Greg Colbert, President
October 22, 2015
Page 2

equipped with refrigerated ISCO automatic samplers, flow monitors, and telemetered devices. The water quality data is expected to be used towards calibrating a computer-generated hydrologic watershed model. Once calibrated, the model could be used towards identifying and quantifying the pollutant sources, as well as preparing various simulations for different BMP scenarios that could be used in tracking specific changes within the watershed.

Meeting Expectations

The meeting will allow concerned parties to learn about the history of the project, current activities, and potentially help guide the direction of future activities designed to improve the water quality of Ka'elepulu Pond and the watershed as a whole.

If you have any questions, require more information, or to RSVP, please contact Mr. Randy Hamamoto at 529-7244 or by email at randy.hamamoto@aecom.com.

Sincerely,

Ross S. Sasamura, P.E.
Director and Chief Engineer

Enclosures: Location Map of Enchanted Lake Elementary School
Project Map
Project Photos

Stakeholders Meeting 2 Announcement

Ka'elepulu Pond Water Quality Project

The City and County of Honolulu, Department of Facility Maintenance - Storm Water Quality Branch is hosting a second Stakeholders meeting as a followup to the initial stakeholder meeting held on October 26, 2015 to discuss the ongoing Ka'elepulu Pond Water Quality Project, watershed model and water quality monitoring results. Your attendance and input would be greatly appreciated to ensure a successful project outcome. The Meeting will be held **December 7th, 2016 from 6:00 pm to 8:00 pm at Enchanted Lake Elementary School.** Please RSVP by Friday December 2nd, 2016.

The goal of the Ka'elepulu Pond Water Quality Project is to assess existing stormwater conditions and make recommendations to address sediment build-up and other water quality issues adversely impacting the pond.

Background

In FY14, SWQ initiated a water quality watershed planning study for the Ka'elepulu Pond area. The intent of the study would be to identify the potential sources of the pollutants within the watershed and recommend various BMP improvements that could be feasibly implemented to improve the overall health of Ka'elepulu Pond. As part of the study, SWQ began a water quality-monitoring program to install, operate and maintain six (6) water quality-monitoring stations at various locations throughout the watershed to test for water quality constituents such as TSS, Ammonia Nitrogen, Nitrate-Nitrite Nitrogen, TP and Enterococci. The water quality data was collected and used to calibrate a computer generated hydrologic watershed model. The model identifies and quantifies the pollutant sources, and can be used to develop simulations for different BMP scenarios that could be used in tracking specific changes within the watershed.

BMP improvement projects that have been implemented include Kamahele Ditch Improvements and Kaelepulu Catch Basin Improvements. Ongoing BMP projects in the design phase include the Hele Channel Improvements and Curb Inlet Screens.

Meeting Expectations

The meeting will allow concerned parties to learn about the history of the project, completed improvements, current activities, and potentially help guide the direction of future activities designed to improve the water quality of Ka'elepulu Pond and the watershed as a whole.

For more information or to RSVP, please contact Randy Hamamoto at 808.529.7244 or by email at randy.hamamoto@aecom.com

Sincerely,

_______________, CCH

Sign In Sheet – Stakeholders Meeting 1

AECOM
1001 Bishop Street, Suite 1600, Honolulu, HI 96813
T 808.521.3051 F 808.524.0246 www.aecom.com

AECOM

STAKEHOLDERS MEETING
KA'ELEPULU POND WATER QUALITY PROJECT

Date: October 28, 2015 **Time:** 6:00 pm to 8:00 pm **Place:** Enchanted Lake Elementary School

Name	Organization
Randal Wakumoto	CCH, DFM, SWQ
Stephen Blanton	AECOM, Portland
Brandon Weaver	AECOM
Noah Wong	AECOM
Bob Bourke	Enchanted Lakes Residents Assoc.
Steven Brennan	Enchanted Lakes Residents Assoc.
Kitty Courtney	Enchanted Lakes Residents Assoc.
Cindy Turner	Turner & de Vries
Hugo de Vries	Turner & de Vries
James Adams	Kukilakila Community Assoc.
	Kukilakila Community Assoc.
	Kukilakila Community Assoc.
Brad Kwasnowski	Cardno
Ben Berridge	Cardno

Sign In Sheet – Stakeholders Meeting 2

AECOM
1001 Bishop Street Suite 1600 Honolulu HI 96813
T 808 521 3051 F 808 524 0246 www.aecom.com

AECOM

STAKEHOLDERS MEETING - 2
KA'ELEPULU POND WATER QUALITY PROJECT

Date: December 7, 2016 **Time:** 6:00 pm to 8:00 pm **Place:** Enchanted Lake Elementary School

Name	Organization
Randall Wakumoto	CCH, DFM, SWQ
Stephen Blanton	AECOM, Portland
Randy Hamamoto	AECOM
Noah Wong	AECOM
Alan & Judy Richardson	ELRA
Bill Sullivan	ELRA
George Heiligman	ELRA
Jane Carlile	Wetlands Reader
BOB MOLYNEUX	ELRA
Jean Compton	ELRA
Nicolas Ayabe	Senator Jill Tokuda's office
JIM GEBHARD	ELRA
DEREK ESIBILL	ELRA
CHUCK PRENTISS	KAILUA NB
Bob Bourke	ELRA

Name	Organization
Bob Tasse	ELRA
Franklin Denis	
LEONARD LEPINE	RESIDENT
STANN REIZISS	
Steve Brown	KUKIWAKIIA COMMUNITY ASSN
Mark Heckman	Resident
GUS GUSTAVSON	Resident
Doug Kroll	DD Kroll
Michele Compton	ELRA
Jean Fernie	ELRA
Mike Compton	ELRA
Jim Fernie	ELRA
Lynette Frazier	"
SEAN HARDING	ERLA
DAVID + SARAH MOORE	ELRA
Jennifer Barra	Office of Senator Laura Thielen
FRAN Tanner	ELRA
SHANNON OSHIRO	ELRA
GREG COLBERT	ELRA

2

Name	Organization	
Cindy Turner	Kaelepulu Wetland	
Margaret Novack	ELPA	
Claudia MacLeod	Kukilakila	
Kathleen Rielly	ELRA	
Chuck Burrows	Kawainui-Kaelua	
	Ka Wai Ola	

Appendix 2 Previous Water Quality Sampling Results for Ka‘elepulu Pond

Sampling Results from Bob Bourke – Enchanted Lake Home Owners Association

Sampling Location	Storm 1 – 2.8" January 2, 2004 Flow Duration 6 hrs			Storm 2 – 2.5" February 1, 2005 Flow Duration 2.5 hrs			Storm 4 – 1.85" February 22, 2006 Flow Duration 2.5 hrs			Storm 5 – 1.85" March 19, 2006 Flow Duration 3 hrs		
	TSS (mg/L)	Sediment Inflow (kg/L)	Sediment Load (kg)	TSS (mg/L)	Sediment Inflow (kg/L)	Sediment Load (kg)	TSS (mg/L)	Sediment Inflow (kg/L)	Sediment Load (kg)	TSS (mg/L)	Sediment Inflow (kg/L)	Sediment Load (kg)
Cedar House	223	614	3683	365	1783	4457	55			347	396	1189
Go to Drain				3180	972	2431	428	131	327	318	97	292
DOT Go To Drain	6990	5700	34202									
Kaopa C2 Channel	150	153	917	1556	2379	5948	159	49	122	632	895	2684
Kaʻelepulu Inlet Channel	122	1829	10973	272	1386	3466	196	1998	4995	566	13452	40355
Urban Storm	72	22	132				14	1	4	0.5	0	0
76 Keolu Hills Drain	51	272	1634	100	489	1223	22	2	6	10	21	63
St John GC	48.7	23	139	57	17	42	10	1	1	35	11	32
Lg Channel Inlet				120	367	917	28	43	107	22	34	101
Keolu flat Drain							38	58	145	46	252	755
Kaʻelepulu Outlet Channel										40	1223	3670
Buzz's	37	377	2263	22	224	561				24	1056	3168
Kaʻelepulu School	19.6	16	96	440	748	1869	54	NA	NA	170	3554	10661
Total Estimated Sediment Entering Pond - Tons			**13.0**			**7.5**			**5.3**			**52.0**

Storm Water Best Management Practices (BMP) Plan, November 2008

WQ Parameter	Date	Sample Values	Location
Total Solids	09/27/06	40.10 %	WKIP 14
Total Kjeldahl Nitrogen	10/06/06	1,300 mg-N/kg	WKIP 14
Total Phosphorus	10/11/06	987 mg/kg	WKIP 14
Total Solids	09/27/06	55.50 %	WKIP 52
Total Kjeldahl Nitrogen	10/06/06	1,060 mg-N/kg	WKIP 52
Total Phosphorus	10/11/06	1,050 mg/kg	WKIP 52

Appendix 3 Additional Site Investigation Photographs

Stormwater Management Issues Found in Ka‘elepulu

Houses without gutters – allowing the stormwater runoff generated on the roofs of residences to drain directly off the structure tend to lead to increased infiltration if the perimeter of the residence is landscaped. In many cases the roof runoff discharges onto paved surface and is directed to flow directly into the street gutters.

Downspouts Discharging to paved surfaces – this practice provides no opportunity for infiltration and runoff quickly flows across the paved areas into the street gutters and into the storm conveyance system

Downspouts connected Directly to Collection System – many residences with rain gutter have the downspout connected directly to the storm sewer collection system.

Accumulated Material in Gutters – throughout the watershed there is evidence that street sweeping is regularly occurring. The road debris accumulated on the down gradient side of the storm inlet reflects the material that has been pushed past the inlet during higher flows. The shown material appears to be larger material loosened from the repaving efforts. It can be assumed a larger volume of material entered the stormwater conveyance system and was deposited in the lower channels.

Organic Material in Open Conveyance System – Many of the concrete drainage channels are constructed between two residences. These facilities tend to become dumping grounds for yard debris and other organic material. This photograph illustrates a channel piled with palm fronds and leaves. The relatively large size of the palm fronds increase the chances of material accumulation on grated culvert inlets causing localized flooding.

Lot Coverage – There are multiple residences spread throughout the study area where a large portion of the site is impervious surface, either roof or parking. This type of construction practice does not allow for infiltration of stormwater runoff.

Bare Soil on Slopes – Multiple areas in the upper watershed	
Unprotected Bare Road Cuts – the Old Kalanianaole Hwy was cut into the slopes of the hills. Most of the road cuts are bare, with vegetation roots exposed. The eroded material accumulated on the shoulder	
Garbage in Gutters	

Bare Lands – This photograph illustrates bare soils that contribute to the sediment load. Similar patches of unvegetated area are found at many of the school site within the study area. There is not visual evidence of channelization from runoff most of the site, likely because of mild slopes, but precipitation impact will results is elevated concentrations of sediment in the sheet flow runoff.

Keolu Concrete Channel – Surface runoff in October 2014. Both the flow from the pipe and the flow within the concrete channel are relatively clear of sediment.

Stormwater Outfall into the Keolu Concrete Lined Channel – the stormwater flow appears to be relatively low in suspended sediments due to the clean appearance.

Old Kalanianaole Highway – Sediment load in the stormwater gives it a reddish-brown appearance. The source of sediment is likely the bare cut slopes across the road. Accumulated runoff is maintained along the shoulder by the vegetation.

St. John Vianney – Earth lined channel. Stormwater flow is relatively low is suspended solids. The unvegetated bank may be due to channel slope erosion. There are also multiple trees that have been recently removed so there may be in-channel activity also.

St. John Vianney – Farther downstream the stormwater appears to be browner due to increased sediment loading. This section of the channel may be backwater from Kaʻelepulu Pond and the brownish water is from the pond.

Hele Channel at Keolu Drive – The flow in the Hele channel is light brown. Most of the soils in the area are red!!!!!!!!!! At least one barrel of the culverts under Keolu Drive is blocked during low flows resulting in the clear water shown along the left bank. This indicates the flow is not influenced by the pond when this photo was taken.

Hele Channel at Keolu Drive – This is looking upstream at the Hele channel. The water is turbid the color is more gray than the brown or red.

Hele Channel at Liku Street – shallow flow, relatively clear, as you can see the bottom of the channel. the watershed is mostly residential with only a small portion of the Keolu Hills

Akipola Lined Channel at Keolu Drive – Clearer runoff entering the channel and mixing with the sediment laden flows.

Akipola Line Channel at Keolu Drive – Looking upstream. Kaʻelepulu Elementary School property is to the left. Stormwater runoff is brown.

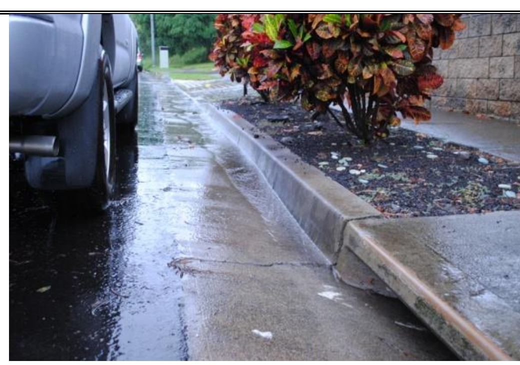
Residential Construction – Akipola Street project with unprotected exposed soil is being washed eroded from the site and entering the stormwater system. Flow in the gutter has high concentration of sediment. Eroded material can be seen in front of the vehicle.

Residential Construction –More material being washed off the side of the Akipola Street worksite.

Residential Construction – Akipola Street, across the street at a neighboring construction site, filter fabric has been placed in front the of the drop inlet. The fabric appears to need captured debris removed.

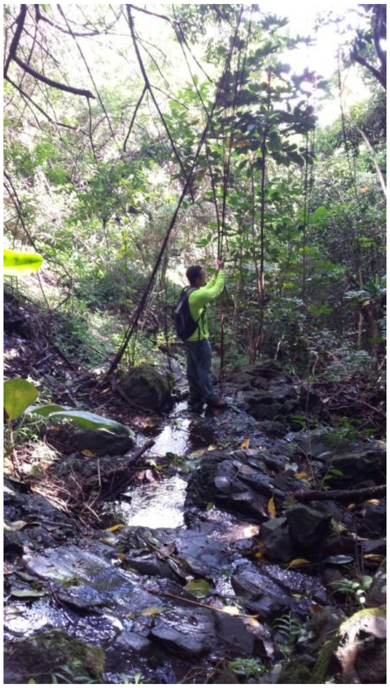
Exposed soil is eroding from a site to be developed. Sediments and gravels are being washed in to the stormwater system. Rills are forming in the soil, channelizing flows and increasing the rate of erosion.

Clear Surface Runoff – this photo illustrates clear stormwater runoff in flowing in the gutters. This indicated relatively little sediment in the flow.



Flows discharging through a wall. Based on the amount of flow, it may be assume this pipe is directly connected to the house gutter system. The water drains lower in the wall do not appear to have flow coming out of them.	
Moss removed from stream side boulder illustrates recent water surface elevation in the creek. This is upstream of the Old Kalanianaole Rd.	

Stream channel conditions upstream of Old Kalanianaole Rd. Due to transmission losses the shown stream flow did not reach the culvert under the road.



Typical sediment found in the stream channel. The mix of material sizes indicates bimodal sediment from two sources; upstream and local.

Evidence of natural slides providing sediment input to the unnamed stream reach above the Old Kalanianaole Highway.

Upstream face of the emergency overflow for the Kapaa Silt Basin. A grated low flow outlet is at the base of the concrete structure. Flows feed Keolu Channel

Appendix 4 Potential Project Cost Estimates

AECOM Imagine it. Delivered.

JOB TITLE ______
PROJECT/JOB NO. ______ CALCULATION NO. ______
COMPUTED BY ______ DATE ______
VERIFIED BY ______ DATE ______
SCALE ______ SHEET NO. ______ OF ______

KAPAA SILT BASIN MODIFICATIONS

BASIN AREA UPGRADIENT OF BERM → ~13 ACRE

↳ 566,280 FT^2

- ASSUME ACCUMULATED MATERIAL IS 3 FT DEEP.

= 1,698,840 FT^3

= 62,920 CY

EXCAVATION × $30 CY

= $1,887,600

ADD 10% FOR REPAIR OF BERM + PLANTING

= $2,076,360

AECOM Imagine it. Delivered.

JOB TITLE ______
PROJECT/JOB NO. ______ CALCULATION NO. ______
COMPUTED BY ______ DATE ______
VERIFIED BY ______ DATE ______
SCALE ______ SHEET NO. ______ OF ______

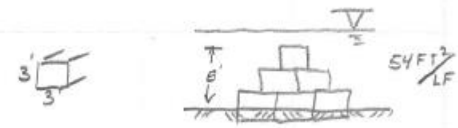
WETLANDS

SIZING → 4-6% OF TRIB AREA (ASSUME 5%)

WETLAND 1 = 144 AC ⟹ 7 AC (AK1 + AK2)
WETLAND 2 = 125 AC ⟹ 6 AC (WKIP 46-50)

WETLAND 1

560' x 560' = 7 AC



PERIMETER = 2240 L.F.
x 54 FT² = 120,966 FT³
↳ 4480 CY

@ $80/CY FOR GABIONS = $358,418
↳ INCLUDES ROCK FILL

WETLAND 2

521' x 521' = 6 ACRES

PERIMETER = 2087 LF
x 54 FT² = 112,704 FT³
↳ 4174 CY

@ $80/CY FOR GABIONS = $333,937
↳ INCLUDES ROCK FILL

$692,355
(+) 10% PLANTING MATERIALS

$761,590

AECOM Imagine it. Delivered.

JOB TITLE
PROJECT/JOB NO. CALCULATION NO.
COMPUTED BY DATE
VERIFIED BY DATE
SCALE SHEET NO. OF

HYDRO SEPERATORS

FROM VORTECHNIC SPECIFICATION

USE MODEL 2000 TREATS 2.8CFS → 1999 COST = 7,200

ASSUME 2% INFLATION

2018 = 10

- USING "COMPETITIVE PRICING" SPREADSHEET

MODEL 2000 → $10,200 (YR 2010)

W/INFLATION (2%) 2018 COST $12,000 TREATS 2.8 CFS (WQ)

USING CCH WQ DESIGN RATIONAL METHOD

C = 0.95, i = 0.4 IN/HR, A = 1.0 AC } 0.38 CFS

THE 2000 UNIT WILL TREAT 7 AC $\frac{2.8}{0.38}$ = 7.39 AC (IMP)

980 ACRES NOT GOING TO WETLANDS OR SILT BASIN

44% BASIN IMP

86 UNITS

980 AC * 0.44 = 431 ACRES OF IMPERVIOUS

= 86 UNITS (ASSUME 5 AC TREATMENT AREA)

× 12000/UNIT

= $1,034,880

$4000 INSTALL EACH × 86 UNIT

$1,378,880

AECOM Imagine it. Delivered.

JOB TITLE

PROJECT/JOB NO. CALCULATION NO.

COMPUTED BY DATE

VERIFIED BY DATE

SCALE SHEET NO. OF

RAIN GARDENS (2003 NC REPORT)

$ = 2,861 x^0.438 (SANDY SOILS)

X = WATERSHED, ACRE

1 AC ⇒ $2861.00

AS WITH HYDRO SEPERATOR

980 ACRE OF TOTAL AREA
44% IMP

431 AC OF IMPERVIOUS AREA
* $2861 / AC ⇒ $1,233,663
↳ 2018 COST = $3850
(2% INFLATION)

GREEN STREETS CITY OF PORTLAND

$4.65/FT² OF TREATED IMPERVIOUS
$0.50/FT² " " " FOR STREET/SIDEWALK REPAIR
$5.15/FT²

HUI KOOLAUPOKO

$500/100 FT² OF RAINGARDEN
↳ $5/FT² FOR RAIN GARDEN CREATION

SIZING FACTOR: 0.06 (FROM CLEAN WATER SERVICE)

431 AC x 0.06 = 1,126,462 FT² OF RAIN GARDEN

≈ $5,632,308