Appendix F4: Action Plan for Retrofitting the Existing MS4 with Structural BMPs, 2012

Action Plan for Retrofitting the Existing MS4 with Structural BMPs

For the City and County of Honolulu
Municipal Separate Storm Sewer System
National Pollutant Discharge Elimination System
Permit No. HI S000002

FINAL

June 2012

Prepared by
Department of Environmental Services
City and County of Honolulu

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2012 JUN 22 10:46AM

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IN REPLY REFER TO:

SWQ 12-165

June 22, 2012

Loretta J. Fuddy, A.C.S.W., M.P.H.
Director of Health
State Department of Health
Environmental Management Division
Clean Water Branch
919 Ala Moana Boulevard, Room 301
Honolulu, Hawaii 96814-4920

Dear Ms. Fuddy:

Subject: Action Plan for Retrofitting the Existing MS4 with Structural BMPs
Municipal Separate Storm Sewer System NPDES Permit No. HI S000002

Attached is the "Action Plan for Retrofitting the Existing MS4 with Structural BMPs" dated June 2012. The plan is being submitted in accordance with Part D.1.f.(1)(vi) of the City's permit, which requires the City to address the following items.

- Continue with implementation of activities for Wailupe, Kuliouou, and Niu streams as described in the Department of Environmental Services (ENV) 2001 report titled "Action Plan: Implementing Feasible Opportunities to Retrofit Structural BMPs."

- Evaluate recommendations of the 2008 ENV report titled "Storm Water Best Management Practices (BMP) Plan for Four Major Outlets at Kaelepuu Pond."

- Evaluate the recommendations in the Malama Maunalua 2010 draft report titled "Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed."

- Provide an action plan for the bulleted items above within one (1) year of the effective permit date.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions, please contact Gerald Takayesu of our Storm Water Quality Branch, Division of Environmental Quality, at 768-3287.

Sincerely,

Timothy E. Steinberger, P.E.
Director

Attachment: Action Plan for Retrofitting the Existing MS4 with Structural BMPs, June 2012

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List of Acronyms and Abbreviations

2001 Action Plan	Action Plan to Implement Feasible Opportunities for Existing Structural BMPs, dated October 2001
Bio Clean	Bio Clean Environmental Services, Inc.
BMPs	Best Management Practices
CDS	Continuous Deflective Separation
City	City and County of Honolulu
CIP	Capital Improvement Program
CWA	Clean Water Act
DLNR	Department of Land and Natural Resource, State of Hawaii
DOT	Department of Transportation, State of Hawaii
ENV	Department of Environmental Services, City and County of Honolulu
FY	Fiscal Year (July 1 of previous year to June 30 of current year)
LID	Low Impact Development
MS4	Municipal Separate Storm Sewer System
NED	National Economic Development
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
Permit	NPDES Permit No. HI S000002
Rules	Rules Relating to Storm Drainage Standards
State	State of Hawaii
SWMPP	Storm Water Management Program Plan
TMDL	Total Maximum Daily Load
USACE	United States Army Corporation of Engineers

1. Introduction

This report has been prepared as required under Part D.1.f(1)(vi) of the National Pollutant Discharge Elimination System (NPDES) Permit No. HI S000002 (Permit), for the City and County of Honolulu's (City) municipal separate storm sewer system (MS4).

The Permit states:

> *"Part D.1.f(1)(vi) Action Plan for Retrofitting the Existing MS4 with Structural BMPs.*
>
> *The Permittee shall:*
>
> - *Continue with the implementation of the activities for Wailupe Stream, Kuliouou Stream, and Niu Stream as described on Pages 10-11 of the "Action Plan: Implementing Feasible Opportunities to Retrofit Structural BMPs," dated October 2001, and submitted to DOH on October 31, 2001, to address retrofitting the existing MS4 with structural BMPs. All structural BMPs as identified in the Action Plan, dated October 2001, shall be completed within five (5) years of the effective date of this permit.*
> - *Evaluate the recommendations of the report titled, "Storm Water Best Management Practices (BMP) Plan for Four Major Outlets at Kaelepulu Pond," Kailua, Hawaii, November 2008.*
> - *Evaluate the recommendations of the draft report titled, "Watershed Based Plan for Reduction of Non-point Source Pollution in Wailupe Stream Watershed," dated June 2010.*
> - *Provide the DOH with an updated Action Plan within one (1) year of the effective date of this permit, which shall identify retrofits to be implemented, explanation on the basis for their selection and an implementation schedule, including addressing each of the bulleted items above. The implementation schedule shall cover a five (5) year period and be updated yearly to include additional retrofit projects with water quality protection measures for the 5th year of the schedule. The annual updates to the implementation schedule shall be included in the Annual Report with a description of the projects status. The Action Plan may include, but not be limited to projects in compliance with any TMDL implementation and reduction plan."*

Structural Best Management Practices (BMPs) are engineered and constructed systems that improve the quality and/or control the quantity of storm water runoff. This has been interpreted by the City as also applying to retrofitting structures or segments in the system by either adding in-line filters, such as catch basin inserts, or adding structural controls, such as grassed or vegetated buffer strips, and detention basins. Retrofitting drainage systems for BMPs require modification to existing structures and analysis to ensure that the BMP will be compatible with the hydraulics of the existing system.

This report has been prepared to address the bulleted items above including reporting on the status of the U.S. Army Corps of Engineers (USACE) flood control projects for Wailupe Stream and Kuliouou Stream that were discussed in the October 2001 "Action Plan to Implement Feasible Opportunities for Existing Structural BMPs" (2001 Action Plan) and the evaluation of recommended structural BMPs for Kaelepulu Pond and Wailupe Watershed. In addition, the City has several other retrofitting projects to address water quality which are also discussed. Finally, this report includes a discussion on non-structural BMPs that the City implements to address storm water quality, which were recommended in both planning reports for Kaelepulu Pond and Wailupe Watershed.

2. Structural BMP Retrofits for Wailupe Stream, Kuliouou Stream and Niu Stream by the U.S. Army Corps of Engineers

The 2001 Action Plan included recommendations from a USACE study conducted in response to a flood that occurred on New Year's Eve, 1987, along with subsequent follow up studies. The purpose of the report, "Final Reconnaissance Report, Urban Flood Control Study," May 1992, was to complete an assessment of the condition and adequacy of East Oahu drainage systems and investigate possible Federal funding of projects. In this initial plan, the USACE addressed improvements to Kawainui Marsh, Waimanalo, Kuliouou, Niu Valley, Wailupe Stream, and Hahaione Valley to protect people and property along the streams' floodways. The initial reconnaissance report was followed up with "Final Supplemental Reconnaissance Report, Urban Flood Control Study, Honolulu, Hawaii" dated December 1994 and the "Final Feasibility Report, Wailupe Stream Flood Control Study, Oahu, Hawaii," dated December 1998, to address Wailupe Stream recommendations.

As stated in the 2001 Action Plan, the USACE recommended continued study at Wailupe Stream and deferral of action on Niu Valley and Kuliouou pending the results of further investigation of Wailupe Stream. The cost-benefit ratio for Wailupe was expected to be significantly higher than for either Niu or Kuliouou. If Wailupe would not be funded, then it was doubtful that improvements to the other two streams could be justified. The City is a local sponsor for the projects and provides funding along with the State of Hawaii (State). The recommended alternatives and project costs as determined by the USACE follow.

2.1. Initial Recommendations and Current Status

Information from the 2001 Action Plan and current status of USACE recommendations for Wailupe Stream, Kuliouou Stream, and Niu Stream are given below (note that the estimated costs were 2001 or earlier values).

Wailupe Stream:

There were two flood reduction alternatives that received serious consideration. Both included: (1) replacing the existing 550 cubic yard capacity debris basin with a new 42,000 cubic yard capacity basin along Wailupe Stream; (2) construction of a new 24,000 cubic yard capacity debris basin in the Kului Stream tributary; (3) approximately 6,000 feet of concrete channel improvements from the two basins to coast; and (4) an unlined channel from the coast line through the existing reef approximately 200 feet from the end of the concrete lined channel. The total cost for either of the alternatives that were given serious consideration was estimated to be in excess of $34 million. The USACE study concluded that even the alternative with highest benefit/cost ratio (0.89) would not meet the Federal National Economic Development (NED) criterion of having positive net benefits. However, because of community concern as well as concern at the local, state, and federal levels, the USACE has continued its study for other projects that would have an acceptable benefit/cost ratio.

The USACE also studied the feasibility of constructing debris basins only, but concluded that "past experience has shown that the construction of debris basins without channel improvements can disrupt the delicate balance of natural stream degradation and replenishment, thus leading to increased erosion within the stream," and that "this alternative would not satisfy the study objectives of reducing the flood hazard with Aina Haina and it was thus eliminated from further consideration.

Current Status:

The latest status available from Fiscal Year (FY)10 was that City and State sponsors have agreed with the USACE to expand the scope of work for Wailupe Stream project to include ecosystem restoration. Design has not yet started on the Wailupe Stream project. No other information was available from the USACE at this time.

Kuliouou Stream:

For Kuliouou Stream, the USACE proposed construction of six debris dams, (concrete and steel construction, and maximum height of thirty feet). The necessary debris basin capacity was estimated at 90,000 cubic yards. The project also included improvements to the existing lined channel. The project cost, including land, engineering and design, construction and construction management, was estimated to be $9.78 million. The estimated project cost for construction of the debris basins only, exclusive of land and damages, relocation, access roads/bridges, design and construction management, was $5.21 million.

Current Status:

The latest status for Kuliouou Stream flood control projects was given in April 2012. In FY08, funds were approved for the Kuliouou Stream flood control projects. The City provided matching funds for a feasibility study for this project in FY08 and FY09 (see Appendix A). The USACE is currently performing a feasibility study at Kuliouou Stream and assessing alternative BMPs which include enlarging the existing debris basin in a more ecologically friendly way than recommended in the 1994 report. The USACE anticipates having a prioritized list of alternatives by July 2012 and the expected completion date of the feasibility study is March 2014. Following the feasibility study, plans and specifications would be developed followed by construction. As part of USACE projects, Federal participation needs to be warranted, meaning that the benefits of the projects outweigh the cost of building the project. Additionally, the date for completion of construction would be contingent upon availability of Federal construction funding. With the current schedule and assuming that the project will be funded, completion of construction is projected in 2016.

Niu Stream:

In the 1994 final supplemental reconnaissance report, the USACE proposed construction of a total of nine dams (concrete and steel construction, and maximum height of thirty feet), in two of Niu Stream's tributaries: five debris dams upstream of the existing boulder basin in Pia Valley, and four debris dams in Kupaua Valley. The necessary debris basin capacity was estimated at 184,000 cubic yards. The project also included improvements to the existing lined channel. The project cost, including land, engineering and design, construction and construction management, was estimated to be $9.53 million. The estimated project cost for construction of the debris basins only, exclusive of land and damages, relocation, access roads/bridges, design and construction management, was $6.26 million.

Current Status:

There is no ongoing activity for the Niu Stream project.

2.2. Limitations and Implementation Plan

Although further studies are occurring at both Wailupe and Kuliouou streams, work on Niu stream has not been initiated following the original recommendation of the USACE. Further, the alternatives being studied by the USACE for Wailupe stream and Kuliouou stream are now different than the original recommendations reported in the 2001 Action Plan. The projects are also under the same criteria of needing to meet NED criterion of having positive net benefits to receive Federal funding. The projects have not met this criterion in the past and construction is contingent upon Federal funding.

As a result, a June 2016 deadline (five years from the effective date of the Permit) to implement the BMPs specified in the 2001 Action Plan is not feasible for the City as it is supporting the efforts of the USACE as a local sponsor to provide funding. Projects are dependent upon a partnership with the USACE, and funding by Federal, State and local sponsors. Regular updates will be given in each Annual Report on the status of the projects.

Because the City cannot fulfill a 2016 deadline for the structural BMPs reported in the 2001 Action Plan, the City plans to review the possibility of other BMP retrofits to the MS4. Although the USACE studies were completed with the primary purpose of addressing flood control, potential City MS4 retrofits will focus on storm water quality.

The City will evaluate the possibility of installing other structural controls on City parcels in the three areas which may include grass swales, infiltration trenches or vegetated buffer strips. In addition, the plan will include evaluating the possibility of installing catch basin inserts to address storm water quality discharged through the MS4. The City has initiated a cursory review of the most recent catch basin inspection data records from May 2011 for Kuliouou, Niu Valley, and Aina Haina (Wailupe) areas. Inspection criteria included trash, debris and sediment. Analysis of the existing data makes it possible to prioritize areas for retrofits. Progress towards evaluating and construction of potential retrofits will be reported in the Annual Report and projected for completion in 2016, which would fulfill the permit deadline for the planned USACE flood control structural BMPs.

Wailupe Stream was also the subject of another study focusing on storm water quality improvements, including some overlapping recommendations with the USACE flood control projects. These recommendations are discussed below.

3. Wailupe Watershed Plan Evaluation

The City has evaluated the recommendations of the report titled "Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed," dated June 2010, prepared by Malama Maunalua. This plan included structural retrofits as well as non-structural pollutant controls to reduce pollutants originating from Wailupe Watershed. Wailupe watershed is drained by Wailupe Stream into Maunalua Bay which is on the Clean Water Act (CWA) 303(d) list of impaired water bodies. Primary pollutants of concern include fine terrigenous (land-based) sediments originating from the Wailupe watershed, nitrogen, chlorophyll A, and other non-point source pollutants such as hydrocarbons and heavy metals.

3.1. Malama Maunalua Study Initial Recommendations

Structural BMP recommendations outlined in the plan by Malama Maunalua included some that fall partly or solely under the responsibility of the City. These recommendations are listed below:

- Hydrodynamic Separators (Nutrient Separating Baffle Boxes by Bio Clean Environmental Services, Inc. [Bio Clean])
- Catch Basin Inserts (by Bio Clean)
- Extended detention basins
- Grass swales
- Infiltration trenches
- Porous pavement
- Coir logs for stream bank stabilization

Other recommendations were made which fall under other agencies such as State Department of Transportation (DOT), the USACE, State Department of Land and Natural Resources (DLNR), and private and commercial land owners such as Kamehameha Schools. In addition, the report recommended non-structural solutions including a good housekeeping program for residents, volunteers and community groups, and commercial businesses. Table 1 lists the recommended management practices, implementation priority and responsible entities as specified by Malama Maunalua. Appendix B contains a glossary of definitions for the referenced BMPs.

Table 1: Malama Maunalua Recommended BMPs for Wailupe Watershed[*]

Management Practice	Load Reduction Potential	Relative Cost[†]	Implementation Priority	Responsible Entities
Nutrient Separating Baffle Box	High	High	High	▪ City ▪ DOT
Coir logs	Moderate	Moderate	Moderate	▪ City
Catch Basin Inserts	High	Low	High	▪ City
Extended detention basin	Moderate	High	High	▪ City ▪ Private
Good housekeeping practices	Moderate	Low	High	▪ Community groups ▪ Residents/volunteers
Grass swale	Low	Moderate	Low	▪ City ▪ Private ▪ Commercial
Green roof-green grid	Low	High	Low	▪ Commercial/business owners
Infiltration trench	Moderate	Moderate	Moderate	▪ City ▪ Private ▪ Commercial
Invasive species control	Moderate	High	Low	▪ Various[‡]
Modular wetland	High	Moderate	High	▪ Private
Natural/native vegetation	Low	Moderate	Low	▪ DLNR ▪ Volunteers
Porous pavement	Moderate	Moderate	Moderate	▪ City ▪ Private ▪ Commercial
Rain barrels	Low	Low	Moderate	▪ Residents/volunteers
Subsurface storage	High	High	Moderate	▪ Private
Turf reinforcement mats	High	High	Moderate	▪ USACE

[*] Table adapted from "Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed," June 2010 by Malama Maunalua

[†] According to the Malama Maunalua plan, "relative cost relates the cost of the practice to its performance in terms of reduction of [non-point source] pollutant the practice can be expected to achieve," and therefore may differ from reasonable costs assumed by agencies and entities responsible for implementing these BMPs.

[‡] The Malama Maunalua plan does not name specific responsible entities for this management practice but acknowledges that this task will require collaboration between multiple stakeholders and conservation groups, and is dependent upon studies and efforts of government entities, private entities (i.e. members of the Koolau Mountain Watershed Partnership) and public institutions (i.e. University of Hawaii).

The Malama Maunalua plan identified MS4s, both City and DOT, as the primary target for pollution reduction. Consequently, all of the recommended structural BMP retrofits to the MS4 were specified as

high priority: Nutrient Separating Baffle Boxes, catch basin inserts, and the two recommended extended detention basins. The recommended extended detention basins were included as one of the proposed recommendations under consideration by the USACE. These basins would primarily address issues of flooding but would also reduce the transport of fine sediment, the primary pollutant of concern identified in the plan. Therefore, the other retrofit recommendations to be evaluated further included Nutrient Separating Baffle Boxes and catch basin inserts.

In all, the Malama Maunalua plan recommended 85 sites for Nutrient Separating Baffle Boxes (Bio Clean) with both the City and DOT named as responsible entities. The plan also identified this BMP as having a relatively high cost when compared with the pollution reduction the BMP would achieve. While the plan specified locations and quantities of Nutrient Separating Baffle Boxes, it did not prioritized locations or quantities of catch basin/grated inlet inserts for the 489 existing inlets in the City's MS4 within the Wailupe watershed area. Additionally, installation of both Nutrient Separating Baffle Boxes and catch basin inserts along the same pipe network would be redundant; therefore, where no Nutrient Separating Baffle Boxes are installed, it is recommended to install catch basin inserts and vice versa. In general, the plan also recommends installing catch basin inserts on the most heavily used streets, near parking lots and near areas where trash accumulates.

3.2. Selection of Structural BMP Retrofits for further Evaluation

Any retrofits to be installed in the Wailupe Watershed require further evaluation including hydraulic and hydrologic analysis and long term operations and maintenance (O&M) costs. The City also needs to evaluate partnerships with other agencies listed in the recommendations such as the DOT for Nutrient Separating Baffle Box installation and the DLNR and USACE for preventive measures such as revegetation, erosion matting, and feral pig control, to reduce sediment generation and transport before it reaches the City's MS4. The City also has an erosion control program to address erosional areas originating in the City's right-of-way. Temporary and permanent erosion control BMPs in the Wailupe area will be evaluated as part of this program to address sediment transport to Maunalua Bay where feasible. These preventive measures, along with the possible construction of extended detention basins being considered as an alternative by the USACE, will address the main concern of fine sediments and other pollutants.

For the Wailupe Watershed, if the City finds that Nutrient Separating Baffle Boxes are needed as a treatment control and are a feasible option for the area, further hydrologic and hydraulic analysis will be required to verify that they meet required flow capacities. It has been found in other feasibility studies by the City that hydrodynamic separators can unfavorably affect existing hydraulics and would be conservative in evaluation for residential areas and areas with flood potential as is the case in the Wailupe watershed area. The City also needs to consider locations of maintenance access easements and O&M costs. As mentioned in Section 2.2, the City is evaluating locations for catch basin inserts or an equivalent BMP based on past catch basin inspection data for the Niu Valley, Kuliouou, and Aina Haina (Wailupe) areas. Inspection criteria include trash, debris and sediment. Additionally, the City is evaluating opportunities for other structural controls on City parcels.

The City is also actively pursuing other efforts to reduce nonpoint source pollution into Maunalua Bay and other receiving waters. These efforts are discussed in Section 6 of this report.

4. Structural BMP retrofits for Kaelepulu Pond

The City has evaluated the recommendations of the report titled, "Storm Water Best Management Practices (BMP) Plan for Four Major Outlets and Kaelepulu Pond," Kailua Hawaii, November 2008 which was prepared for the City's Department of Environmental Services (ENV). This plan recommended structural retrofits as well as non-structural pollutant controls to reduce the primary concerns of odor and sediment entering into Kaelepulu pond in addition to pollutants identified during

field investigations. The project focused on four drainage areas that drain into Kaelepulu pond, WKIP 10, 14, 52, and 44, which were identified as major contributors of sediment and gross pollutants (floatable debris including green waste and trash).

4.1. Initial Recommendations

Structural BMPs that were recommended for the system were based on: locations of maintenance access easements; sediment accumulation "hot spots" or high pollutant areas; storm water flow rates; location of tail waters; and water quality treatment flow rates, sediment removal efficiencies and overall cost of the BMP device including installation and O&M.

The recommendations for each of the four studied drainage areas included a Hydrothane Systems, Inc. Trashrack to be installed near the outlet and last serviceable location of each of the drainage areas to capture gross pollutants before they enter Kaelepulu Pond (see Appendix B). Additional options included installing catch basin inserts with shelf systems to treat the street runoff into the system.

Since a majority of the flow (and pollutants) is conveyed to Kaelepulu pond via open channel (compared to lateral in-line pipe systems), it became the focus areas for a structural BMP approach. It was recommended that a pilot project be initiated utilizing a Nutrient Separating Baffle Box for the WKIP 10 Hele concrete-lined channel. Nutrient Separating Baffle Boxes separate organics and litter from sediments and standing water to prevent organic leaching and the possibility of the system going septic. Additionally, there were areas within Hele Channel that needed wall rehabilitation, and areas downstream in the natural portions of the channel which required bank stabilization to reduce erosion.

4.2. Selection of Structural BMPs and Implementation Schedule

Further hydrologic analysis concluded that the existing drainage infrastructure at the proposed Hydrothane Trash Rack locations and Nutrient Separating Baffle Box location did not meet flow capacities per the current drainage requirements. It was concluded that the proposed structural BMPs would unfavorably affect existing channel hydraulics and therefore were not selected for installation.

The structural BMPs that were selected included catch basin inserts and stream bank improvements to Hele Channel and Kamahele Ditch. The project has been split into two phases: a catch basin improvements project and a stream bank improvements project.

Phase I: Catch Basin Improvements

The catch basin improvements portion of the project is scheduled to be bid at the end of calendar year 2012 and construction should begin in early 2013. In all, a total of 33 catch basin inserts will be installed based on the original recommendations, with some minor modifications due to site restrictions. The curb inlet boxes will address pollutants in street runoff including floatable debris and hydrocarbons. This phase of the plan also includes necessary structural improvements to two of the catch basins.

Phase II: Stream Bank Improvements

The stream bank improvements portion is projected to be bid at the end of calendar year 2013 for construction in 2014, depending on permitting issues and funding availability. The plan will include the installation of an anchored reinforced vegetation system on the side slopes of the Hele Channel and the Kamahele Ditch to prevent further erosion. Additionally, concrete armor units will be installed at the toe of the slope of the Hele Channel in areas that are severely eroded.

5. Other Retrofits

In addition to the Kaelepulu project described above, the City has several other capital improvement program (CIP) projects where structural and commercially available BMPs have been or are being installed to address storm water quality. A detailed listing of CIP projects and funding related to flood

control, erosion control, and storm water quality as reported in the FY11 Annual Report is given in Appendix A for FY08-FY12.

5.1. Other Retrofits to the MS4

The City has evaluated several priority locations for retrofitting potential to address storm water quality. These include drainage systems in the Waikiki beach area, Ala Wai Canal, Salt Lake, Kuapa Pond, and Wahiawa Reservoir. Culverts draining into Wahiawa Reservoir, Kuapa Pond, and Salt Lake are privately owned, but receive runoff from City drains. Other priority areas identified throughout the permit term will be included and updated as part of the implementation schedule to be reported in upcoming Annual Reports.

Based on review and analysis of the commercially available BMP devices as well as the hydrological and physical characteristics of the watersheds and drainage systems, manufactured storm water treatment options were recommended. In most cases, the City was not able to implement all of the BMP recommendations as identified in initial planning reports either because of a lack of funding or interest from contractors. All of the projects involve installing catch basin inserts to filter street runoff. The Wahiawa Reservoir project thus far is the only project that includes a hydrodynamic separator unit as part of the bid set. This is the first hydrodynamic separator unit being installed by the City and will be used as a pilot to evaluate the possibility for installation in other locations in the future. Currently, the City is evaluating other locations for water quality improvements and/or retrofits to the existing MS4; however, those discussions are still in the preliminary stage and the exact timetable for implementation cannot yet be determined. A summary of the location and timeline for each of the funded studies are shown below in Table 2.

Table 2: Structural BMP Retrofits Project Timeline

Waikiki Structural BMPs Phase I	
Start Date:	2007-Apr
End Date:	2008-Oct
Waikiki Structural BMPs Phase II	
Start Date:	2008-May
End Date:	2010-Sep
Ala Wai Structural BMPs	
Start Date:	2008-May
End Date:	2010-Sep
Salt Lake Structural BMPs Phase I	
Start Date:	2009-Sep
End Date:	2010-Oct
Salt Lake Structural BMPs Phase II	
Start Date:	Anticipated in 2014
End Date:	Pending
Wahiawa Structural BMPs	
Start Date:	2012-July
End Date:	Pending
Kuapa Pond Structural BMPs	
Start Date:	Anticipated in 2014
End Date:	Pending

Waikiki:

Given the concerns regarding water quality and the importance of Waikiki to the tourism industry and the City's economy, the City selected the Waikiki Beach area as a priority area to protect the water quality of its receiving waters from discharges of the storm drain system. The City has installed 135 catch basin inserts and grated inlet inserts (Bio Clean) in the Waikiki Beach area, completing the project in two phases. The catch basin inserts address drainage systems in Waikiki which drain to off-shore coastal waters. Drainage systems discharging to the Ala Wai canal were also addressed in a separate project discussed below.

Ala Wai Canal:

The City has installed 34 catch basin inserts and grated inlet inserts (Bio Clean) to reduce pollutants in street runoff discharging into the Ala Wai Canal. Ala Wai Canal discharges directly into Mamala Bay and is one of the City's Total Maximum Daily Load (TMDL) watersheds with effluent limitations developed by the DOH. The areas discharging into the Ala Wai addressed in the initial planning reports include the Kapahulu and Diamond Head area, the upper Kapahulu and Kaimuki area, and the Moiliili and lower Manoa area.

Salt Lake:

A major portion of Salt Lake was filled to create a golf course in the 1970's leaving only a series of ponds and a circumferential canal separating the golf course from surrounding land uses. Study of possible BMPs was conducted after past complaints from residents of obnoxious odors originating in the canals and ponds. Additionally, it was found that there were problems with sediment, trash and other pollutants associated with urban runoff. The City has installed 91 catch basin inserts to target sediment, trash, and debris in the canals and associated ponds. In addition to these 91 catch basin inserts, the City plans to install two debris basins in the Salt Lake area in 2014.

Wahiawa Reservoir:

Wahiawa Reservoir, located in Central Oahu, receives non-point source pollution as direct storm runoff from the surrounding Wahiawa community composed of residential, industrial, and commercial areas as well as from upland forested and agricultural lands. Point sources of pollutants to the reservoir include a wastewater treatment facility outfall. The City is installing 20 catch basin inserts and one Continuous Deflective Separation (CDS) hydrodynamic separator (CDS PSWC56_40 Unit) in the Wahiawa area to reduce pollutants discharging through its MS4. The anticipated start date of this project is in July 2012.

Kuapa Pond:

Kuapa Pond is located in South East Oahu in the Hawaii Kai area. The City is in the planning phases for the Kuapa Pond study to address pollutants discharging from the City's MS4 into the privately owned water body. Construction is not anticipated until 2014.

5.2. Existing City-owned Control Structures

The City maintains 23 boulder/debris and detention/retention basins as shown on Table 3. Debris/boulder basins, while historically viewed as flood/debris control for public safety, also act as storm water BMPs by retaining soil and other debris moved by flood waters. Similarly, detention/retention basins are designed to detain or retain peak storm water flows to prevent down-stream flooding. These structural controls allow pollutants to settle out thereby helping to prevent sediment or other pollutants from entering the storm drainage system and receiving waters. In addition, there are also three debris booms installed at the Ulehawa Stream's east (U-2) and west (U-3) tributaries. Inspection and maintenance of existing structural controls are outlined in the City's Storm Water Management Program Plan (SWMPP), June 2012.

Table 3: City Debris/Boulder and Retention/Detention Basins

District	Basins
Honolulu	16th Avenue Hahaione (East) Hahaione (West) Kalani Iki Kamiloiki Kapakahi (Aina Koa) Kuliouou Manauwea Street Moanalua Niu Valley (East) Niu Valley (West) Nuhelewai (Aupuni) Waialae Nui (Kilauea) Wailupe
Pearl City	Aiea Stream Komo Mai Drive Waiawa Waimalu Stream
Waianae	Kaupuni K2
Laie	Paumalu Flood Control
Kaneohe	Hio Place
Kailua & Waimanalo	Kahawai Stream Kaopa Silt Basin

6. Non-Structural BMPs

6.1. Education and Outreach

In addition to the structural BMPs proposed, the "Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed" and "Storm Water Best Management Practices Plan for Four Major Outlets and Kaelepulu Pond," also recommended non-structural BMPs for residents, volunteers, community groups, and commercial businesses in the respective areas. The City aids in this effort with its education and outreach program which promotes BMPs for residents and businesses including BMPs for chemical storage and less toxic alternatives, spill cleanup procedures, and proper waste disposal. The City also promotes and educates the public on green infrastructure practices such as installing rain barrels, rain gardens, using native vegetation where possible, and permeable hardscapes as alternatives to impermeable pavement. The City has just released a Green Infrastructure for Homeowners handbook as a resource to help residents mitigate storm water pollution and decrease the volume of storm water runoff leaving their properties. The education and outreach program is carried out as detailed in the City's SWMPP.

6.2. Pollution Prevention and Good Housekeeping

The City also conducts its own pollution prevention and good housekeeping program which includes street sweeping, litter pickup, and catch basin inspection and cleaning, in an effort to prevent pollutants from entering or discharging through the MS4. Based on two studies initiated in the Salt Lake neighborhood in 1998 and 2008, both the ENV and the Department of Facility Maintenance concluded that street sweeping is an effective tool in collecting debris and other medium to large sized particles from the street. Additionally, it was determined that restricting on-street parking increased the efficiency of the sweeper by allowing it to get closer to the curb, which provided greater debris and sediment capture rates from the road where most of the accumulated sediment was deposited. This BMP is preferable to structural or treatment BMPs that can be costly and/or take up considerable space. The more obvious benefit is the collection and removal of trash, leaves, and other visible debris that collect in the gutters, which can block storm water collection structures, and can cause localized flooding during heavy rains. All non-structural solutions are currently performed as detailed in the City's SWMPP and will continue as specified.

6.3. Standards Revision to include Low Impact Development

Importantly, the "Watershed Based Plan for Reduction of Nonpoint Source Pollution in Wailupe Stream Watershed" emphasized the need for private and commercial landowners to also implement structural BMPs to protect water quality. The City's Rules Relating to Storm Drainage Standards (Rules) require all new development and redevelopment projects that meet specific criteria to install post-construction permanent BMPs to control the runoff of pollutants from the site following completion of construction. Since adoption of the Rules, several new developments, including new City parks, have implemented structural BMPs as part of the post construction water quality measures. The Rules are currently being updated to specify more stringent water quality standards, including Low Impact Development (LID) requirements. LID refers to storm water management practices which seek to mimic natural processes and protect water quality via infiltration, evapotranspiration or reuse of storm water runoff at the site where it was generated. LID BMPs include infiltration basins, infiltration trenches, bioretention basins, bioretention filters, dry swales, vegetated buffer strips, and vegetated swales.

7. Next Steps

The next steps for the City will be to identify priority areas, compare the total cost of alternatives, including non-structural BMPs, and provide resources to address these priorities. As mentioned above, the City is evaluating possible retrofits in the Aina Haina (Wailupe), Niu Valley, and Kuliouou valley areas. Retrofit projects are ongoing at Kaelepulu Pond, Wahiawa Reservoir and Salt Lake, and the City is initiating a structural BMPs project for Kuapa Pond in Hawaii Kai.

A study of the City's contribution compared to other sources, and alternative approaches must be considered prior to implementing any measures. The total cost of implementing structural BMPs also needs to be a part of the decision process. This would include construction, operation and maintenance of the device, and collection and disposal of debris. The economics of any storm drain filter or other retrofit to the existing municipal separate storm sewer system would be compared to results achievable through street sweeping and other non-structural BMPs. All expenditures are subject to availability of funding and approval by the City Administration.

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Appendix A

Listing of FY08-FY12 Flood/Erosion Control/Water Quality Projects

Listing of FY08-FY12 Flood/Erosion Control/Water Quality Projects

FY08 CIP Projects	
▪ Ewa Villages Revitalization Project – Area D *Plan, design and construct drainage improvements and provide construction inspection*	$1,350,000
▪ NPDES Modification for Corporation Yards *Plan, design, construct corporation yard improvements, and provide construction inspection and related equipment to meet NPDES requirements*	$5,400,000
▪ Honolulu Police Department NPDES Small MS4 Permit Program *Plan, design, and construct improvements to police stations and facilities to meet NPDES requirements provide construction inspection and related equipment*	$275,000
▪ Honolulu Fire Department NPDES Small MS4 Permit Program *Plan, design and construct improvements at fire stations and facilities to meet NPDES requirements, provide construction inspection and related equipment*	$275,000
▪ Flood Control Improvements at Various Locations *Acquire land, plan, design, construct and inspect flood control improvements at various locations such as Mailiili Stream Wall Reconstruction, Maili Stream Wall Reconstruction, Ulehawa Stream Wall Reconstruction, Aikahi Ditch, Waipio Gentry Ditch, Anolani Ditch, Nuuanu Stream bank reconstruction, Aiea Stream access, Pokai Bay Ditch, Huli Lined Channel access, Mailiili Stream access, Kaneohe Stream, Aikahi Ditch access, Maili Stream access, Waialae Nui, and Lualualei*	$3,340,000
▪ Honouliuli Flood Control and Drainage Improvements *Plan flood control and drainage improvements for Honouliuli and the West Loch Golf Course*	$100,000
▪ Kaelepulu Stream Mangrove Removal *Construction for the eradication of mangrove in Kaelepulu Stream from 651 Akoakoa St. (TMK: 4-2-77-13) to Kaawakea Bridge (TMK: 4-2-77-107) to Wanaao Bridge (TMK: 4-2-75-17) to Kaelepulu Stream-rear of 485 Wanaao Road (TMK: 4-2-19-48)*	$200,000
▪ Kapunahala Stream Flood Control Project, Kaneohe, TMK: 4-5-23 & 24 *Plan and design flood control improvements*	$100,000
▪ Kawainui Stream Mangrove Removal *Plan, design and construct mangrove and invasive species removal at Kawainui Stream in the vicinity of the levy that runs across the marsh*	$100,000
▪ Kuliouou Flood Control *Provide, the local match for a federal feasibility study with the Corps of Engineers for flood control improvements*	$75,000
▪ Manoa Valley Flood Control *Design drainage improvements*	$400,000
▪ Kaneohe Stream Bank Restoration Near Keole Place *Construct and inspect stream bank improvements*	$3,850,000

FY08 CIP Projects	
▪ Rock Slide Potential Inspections and Mitigative Improvements *Acquire land, plan design, construct and inspect mitigative measures for unanticipated rockfall and other earth stability hazards*	$1,320,000
▪ Alani Drive Drainage Improvements *Construct drainage improvements*	$300,000
▪ Carlos Long Street Drainage Improvements, Palolo (TMK: 3-4-12: 24 & 25) *Design drainage system improvements*	$150,000
▪ Drainage Improvements at Various Locations *Acquire land, plan, design and construct drainage improvements at various locations such as Kaamilo Ditch, Heeia Street, Punchbowl Street, Laulaunui Street, Kealia Drive, Lokahi Street, Pohakupuna Road, Loulu Street, Piikoi Street, Kalihi Street, Walina Street, Meleana Street, Ahuimanu Road, Mokuone Street, Seaside Avenue, Kalakaua Avenue, Waialae Avenue, Huelani Place, and Lualualei*	$1,325,000
▪ Duncan Drive – Puahuulua Place Relief Drain Project *Plan, design and construct relief drain*	$401,000
▪ Storm Drainage Improvements *Acquire land, plan, design and construct storm drainage improvements at various locations such as Lilipuna Road, Kaniela Place, Storm Drain, Nuuanu Pali Drive, Ahuwale Ditch, Haku Ditch, Wailele Road Outlet, Hanapepe Outlet, and Hoaloha Place*	$765,000
▪ Water Quality Improvements, Salt Lake *Maintenance dredge the Salt Lake Waterway*	$200,000
▪ Storm Drain Outlets in Waikiki Beach *Construct structural best management practices*	$600,000
▪ Storm Drain Outlets Near Ala Wai Canal *Design and construct structural best management practices*	$620,000
▪ Storm Drainage Best Management Practices in the Salt Lake Drainage System (TMK: 1-1-63) *Construct the storm drainage best management practices*	$800,000
▪ Department of Parks and Recreation NPDES Small MS4 Permit Program *Plan, design and construct improvements at park facilities to meet NPDES requirements and provide construction inspection and related equipment*	$275,000
▪ Mitigative Improvements at Parks *Plan, design, construct and provide construction inspection for mitigation improvements such as rock slides and seawall improvements*	$2,000,000
▪ Department of Enterprise Services NPDES Small MS4 Permit Program *Plan, design and construct improvements at enterprise facilities to meet NPDES requirements and provide construction inspection and related equipment*	$440,000
TOTAL, FY08 CIP PROJECTS	**$24,661,000**

FY09 CIP Projects	
▪ Ewa Villages Revitalization Project – Area D *Design & construct drainage improvements and provide construction inspection*	$500,000
▪ NPDES Modification for Corporation Yards *Plan, design, construct corporation yard improvements, and provide construction inspection and related equipment to meet NPDES requirements*	$7,350,000
▪ Honolulu Police Department NPDES Small MS4 Permit Program *Plan, design and construct improvements to police stations, and facilities to meet NPDES requirements. Provide construction inspection and related equipment*	$600,000
▪ Honolulu Fire Department NPDES Small MS4 Permit Program *Plan, design and construct improvements at fire stations and facilities to meet NPDES requirements, provide construction inspection and related equipment*	$600,000
▪ Flood Control Improvements at Various Locations *Acquire land, plan, design, construct and inspect flood control improvements at various locations to include but not limited to Mailiili Stream Wall Reconstruction, Maili Stream Wall Reconstruction, Ulehawa Stream Wall Reconstruction, Aikahi Ditch, Waipio Gentry Ditch, Anolani Ditch, Aiea, Halawa, Waimalu Stream Dredging, Aiea Stream access, Pokai Bay Ditch, Huli Lined Channel access, Mailiili Stream access, Kaneohe Stream, Aikahi Ditch access, Maili Stream access, Waialae Nui, Pauoa Stream and Von Hamm*	$3,736,000
▪ Kapunahala Stream Flood Control Project, Kaneohe, TMK: 4-5-23 & 24 *Plan flood control improvements*	$150,000
▪ Kawa Stream and Ditch Improvements *Plan and design improvements*	$110,000
▪ Kuliouou Flood Control *Provide the local match for a federal feasibility study with the Corps of Engineers for flood control improvements*	$200,000
▪ Manoa Valley Drainage Improvements *Construct drainage improvements*	$300,000
▪ Drainage Outfall Improvements *Design and construct drainage improvements at various locations such as Waolani Stream drainage system at Kawananakoa Place, Pupu St, Lahilahi, Pokiwai and Kuliouou*	$795,000
▪ Maunalaha Road Embankment Restoration *Construct and inspect embankment improvements*	$460,000
▪ Moanalua Stream Lining Reconstruction *Plan and design stream lining improvements*	$110,000

FY09 CIP Projects	
▪ Rock Slide Potential Inspections and Mitigative Improvements *Acquire land, design, construct and inspect mitigative measures for unanticipated rockfall and other earth stability hazards such as Pupukea*	$5,200,000
▪ Drainage Improvements at Various Locations *Acquire land, plan, design, construct and inspect drainage improvements at various locations such as Heeia Street, Laulaunui Street, Kealia Drive, Lokahi Street, Pohakupuna Road, Loulu Street, Walina Street, Meleana Street, Ahuimanu Road, Mokuone Street, Seaside Avenue, Kalakaua Avenue, Huelani Place, Mapunapuna and Mikiola Drive*	$2,565,000
▪ Duncan Drive – Puahuula Place Relief Drain project *Construct relief drain improvements at Puahuula Place and Duncan Drive*	$750,000
▪ Haleiwa Road Drainage Improvements *Plan and design to install drainage sumps and piping to release storm water in the area between 66-420 to 66-450 Haleiwa Road and creating release into Kaiaka Bay Beach Park natural drain*	$100,000
▪ Papipi Road Drainage Improvements *Conduct drainage study*	$100,000
▪ Storm Drainage *Acquire land, plan, design and construct storm drainage improvements at various locations such as Lilipuna Road, Kaniela Place Storm Drain, Nuuanu Pali Drive, Ahuwale Ditch, Haku Ditch, Wailele Road Outlet, Hanapepe Outlet, Hoaloha Place and Kalapaki St. Ditch*	$1,570,000
▪ Hydrodynamic Separator, Kahuhipa Street, Kaneohe *Design, construct, inspect and acquire equipment for storm water system improvements*	$287,000
▪ Storm Drainage Best Management Practices in the Salt Lake Drainage System *Plan, design, construct, inspect and provide equipment for the storm drainage best management practices and maintenance dredging of Salt Lake. No monies shall be extended or encumbered for this project unless federal funds are committed to the project and all legal issues regarding the project, including the financial obligations of all parties involved, concerning the short and long term maintenance and dredging of Salt Lake have been resolved*	$2,235,000
▪ Storm Drainage Best Management Practices in the Vicinity of Kaelepulu Pond *Plan, design, construct, inspect and provide equipment for the storm drainage best management practices*	$1,725,000
▪ Waikiki Drain Outfall Improvements *Plan and design the outfall improvements*	$200,000
▪ Ala Moana Regional Park (TMK: 2-3-37:01; 42.7 Acres) *Additional design funds for improvements such as the reconstruction of canal walls*	$50,000

FY09 CIP Projects	
▪ Department of Parks and Recreation NPDES Small MS4 Permit Program *Plan, design and construct improvements at park facilities to meet NPDES requirements and provide construction inspection and related equipment*	$600,000
▪ Mitigative Improvements at Parks *Plan, design, construct and provide construction inspection for mitigation improvements such as rock slide, seawall, retaining wall, and canal wall improvements*	$750,000
▪ Department of Enterprise Services NPDES Small MS4 Permit Program *Plan, design and construct improvements at enterprise facilities to meet NPDES requirements and provide construction inspection and related equipment*	$1,100,000
▪ West Loch Golf Course – Ponds & Waterways *Plan and design improvements such as dredging of silt retention basins throughout the course and also Honouliuli Stream that drains into the course*	$410,000
TOTAL, FY09 CIP PROJECTS	**$32,553,000**

FY10 CIP Projects	
▪ Ewa Villages Revitalization Project – Area D *Design and construct drainage improvements and provide construction inspection*	$1,150,000
▪ NPDES Modification for Corporation Yards *Plan, design, construct corporation yard improvements, and provide construction inspection and related equipment to meet NPDES requirements*	$3,500,000
▪ Honolulu Police Department NPDES Small MS4 Permit Program *Plan, design and construct improvements to police stations and facilities to meet NPDES requirements. Provide construction inspection and related equipment*	$760,000
▪ Honolulu Fire Department NPDES Small MS4 Permit Program *Plan, design and construct improvements at fire station and facilities to meet NPDES requirements, provide construction, inspection and related equipment*	$275,000
▪ Aiea Stream Outlet Dredging *Design stream outlet dredging*	$100,000
▪ Flood Control Improvements at Various Locations *Acquire land, plan, design, construct and inspect flood control improvements at various locations such as Mailiili Stream Wall Reconstruction, Maili Stream Wall Reconstruction, Ulehawa Stream Wall Reconstruction, Hilo Place Basin, Pauoa Stream and Manoa Stream near Poelua Street*	$1,385,000
▪ Drainage Outfall Improvements *Design and construct drainage improvements at various locations such as Waolani Stream drainage system at Hobron Lane and Hanapepe Loop*	$620,000
▪ Kuahea Street Area Movement, Palolo Valley *Design and construct roadway, underground utilities, and slope stabilization improvements. The project qualifies for State financing and/or reimbursement*	$2,000,000
▪ Manoa Stream Tributary Retaining Wall *Design a stream retaining wall*	$250,000
▪ Moanalua Stream Lining Reconstruction *Construct stream lining improvements*	$400,000
▪ Rock Slide Potential Inspections and Mitigative Improvements *Acquire land, plan, design, construct and inspect mitigative measures for unanticipated rockfall and other earth stability hazards such as Pupukea Road, Puowaina Drive and Round Top Drive*	$1,130,000
▪ Round Top Drive Emergency Roadway Reconstruction *Reconstruction and stabilize roadway. The project qualifies for State (State Civil Defense) financing and Federal (FEMA) reimbursement*	$3,550,000
▪ Drainage Improvements at Various Locations *Acquire land, plan, design, construct and inspect drainage improvements at various locations Old Kalanianaole Road, Palani Avenue, Punchbowl Street, Miller Street, Iwilei Road, Auyong Homestead Road, the intersection of Lanikaula and Kalawao Streets, and a portion of Alani Drive*	$1,160,000

FY10 CIP Projects	
▪ Storm Drainage Improvements *Acquire land, plan, design and construct storm drainage improvements at various locations such as Ahuwale Ditch, Haku Ditch, Kalapaki Street Ditch, Kokokahi Place, Hele Ditch, Kipu Ditch and Ahikoe Street Ditch*	$1,500,000
▪ NPDES MS4 Erosion Prone Area Improvements *Plan and design erosion control measure*	$400,000
▪ Storm Drainage Best Management Practices, Downtown-Chinatown *Plan and design structural best management practices*	$60,000
▪ Storm Drainage Best Management Practices in the Salt Lake Drainage System *Plan and design storm drainage best management practices*	$210,000
▪ Storm Drainage Best Management Practices in the Vicinity of Wahiawa Reservoir *Plan, design, construct and inspect structural best management practices*	$845,000
▪ Storm Drainage BMP's in the Vicinity of Kuapa Pond *Plan and design structural best management practices*	$350,000
▪ Ala Moana Regional Park (TMK: 2-3-37:01; 42.7 Acres) *Design and construct canal wall improvements*	$815,000
▪ Department of Parks and Recreation NPDES Small MS4 Permit Program *Plan, design, construct improvements at park facilities to meet NPDES requirements and provide construction inspection and related equipment*	$720,000
▪ Hanauma Bay Erosion/Rockfall Mitigative Improvements *Plan, design and construct mitigative park improvements such as erosion and potential rockslide conditions*	$230,000
▪ Hanauma Bay NPDES Small MS4 Permit Program *Plan, design, construct and provide construction inspection and related equipment to meet NPDES requirements*	$600,000
▪ Mitigative Improvements at Parks *Plan, design, construct and provide construction inspection and related equipment for mitigation improvements such as rock slide, seawalls and retaining walls in City parks*	$1,770,000
▪ Department of Enterprise Services NPDES Small MS4 Permit Program *Plan, design and construct improvements at Enterprise facilities to meet NPDES requirements and provide construction inspection and related equipment*	$1,260,000
▪ West Loch Golf Course – Ponds and Waterways *Plan, design, construct and provide construction inspection for golf course improvements such as dredging of silt retention basins throughout the course and also Honouliuli Stream that drains into the course*	$1,110,000
TOTAL, FY10 CIP PROJECTS	**$26,150,000**

FY11 CIP Projects	
▪ Flood Control Improvements at Various Locations *Acquire land, plan, design, construct and inspect (including reviews) flood control improvements at various locations such as Aiea Stream Access, Wailani Stream, Kahaluu Debris Basin and Mailiili Channel Restoration*	$2,720,000
▪ Halawa Stream Dredging *Design dredging improvements*	$100,000
▪ Waimalu Stream Dredging *Design and construct stream dredging*	$5,010,000
▪ Drainage Outfall Improvements *Plan, design and construct drainage improvements at various locations such as Pupu St., Lahilahi St., Pokiwai Ditch, Kuliouou Stream and Hookele St. Drain Outfall*	$620,000
▪ Drainage Improvements at Various Locations *Acquire land, plan, design, and construct drainage improvements at various locations such as Palani Avenue, Miller St., Auyong Homestead Road and Meleana Place*	$1,320,000
▪ Kawailoa Road Drainage Improvements *Plan, design, and construct drainage improvements*	$100,000
▪ Storm Drainage Improvements *Acquire land, plan, design, and construct storm drainage improvements at various locations such as Kokokahi Place, Kipu Ditch, Ahikoe Ditch, and Hausten Ditch. At least $200,000 shall be appropriated to reinforce the eroding and damaged concrete masonry block channel and restore this section of Hausten Ditch, where it meets on the mauka side of Kapiolani Boulevard and these monies shall not be expended for any other purpose*	$1,720,000
▪ Waialua Beach Road – Remediate Ponding *Plan and design roadway improvements to prevent ponding*	$100,000
▪ Waikalua Road – Paewalani Place Drainage Relief Improvements *Plan, design, and construct drainage improvements at Paewalani Place and the adjacent areas in the vicinity of Waikalua Road*	$40,000
▪ NPDES MS4 Erosion Prone Area Improvements *Design, construct and inspect erosion control measures*	$900,000
▪ Storm Drainage Best Management Practices, Downtown-Chinatown *Plan and design structural BMPs*	$160,000
▪ Storm Drainage Best Management Practices in the Vicinity of Kaelepulu Pond *Plan and design for storm drainage BMPs*	$250,000
TOTAL, FY11 CIP PROJECTS	**$13,040,000**

FY12 CIP Projects	
▪ Flood Control Improvements at Various Locations *Acquire land, plan, design, construct and inspect (including reviews) flood control improvements at various locations*	$1,640,000
▪ Kawa Stream and Ditch Improvements *Plan and design stream and ditch improvements*	$510,000
▪ Manoa Valley Flood Control *Construct flood control improvements*	$1,200,000
▪ Drainage Outfall Improvements *Plan, design, construct and inspect drainage improvements at various locations*	$450,000
▪ Drainage Improvements at Various Locations *Plan, design, construct and inspect drainage improvements at various locations*	$910,000
▪ Moanalua Stream Lining Reconstruction *Reconstruct stream lining*	$400,000
▪ Storm Drainage Improvements *Plan, design and construct storm drainage improvements at various locations*	$210,000
▪ Waialua Beach Road – Remediate Ponding *Plan and design a replacement culvert for flooding and ponding mitigation*	$150,000
▪ NPDES MS4 Erosion Prone Area Improvements *Plan and design erosion control measures*	$350,000
▪ Storm Drainage Best Management Practices, Downtown-Chinatown *Plan and design structural BMPs*	$200,000
▪ Storm Drainage Best Management Practices in the Vicinity of Kaelepulu Pond *Construct, inspect and procure equipment for storm drainage BMPs*	$860,000
▪ Waikiki Drain Outfall Improvements *Design storm drain outfall improvements*	$100,000
TOTAL, FY12 CIP PROJECTS	**$6,980,000**

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Appendix B

Glossary of Referenced BMPs

Glossary of Referenced BMPs

The following glossary terms relating to referenced or proposed BMPs were adopted from multiple sources, including the USEPA National Menu of Stormwater Best Management Practices and the City and County of Honolulu Green Infrastructure for Homeowners Handbook.

Baffle Box

Baffle boxes are typically made of concrete or fiberglass structures containing a series of sediment settling chambers separated by baffles. The primary function of baffle boxes is to remove sediment, suspended particles, and associated pollutants from storm water. Baffle boxes may also contain trash screens or skimmers to capture larger materials, trash, and floatables. Baffle boxes are located either in-line or at the end of storm pipes.

Catch Basin Insert

Catch basin inserts (a.k.a. drain inlet inserts or grate inlet inserts) are filters placed in inlets to help remove sediment and debris from storm water runoff. They are used to increase a catch basin's efficiency at removing trash, debris and sediment and some oil and grease, organics, and metals. There are several manufactures and models, each incorporating slightly different design variations.

Catch Basin Insert from the City's "Efficiency of Storm Drain Filters in Removing Pollutants from Urban Road Runoff"

Coir Log

Coir logs (also called fiber rolls, fiber logs or straw wattles) are tube-shaped erosion-control devices filled with straw, flax, rice, coconut fiber material, or composted material. Coir logs complement permanent best management practices used for source control and revegetation. Coir logs also help to slow, filter, and spread overland flows and can help reduce sediment loads to receiving waters by filtering runoff and capturing sediments.

Extended Detention Basin

Dry extended detention basins (also known as dry ponds, detention ponds, extended detention ponds) are basins that have been designed to detain storm water runoff from a water quality design storm for some minimum time (e.g., 24 hours) to allow particles and associated pollutants to settle. They can also be used to provide flood control by including additional flood detention storage.

Extended Detention Basin on Oahu

Infiltration Trench

An infiltration trench is a rock-filled trench with no outlet that receives storm water runoff. Runoff is stored in the void space between the rocks and infiltrates through the bottom and into the soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants.

Grass Swale

A grass or vegetated swale is an open channel management practice designed specifically to treat and attenuate storm water runoff for a specified water quality volume. As storm water runoff flows through these channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. They trap particulate pollutants, promote infiltration, and reduce the flow velocity of storm water runoff. Vegetated swales can serve as part of a storm water drainage system and can replace curbs, gutters and storm sewer systems.

Grass Swale in Central Oahu Regional Park, Oahu

Green Roof at the Fasi Municipal Building, Honolulu, Oahu

Green Roof

Green roofs are living, vegetative roofing alternatives which cover impervious surfaces, roofs, with permeable plant material and soil. This reduces runoff and uses the natural ability of vegetation to treat storm water runoff.

Hydrodynamic Separator

Hydrodynamic separators are flow-through structures with a settling or separation unit to remove sediments, floatables and other pollutants. Depending on the type of unit, this separation may be by means of swirl action or indirect filtration. There are several proprietary models, each incorporating slightly different design variations, such as in-line or off-line applications.

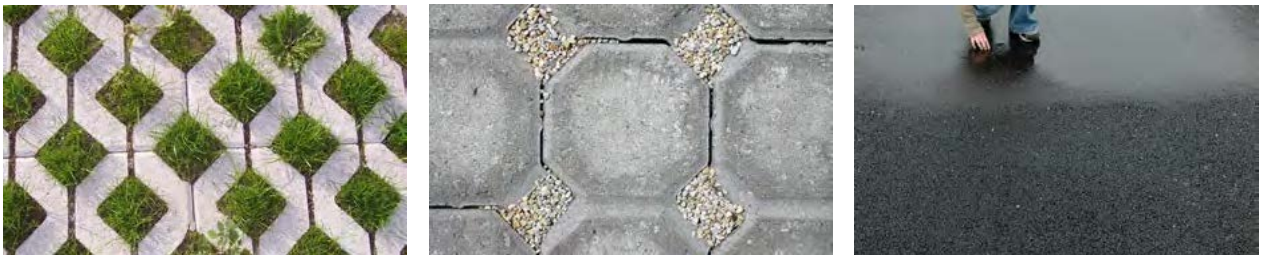
Installation of a Hydrodynamic Separator on Oahu.

Modular Wetland

Modular wetlands or manufactured wetlands consist of multiple chambers or modules that circulate storm water for an extended period of time to allow for contact and interaction with wetland vegetation. A subsurface flow of storm water is routed through a gravel and wetland vegetation root system allowing for microbial utilization and plant uptake of pollutants. Modular wetlands are reportedly effective at removing dissolved and suspended solids, nutrients, pesticides, heavy metals and bacteria from urban runoff.

Porous Pavement

Pervious, permeable or porous pavement is a permeable surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. There are a few porous pavement options, including porous asphalt, pervious concrete, interlocking paver blocks, and grass pavers. Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but are manufactured without “fine” materials, and incorporate void spaces to allow infiltration. Grass pavers are concrete interlocking blocks or synthetic fibrous gridded systems with open areas designed to allow grass to grow within the void areas.



Permeable Hardscape Examples from the City’s “Green Infrastructure for Homeowners” Handbook

Rain Barrel

A rain barrel is a structure that collects and stores rainwater from roofs that would otherwise be lost to runoff and diverted to storm drains and streams. The stored water can then be used for irrigation and other non-potable uses.

Subsurface Storage

Subsurface storage refers to systems that temporarily store storm water runoff underground. These systems can be designed to hold the water for use as irrigation or fitted with perforated holes to allow the water to slowly drain into the substrate beneath the storage device.

Trashrack

A trashrack is a filter structure or bar screen placed at intake structures to prevent entrance of gross pollutants (floatable debris including green waste and trash).

Turf Reinforcement Mats

Turf reinforcement mats combine vegetative growth and synthetic materials to form a high-strength mat that helps to prevent soil erosion in drainage areas and on steep slopes. They are composed of interwoven layers of non-degradable geosynthetic materials form a three-dimensional matrix. They are thick and porous enough to allow for soil filling and retention. By protecting the soil from scouring force and enhancing vegetative growth, turf reinforcement mats can raise the threshold of natural vegetation to withstand higher hydraulic forces on stabilization slopes, stream banks and channels. In addition to reducing flow velocities, the use of natural vegetation provides particulate contaminant removal through sedimentation and soil infiltration, and improves the aesthetics of a site.

Use of Turf Reinforcement Mats on Kauai

Vegetated Buffer Strip

Vegetated buffer strips (also known as grassed buffer strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and allowing sediment and other pollutants to settle, and by providing some infiltration into underlying soils.

Vegetated Filter Strip in Waikiki, Oahu