RETROFIT FEASIBILITY STUDY
Honolulu International Airport

Small Municipal Separate Storm Sewer System
File No. HI S000005

Prepared For:

State of Hawaii
Department of Transportation
Airports Division
400 Rodgers Boulevard, Suite 700
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ATTACHMENTS

1.0 CERTIFICATION AND LIMITATIONS

EnviroServices & Training Center (ETC), LLC has completed this Retrofit Feasibility Study for the Honolulu International Airport (HNL). ETC's findings and conclusions presented in this report are professional opinions based solely upon visual observations of sites within HNL, government regulations, and information available about storm water retrofits at the time of this study.

This report is intended for the sole use of the Client, Department of Transportation – Airports Division, exclusively for HNL. The scope of services performed in execution of this project may not be appropriate for satisfying the needs of other users, and any use or reuse of this report or the findings and designs presented herein is unauthorized and at the sole risk of said user.

ETC makes no guarantee or warranty; either expressed or implied, except that our services are consistent with good commercial or customary practices designed to conform to acceptable industry standards and governmental regulations. No warranty or representation, expressed or implied, is included or intended in its proposal, contracts, or reports.

The retrofits proposed in this study are evaluated on a "concept" level and will require final engineering details prior to construction. The design engineer will hold the ultimate responsibility to determine whether a proposed retrofit can be implemented based on the final engineering study and design. DOTA will implement those retrofits approved by a certified engineer as funds become available.

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2.0 INTRODUCTION

As part of the National Pollutant Discharge Elimination System (NPDES) Small Municipal Separate Storm Sewer System (MS4) permit requirements for Honolulu International Airport (HNL), State of Hawaii, Department of Transportation, Airports Division (DOTA) will complete a retrofit feasibility study on the existing MS4 discharges to receiving waters listed pursuant to Section 303(d) of the Clean Water Act for pollutants such as sediment, siltation, turbidity, and/or trash. Under this study, DOTA will plan, strategize, and implement retrofits that shall include water quality Best Management Practices (BMPs).

2.1 Tasks

DOTA made extensive use of the Center for Watershed Protection's national publication on storm water retrofitting, *Urban Stormwater Retrofit Practices* (Schueler *et al*., 2007) (USRM) in order to indentify and complete the tasks involved in a retrofit study.

- **Task 1 – Develop Performance Goals –** Performance goals were identified for HNL based on the 303(d) list of impaired waters, known pollutants or issues in the current MS4, and goals of the storm water program as a whole.
- **Task 2 - Desktop Analysis** – A desktop analysis of HNL and the two associated watersheds was conducted to develop an initial ranking of retrofit potential for DOTA spaces based on the performance goals identified in Task 1.
- **Task 3** – **Retrofit Inventory –** An inventory of sites was compiled that had the potential for the inclusion of retrofits based on the desktop analysis in Task 2.
- **Task 4 – Field Investigation** – Fieldwork was conducted on July 19, 2010, by ETC and focused on the sites identified in Task 3. Evaluations of the sites were recorded on the Retrofit Reconnaissance Investigation (RRI) form from the USRM.
- **Task 5 – Retrofit Evaluation & Ranking** – Retrofit projects were evaluated based on pollutant load reductions, cost-effectiveness, and other screening factors derived from the initial performance goals. These projects were discussed with DOTA engineers to determine the strongest candidates for design work.
- **Task 6 – Final Report** – A final report was drafted detailing the conceptual retrofits selected for further design and implementation at HNL.

2.2 Specific Conditions at HNL

The retrofit feasibility study at HNL took into consideration additional restrictions imposed on projects due to its status as an active airport. Federal Aviation Administration (FAA) rules prohibit building wildlife habitats due to the hazards that birds may pose to aircraft safety. Therefore, large wetlands and other retrofits that have the potential to attract birds will not be considered in this study.

Additionally, at the time of this study, an airport modernization plan has been developed. Therefore, potential retrofits were also evaluated based on the current modernization plans in order to determine whether the future construction would have an impact on the implementation of that retrofit.

3.0 HNL SMALL MS4 CHARACTERISTICS

DOTA is responsible for operating and maintaining the Honolulu International Airport (HNL) and the associated infrastructure, including the storm water drainage system (Small MS4) (Attachment I, Figure 1). HNL is divided into various basins based on the drainage in each particular area (Table 1).

TABLE 1: BASINS AND BASIN AREAS

BASIN	AREA* (ACRE)	WATERSHED	BASIN	AREA* (ACRE)	WATERSHED
A1	18.72	Keehi	B17	73.47	Manuwai
A2	102.64	Keehi	B18	52.56	Manuwai
A3	54.46	Keehi	C1	309.03	Manuwai
A4	75.53	Manuwai	C2	118.46	Manuwai
A5	9.08	Manuwai	D1	10.76	Manuwai
A6	124.72	Manuwai	D2	5.47	Manuwai
A7	18.02	Manuwai	D3	5.62	Manuwai
A8	59.08	Manuwai	D4	9.48	Manuwai
A9	46.37	Manuwai	D5	5.58	Manuwai
A10	184.54	Manuwai	D6	6.16	Manuwai
B3	189.00	Manuwai	D7	8.37	Manuwai
B4	103.63	Manuwai	D8	3.43	Manuwai
B5	36.63	Manuwai	D9	7.16	Half/Half
B6	45.90	Manuwai	D10	212.98	Half/Half
B7	70.14	Manuwai	D11	11.05	Keehi
B8	50.26	Manuwai	D12	4.21	Keehi
B9	89.97	Manuwai	D13	7.44	Keehi
B10	52.03	Manuwai	D14	29.93	Keehi
B11	13.08	Manuwai	D15	10.23	Keehi
B12	24.58	Manuwai	D16	7.34	Keehi
B13	51.70	Manuwai	D17	8.22	Manuwai
B15	14.22	Manuwai	E	39.22	Keehi
B16	38.88	Manuwai			

*Areas are approximate based on the HNL autocad drainage map.

3.1 HNL Small MS4 Summary

HNL contains four active runways, thirty taxiways, and one maintenance baseyard within 4,520 acres on southern Oahu (Attachment I, Figure 1). Over 20 million visitors are transported through the airport by 27 international and domestic carriers, 3 interisland airlines, and 4 commuter airlines. This area is also utilized by industrial and commercial tenants that perform activities ranging from aircraft maintenance and fueling to autobody repair and cargo operations. These areas are divided into separate basins (Table 1) which drain storm water through the Small MS4 structures which are summarized in Table 2.

TABLE 2: SMALL MS4 DRAINAGE STRUCTURES

STRUCTURE TYPE	TOTAL NO.
Box Culvert	33
Catch Basin	249
Head Wall	14
Inlet	795
Manhole	401
Outfall	152
Evaporation Pond	3
Trench Drain	47
Open Channels	6
Oil Water Separators	97

Storm water protection has been a concern at HNL prior to this retrofit feasibility study. Several permanent storm water Best Management Practices (BMPs) are already in place at HNL. These retrofits include:

- 97 oil water separators, 68 of which are operated and maintained by DOTA and 29 by tenants;
- 3 evaporation ponds that receive water from wash pads and hardstand areas where aircraft maintenance is conducted;
- 6 channels stabilized with vegetation;
- 1 Koi pond garden located near the Central Concourse;
- 1 swale between Taxiway "A" and Runway "8L" treating water from Manuwai Canal; and
- Small filter strips between facilities and the roadway drainage on the following streets:
  - Lagoon Drive
  - Palekona Street
  - Iako Place
  - Lauhoe Place
  - Pohakulana Place
  - Keehi Place
  - Mokuea Place
  - Nakolo Place
  - Kapalulu Place
  - Kaulele Place
  - Iolana Place

- Aolele Street
- Paiea Street
- Elliot Street.

3.2 Climatologic Conditions

The main features of Oahu's climate include mild temperatures throughout the year ranging from 88˚F (31˚C) to 74˚F (23˚C) and moderate humidity of 53% during the day. The northeasterly trade winds generated by a high pressure center north of the islands are the dominant factor that governs the climate in Hawaii. Two mountain ranges on Oahu, the Koolau Mountains which extend along the northeastern side of the island and the Waianae Mountains which extend along the southwestern side of the island, influence every aspect of the climate. Both mountain ranges serve to block the trade wind moisture and as a result, showers occur almost daily on the windward side while on the leeward side showers are light. The trade winds are generally strongest during the summer (May through October) and are periodically disrupted by storms in the winter (October through April), which result in heavy rain and thunderstorms throughout the island. At the site, the average annual rainfall reported by the U.S. Department of Agriculture is between 20 to 25 inches, most of which occurs during the winter months.

3.3 Geology and Hydrogeology

3.3.1 Regional Geology

Oahu is formed by the erosional remnants of two shield volcanoes. These are the Waianae range to the west and the Koolau range to the east. The Waianae volcano is estimated to have formed 2.4 to 3.6 million years before present. It consists of a tholeiitic lava shield with a thick cap of transitional to alkalic rock. Rejuvenation-stage volcanics of undifferentiated age occur in Kolekole Pass and on the south flank of the Waianae shield. Dike orientations define northwest and southwest rift zones (Macdonald, et al., 1983).

The Koolau volcano is estimated to have formed 1.8 to 2.6 million years before the present. It consists of a tholeiitic lava shield and lacks an alkalic cap. It has well defined major dike complex trending northwest-southwest. A third, minor rift zone referred to as the Kaau rift trends southward from Kaau crater, near the upland crest of the Koolau Ridge. After a long dormant period and periods of deep erosion, the Koolau volcano developed abundant and scattered rejuvenation-stage vents, typically aligned on northeast-striking fissures (Macdonald, et al., 1983).

3.3.2 Site Geology

The soil at the site is mapped as fill land, mixed (FL). FL consists of dredged material from the ocean, material from nearby areas, garbage, and general material. This land type occurs near Pearl Harbor and in areas of Honolulu adjacent to the ocean. The land type is used for urban development including airports, housing areas, and industrial facilities (USDA, 1972). In addition, previous investigations encountered coralline sand to a depth of 7 feet below ground surface (bgs) and fine grained, well sorted, gray sand below 7 ft bgs (J. R. Herold & Associates, 1999). At a depth below 11 to 13 ft bgs, it was noted that the soil type appeared to be dense, gray gravel (Dames & Moore, 1993).

3.3.3 Regional Hydrogeology

The primary drinking water in the Hawaiian Islands is drawn from basal groundwater. Basal groundwater is formed by rainwater percolating down through the residual soils and permeable volcanic rock. The portion of the island situated below sea level, except within rift zones of the volcanoes, is saturated with ocean salt water and thus forms a basal lens called the "Ghyben-Herzberg" lens. A zone of transition between the fresh groundwater and the ocean salt water occurs due to the constant movement of the interface as a result of tidal fluctuations, seasonal fluctuations in recharge and discharge and aquifer development (Macdonald, et al., 1983).

Downward percolation of rainwater may be stopped by impermeable layers such as dense lava flows, alluvial clay layers and volcanic ash. The groundwater then forms a perched or high level aquifer, which is not in contact with salt water. Recharge of the aquifer occurs in areas of high rainfall, which are the interior mountainous areas. The groundwater flows from the recharge areas to the areas of discharge along the shoreline. Frictional resistance to groundwater flow causes it to pile up within the island until it attains sufficient hydraulic head to overcome friction. Thus, basal groundwater tends to slope toward the shoreline.

3.3.4 Site Hydrogeology

The site is underlain by the Moanalua Aquifer System, which is part of the Honolulu Aquifer Sector on the island of Oahu. The aquifer is classified by Mink and Lau, 1990, with the system identification number 30104116 (23321). This system includes an unconfined basal aquifer in sedimentary (nonvolcanic) lithology. The groundwater in this aquifer has a moderate salinity (1,000 to 5,000 mg/l Cl^-) making it neither a drinking water source nor ecologically important. The groundwater is also described as replaceable with a high vulnerability to contamination.

The site is further underlain by a second aquifer of the same system. The aquifer is a confined, basal aquifer in flank compartments, and is classified with the system identification number 30104121 (11113). The groundwater in this aquifer is fresh with less than 250 mg/l Cl^- and is currently used as a drinking water source. It is also described as irreplaceable with a low vulnerability to contamination (Mink and Lau, 1990).

4.0 WATERSHED CHARACTERIZATION

The retrofit feasibility study was conducted using a drainage area approach, which involves assessing and prioritizing water quality issues according to specified drainage areas to develop and implement BMPs. The Honolulu International Airport is on the discharge end of two watersheds, Manuwai and Keehi, as defined by the Hawaii Statewide Geographic Information Systems (GIS) Program maintained by the Office of Planning (Attachment I, Figure 2). However, DOTA can only implement retrofits in areas within HNL due to land ownership concerns. Therefore, other areas in these two watersheds were not included in the retrofit analysis.

4.1 Manuwai Watershed

The Manuwai Watershed is located on the southern portion of the island of Oahu and contains 4210.231 acres of land. The Manuwai Canal is the surface water body in this watershed that drains the airport as well as Hickam Air Force Base. The canal flows south through HNL to Ahua Pond, which discharges to Mamala Bay.

This watershed contains the majority of HNL, including the terminals, a majority of the runways and taxiways, hardstands, as well as industrial and commercial tenants along Lagoon drive. The northern and western portions of the watershed, consisting of over 50 percent of the watershed, are used by the Federal Government for Hickam Air Force Base, military housing, and golf courses. DOTA has developed a relationship with the military in order to jointly comply with environmental requirements in this area.

Mamala Bay (oceanic) is listed on the 303(d) list for impaired water bodies and the constituents of concern include total nitrogen and chlorophyll a.

4.2 Keehi Watershed

The Keehi Watershed is located on southern portion of the island of Oahu and encompasses 1578.23 acres of land. There are no surface water bodies that drain the area with the exception of Kaloaloa Canal, which flows east along Aolele Street to Keehi Lagoon. The majority of storm water is directed to the City and County of Honolulu's MS4 or the Federal Government's MS4.

This watershed contains the eastern portion of HNL, including the baseyard, rental cars, and industrial tenants on Ualena Street. Additionally, the area north of HNL contains several mixed industrial businesses, military housing, residential areas, and a golf course. The western portion of the Keehi Lagoon Park is also included in this watershed.

Keehi Lagoon is listed on the 303(d) list for impaired water bodies and the constituents of concern include nutrients (total nitrogen, nitrates and nitrites, total phosphorus), chlorophyll a, enterococci, turbidity, and total suspended solids.

5.0 RETROFIT GOALS

Storm water retrofitting involves the redesign and installation of storm water BMPs in areas of existing development to meet a retrofit goal. The retrofit goals identified for the HNL Small MS4, in order of priority, include:

1. Reduce Pollutants of Concern
2. Trapping Trash and Floatables
3. Reduce Runoff Volumes
4. Storm Water Demonstration and Education

5.1 Reduce Pollutants of Concern

The HNL Small MS4 discharges to Keehi Lagoon and Mamala Bay in southern Oahu. Since, HNL activities are centralized within their property boundaries, DOTA shall only be concerned with the impairments related to these water bodies. In addition to the 303(d) list of impaired water bodies (2004), State of Hawaii, Department of Health (DOH) has also established the list of impaired water bodies on Oahu in the State of Hawaii Water Quality Monitoring and Assessment Report (2006).

TABLE 3: IMPAIRED RECEIVING WATERS

WATER BODIES	POLLUTANTS FROM 303(D) LIST, 2004	POLLUTANTS FROM WATER QUALITY MONITORING AND ASSESSMENT REPORT, 2006
Keehi Lagoon (Point X)	▪ Enterococci ▪ Total Nitrogen ▪ Chlorophyll a ▪ Total Phosphorus	▪ Enterococci ▪ Total Nitrogen ▪ Chlorophyll a ▪ Total Phosphorus
Keehi Lagoon waters and nearshore waters to 30’ from lagoon mouth to Pearl Harbor	▪ Nutrients ▪ Turbidity ▪ Suspended Solids	▪ Nutrients ▪ Turbidity ▪ Suspended Solids ▪ Total Nitrogen ▪ Nitrates + Nitrites ▪ Total Phosphorus
Mamala Bay (oceanic)	▪ Total Nitrogen ▪ Chlorophyll a	▪ Total Nitrogen ▪ Chlorophyll a

HNL shall target the following list of pollutants identified from Table 3 for retrofit projects under the scope of this study.

1. Suspended Solids / Turbidity
2. Total Nitrogen
3. Nitrates + Nitrites
4. Total Phosphorus
5. Chlorophyll a
6. Enterococci
7. Oil and Grease

At the time of this report, there are no established Total Maximum Daily Loads (TMDLs) or Waste Load Allocations (WLA) for Keehi Lagoon and Mamala Bay. Therefore, there are no quantitative target levels for the pollutants of concern. However, DOTA shall strive to reduce pollution and to improve water quality by implementing water quality BMPs. Total Phosphorus will be used as an indicator pollutant for the others listed above and retrofits will strive to reduce the indicator pollutant by 25%. This retrofit study will evaluate TP removal efficiencies based on data obtained from existing literature and manufacturer's specifications. Implemented BMPs may not reach the 25% removal goal.

5.2 Trapping Trash and Floatables

This retrofit goal was selected based on reports from the maintenance crew and contractors at HNL, which indicated that significant volumes of trash were being removed from the storm drains and along the coastline (Attachment III). Therefore, DOTA will seek to install BMPs that will prevent the trash and debris from impacting the receiving waters.

5.3 Reduce Runoff Volumes

Due to the nature of activities at HNL, large amounts of impervious cover have been constructed in the area. The impervious cover leads to increases in peak discharge, velocity, and volume of storm water runoff as well as increased pollutant loads. Reducing runoff volume also reduces pollutants by allowing storm water to infiltrate the ground prior rather than discharge to the receiving water through the MS4.

5.4 Storm Water Demonstration and Education

In order to promote education and stewardship, demonstration retrofits may be installed in a public area to treat localized runoff and introduce new storm water technologies.

5.5 Performance Goal Summary

Table 4 contains the goals that will be used to evaluate potential retrofits at HNL.

TABLE 4: RETROFIT PERFORMANCE GOALS

DESCRIPTION	**PRIMARY PERFORMANCE GOALS**
Pollutant Removal	Retrofits/BMPs shall achieve at least 25% reduction from existing, on-site total phosphorus loads for areas treated by retrofit/BMPs. Provide retrofit/BMP designs that also address removal of sediment as well as oil and grease loads as priority pollutants.
Trap Trash and Floatables	Retrofits/BMPs shall achieve at least 25% reduction in existing, on-site trash and other floatables.
Reduce Runoff Volumes	Retrofits shall promote infiltration and overall reduction in runoff volume to the extent achievable.
Education and Outreach	Provide outdoor learning and community outreach opportunities on DOTA land.
DESCRIPTION	**SECONDARY BENEFITS**
Quick Implementation Projects	Indentify quick implementation projects (constructed within 1 year) based on existing CIP projects, availability of funds, projects underway, etc.
Specific Problems	Identify retrofits for problem areas such as Ualena Street tenants, Baseyard sweeper rubbish, and the triturators.

6.0 DESKTOP ANALYSIS

The storm water retrofit assessment was divided into two focus areas, storage retrofits and on-site retrofits. Storage retrofits were evaluated by examining the drainage canals and major outfalls at HNL. On-site retrofits were evaluated by examining areas of significant industrial activity such as the baseyard facility and aircraft hardstands at HNL. Due to leasing conflicts, tenant areas were not evaluated as a part of this retrofit study, except in areas of historical issues.

The desktop analysis was conducted using a basin-by-basin approach to locating potential retrofits. Data used in the desktop analysis included the following:

- Drainage Map – The autocad map developed for HNL included all storm drainage structures such as inlets, pipes, channels, outfalls, etc. obtained from as-built drawings and a field survey.
- GIS Program – The GIS program included layers from the Hawaii Statewide GIS Program from watersheds, hydrology, topography, zoning and land use, aerial photography, and road network.
- Aerial Maps – Google Earth© was utilized to provide both an aerial and street view of potential retrofit sites at HNL.
- Maintenance Data – The DOTA maintenance crew and contractor maintenance crew provided DOTA with information about how much trash and debris was removed from storm drainage structures.
- Monitoring Data – DOTA had previously conducted storm water monitoring at set locations within HNL.

6.1 Storage Retrofits

Storage retrofits are considered in those locations where large storage volumes are found and include the following:

- SR-1 Modify Existing Ponds
- SR-2 Storage above Roadway Culverts
- SR-3 New Storage below Outfalls
- SR-4 Treatment in the Conveyance System
- SR-5 Storage in Transport Right of Ways
- SR-6 Large Parking Lot Retrofits

6.1.1 SR-1 Modify Existing Ponds

There are three existing ponds within HNL designed to allow water to evaporate. This is an important design structure to prevent standing water and limit bird populations. Inspection of the evaporation ponds indicates that the current design is adequate and therefore will not be altered with a retrofit.

6.1.2 SR-2 Storage above Roadway Culverts

Road crossings have the potential to be modified for temporary water quality storage. The available storage can also be increased by excavating areas adjacent to the upstream channel. Desktop analysis revealed one potential site for roadway culvert storage:

- Culvert near storm drain manhole 5466 in Basin D10.

The remaining roadway culverts did not appear to have sufficient area to expand the canal storage.

6.1.3 SR-3 New Storage below Outfalls

This retrofit creates new treatment adjacent to the stream corridor near the terminus of an existing storm drain outfall. Outfall retrofits are designed off-line by splitting flow from the existing storm drain pipe (or ditch) and diverting it to a storm water treatment area formed by an existing depression, excavation, or constructed berm. Desktop analysis revealed that the majority of outfalls at HNL are tidally influenced and that there is limited space surrounding outfall locations. However, several outfalls were identified as having the potential for additional storage:

- Outfall 4641, located south of Kalewa Street in Basin A1.
- Outfall 4771, located south of Runway 26R in Bain A2.
- Outfall 4658, located near ARFF Station 2 on Lagoon Drive in Basin A9.
- Outfalls 4761, 4764, 4765, and 4766 on the Reef Runway in Basin A10.
- Outfalls 4818, 4221, 4815, 4811, 4810, 4808, 4807, and 4805 on the Reef Runway in Basin B3.

6.1.4 SR-4 Treatment in the Conveyance System

Treatment in the conveyance system can be obtained through in-channel designs where the treatment storage is obtained within the channel or off-channel designs where the treatment storage is provide in cells adjacent to the channel. Desktop analysis revealed one potential location for off-channel designs:

- Diverted storm water from Manuwai Canal to the swale located between Taxiway A and Runway 8L in basin B17 may be evaluated for further retrofit opportunities.

Due to area restrictions the remaining channels were identified for potential in-channel designs:

- Rock channel from storm drain 4105 near ARFF 2 on Lagoon Drive in Basin A10.
- Unnamed canal near the T-Hangars in Basin B4.
- Unnamed canal south of Runway 4L in Basin B6.
- Unnamed canal on Elliot Street in Basin B12.
- Unnamed canal by Access A in Basin D10.
- Kaloaloa Canal in Basins D11, D12, D13, and E. This canal may require dechannelization prior to retrofit.
- Unnamed canal north of the Kaloaloa Canal and south of Ualena Street in Basin E.

6.1.5 SR-5 Storage in Transport Right of Ways

This retrofit option is not feasible at HNL due to lack of additional space around roadways.

6.1.6 SR-6 Large Parking Lot Retrofits

Large parking lots are those that are five acres or greater in size and are designed for vehicles. There are several parking lots at HNL to accommodate travelers and employees; however, none are greater than five acres with enough room for a storage retrofit.

6.2 On-Site Retrofits

On-site retrofits are considered in those locations where there are excessive impervious areas or potential pollutant activities and include the following:

- OS-7 Hotspot Operations
- OS-8 Small Parking Lot Retrofits
- OS-9 Individual Streets
- OS-10 Individual Rooftops
- OS-11 Little Retrofits
- OS-12 Landscapes- Hardscapes
- OS-13 Underground Retrofits

6.2.1 OS-7 Hotspot Operations

Hot spots are defined as areas were operations generate higher concentrations of storm water pollutants and/or have a higher risk of spills, leaks, or illicit discharges. All industrial and commercial tenants at HNL have been provided with site-specific BMPs to follow during operations to limit storm water impacts; however, for certain operations physical retrofits may provide additional storm water protection. Desktop analysis for hotspots has been supplemented with local knowledge of airport tenants and includes the following:

- HNL Baseyard, including sweeper washing
- HNL Triturators, Gate 6 and Gate 34
- Rental Car Check-In Stations
- Ualena Street Tenants, including So Ono Food Products, Royal Hawaiian Movers, and Autobody Shops

Sites and technologies selected for hot spots are discussed in Section 7.2.

6.2.2 OS-8 Small Parking Lot Retrofits

Small parking lots are considered those less than five acres. Parking areas at HNL are listed in Table 5. A wide range of storm water treatment options can be adapted for this retrofit, including impervious cover reduction, permeable pavers, bioretention islands, perimeter bioretention, perimeter sand filter, filter strips, infiltration, and dry swales.

TABLE 5: HNL PARKING LOTS

AREA DESCRIPTION	BASIN	APPROXIMATE SIZE (ACRES)	NOTES
Employee Parking off Elliott Street	B15	4.46	This parking lot is slated to be moved as part of the modernization plan. DOTA may be able to include retrofits in new lot site during construction phase.
Commuter Terminal Parking (Lot B)	D1	6	This parking lot is slated to be removed as part of the modernization plan.
Interisland Terminal Parking (Lot M)	D1, D2	2.66	This parking structure is 7 stories high with 1,787 parking spaces.
International Parking (Lot A)	D2, D3	2.35	This parking structure has 1,800 spaces and several levels.
Overseas Terminal Parking (Lot D)	D4, D6	3.33	This multi-level parking structure has 1,570 spaces.
Economy (Lot J)	D4	2.38	
Employee Parking (Lot C)	D6	1.5	
Car Rental Parking Area	D7, D8, D9	4.46	This area will be rebuilt as part of the modernization plan and on-site BMPs may be included in the design phase.
Parking Lot G	D10	2.64	
Parking Lot Q	D10	6.9	No space available for storage retrofits.
Parking Lot R	D10	4.23	
Cell Phone Waiting Lot on Aolele Street	D10	0.29	
Maintenance Baseyard Interior Parking	D11	0.97	
Maintenance Baseyard Exterior Parking	D11	0.54	
Palekona Drive Parking Lot	A9	1.06	
Parking at the end of Lagoon Drive	A9	0.7	

6.2.3 OS-9 Individual Streets

These retrofits apply to roadbeds or rights-of-way for individual streets. A wide array of retrofits may be included in this category such as bioretention cells, swales, catch basin inserts, and perforated storm drain pipes. All streets within HNL were considered for retrofit potential during the field evaluation.

6.2.4 OS-10 Individual Rooftops

This retrofit is designed to capture, store, treat, and then gradually release runoff from individual rooftops. The goal is to systematically retrofit as many rooftops as possible. Rooftops with significant area (>25,000 square feet) were evaluated for retrofits due to the larger impact they may have on receiving waters and included the following:

- Building 223 in Basin A3.
- Building 206 in Basin A4.
- T-Hangar Building 420 in Basin A9.
- T-Hangar Building 421 in Basin A9.
- T-Hangar Building 422 in Basin A9.
- Ewa Concourse in Basin B10.
- New Hawaiian Airlines Building in Basin B11.
- Interisland Terminal in Basin B13.
- Central Concourse in Basin B9.
- New Mauka Concourse in Basin D1.
- Diamondhead Concourse in Basin D10.
- International Parking Structure in Basin D2.
- Overseas Parking Structure in Basin D4 and D6.
- Airport Terminal in Basin D5.

6.2.5 OS-11 Little Retrofits

Little retrofits consist of on-site practices that treat runoff from directly connected impervious areas less than one acre in size, such as sidewalks and vacant lots. Treatment options can include swales, infiltration, filter strips, impervious cover conversion, impervious cover disconnection, and soil compost amendment. The impervious area created by sidewalks and roadways are addressed with the storm drain retrofits, which are discussed further in Section 7.1. Additionally, the vacant lot on Kalewa Street was considered for a little retrofit.

6.2.6 OS-12 Landscapes – Hardscapes

These retrofits involve treating storm water from highly urban settings with landscaping areas such as plazas, waterfronts, urban streetscapes, and pocket parks. These urban landscapes represent a minor amount of storm water treatment; however, they are highly visible and may allow further opportunities for public education. Desktop analysis is not feasible for these retrofits; therefore potential areas for landscaping will be noted during field investigations of larger sites.

6.2.7 OS-13 Underground Retrofits

Underground retrofits will be considered as a last resort due to their high cost. They will be restricted to areas that are too small for other retrofits and discharge high pollutant loadings to sensitive waters. Common treatment methods include underground sand filters, multi-chamber treatment trains, and proprietary storm water treatment devices such as the Continuous Deflective Separation (CDS) device. Oil Water Separators (OWS) and CDS devices have already been installed at hot spots in HNL (i.e. gate and hardstand areas); therefore, these devices will not be included unless investigation reveals that other retrofits are not feasible.

7.0 RETROFIT RECONNAISSANCE INVESTIGATION (RRI)

The completed desktop analysis yielded a list of 84 potential locations for retrofits. Each location was given a unique identification number based on the basin where it is located. Field crews visited sites from the desktop analysis list and evaluated them with detailed field inspection forms obtained from the USRM by the Center for Watershed Protection as well as the field guide (Attachment IV). The list of desktop analysis retrofit locations is included in Attachment V.

Retrofits identified in the desktop analysis were evaluated in the field and then ranked based on the goals established during Task 1 of this study. 60 of the original 84 potential locations were evaluated as not feasible. The final list of potential retrofits is included in Section 7.5 and the completed RRI forms are located in Attachment VI. This list does not include storm drain or hotspot retrofits since these are automatically ranked as a high priority for implementation. All retrofits will be considered as the funds become available.

7.1 Storm Drain Retrofits

DOTA has proactively been considering retrofits for the storm drains at HNL prior to this report. An example storm drain retrofit was installed on storm drain 7572 located in Basin D2. Photographic documentation of this installation is included in Attachment III. This retrofit is designed to remove excess trash and debris before it enters the Small MS4. Additionally, the retrofit decreases the effort required during storm drain maintenance. Based on this installation, it is projected that further storm drain retrofits would cost approximately $3,000 per drain. The remaining storm drains at HNL were evaluated and ranked based on storm drain maintenance data (Attachment III). Retrofits installed in these storm drains are not limited to the example provided and may include other proprietary BMPs as they become available.

7.2 Hot Spot Retrofits

Through inspections conducted over several years at HNL, particular hot spots have been identified as having the potential to contribute pollutants to HNL's Small MS4. These have not been included in the ranking system since they are already considered a top priority. The descriptions of these top priority projects are located on RRI forms in Attachment VII.

7.2.1 Triturators

The triturator is utilized by tenants at HNL to dump lavatory waste collected from aircraft. There are two sites, located at Gate 6 and Gate 34, equipped with triturators. They work by allowing the lavatory truck to drive over an opening in the ground. The waste is discharged from the truck into the ground and directed to the sanitary sewer. The issues identified at both sites involve the fact that the trituators are at a higher elevation than the surrounding area and any wastes spilled or water leaking off of the truck may flow to the storm drain system. This discharge has been temporarily corrected using booms to protect the storm drains; however, a more permanent solution is suggested through this retrofit study. The solution involves the placement of walls at least one foot high around the perimeter of the triturator units. In the covered driveway areas, trench drains would be installed that flow back into the sanitary sewer, which would serve as containment for any spilled wastes. The designer will need to ensure that the trench drains are designed to prevent excess storm water infiltration into the sanitary sewer.

7.2.2 Maintenance Baseyard Sweeper Rubbish

The sweeper trucks utilized by baseyard personnel to keep roadways, runways, and taxiways clean require a location to wash the trucks following their sweeper runs. The trucks contain large and fine debris as well as water. This retrofit study proposes constructing a permanent clean-out location for the sweeper trucks. The engineer may alter the final design; however, the concept design is to construct a contained concrete pad with a sump. The sweepers would dump their waste on the concrete pad and allow for evaporation of the sweeper water. Once the material had dried, the debris could be removed and deposited in the trash bin for disposal.

7.2.3 Ualena Street Tenants

Ualena Street tenants conduct a variety of different activities that could impact the environment. Additionally, those pollutants are easily conveyed to Keehi Lagoon through the canal located south of the facilities along Aolele Street. RRI designs developed for each location are included in Attachment VII.

7.3 Ranking Criteria

The remaining sites from the desktop analysis list were ranked based on the field analysis and the performance goals identified in Section 3. The ranking system used for these sites is based on the March 2008 *Charlottesville Stormwater Stewardship on Public Lands* (Charlottesville Report) by Charlottesville, Virginia and the Center for Watershed Protection.

TABLE 6: SCORING CRITERIA USED FOR RANKING

PRIMARY SCREENING FACTOR	DESCRIPTION	SCORING
Pounds of Total Phosphorus (TP) Removed – TP used as indicator for other pollutants	Screening factor that combines influence of total impervious area treated and removal efficiency of proposed retrofit.	Top Quartile = 10
		Second Quartile = 7
		Third Quartile = 5
		Fourth Quartile = 2
Cost Effectiveness (per pound of TP treated)	Cost per pound of TP treated.	Top Quartile (highest cost) = 2
		Second Quartile = 5
		Third Quartile = 7
		Fourth Quartile (lowest cost) = 10
Runoff Reduction	Ability of practice to reduce overall volume of runoff through infiltration, absorption, runoff capture & reuse, etc.	Practice includes soil absorption (bioretention), infiltration, or collection = 10
		Practice includes filtering, runoff dispersion, or other practice that provides some runoff reduction = 5
		Practices does not include these features = 0
Public Education	Whether practice is strategically located on property and has design features that would be of interest to the community	Exceptional opportunity = 10
		Moderate opportunity = 5
		Marginal opportunity = 0
SECONDARY SCREENING FACTOR	**DESCRIPTION**	**SCORING**
Quick Implementation	Whether property has current funding or planning process	Good chance for quick implementation = 1

	underway where retrofit could fit into larger project	Not at this time = 0
Specific Problem	Whether the practice is designed to address a specific storm water problem identified at HNL.	Practice addresses a specific problem = 1
		Practice does not address a specific problem = 0
Low Maintenance Burden	Practice does not require frequent cleaning, dredging, excavation, etc. Most maintenance activities involve vegetation (pruning, weeding, etc.)	Routine maintenance involves mainly vegetation or pumping of storm drain features = 1
		Maintenance involves periodic dredging or excavation = 0
No Permitting Issues	Permits for activities in canals, shoreline, and areas over 1 acre not likely.	Permits not likely = 1
		Permits likely = 0
Few Site & Utility Constraints	RRI does not identify utility, usage, or FAA constraints at location of practice.	No constraints identified = 1
		Constraints identified = 0

The scores for each site were weighted as follows to allow for a maximum score of 100:

- Total Pounds of TP Removed (x3)
- Cost Effectiveness (x3)
- Runoff Reduction (x1.5)
- Public Education (x2)
- All Secondary Screening Factors (x1)

The weighted scores for each site were tallied and then compared to determine the highest ranking retrofit sites.

7.4 Deriving Data for Pollutant Load Reductions & Cost

The data for pollutant load reductions and costs pertinent to each BMP were determined using Appendices B, D, and E of the USRM as well as the EPA website. Specific data relevant to HNL was obtained from the Western Regional Climate Center and storm water monitoring events conducted from 2008 through 2010. The following equations were utilized to estimate pollutant loads:

$$\boxed{L = \frac{P \times Pj \times Rv}{12} \times C \times A \times 2.72} \qquad \boxed{Rv = 0.05 + 0.009 \times I}$$

TABLE 7: POLLUTANT LOAD CALCULATION PARAMETERS

PARAMETER	PARAMETER DESCRIPTION	HNL VARIABLES
P	Precipitation (in/yr)	20.87
Pj	Fraction of Runoff Producing Events	0.126
Rv	Runoff Coefficient	Site Dependent
I	Site Imperviousness	Site Dependent
C*	Mean Concentration of TP (mg/L) Mean Concentration of TN (mg/L) Mean Concentration of TSS (mg/L) Mean Concentration of Oil & Grease (mg/L)	0.445 3.385 23.065 3.494
A	Area (acres)	Site Dependent

*Based on storm water monitoring data from 2008, 2009, and 2010.

The pollutant removal efficiencies and unit costs of the retrofit BMPs are provided in Tables 8 and 9, respectively. This data was used to develop a spreadsheet for each site that assisted in ranking each of the retrofits based on pollutant removal and cost effectiveness.

TABLE 8: UNIT COSTS OF RETROFIT BMPS

PRACTICE	QUALIFIER	UNIT COST* (2006 $/CF TREATED)	SOURCE
Bioretention/ Rain Garden	<0.5 ac treated	$30.00	USRM Table E.4 & Section D.1
Bioretention/ Rain Garden	>0.5 ac treated	$10.50	USRM Table E.4 & Section D.3
Water Quality Swale	Engineered swale	$10.50	Similar to a bioretention cost.
Detention Basin		$5.00	USRM Table E.4
Catch Basin Insert		$4.00	From EPA Fact Sheet about Catch Basin Inserts.
Downspout Disconnection to Rain Barrel	1 or several 55-gallon barrels	$25.00	From Charlottesville Report
Rainwater Harvesting	Cistern or larger storage device	$15.00	From Charlottesville Report
Impervious Cover Removal		$20.00	From Charlottesville Report
Sand and Organic Filter		$20.00	From Charlottesville Report
Pervious Pavement		$20.00	From Charlottesville Report
Storm Water Planter		$27.00	From Charlottesville Report
Green Roof	1” of rainfall, $20.00 per square foot of roof	$1.67	From EPA Fact Sheet about Green Roofs.

TABLE 9: POLLUTANT REMOVAL EFFICIENCY OF RETROFIT BMPS

PRACTICE	QUALIFIER	TP	TN	TSS	O&G	NOTES
Bioretention/ Rain Garden		75	60	60	90	EPA Fact Sheet on Bioretention. Mean values provided for TP and TN. TSS and O&G obtained from USRM Appendix D.
Filter Strip	150-ft Length	40	20	84	90	EPA Fact Sheet on Vegetated Filter Strip. O&G removal rate based on bioretention.
Filter Strip	75-ft Length	25	27	54	90	EPA Fact Sheet on Vegetated Filter Strip. O&G removal rate based on bioretention.
Water Quality Swale	Engineered swale	25	55	80	80	USRM Appendix D, Table D.7, Median range
Detention Basin		20	25	50	70	USRM Appendix D, Table D.1, Median range
Catch Basin Insert		15	10	15	5	Best professional judgment. However, will vary depending upon proprietary device used.
Downspout Disconnection to Rain Barrel	1 or several 55-gallon barrels	75	60	60	90	Assuming rainwater is used for landscaping water, rates will be similar to rain garden.
Impervious Cover Removal		90	90	90	90	Best professional judgment
Sand and Organic Filters		60	30	85	85	USRM Appendix D, Table D.5, Median Range
Pervious Pavement		65	40	90	90	USRM Appendix D, Table D.6, Median Range
Storm Water Planter		37.5	30	30	45	Assumed to have approximately half the efficiency of rain gardens.
Green Roof		75	60	60	90	Assumed to be similar to rain garden.

Notes: TP = Total Phosphorous
TN = Total Nitrogen
TSS = Total Suspended Solids
O&G = Oil and Grease

7.5 Project Recommendations

Table 10 provides the listing of project recommendations for storm water retrofits at HNL based on ranking. The locations of these projects within HNL are depicted on Figure 3 in Attachment I.

TABLE 10: FINAL LIST OF POTENTIAL RETROFIT BMPS AT HNL

Rank	Description	Project ID	Total Pounds of TP Removed	Cost Effectiveness	Runoff Reduction	Public Education	Quick Implementation	Specific Problem	Low Maintenance Burden	No Permitting Issues	Few Site Constraints	Total
1	Bioretention on Lagoon Drive	A2-2	30	21	15	20	0	0	1	0	0	87
2	Paiea Street Bioretention	E-7	30	15	15	20	0	0	1	1	1	83
3	Ewa Concourse Green Roof	B10-3	21	30	15	10	0	0	1	1	1	79
4	Overseas Terminal Green Roof	D5-1	21	30	15	10	0	0	1	1	0	78
5	Interisland Terminal Green Roof	B13-2	15	30	15	10	0	0	1	1	1	73
6	New Elliot Street Parking Lot Bioretention	B15-1	30	15	15	10	1	0	1	0	1	73
7	Central Concourse Green Roof	B9-1	15	30	15	10	0	0	1	1	0	72
8	New Mauka Concourse Green Roof	D1-1	15	30	15	10	0	0	1	1	0	72
9	Rain Garden in Vacant Lot on Kalewa Street	D16-2	21	21	15	10	0	0	1	0	1	69
10	Dry Detention Basin on Kalewa Street	A1-1	21	21	15	10	0	0	0	0	0	67
11	Bioretention at Outfall 4105 near ARFF 2	A10-1	15	15	15	20	0	0	0	0	1	66
12	Dry Detention Basin South of Runway 26R	A2-1	30	21	15	0	0	0	0	0	0	66
13	New Hawaiian Air Hangar Green Roof	B11-1	6	30	15	10	1	0	1	1	1	65
14	Parking Lot R Bioretention	D10-6	21	15	15	10	0	0	1	1	1	64
15	Cell Phone Waiting Lot Permeable Pavers	D10-7	6	21	15	20	0	0	0	1	1	64
16	Nakolo Place Parking Lot Bioretention	A4-1	6	15	15	20	0	0	1	1	1	59
17	Lagoon Drive Parking Lot Bioretnetion and Permeable Pavers	A9-3	15	6	15	20	0	0	1	1	1	59
18	Detention Basin from Unnamed Canal at the End of Runway 4L	B6-1	21	21	15	0	0	1	1	0	0	59
19	Parking Lot G Bioretention	D10-4	15	15	15	10	0	0	1	1	1	58
20	Access "A" Canal Stabilization	D10-1	30	6	7.5	0	0	1	1	0	0	45.5
21	Kaloaloa Canal Stabilization	D14-1	30	6	7.5	0	0	1	1	0	0	45.5
22	Planter for Bldg 223 Roof Runoff	A3-1	6	6	15	10	0	0	1	1	1	40
23	Planter for Bldg 206 Roof Runoff	A4-2	6	6	15	10	0	0	1	1	1	40
24	VIP Trans Oil Water Separator	D16-3	6	21	0	10	0	1	0	0	0	38

8.0 SUMMARY

A total of 24 water quality retrofit projects have been identified and ranked as part of this feasibility study for the Honolulu International Airport. Furthermore, 65 storm drains and 8 hotspots were identified for retrofit BMPs. Secondary projects were also identified during the field reconnaissance and include repairing outfall 4747 in Basin B4, cleaning outfall 10276, and repairing channel erosion to the bridge and culvert near storm drain 5464.

The purpose of this retrofit feasibility study was to identify and prioritize storm water retrofit opportunities within HNL that could assist DOTA in meeting NPDES requirements. The projects were evaluated based on the retrofit goals of reducing pollutants of concern, trapping trash and floatables, reducing runoff volumes, and providing opportunities for storm water demonstration and education. The identified retrofit opportunities have been listed based on concept design and will require further engineering study to determine their implementation potential. Additionally, concepts may need to be altered as the Airport Modernization Plan plans become finalized. Retrofit sites will be further evaluated and implemented as funds become available to the DOTA.

9.0 REFERENCES

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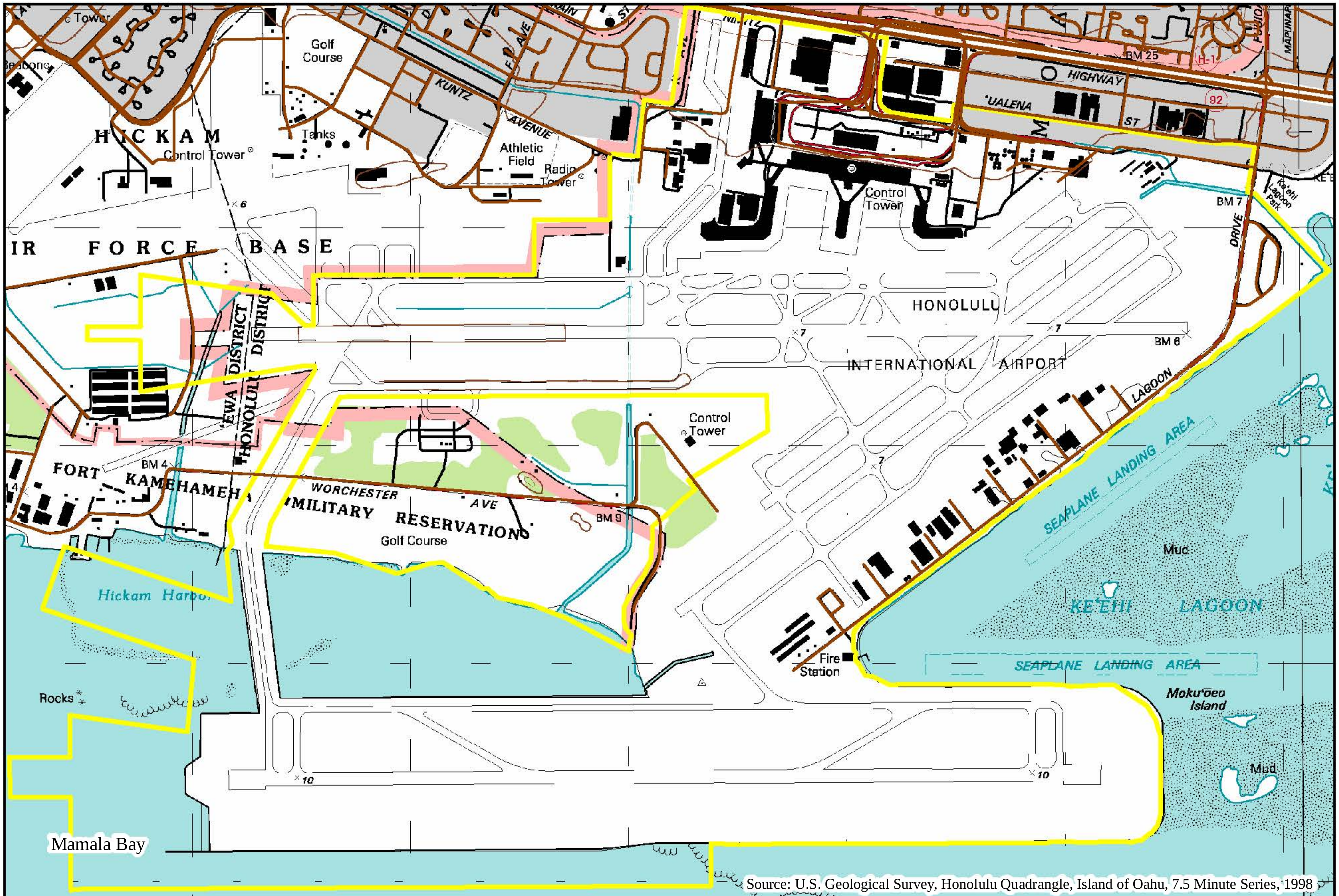
ATTACHMENT I

Figures



Absolute Scale 1:24,000

0 0.1 0.2 0.4 0.6 0.8 Miles

EnviroServices & Training Center, LLC

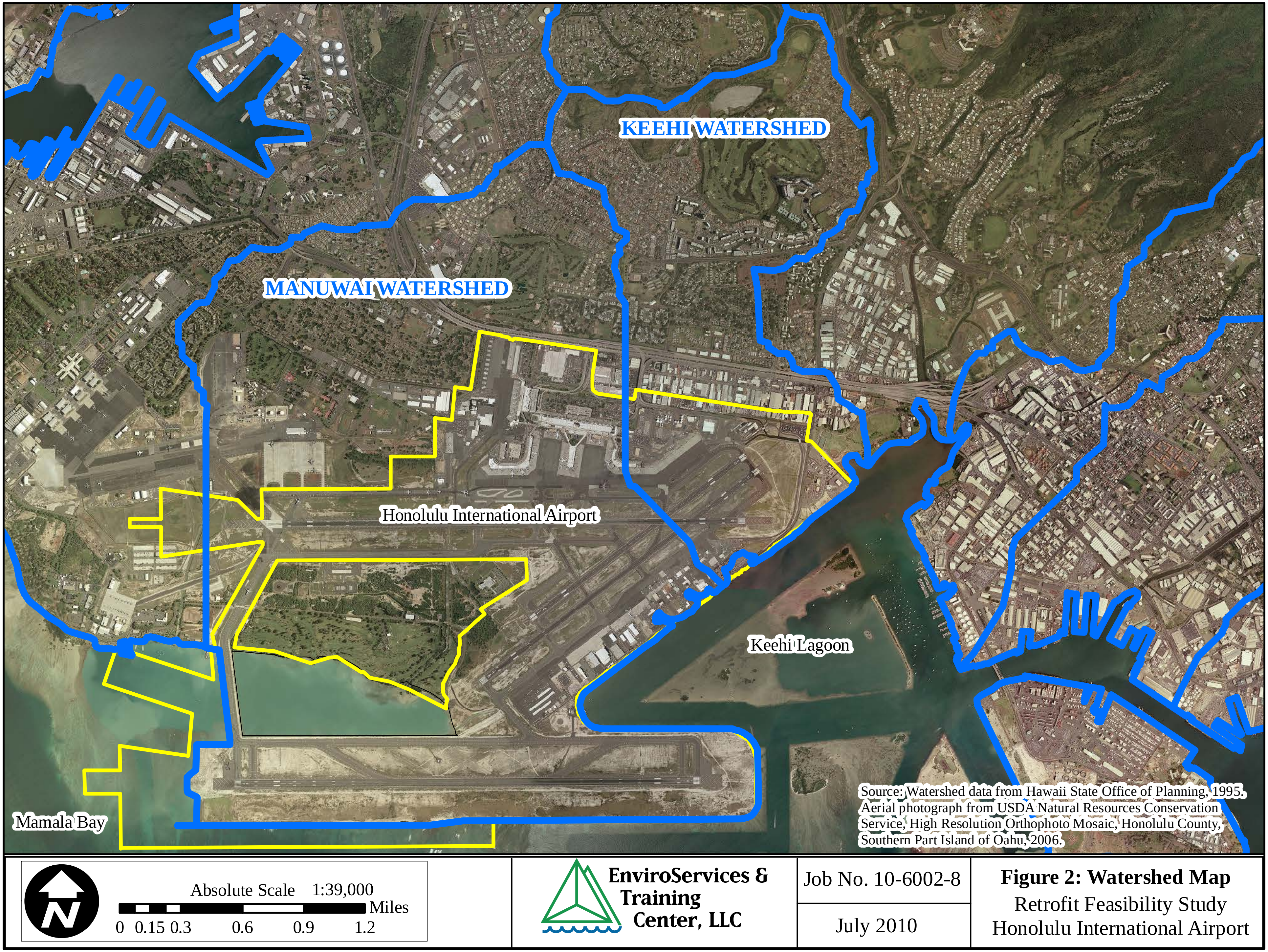
Job No. 10-6002-8

July 2010

Figure 1: Location Map

Retrofit Feasibility Study

Honolulu International Airport

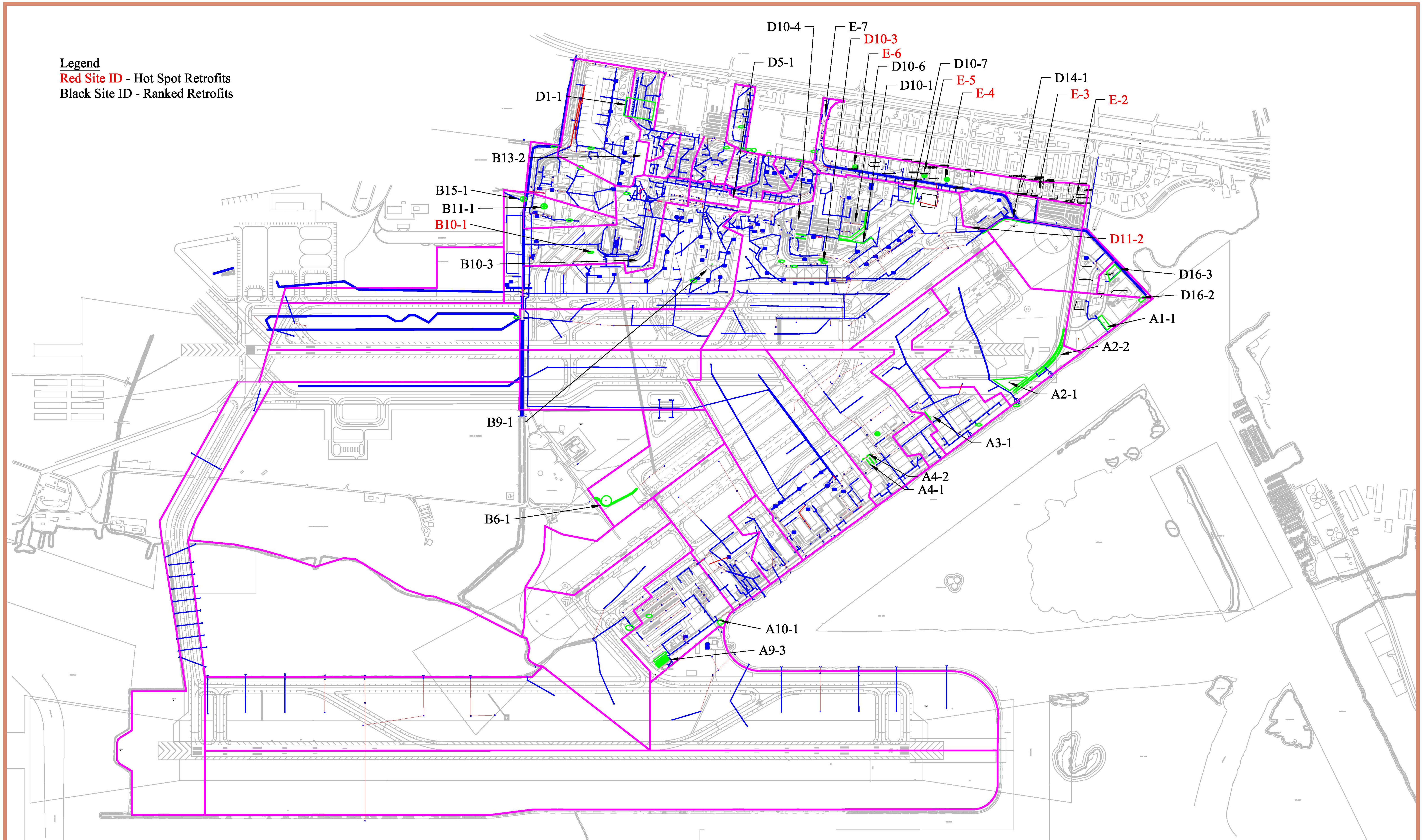


EnviroServices & Training Center, LLC

Job No. 10-6002-8

July 2010

Figure 2: Watershed Map
Retrofit Feasibility Study
Honolulu International Airport



1500 0 1500 3000

GRAPHIC SCALE IN FEET

North

HONOLULU INTERNATIONAL AIRPORT

DEPARTMENT OF TRANSPORTATION STATE OF HAWAII

Airports Division

INDEX

Date : July 2010

RETROFIT LOCATION MAP HONOLULU INTERNATIONAL AIRPORT

Figure 3

ATTACHMENT II

Airport Modernization Plan Rendering

1. New Hawaiian Airlines Air Cargo
2. New Hawaiian Airlines Maintenance Facility
3. New Inter-Island Maintenance Hardstands
4. Widened and Straightened Taxilane G&L
5. International Parking Structure
6. New Consolidated Rental Car Facility

A. New Mauka Concourse
B. Existing Inter Island Terminal (IIT) (Terminal 2)
C. Commuter Operations Area
D. New Ewa Concourse
E. New Frontal Gates with APM system
F. Renovated Central Concourse
G. Existing Over Sea Terminal (OST)
H. New Diamond Head Concourse
J. New Waikiki Concourse

ATTACHMENT III

Storm Drain Ranking and Example Retrofit

Storm Node Ranking

Ranking	EID	Basin	Amount of Waste Removed
5	4632	A2	250 LBS. DIRT, GREEN WASTE
5	4703	A6	300 LBS. DIRT
5	5748	A6	150 LBS OF DIRT AND TRASH REMOVED.
5	4140	B10	100 LBS. DIRT, TRASH
5	5522	B9	150 LBS. OF DIRT AND TRASH REMOVED.
5	4319	D10	500 LBS. DIRT
5	4336	D10	150 LBS. DIRT
5	4366	D10	150 LBS.
5	7513	D10	150 LBS. DIRT
5	10227	D10	350 LBS. DIRT, TRASH
5	4580	D12	150 LBS DEBRIS
5	4598	D15	200 LBS. --- DIRT, TRASH, CEMENT, BATTERY
5	5147	D17	200 LBS DEBRIS
5	5096	D2	400 LBS DEBRIS
5	5121	D4	100 LBS. DIRT
5	5123	D4	300 LBS. DIRT
5	5132	D4	450 LBS. DIRT
5	7466	D4	150 LBS DEBRIS
5	7520	D4	500 LBS. DIRT, TRASH
5	7525	D4	150 LBS. DIRT
5	7465	D6	150 LBS DEBRIS
5	7534	D6	300 LBS DEBRIS
5	10197	D6	150 LBS. DIRT, TRASH
5	10217	D6	150 LBS DEBRIS
5	10255	D6	150 LBS DEBRIS
5	7553	D8	100 LBS DEBRIS
4	4150	B10	75 LBS. DIRT, TRASH
4	4182	B10	75 LBS. DIRT
4	7409	B13	75 LBS. OF DIRT REMOVED.
4	5983	B9	75 LBS. DIRT
4	4601	D16	75 LBS. DIRT, TRASH
4	5114	D3	75 LBS DEBRIS
4	5186	D7	80 LBS DEBRIS
4	5212	E	75 LBS DEBRIS
3	4700	A6	50 LBS. DIRT
3	4702	A6	50 LBS. DIRT
3	7620	B10	50 LBS. DIRT
3	10161	B10	50 LBS OF DIRT AND TRASH REMOVED.
3	5253	B11	50 LBS. OF DIRT REMOVED.
3	4145	B9	50 LBS. DIRT
3	5357	B9	50 LBS. DIRT
3	5976	B9	50 LBS. DIRT
3	4318	D10	40 LBS. DIRT
3	4341	D10	30 LBS. DIRT
3	5168	D17	50 LBS. DIRT
2	5626	A2	25 LBS. DIRT, TRASH
2	4623	A3	30 LBS. DIRT, TRASH
2	5818	A3	25 LBS. DIRT, TRASH
2	4694	A6	25 LBS. DIRT, TRASH
2	4697	A6	50 LBS. DIRT
2	4705	A6	30 LBS. DIRT
2	5752	A6	25 LBS DEBRIS
2	7692	A6	25 LBS. DIRT

2	4755	A9	30 LBS. TRASH
2	5678	A9	25 LBS. DIRT
2	5703	A9	25 LBS. DIRT, TRASH
2	4141	B10	25 LBS. DIRT, TRASH
2	4142	B10	25 LBS. DIRT, TRASH
2	4149	B10	25 LBS. DIRT, TRASH
2	7614	B10	25 LBS. DIRT, TRASH
2	5077	B12	25 LBS. OF DIRT REMOVED.
2	5665	B4	25 LBS. DIRT
2	5554	B9	25 LBS. DIRT
2	5389	D10	25 LBS. DIRT, TRASH
2	7490	D2	25 LBS. DIRT

Ranking Criteria	
	Pounds Removed
1*	≤20
2	>20 - ≤30
3	>30 - ≤50
4	>50 - ≤100
5	≥ 100

*Not included in this report

POI Permanent BMP Installation Report – Project No. BO1909-23

Installed by : Hawaii Industrial Services, Ltd. 808.836.8653

POI Id:	7572
POI Equipment Type :	Drainage Catch Basin (58)
Inspection Schedule:	Semi Annual
Indentification Photo:	

☐ Numerical Labeled Needed?

☑ Placard (Stenciled)?

Map Location (Basin):	D2
GPS Coordinates:	
POI Latitude:	[21 deg 20' 6" N]
POI Longitude:	[157 deg 55' 18.8" W]

Installation Date: 06/22/2010

Pre-Installation Photo(s):

Installation Photo(s):

ATTACHMENT IV

Blank Retrofit Reconnaissance Inventory (RRI) Form and Field Guide

DATE:	**INVESTIGATOR:**	
WATERSHED:	**BASIN:**	**SITE ID:**

SITE DESCRIPTION

Name:

Address:

Land Use:	☐ DOTA	☐ Tenant	☐ Unknown

Proposed Retrofit Location:

Storage		**On-Site**	
☐ Above Roadway Culvert	☐ Below Outfall	☐ Hotspot Operation	☐ Small Parking Lot
☐ In Conveyance System	☐ Large Parking Lot	☐ Individual Streets	☐ Individual Rooftops
☐ Other:		☐ Small Impervious Area	☐ Landscapes / Hardscape
		☐ Underground	☐ Other:

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈	**Drainage Area Land Use:**	
Imperviousness ≈ %	☐ Industrial	☐ Federal / Military
Impervious Area ≈	☐ Commercial	☐ Park
Notes:	☐ Airport Common Use	☐ Undeveloped
	☐ Vacant	☐ Other:

EXISTING STORM WATER MANAGEMENT

Existing Storm Water Practice:	☐ Yes	☐ No	☐ Possible

If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:

Existing Head Available and Points Where Measured:

PROPOSED RETROFIT

Purpose of Retrofit:

☐ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☐ Demonstration / Education ☐ Repair ☐ Other:

Retrofit Volume Computations – Target Storage:	**Retrofit Volume Computations – Available Storage:**

Proposed Treatment Options:

☐ Extended Detention ☐ Dry Pond ☐ Created Wetland ☐ Bioretention
☐ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other:

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

SITE CONSTRAINTS

Adjacent Land Use:

☐ Industrial ☐ Federal / Military
☐ Commercial ☐ Park
☐ Airport Common Use ☐ Undeveloped
☐ Residential ☐ Other:

Possible Conflicts Due to Adjacent Land Use?

☐ Yes ☐ No

If Yes, Describe:

Access:

☐ No Constraints

Constrained due to:

☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Tenant Activities
☐ Airport Operations ☐ Other:

Conflicts with Existing Utilities:

☐ None
☐ Unknown

Yes	**Possible**	
☐	☐	Sewer
☐	☐	Water
☐	☐	Jet Fuel Lines
☐	☐	Electric
☐	☐	Other:

Potential Permitting Factors:	**Probable**	**Not Probable**
Impacts to Wetlands	☐	☐
Impacts to Stream / Canal	☐	☐
Impacts to Shoreline	☐	☐
Dewatering	☐	☐
Area over 1 acre	☐	☐
Other factors:		

Soils:

Soil auger test holes:	☐ Yes ☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes ☐ No
Evidence of shallow bedrock:	☐ Yes ☐ No
Evidence of high water table (gleying, saturation):	☐ Yes ☐ No

SKETCH

Site ID: _________

DESIGN OR DELIVERY NOTES	
FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT	
☐ Confirm land usage	☐ Obtain existing storm water practice as-builts
☐ Determine inclusion in modernization plan	☐ Obtain site as-builts
☐ Confirm drainage area	☐ Obtain detailed topography
☐ Confirm drainage area impervious cover	☐ Obtain utility mapping
☐ Confirm volume computations	☐ Confirm storm drain invert elevations
☐ Complete concept sketch	☐ Confirm soil types
☐ Other:	
INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS	

SITE CANDIDATE FOR FURTHER INVESTIGATION:	☐ YES	☐ NO	☐ MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S):	☐ YES	☐ NO	☐ MAYBE
IF YES, TYPE(S):			

THIS RRI FIELD GUIDE TEMPLATE SHOULD BE COMPLETED WITH LOCAL DATA AND ADAPTED TO MEET THE NEEDS OF LOCAL RETROFIT FIELD CREWS

UNIQUE SITE ID NOMENCLATURE GUIDANCE

Unique Site ID = Subwatershed Acronym –Sequential Number

Subwatershed Name	Subwatershed Acronym
Basins A1 - E	

Investigation Type	Acronym
Retrofit Reconnaissance Investigation	R

Sequential Numbering begins at "1" for each subwatershed

DELINEATING DRAINAGE AREA AND ESTIMATING CURRENT IMPERVIOUS COVER

Simple Pipe – Drainage Area Ratios	
Pipe Diameter (inches)	**Drainage Area (approx. acres)**
6	0.1 to 1
12	1 to 2
24	2 to 5
36	5 to 25
48	25 to 100
60	100 to 200

Land Use / Impervious Cover Relationships	
Land Use Category	**Impervious Cover (%)**
Agriculture	1.9
2 Acre Lot Residential	10.6
1 Acre Lot Residential	14.3
½ Acre Lot Residential	21.2
1/4 Acre Lot Residential	27.8
1/8 Acre Lot Residential	32.6
Townhome Residential	40.9
Multifamily Residential	44.4
Light Industrial	53.4
Commercial	72.2

RETROFITTING OBJECTIVES

Core Retrofitting Objectives:	25% reduction in existing TP loads. Reduce runoff volume. Public education opportunities.
Designated Pollutant(s) of Concern:	Nutrients, TSS, chlorophyll a, bacteria, oil and grease
Type of Storage Needed:	1.2" x impervious for on-site areas. Drainage control on a case-by-case basis.

Event	Depth (inches)
Water Quality Storm	1.2"
Minimum Water Quality Depth ("walkaway" volume)	0.6"
Runoff Reduction Depth	
1-year 24-hour Storm (channel protection)	2.88"

Event	Depth (inches)
2-year 24-hour Storm	3.94"
10-year 24-hour Storm	6.63"
100-year 24-hour Storm	11.05"

*Annual rainfall = 20.87" with 46 days over 0.1"

PREFERRED STORMWATER TREATMENT OPTIONS

Ability of Stormwater Treatment Options to Address Retrofit Objectives

Retrofit Objective	Stormwater Treatment Option							
	Extended Detention	Wet Ponds	Wetlands	Bioretention	Filtering	Infiltration	Swales	Other
Correct Past Mistakes	●	●	●	●	⦿	●	●	⦿
Reduce Flood Damage	●	●	●	○	○	⦿	○	○
Education / Demonstration	⦿	⦿	●	●	●	●	●	●
Trap Trash & Floatables	●	●	●	⦿	●	○	○	○
Reduce Flows to Combined Sewer	⦿	○	⦿	●	○	●	⦿	●
Renovate Stream Corridor	⦿	●	●	●	○	⦿	⦿	○
Reduce Bank Erosion	●	⦿	⦿	⦿	○	⦿	⦿	⦿
Support Stream Repair	●	⦿	●	⦿	⦿	●	⦿	○
Full Watershed Restoration	●	●	●	●	●	●	●	●

KEY
● = Primary stormwater treatment option to address objective
⦿ = Secondary stormwater treatment option
○ = Supplemental stormwater treatment option

Comparison of Pollutant Removal Capability

Stormwater Treatment Option	Stormwater Pollutant						
	TSS	TP	TN	Metals	Bacteria	Organic Carbon	Oil & Grease
Extended Detention	⦿	X	○	○	○	X	⦿
Wet Ponds	●	⦿	○	⦿	⦿	○	⦿
Wetlands	⦿	⦿	○	○	⦿	X	●
Bioretention	⦿	X	○	●	●	⦿	●
Filtering	●	⦿	○	⦿	⦿	⦿	●
Infiltration	●	⦿	○	●	?	●	●
Swales	●	X	○	⦿	X	⦿	●
Rooftop	*Varies*						

KEY
● = Excellent Removal (76 to 100%)
⦿ = Good Removal (51 to 75%)
○ = Fair Removal (26 to 51%)
X = Low Removal (0 to 25%)
? = Unknown Removal

NOTES
See Profile Sheets in Chapter 2 for precise removal rates and ranges and Appendix B for documentation on derivation of removal rates

COMPUTING THE RETROFIT STORAGE VOLUME

The ***water quality target volume*** can be determined using the following equation:

$$V_t = P/12 * Rv * DA$$

Where:
- V_t = Target storage volume (acre feet)
- P = Target rainfall depth (in inches for the 90% storm)
- Rv = Runoff coefficient = 0.05 + 0.009 (IC)
- DA = Drainage area (acres)
- 12 = Conversion factor (inches to feet)

To calculate ***channel protection target volume***, use the following equation:

$$V_t = P/12 * IC/100 * DA * 0.6$$

Where:
- V_t = Target storage volume (acre feet)
- P = 1-year 24-hour storm depth (inches)
- IC = Impervious cover (%)
- DA = Drainage area (acres)
- 12 = Conversion factor (inches to feet)
- 0.6 = Pond routing factor

COMPUTING AVAILABLE RETROFIT STORAGE

For ponds and wetlands, use the following simplified equation to estimate available storage:

$$V_{av} = 2/3 * d * SA$$

Where:
- V_{av} = Available storage at the site (acre-feet)
- SA = Surface area of the facility (acres)
- d = Estimated max depth (feet)
- 2/3 = Average volume factor

For other stormwater treatment options, available storage can be estimated based on the typical surface area or depth requirements of different stormwater treatment options:

Drainage Area – Surface Area Relationships		
Stormwater Treatment Option	**% of Contributing Drainage Area**	**Average Depth (ft)**
Dry ED Ponds	1 to 3%	6
Wet Pond	1 to 3%	6
Constructed Wetland	3 to 5%	2
Bioretention	5 to 10%	1-2
Sand Filters	0 to 5%	2
Infiltration	0 to 5%	1-2
Swales	5 to 15%	2
Filter Strips	5 to 15%	1
Other Retrofits	**Sizing Considerations**	**Average Depth (ft)**
Dry wells	Each dry well can treat 500 sf of roof	1
Rain barrel (50 gal)	Max area draining to rain barrel 500 sf	3-5
Cistern (500 gal)	Max area draining to cistern 1000 sf	5-10
Planter boxes	Max area draining to box 15,000 sf	1.0
Green roofs	1 to 1 ratio of impervious area treated	0.5
Permeable pavers	1 to 1 ratio of impervious area treated	0
Rain gardens	10% of rooftop area	1

Minimum Setbacks

Minimum Distance… *	To Be Maintained From…
10 feet	Property Line
25 feet	Building Foundation
100 feet	Septic System Fields
100 feet	Private Well
1,200 feet	Public Water Supply Well
400 feet	Surface Drinking Water Source
100 feet	Surface Water
Do not submerge	Sewer Line
10 feet	Dry Utilities
15 feet	Overhead Wires
10 feet	Road (Seepage)
30 feet	Highway
*** Confirm that these common setbacks are consistent with local regulations**	

Emergency Contact Information

Field Crew #1 cell phone:	Katie Davis, 808-226-0728
Field Crew #2 cell phone:	
Fire, non-emergency:	
Police, non-Emergency:	
Illegal dumping hotline:	AIR-EE, 808-838-8002
Blocked storm drain inlet or pipe:	AIR-EE, 808-838-8002
Erosion or drainage problems on private property:	
Erosion or drainage problems on public property:	
Sanitary sewer problems:	
Sediment from construction site entering stream:	
Septic leaks / septic tanks:	
Stormwater pond safety or maintenance issue:	AIR - EE, 808-838-8002
Swimming pool discharge:	
Trash and debris in parks and streams:	
Water main break:	

*All other emergency call Airport Emergency Services, 836-6670.

ATTACHMENT V

Desktop Analysis Retrofit List

HNL Desktop Analysis for Potential Retrofits

Basin	ID #	RRI Form	Retrofit Type	Area Description	Potential Retrofits	Field Notes
A1	A1-1	X	SR-3	Outfall 4641	Flow splitter on 4640 to bioretention	Near the end of a runway. No trees or birds.
A1	A1-2	NF	OS-9	Kalewa Street Sidewalks	Filter strip, rain garden, SD wetlands	Not enough space.
A1	A1-3	NF	OS-9	Lele Street Sidewalks	Filter strip, rain garden, SD wetlands	Not enough space.
A10	A10-1	X	SR-4	SD 4105	Filter in channel	
A10	A10-2	NF	SR-3	Between RA and 8R	Grass Swale	
A2	A2-1	X	SR-3	Outfall 4771	Flow splitter to bioretention	
A2	A2-2	X	OS-9	Lagoon Drive Sidewalks	Filter strip, rain garden, SD wetlands	Bioretention cell in road center.
A3	A3-1	X	OS-10	Building 223 Roof (Former UPS Supply Chain)	Rain barrel, cistern, green roof, planter	Planter
A3	A3-2	-	OS-9	Lagoon Drive Sidewalks	Filter strip, rain garden, SD wetlands	Consider park or rain garden on shoreline side of Lagoon Dr
A3	A3-3	NF	OS-9	Iolana Place	Filter strip, rain garden, SD wetlands	Not enough space.
A3	A3-4	NF	OS-9	Kaulele Place	Filter strip, rain garden, SD wetlands	Not enough space.
A4	A4-1	X	OS-8	Parking Lot for Bldg 206	Bioretention islands, permeable paver	
A4	A4-2	X	OS-10	Building 206 Rooftop	Cistern, green roof, planter	
A4	A4-3	Repeat	OS-9	Lagoon Drive Sidewalks	Filter strip, rain garden, SD wetlands	Consider park or rain garden on shoreline side of Lagoon Dr
A4	A4-4	NF	OS-9	Kapalulu Place	Filter strip, rain garden, SD wetlands	Not enough space.
A4	A4-5	NF	OS-9	Nakolo Place	Filter strip, rain garden, SD wetlands	Not enough space.
A6	A6-1	NF	OS-9	Keehi Place Sidewalks	Filter strip, rain garden, SD wetlands	Not enough space.
A6	A6-2	Repeat	OS-9	Lagoon Drive Sidewalks	Filter strip, rain garden, SD wetlands	
A6	A6-3	NF	OS-9	Pohakulana Place Sidewalks	Filter strip, rain garden, SD wetlands	Not enough space.

HNL Desktop Analysis for Potential Retrofits

Basin	ID #	RRI Form	Retrofit Type	Area Description	Potential Retrofits	Field Notes
A6	A6-4	NF	OS-9	Mokuea Place	Filter strip, rain garden, SD wetlands	Not enough space.
A7	A7-1	-	OS-9	Lagoon Drive	Filter strip, rain garden, SD wetlands	
A8	A8-1	NF	OS-9	Iako Place	Filter strip, rain garden, SD wetlands	Not enough space.
A9	A9-1	NF	SR-3	Outfall 4658	Flow splitter to bioretention at 4655	Head difference too great and tidally influenced.
A9	A9-2	X	OS-8	Palekona Street Parking Lot	Bioretention islands, permeable paver	
A9	A9-3	NF	OS-8	Lagoon Drive Parking Lot	Bioretention islands, permeable paver	Grading of parking area is an issue.
A9	A9-4	NF	OS-9	Palekona Street	Filter strip, rain garden, SD wetlands	Not enough space.
A9	A9-5	Repeat	OS-9	Lagoon Drive	Filter strip, rain garden, SD wetlands	
A9	A9-6	NF	OS-10	Bldg 422 Rooftop	Cistern, green roof, planter	Approx Roof Coverage 29,400 SF
A9	A9-7	NF	OS-10	Bldg 421 Rooftop	Cistern, green roof, planter	Approx Roof Coverage 53,150 SF
A9	A9-8	NF	OS-10	Bldg 420 Rooftop	Cistern, green roof, planter	Approx Roof Coverage 39,300 SF
B10	B10-1	X	OS-7	Gate 34 Triturator	Containment structures	
B10	B10-2	NF	OS-9	Ewa Service Road	Filter strip, rain garden, SD wetlands	
B10	B10-3	X	OS-10	Ewa Concoure Rooftop	Cistern, green roof, planter	
B11	B11-1	X	OS-10	New Hawaiian Air Rooftop	Cistern, green roof, planter	
B12	B12-1	NF	SR-4	Elliot Street Canal	In channel treatment, wet swale	
B13	B13-1	NF	OS-9	Elliot Street	Filter strip, rain garden, SD wetlands	
B13	B13-2	X	OS-10	Interisland Terminal Rooftop	Cistern, green roof, planter	
B15	B15-1	X	OS-8	New Elliot St Parking Lot	Bioretention islands, permeable paver	
B17	B17-1	-	SR-4	Swale between A and 8L	Enhance current BMP	Swale sufficient
B3	B3-1	NF	SR-3	Between RA and 8R	Grass Swale	
B4	B4-1	NF	SR-4	Canal from T-Hangars	Wet swale or offline bioretention	Limited by runway to west
B4	B4-2	-	Other	Outfall 4747	Needs Repairs	

HNL Desktop Analysis for Potential Retrofits

Basin	ID #	RRI Form	Retrofit Type	Area Description	Potential Retrofits	Field Notes
B6	B6-1	X	SR-4	Hickam Canal	Wet swale or offline bioretention	Develop current detention basin.
B6	B6-2	NF	Other	Locate 10276		Canal on Hickam area
B6	B6-3	-	OS-7	Outfall 10274	Filter	Addressed with B6-1
B9	B9-1	X	OS-10	Central Concourse Rooftop	Cistern, green roof, planter	
D1	D1-1	X	OS-10	New Mauka Concourse Rooftop	Cistern, green roof, planter	
D10	D10-1	X	SR-2	Culvert near SD 5466	Expand storage above culvert	
D10	D10-10	-	Other	Bridge Near 5464	Channel erosion repair	Addressed with D10-1
D10	D10-2	-	SR-4	Access A Canal	In channel treatment, wet swale	Addressed with D10-1
D10	D10-3	X	OS-7	Gate 6 Triturator	Containment structures	
D10	D10-4	X	OS-8	Lot G	Bioretention islands, permeable paver	
D10	D10-5	NF	OS-8	Lot Q	Bioretention islands, permeable paver	Bioretention area east and west of parking lot already present.
D10	D10-6	X	OS-8	Lot R	Bioretention islands, permeable paver	
D10	D10-7	X	OS-8	Cell Phone Waiting Lot	Bioretention islands, permeable paver	
D10	D10-8	NF	OS-9	Aolewa Place	Filter strip, rain garden, SD wetlands	Some filter strips already in place.
D10	D10-9	NF	OS-10	Diamondhead Concourse Rooftop	Cistern, green roof, planter	Area of possible green roof space too small.
D11	D11-1	NF	SR-4	Kaloaloa Canal	In channel treatment, wet swale	Not enough space.
D11	D11-2	X	OS-7	Maintenance Baseyard	Source Control	Sweeper evap area and stockpile barrier
D11	D11-3	NF	OS-8	Baseyard Parking Lot	Bioretention islands, permeable paver	Not enough space.
D13	D14-1	X	SR-4	Kaloaloa Canal	In channel treatment, wet swale	
D15	D15-1	Repeat	OS-9	Kalewa Street Sidewalks	Filter strip, rain garden, SD wetlands	
D16	D16-1	Repeat	OS-9	Kalewa Street Sidewalks	Filter strip, rain garden, SD wetlands	
D16	D16-2	X	OS-11	Vacant Lot by Pump Station	Pervious paver, rain garden	Determine future use
D16	D16-3	X	OS-7	Vip Trans	Trench to OWS at back of facility	Main goal is to prevent oils and fuels from entering canal.

HNL Desktop Analysis for Potential Retrofits

Basin	ID #	RRI Form	Retrofit Type	Area Description	Potential Retrofits	Field Notes
D17	D17-1	-	OS-9	Rodgers Blvd	Filter strip, rain garden, SD wetlands	Center and perimeter bioretention already in place.
D2	D2-1	NF	OS-10	International Parking Structure Rooftop	Cistern, green roof, planter	Not sufficent space for size of cistern required.
D2	D2-2	NF	OS-9	Ala Onaona Street	Filter strip, rain garden, SD wetlands	
D3	D3-1	-	OS-9	Rodgers Blvd	Filter strip, rain garden, SD wetlands	Vegetation in place, need only conveyance
D4	D4-1	NF	OS-8	Parking Lot J	Bioretention islands, permeable paver	Grading of parking area is an issue.
D4	D4-2	NF	OS-10	Overseas Terminal Parking Structure (Lot D)	Cistern, green roof, planter	Not sufficent space for size of cistern required.
D5	D5-1	X	OS-10	Terminal Rooftop	Cistern, green roof, planter	Consider public demonstration
D6	D6-1	-	OS-8	Employee Lot C	Bioretention islands, permeable paver	Perimeter bioretention already in place.
D6	D6-2	-	OS-8	Public Parking Lot F	Bioretention islands, permeable paver	Will be removed as a part of the modernization plan.
D6	D6-3	NF	OS-10	Overseas Terminal Parking Structure (Lot D)	Cistern, green roof, planter	Not sufficent space for size of cistern required.
E	E-1	X	SR-4	Canal North of Aolele Street	In channel treatment, wet swale	May require dechannelization
E	E-2	X	OS-7	Bldg 180 Autobodies	Source Control	
E	E-3	X	OS-7	2875 Ualena Investment Co.	Source Control	
E	E-4	X	OS-7	Royal Hawaiian Movers	Source Control	
E	E-5	X	OS-7	Punaluu Builders	Source Control	
E	E-6	X	OS-7	So Ono Food Products	Source Control	
E	E-7	NF	OS-9	Paiea Street	Filter strip, rain garden, SD wetlands	
E	E-8	NF	OS-9	Aolele Street	Filter strip, rain garden, SD wetlands	
E	E-7	X	OS-9	Paiea Street	Filter strip, rain garden, SD wetlands	

ATTACHMENT VI

Final Potential Retrofit List and RRI Forms

ATTACHMENT VII

Hotspot RRI Forms