St. Croix East End Watersheds
Existing Conditions Report

July 2011

Prepared for:

St Croix East End Marine Park
USVI Department of Planning and Natural Resources
NOAA Coral Reef Conservation Program
USDA-NRCS, St. Croix Field Office

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Executive Summary

This report is the first product in a watershed planning effort for the East End of St. Croix sponsored by the NOAA Coral Reef Conservation Program and conducted by the Horsley Witten Group, Inc. (HW) in partnership with the USVI Department of Planning and Natural Resources (DPNR), the USDA Natural Resource Conservation Service (NRCS), St. Croix Environmental Association (SEA), and The Nature Conservancy (TNC). Included here is a summary of known conditions, potential pollution sources, and candidate restoration opportunities in six watersheds draining to the St. Croix East End Marine Park (STXEEMP). These watersheds include Southgate, Solitude Bay, Teague Bay, Turner Hole, Madam Carty, and Great Pond Bay.

Basic watershed characteristics such as soils, rainfall, land use, and infrastructure are summarized, as are the common sources of land-based sources of pollution (LBSP) generated within each watershed. Investigations of sources and potential opportunities to address these pollutants, as well as stakeholder meetings, were conducted in November 2010 and January 2011. Over 150 sites were investigated, including commercial businesses, resorts, gut/road crossings, farms, and 22 residential neighborhoods/condos. Based on field observations, new mapping data were produced for road culverts and unpaved/paved roads, and approximately five additional miles of gut channels were added to the existing map data provide by DPNR. Some of the watershed management opportunities indentified include:

- 7 gut stabilization projects;
- 2 pond restorations;
- 7 locations for unpaved road improvements;
- 24 stormwater retrofit sites (with multiple opportunities at some sites);
- 1 flowing discharge for further investigation;
- 7 locations for enhanced pollution prevention measures;
- 58 of 96 culverts in need of maintenance;

Table E.1 summarizes candidate restoration projects to be prioritized with stakeholders in the next phase of the project. Projects were initially ranked by field teams based on a number of preliminary factors including significance of problem; feasibility of implementation; benefits; visibility; stakeholder input; and integration with other initiatives. It should be noted that only culverts with important maintenance concerns are included. The locations of each site can be found in the maps in Appendix A. Each project is described in more detail in Sections 3-8 of this report, as well as in the field notes in Appendix B.

Table E.2 summarizes key watershed management activities for each of the residential areas investigated. Activities include road/driveway/culvert maintenance to reduce erosion and improve drainage; gut management to protect buffers and reduce erosion; vegetation management to advance better landscaping practices; on-lot and large-scale stormwater retrofits; pollution prevention to reduce trash, oil, pet waste and other pollutants; management of residential construction for areas where more development is expected; and septic

inspections to reduce failures. These findings should be used to help direct educational messages to appropriate communities, and identify priority areas for outreach and implementation.

Table E.1. Summary of Potential Restoration Projects

Project Type	Initial Ranking	Site Name (Project ID)[1]	
Gut Stabilization/ Pond Restoration	High	• East Gut-Adam's Farm (SG-G-2) • Southgate Pond/Reserve (SG-1) • Gut at Reef Golf (TB-G-1)	• West Gut at Southside Rd. (GP-G-1) • Sally's Fancy East Gut (GP-G-2)
	Low	• West Gut/Schuster (SG-G-3) • West Gut/ Cheeseburger's (SG-G-1) • Seven Hills Rd. and Gut (SG-RC-22)	• Skov Farm Ponds/Hillside erosion
Road Improvement	High	• Ridge Rd. at Rt. 82 (TB-RC-3) • Goat Hill Rd./TNC (TB-RC-4)	• Seven Flags Rd. (SB-RC-9)
	Medium	• Hope and Carton Hill Neighborhood Road Network (SB-RC-8) • Milgie's Grocery (GP-RC-2)	
	Low	• Private Unnamed Road off Sierra Verde – Bajamar Rd. (SB-RC-1) • Unnamed Road (GP-RC-33)	
Stormwater Retrofit	High	• Green Cay Marina (SG-R-3) • Chenay Bay Retrofits(SG-R-20) • East End Beach Parking (TB-R-1)	• Reef Golf Course (TB-R-3) • Seven Flags Rd. Housing Development (SB-R-3) • Point Udall (TH-R-1)
	Medium	• Green Cay Marina/Road (SG-R-4) • St. Croix Yacht Club (TB-R-2) • Fire Station (SB-R-1) • Blue Water Terrace (SB-R-2) • Coakley Bay Condos (SB-R-5/6)	• Grapetree Bay Hotel (TH-R-4) • Divi Hotel & Resort (TH-R-3) • Divi Casino (TH-R-2) • Parking /Trail Repair (GP-R-3)
	Low	• Tamarind Reef/Road (SG-R-5) • Southgate Baptist Church (SG-R-6) • Cheeseburger Parking lot (SG-R-1) • Southgate Condos (SG-R-2) • Ziggy's Island Market (SB-R-4)	• Carden Beach (SB-R-7) • Candle Reef II Condos Cul-de-sac (SB-R-8) • Villa Madeline (TH-R-5) • STXEEMP Office (GP-R-2)
Pollution Prevention	High	• Chenay Bay (SG-R-20) • Green Cay Marina (SG-R-3) • Solitude Beach (trash cleanup)	• Blue Water Terrace (SB-H-1) • Fire Station (SB-H-2) • Great Pond Parking (GP-R-1)
	Medium	• Southgate Pond Beach	
Culvert Repair/ Maintenance	High	• East Gut/East End Rd. (SG-RC-21) • South Shore Rd./Tipperary New Culverts (SG-RC-31/32) • Culvert at Reef Admin. Building/Rt. 82 (TB-RC-2) • Pony Club Trail Culvert (SB-RC-3) • East End Rd./Gut East Culvert (SB-RC-6) • Seven Flags Rd. Culverts (SB-RC-9) • East End Rd. Culverts-East (SB-RC-19)	• Culvert to Coakley Bay from Ziggy's/Top Side (SB-RC-12) • Unnamed Road Culvert near Fire Station (SB-RC-13) • East End Rd. Culvert – Coakley Bay Condos (SB-RC-16) • New culvert/piped gut at South Shore Rd. (TH)

Project Type	Initial Ranking	Site Name (Project ID)[1]	
Culvert Repair/ Maintenance	Medium	• Cheeseburger Culvert (SG-RC-1) • Seven Seas Culvert (SG-RC-2) • Seven Hills Culverts (SG-RC-7) • Crescent Beach Rd. (SG-RC-6) • Duggan's Entrance (TB-RC-1) • Cotton Valley Neighborhood Southeast Culvert (SB-RC-4) • East End Rd./Blue Water Terr. (SB-RC-7) • East End Rd./Ziggy's/Top Side (SB-RC-11)	• East End Rd. Culvert near Fire Station (SB-RC-14) • Seven Flags Neighborhood culvert (SB-RC-18) • Eastern Culvert on Rt. 624 near proposed Muddy Mongoose (GP-RC-1) • Marienhoj North Culvert/ East Maria Ln. (GP-RC-4) • Marienhoj West Culvert (GP-RC-5)
	Low	• Southgate Baptist Church/East End Rd. Culvert (SG-RC-20) • South Shore Rd./ West Gut Culverts (SG-RC-4/5/ 30) • Southgate Farm Culverts (SG-RC-35/36) • Private Rd. Sierra Verde/Yellow Cliff North Culvert (SB-RC-2)	• Solitude Rd. Culvert (SB-RC-10) • East End Rd.– West (SB-RC-15) • East of Coakley Bay Condos (SB-RC-17) • West Culvert on Rt. 624 (GP-RC-3) • South Shore Rd. (GP-RC-34)

[1] Project IDs are coded by watershed: SG= Southgate; SB = Solitude Bay; TB= Teague Bay; TH=Turner Hole; MC=Madam Carty; GP=Great Pond; and by project type: R=Retrofit; G=Gut Stabilization; RC=Roads and Culverts; H=hotspot. Numbers were sequentially signed by project team and date and do not reflect any ranking.

Table E.2. Residential Investigation Summary

Name	Potential Stewardship Activities						
	Road, culvert, or driveway maintenance	Gut mgmt.	Veg. mgmt.	Stormwater retrofit (on-lot or larger)	Pollution prevention	New residential construction mgmt.	Septic survey
All for the Better/ Tipperary (SG)	X	X	X	X	X		X
Catherina's Hope (TB)						X	
Cotton Valley (SB)	X	X			X		X
Grapetree Bay (TH)						X	
Hilltop Circle (TB)	No action identified						
Hope & Carton Hill (SB)	X	X		X			
Mt. Washington (SG/GP)					X	X	
Marienhoj (GP)						X	
Parara (SG)					X		
Pleasant Valley (SB)	X	X	X	X			
Punnett Bay (Shoy's) (SG)		X	X	X			
Green Cay/Prune Bay (SB)	X		X	X			
Reef Condos (TB)	No action identified						
Sally's Fancy (GP)		X	X		X		
Seven Flags (SB)	X			X			

Name	Potential Stewardship Activities						
	Road, culvert, or driveway maintenance	Gut mgmt.	Veg. mgmt.	Stormwater retrofit (on-lot or larger)	Pollution prevention	New residential construction mgmt.	Septic survey
Seven Hills (SG)	X						
Sierra Verde (SB)	X			X			
Solitude North (SB)						X	
Southgate Farm/Anna's Hope (SG)			X	X			
Union (GP)							X
Villa Madeline (TH)				X			
Yellow Cliff North (SB)	X						
SG= Southgate; SB = Solitude Bay; TB= Teague Bay; TH=Turner Hole; MC=Madam Carty; GP=Great Pond							

General observations and findings that will be used to develop watershed management goals and priority recommendations are discussed in detail in Section 9 of this report. Some of the key findings for watershed management (in no particular order) include:

1. Integrating watershed management priorities with TMDL development and pollutant reduction targets;
2. Developing an overall management strategy for stabilizing unpaved roads in the East End that are chronic sources of sedimentation;
3. Providing technical guidance on the design of drainage infrastructure to improve water quality and reduce maintenance burden;
4. Supporting a Territorial strategy for the management of guts;
5. Enforcing stringent development standards on new construction and redevelopment projects to minimize adverse impacts on environmental resources;
6. Minimizing the potential for flooding by maintaining adequate setbacks from wetlands, guts, and other flood-prone areas;
7. Providing alternative designs for inadequate septic systems and increasing inspections and maintenance requirements;
8. Coordinating with Homeowner and Condo Associations on targeted residential education and outreach;
9. Developing a strategy for maintaining functional capacity of small farm ponds/impoundments;
10. Supporting Territorial wellhead protection program by evaluating conditions within 1000 feet of permitted wells;
11. Identifying pollution prevention opportunities to reduce the risk of pollutants coming into contact with stormwater; and
12. Continuing to strongly support conservation and protection activities.

1.0 Introduction

This report is part of an assessment and planning effort for the six watersheds draining to the St. Croix East End Marine Park (STXEEMP)—a 60 square (sq.) mile area that extends outward three nautical miles from 17 miles of shoreline around the East End of St. Croix, US Virgin Islands (USVI). St. Croix is the largest of the Virgin Islands (80 sq. miles) and is located approximately 35 miles south of St. Thomas, USVI. Frederiksted and Christiansted are St. Croix's primary urban centers, and Hovensa operates one of the Caribbean's largest oil refineries on the southwestern shoreline (Figure 1.1). The East End watersheds are approximately 12 sq. miles in combined area and include: Southgate, Great Pond Bay, Solitude Bay, Madam Carty, Teague Bay, and Turner Hole watersheds. Point Udall in the Teague Bay watershed is considered the easternmost point on the US Atlantic seaboard (Figure 1.2).

Water quality in a number of bays within the STXEEMP has been listed as impaired for turbidity, bacteria, and other parameters generated from land-based sources of pollutants (LBSP). Potential sources of pollutants commonly cited include unpaved roads, construction sites, gut erosion, untreated stormwater runoff, and wastewater discharges. These pollutants can have a negative impact on the ecological health, recreational use, and commercial resources of the STXEEMP; therefore, the East End watersheds have been identified as priorities for assessment and planning by coastal managers.

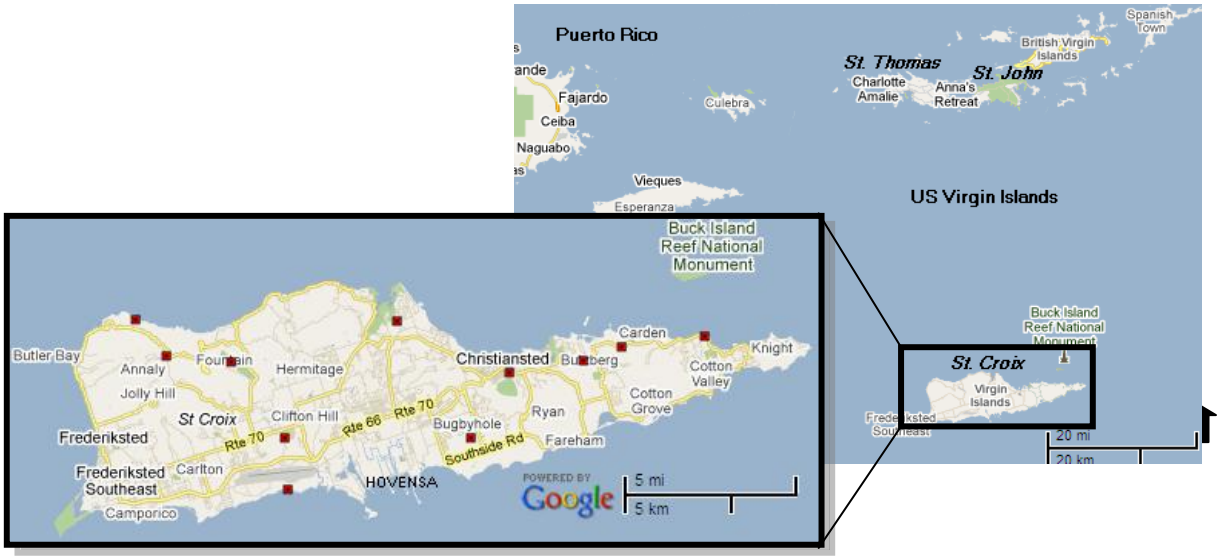

Figure 1.1. Location of St. Croix, USVI

To address LBSP concerns, assess drainage infrastructure, and generate a list of "shovel-ready" projects for implementation, a year-long watershed planning effort is being sponsored by the National Ocean and Atmospheric Administration (NOAA) Coral Reef Conservation Program and conducted by the Horsley Witten Group, Inc. (HW) in partnership with the USVI Department of Planning and Natural Resources (DPNR), the US Department of Agriculture- Natural Resource Conservation Service (NRCS), St. Croix Environmental Association (SEA), and The Nature Conservancy (TNC). The scope of this project includes the following five key elements:

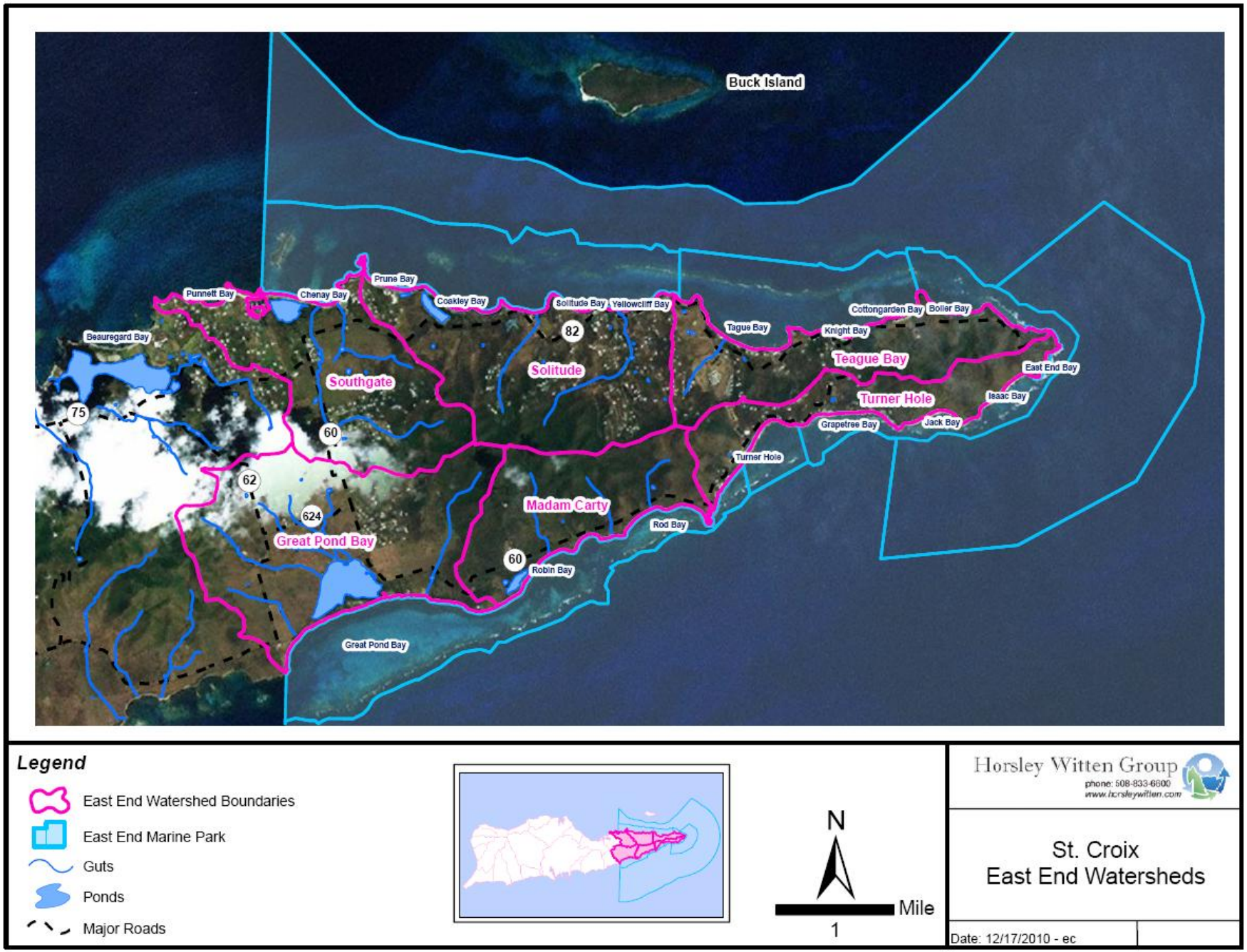

Figure 1.2. St. Croix East End Watersheds Locator Map

1. The compilation of existing studies, mapping, and other information pertaining to the conditions of the East End watersheds;
2. A thorough field investigation to identify pollution sources and potential restoration opportunities;
3. Estimates of relative sediment loads under existing conditions and load reductions expected with various restoration activities;
4. Prioritization of restoration strategies and drafting of engineering design plans for priority projects; and
5. The development of a watershed management plan and implementation strategy for the six East End watersheds.

This report provides a summary of existing watershed conditions based on a review of existing information; observations made during field assessments; and information derived from project partners, key land owners, and input during a number of agency and public stakeholder meetings.

1.1 Purpose

Much work has already been completed by Territorial and Federal agencies, researchers, and others to map land use conditions, monitor water quality, evaluate drainage patterns and pollutant sources, and restore problem areas in the East End watersheds. This report is intended to summarize this existing information on a watershed-basis in order to guide subsequent field work, inform modeling efforts and project designs, and provide a framework for prioritizing watershed management strategies.

We acknowledge that the information presented here is limited to what has been gathered to date, that there are gaps to be filled, and that additional information can be incorporated as appropriate into the final watershed management plan. While general findings and initial restoration options are discussed, this report does not present prioritized recommendations for watershed management and should not be interpreted as more than a documentation of observations.

1.2 Watershed Issues

The negative effects of LBSP on coral reef ecosystem health and function have been well documented, most notably from sedimentation, nutrient loading, toxins, and pathogen introduction (NOAA, 2009). Derived from direct discharges, surface runoff, groundwater seepage, and atmospheric deposition, these pollutants can contribute to disease and mortality of sensitive species, disrupt ecological functions, and reduce community resilience to other stressors (i.e., bleaching events, overfishing, and hurricane damage). Recreational uses and commercial opportunities associated with a healthy marine environment, particularly on the East End of St. Croix, can also suffer from uncontrolled LBSP.

Stormwater runoff across unpaved roads, construction sites, or other bare soils can discharge turbid plumes into nearshore waters even during average rain events (Figure 1.3). Increased runoff volumes from urban development can lead to gut erosion, which can impact gut ecology, contribute to downstream sedimentation, block culverts, and increase the risk of flooding. Trash, oils, and other chemicals that collect on (or are dumped onto) impervious surfaces and in drainage ways can also be transported to marine waters via stormwater runoff. Excess nutrients from septic systems and wastewater discharges can seep into the groundwater or surface drainages, contributing to algal growth and low dissolved oxygen. In some instances, untreated sewage discharges and unmanaged waste from livestock, pets, or wildlife can introduce pathogens, which can lead to beach closures and fishing restrictions.

Figure 1.3. Sediment-laden runoff from unpaved roads in Cotton Valley conveyed in concrete swale (left, photo courtesy of Zandy Hillis-Starr). Uncontrolled runoff resulting in sediment plume in Grapetree Bay during heavy rains in July 2010 (right) (photo courtesy of Kathy LaGrange/Dave Rivers).

The sea grass and coral reef habitats associated with the STXEEMP and the adjacent Buck Island Reef National Monument contain essential fish habitat that supports populations of commercially important species (i.e. conch, lobster) and threatened *Acropora* species among others. The fringing mangroves and open waters of Great Pond and Southgate Pond also provide habitat for migratory birds and other wildlife and are important hydrologically. These areas have been impacted by hurricanes and fishing pressure, and are susceptible to direct and indirect impacts associated with land use activities, including changes in hydrology and water quality. In fact, 8 of 18 DPNR water quality monitoring assessment units around the East End are currently classified as impaired for one or more of the following parameters: turbidity, secchi depth, dissolved oxygen, fecal coliform, enterococci, or pH (DPNR, 2010). Suspected sources of these impairments are listed as land development, erosion and sedimentation, road runoff (new and non-construction); package plants, marina maintenance, sanitary on-vessel discharges, and non-point source discharges. Total Maximum Daily Loads (TMDLs) are to be developed in 2011 by the US Environmental Protection Agency (USEPA) to establish load allocations and set reduction requirements for pollutants of concern in three of the impaired assessment areas.

1.3 Assessment Methods

To gain a better understanding of the sources of LBSP in the East End, the magnitude of the problems, and potential solutions to mitigating impacts, HW and our project partners conducted field assessments in November 2010 and in January 2011. Meetings were held with government agency staff, local residents, businesses, and environmental groups to help identify areas of concern and to arrange on-site investigations on privately-owned properties. Restoration opportunities were evaluated using watershed assessment protocols developed by the Center for Watershed Protection (Kitchell and Schueler, 2004; Wright et al. 2005; and Schueler et. al., 2007) and adapted by HW for application in the USVI. Various types of restoration opportunities were evaluated in each of the East End watersheds as summarized in Table 1.1. These assessments were used to identify potential restoration projects, collect enough information to further refine priority concepts, and to assist in characterizing watersheds for pollutant modeling purposes. More detail on the sites visited and projects identified can be found in Sections 3-9 of this report and located in maps found in Appendix A. Completed field forms can be found in Appendix B.

Public meetings to inform residents and other interested stakeholders on the watershed planning activities were held on November 30, 2010 and January 26, 2011. The events were advertised via email lists from NRCS, the STXEEMP, and SEA, as well as through an article in *The Avis* newspaper. Letters of notification were also distributed electronically and posted at local businesses. Residents were encouraged to provide input on sources of LBSP and to arrange on-site meetings with field investigators (Figure 1.4). A project website was established to share information and provide access to reports, project designs, announce scheduled events, and solicit additional input (www.horsleywitten.com/stx-east-end-watersheds). Information derived from these meetings has been incorporated into the findings presented in this report.

Figure 1.4. Public meeting attendees on January 26, 2011 were divided into six groups and asked to identify locations of interest, brainstorm restoration strategies, and provide tips for implementation (left). Private property owners like May Cornwall, coordinated with field crews to investigate potential problem areas on-site (right).

Table 1.1. Summary of Restoration Opportunities Investigated in the Field

Type	Description
Gut Stabilization 	Extremely eroded guts identified by project partners and landowners were evaluated to determine the cause and extent of erosion, downstream impacts, and continued erosion potential. Strategies for stabilization; basic channel measurements; and feasibility, access, and adjacent buffer were recorded. Accessible guts were evaluated in order to verify and revise DPNR's existing mapping data to reflect field observations.
Road Improvements 	All public and most private roads (excluding driveways) were driven and classified as paved or unpaved. A new road mapping layer was created in GIS to reflect road type, which will be useful for future sediment load modeling and road maintenance planning. Road improvement options for roads with significant erosion, gullying, and raveling were identified.
Culvert Maintenance 	Visible culverts were identified, mapped, and where feasible, assessed. Information was collected on the culvert type and material, pipe diameter, and recommended maintenance needs. A new culvert mapping layer and information database was created in GIS specifically for the USVI Department of Public Works (DPW).
Stormwater Retrofits 	Areas generating stormwater runoff (e.g., parking lots, rooftops, roadways, or compacted pervious areas) were evaluated to determine if new stormwater management practices could be installed, or existing facilities modified, to better capture and treat runoff. Information on existing drainage patterns, surrounding land use, site constraints, and proposed concepts were collected.
Pollution Prevention 	Commercial businesses, public facilities, trash collection areas, and other locations where pollutants are likely to come into contact with stormwater were evaluated. Site activities (e.g., erosion and sediment control, outdoor material storage, waste management, and vehicle maintenance); observed or potential pollutants of concern; and structural and non-structural prevention opportunities were documented for each site.
Residential Assessments 	Neighborhoods were evaluated as a whole to determine the common pollution sources and the type of voluntary watershed stewardship activities that should be targeted to residents (e.g., road maintenance, reduced fertilizer use, lawn conversion, septic maintenance, small lot erosion and sediment control, better pet waste management). Average lot size, potential for new development, and road condition were recorded.

Type	Description
Discharge Investigations 	Type, size, and condition of outfall pipes discharging to guts, wetlands, and shorelines were evaluated. Any observed dry weather flows were recorded and potential sources were identified where possible.
Other 	Small wastewater treatment systems were observed at a number of the watershed resorts and commercial establishments. Small pond conditions, wetland restoration, and conservation area activities were also investigated where proposed or existing projects were identified by project partners.

1.4 Report Organization

The remainder of this report presents findings from a review of existing mapping information and reports; field observations; and stakeholder insight. It is organized as follows:

Section 2: Characteristics of St. Croix's East End—discusses geologic and hydrologic features; natural resources; land use and infrastructure; water quality; and existing management framework and key stakeholders for the East End of St. Croix.

Sections 3-8: Include descriptions of unique watershed features, summaries of potential projects, and descriptions of potential sources of pollution for each of the six individual watersheds.

Section 9: Watershed Findings—a general summary of observations and findings to serve as a framework for the subsequent development of watershed goals and strategies.

Appendix A: Watershed Baseline Maps—aerial maps showing unique features of each watershed, including the locations of potential restoration projects, neighborhoods, estate and parcel boundaries, and the paved and unpaved road network.

Appendix B: Field Assessment Forms—copies of field forms containing information collected in the field (i.e., measurements, notes, and concept sketches). Some field forms contain sketches on aerial photos. These forms are provided to document our field efforts and demonstrate the type of information collected.

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2.0 Characteristics of St. Croix's East End

This section summarizes key information garnered from a review of existing reports, studies, and mapping data that add to our understanding of watershed conditions and will influence watershed management strategies. Table 2.1 summarizes some of the key features of each of the East End watersheds. The hydrologic and geologic features, natural resources, land use, infrastructure, and water quality characteristics of St. Croix's East End are described below. An overview of the existing management framework applicable to the East End (i.e., development regulations, monitoring programs, planning strategies, and key stakeholder groups) is also provided.

Table 2.1. Summary of Key East End Watershed Characteristics[1]

Watershed	Watershed Area		Impervious Cover		Guts[2]	# Ponds	% Flood-plain	Road Miles[3]	# Cul-verts[3]	Wells
	(Acres)	*(mi^2)*	*(Acres)*	*%*	*miles*	*(fresh & salt)*	*(100-yr)*	*Paved/ Unpaved*		
Great Pond Bay	1999.8	3.1	68.8	3%	5.5	8	45%	11.8/4.5	12	12
Madam Carty	1043.3	1.6	14.6	1%	1.9	5	27%	2.6/1.5	1	0
Solitude Bay	1641.0	2.6	152.6	9%	4.9	10	18%	14.6/12.4	28	16
Southgate	1397.8	2.2	126.3	9%	3.8	10	39%	16.4/4.2	27	22
Teague Bay	1021.2	1.6	83.7	8%	0.8	7[4]	16%	10.4/6.6	25	9
Turner Hole	714.0	1.1	69.7	10%	0.3	3	11%	7.0/3.6	9	4
Total	**7817.3**	**12.2**	**515.9**	**7%**	**13.1**	**43**	**29%**	**62.8/32.8**	**96**	**63**

[1] Data derived from existing DPNR mapping layers unless otherwise noted.
[2] HW revised existing DPNR gut mapping layer based on 2011 field assessment.
[3] HW created road and culvert maps based on aerial interpretation and 2011 field verification.
[4] Includes three golf course ponds not currently mapped.

2.1 Geomorphology

The USVI are volcanic in origin, but unlike St. John and St. Thomas, St. Croix was likely formed from the uplifting and exposure of marine terraces and two submerged mountain ranges—the east and west ranges seen today. The mountains on St. Croix are less rugged than those on St. John and St. Thomas, and are separated by broad alluvial plains underlain with marine sediments ("caliche" soils) derived from ancient coral reefs, which extend in a southwest direction from Christiansted and include the south-central and southwestern parts of St. Croix (VI RC&D, 2006 and Renken et al., 2002). The mountainous areas of the East End are characterized by numerous narrow, steep-sided valleys. Rainfall tends to run off these slopes in well-defined surface channels, locally referred to as guts (i.e., ghuts, streams, or watercourses), rather than as subsurface flow due to thin soils and relatively impermeable underlying rock. The shoreline is less irregular on St. Croix than the other islands, which may provide for improved near shore circulation than more isolated areas like Coral Bay on St. John (Figure 2.1).

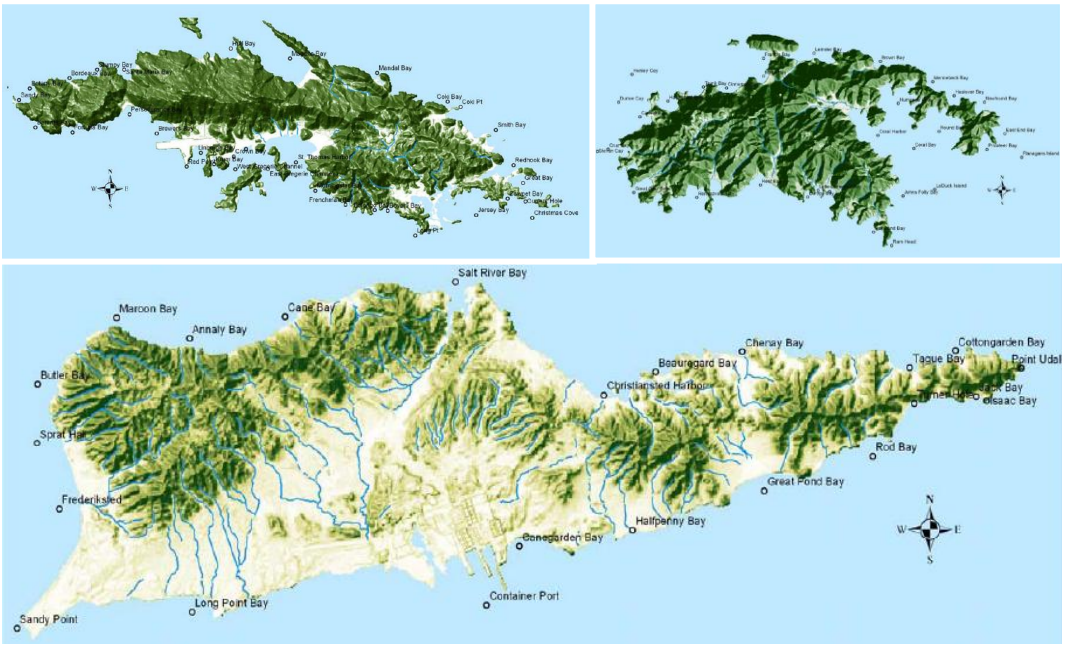


Figure 2.1. Digital terrain model of St. Thomas, St. John, and St. Croix, not to scale (Gardner et. al. 2008)

Soils

The soils on the hilltops and side slopes in the East End of St. Croix are generally shallow, well drained loams (NRCS, 2006). According to the USDA Soil Survey, the majority of the soils in these areas are classified as Southgate-Victory-Cramer, which has a typical soil profile consisting of a 15 cm topsoil of brown loam to very gravelly loam subsoil to a depth of 84 cm. Most of these areas are classified as Hydrologic Soil Group (HSG) B soils, suitable for infiltration (Figure 2.2). Victory soils are formed from weathered bedrock, have a low to medium fertility, and can be slightly acidic. Weathered "rotten-rock" (friable bedrock material) is commonly observed at road cuts, summits, and other areas of exposure. Victory soils are unsuited for crop cultivation, thus, these areas are typically used as rangeland, pasture, or for residential development. In the flatter portions of the East End, particularly in the Southgate and Great Pond watersheds, HSG C soils are more prevalent; which are less suitable for septic systems and stormwater infiltration. According to the USDA Soil Survey, the majority of the soils in the coastal plains areas are classified as Glynn-Hogensborg. Table 2.2 presents a comparative breakdown of HSG soil types by watershed.

Table 2.2. Percentage Breakdown of Watershed Soils by HSG Classification[1]

Watershed	Hydrologic Soil Group			
	A	B	C	D
Great Pond Bay	0%	25%	63%	12%
Madam Carty	1%	58%	38%	3%
Solitude Bay	1%	59%	36%	4%
Southgate	1%	31%	60%	7%
Teague Bay	0%	68%	27%	4%
Turner Hole	0%	70%	24%	5%

[1]Based on 2008 USDA SSURGO data for the USVI

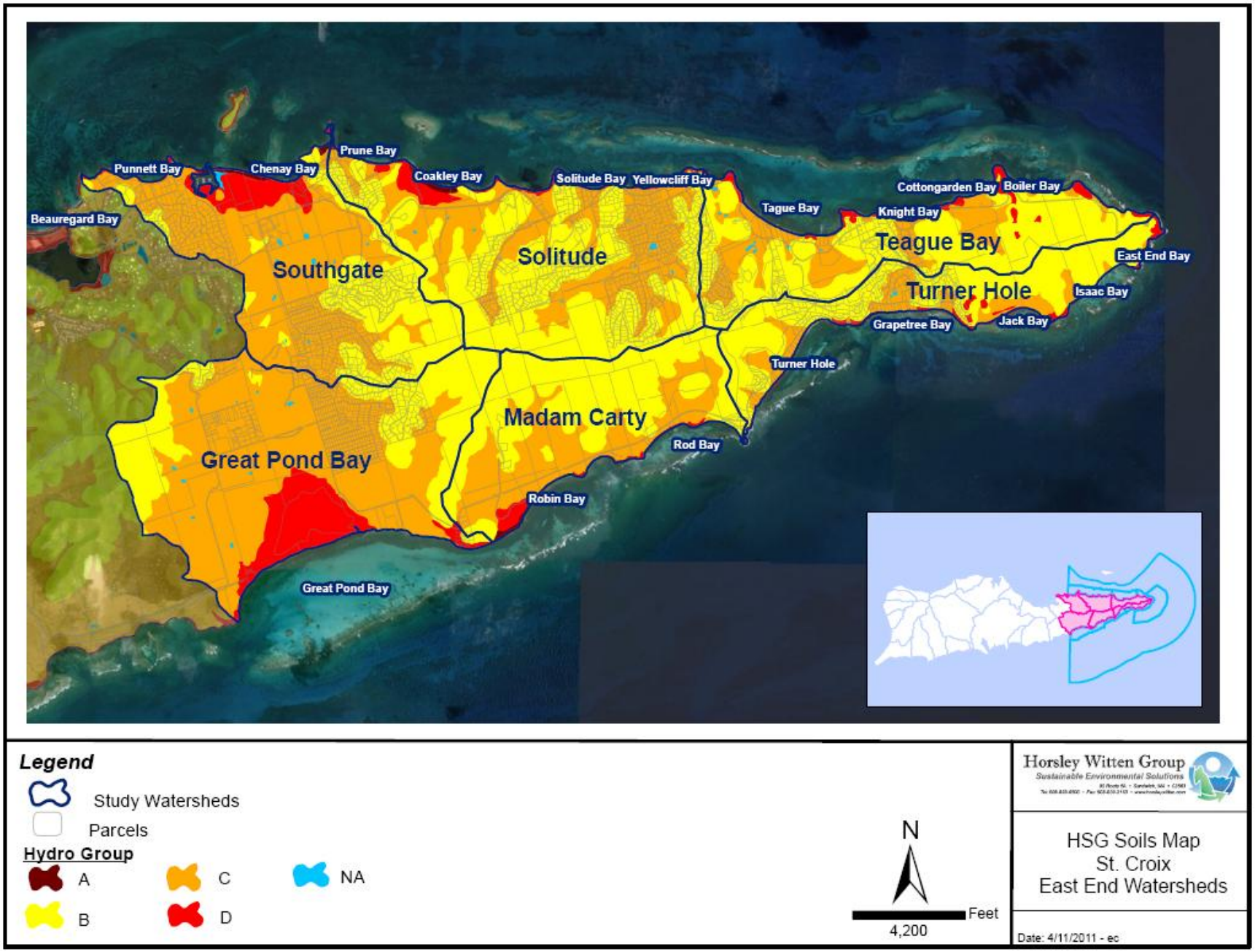


Figure 2.2. Soils map of the East End of St. Croix depicting HSG classifications

Erosion Potential

The Victory and Glynn-Hogensborg soils are listed on the USVI Highly Erodible Soils List (NRCS, 2008). Ramos-Scharrón (2009) suggests—based on results from rigorous watershed erosion studies conducted in St. John, USVI and in La Parguera, Puerto Rico—that disturbed surfaces can erode at rates up to four orders of magnitude higher than undisturbed surfaces. This can result in watershed-scale sediment yields up to 10 times higher than undisturbed conditions. Figure 2.3 illustrates the significant influence of unpaved roads and steep slopes on sediment production and yield modeled by Ramos- Scharrón using the STJ-EROS erosion model.

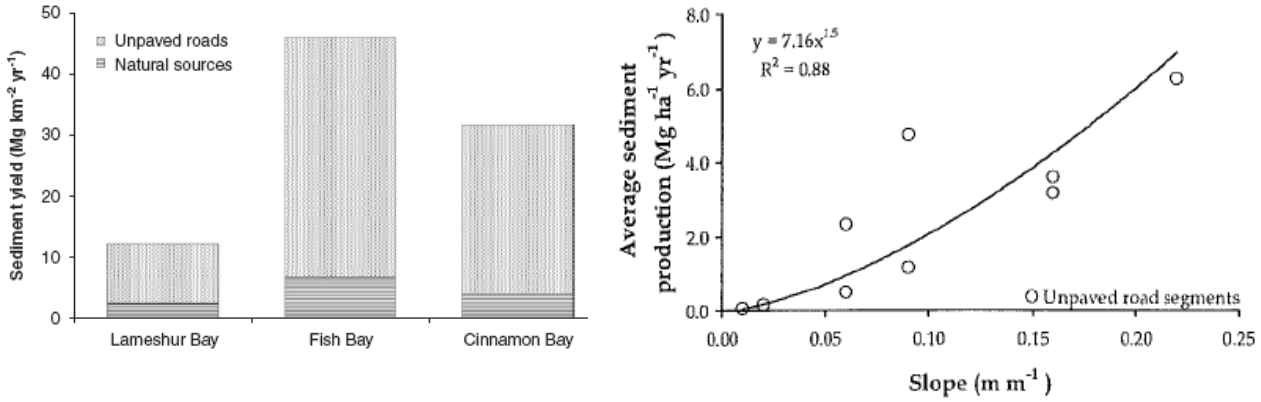


Figure 2.3. (Left) Total sediment yield comparison between unpaved roads and natural sources such as gut erosion, tree throw, and direct hillside erosion in three watersheds on St. John (Ramos- Scharrón and McDonald, 2006). (Right) Increased sediment production curve for unpaved roads as slope increases based on data from La Parguera (Ramos- Scharrón, 2007).

Relative watershed erosion across the Caribbean was estimated by the World Resources Institute (WRI) and NOAA in 2005 using the N-SPECT model, which is based on the Revised Universal Soil Loss Equation (USDA, 1989). Results of the model show that in the East End watersheds, topography, soils, land cover, and road density combine to create a high potential for erosion and sediment loading relative to other watersheds on St. Croix (Figure 2.4). Table 2.3 summarizes modeling input and output parameters used during the model. Erosion rates and potential loading will be further evaluated during this watershed planning process.

Table 2.3. Relative Parameters in N-SPECT Modeling (WRI and NOAA, 2005) [1]

Watershed Name	Area (acres)	Area (km2)	Mean Vulnerability to Erosion	Mean Relative Erosion Potential	Relative Sediment Delivery	Road Density (%)	Mean Erosivity due to Roads
Great Pond Bay	2,000	7.66	798	49	93,320	0.14	119
Madam Carty	1,043	4.17	1,370	73	89,818	0.08	55
Solitude	1,641	6.62	1,257	81	137,958	0.25	245
Southgate	1,398	5.63	792	58	88,112	0.22	186
Teague Bay	1,021	4.12	1,444	83	101,888	0.25	316
Turner Hole	714	2.81	1,722	124	116,264	0.18	269

[1] Parameter either unitless or units not provided.

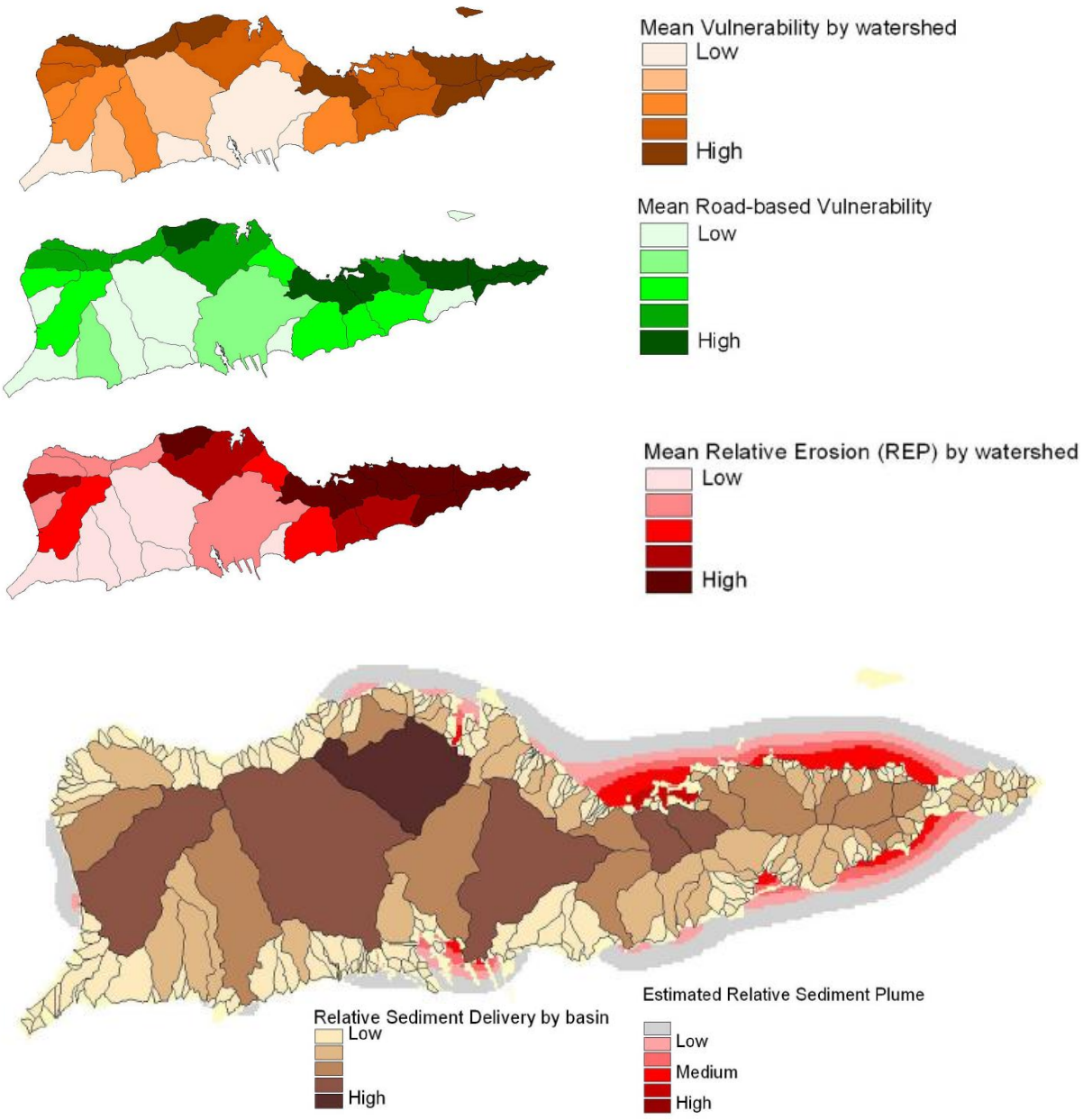


Figure 2.4. N-SPECT model results (from top to bottom) show a high vulnerability of four East End watersheds to erosion based on slope, soil erosivity, rainfall, and land cover conditions; a high road-based vulnerability to erosion in three of East End watersheds based specifically on road slopes, soil erosivity, and road density; and a combined mean relative erosion potential for the East End that is significantly higher than most other areas on St. Croix. Sediment delivery is a function of the overall watershed size and a delivery ratio accounting for number of outlet points (WRI and NOAA, 2005).

2.2 Hydrology

Rainfall

The tropical to semi-arid climate in St. Croix is characterized generally by fair weather, steady easterly tradewinds, and an average annual temperature around 79 °F with 5 – 8°F seasonal variances (Mac et al. 1998). The wet season typically runs from June to November (DPNR, 2002) with the wettest period between September and November—hurricane season. Hurricane Hugo devastated St. Croix in 1989 and caused significant damage to reefs and mangrove systems, and shifts in vegetation on higher elevations from manchineel trees and upland scrub to thorn scrub, tan–tan, and sea grape (Knowles, 1996). St. Croix can be subject to severe and extended droughts, which can be problematic given limited availability of freshwater.

Total annual rainfall varies significantly across the island ranging from more than 50 inches/year in the northwestern part of the island to 25 – 38 in/yr in the eastern part of the island, depending on the source of the data (Figure 2.5).

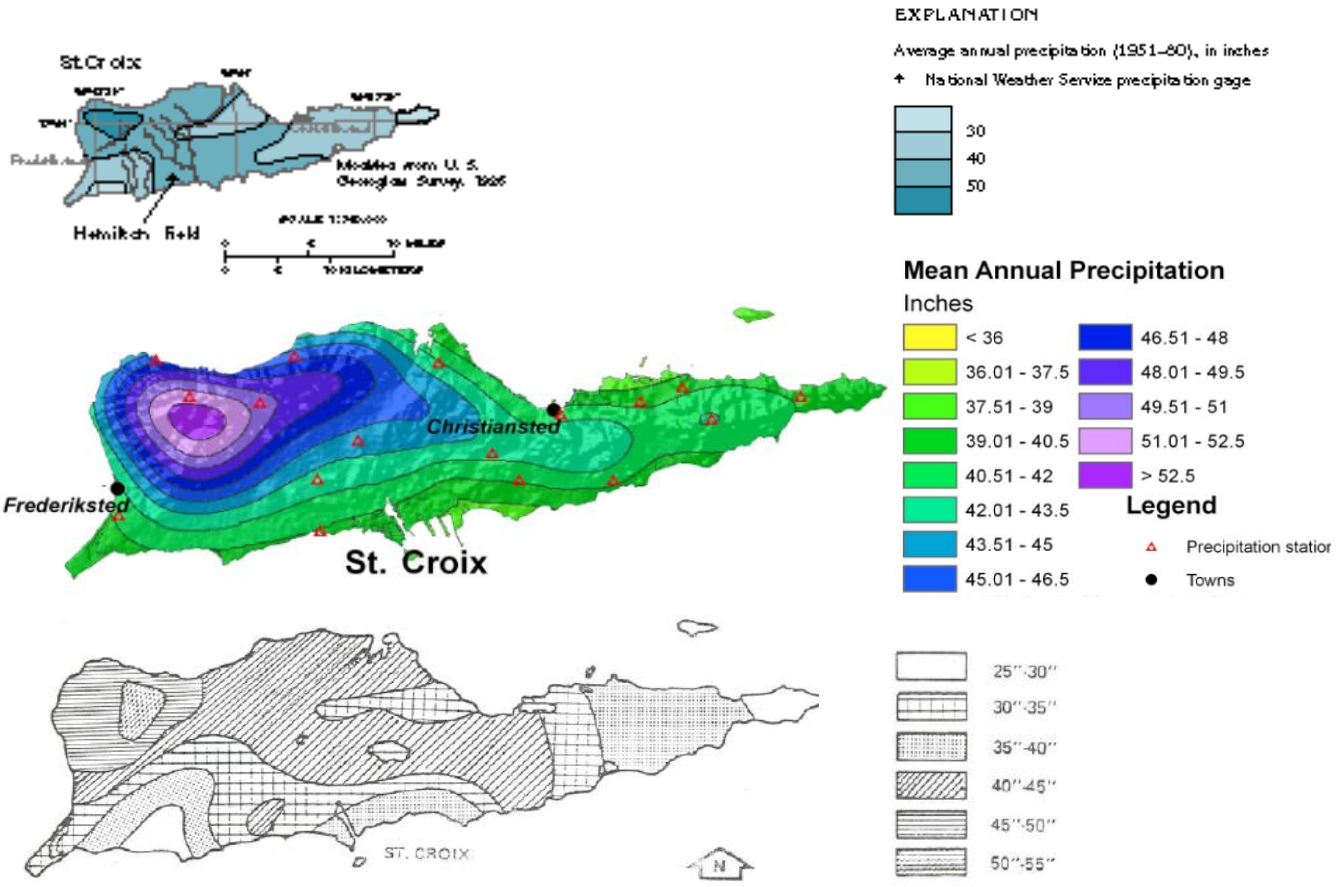


Figure 2.5. Differences in rainfall patterns in three Annual Precipitation Maps: (Top) based on data collected from 1951-1980 by Miller and Whitehead (1999) (in USGS,1999); (Middle) based on over 50 years of records through 2004 (in NOAA, 2006); and (Lower) precipitation data from the 1970's from M.J. Bowden as presented in Rennis et al. (2006).

Monthly rainfall estimates from the Maria Hill station in the Southgate watershed indicate an annual rainfall of approximately 28 inches at the East End (Figure 2.6). This indicates a geographic variation factor of 1.7 from west to east (Gaines, 2004). Rainfall typically occurs in the day more so than at night (VI RC&D, 2006).

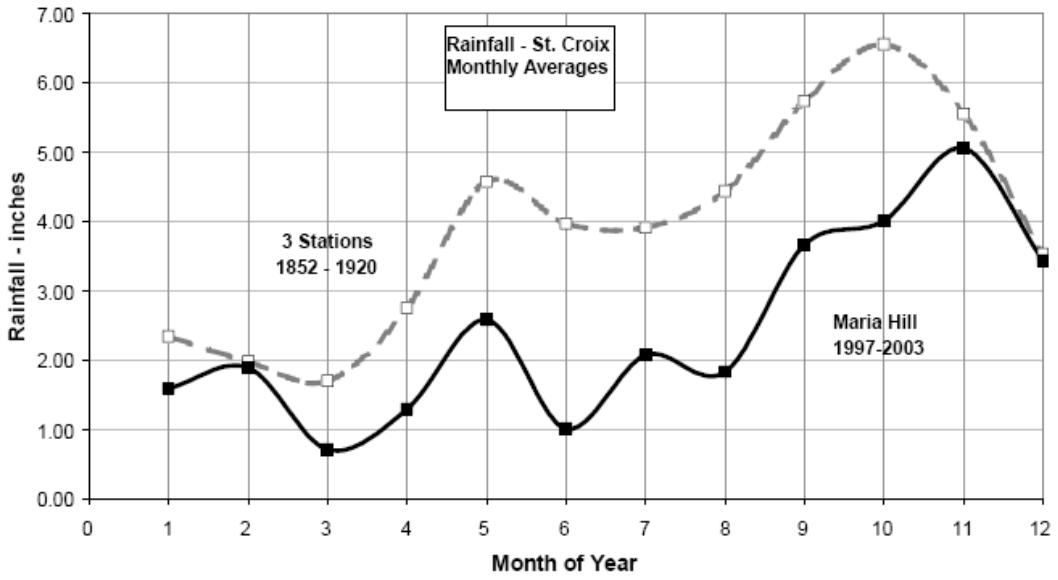


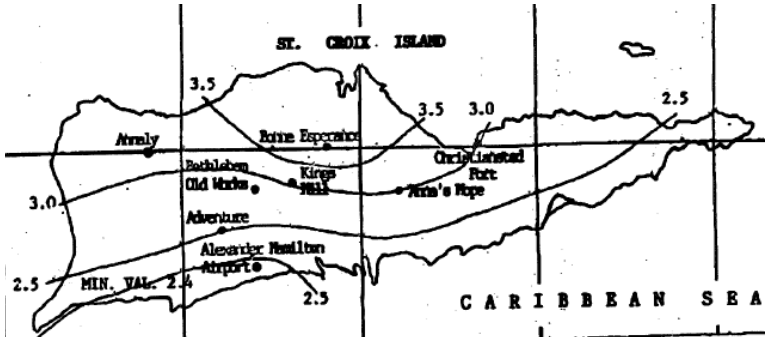
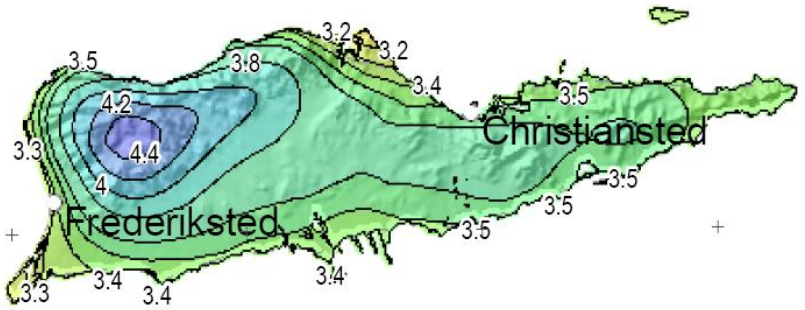
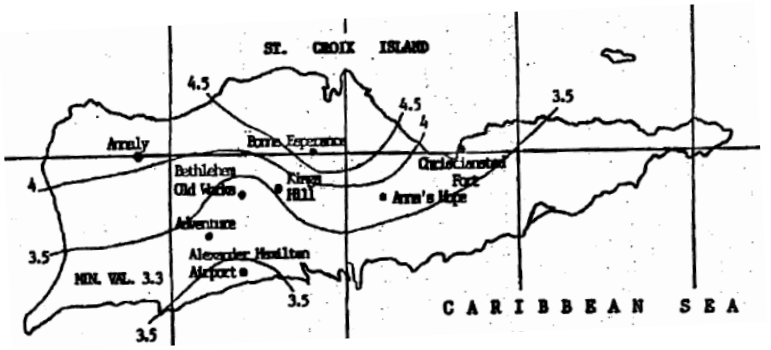
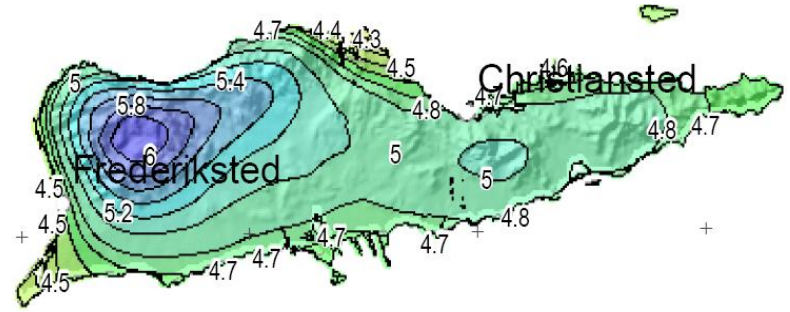
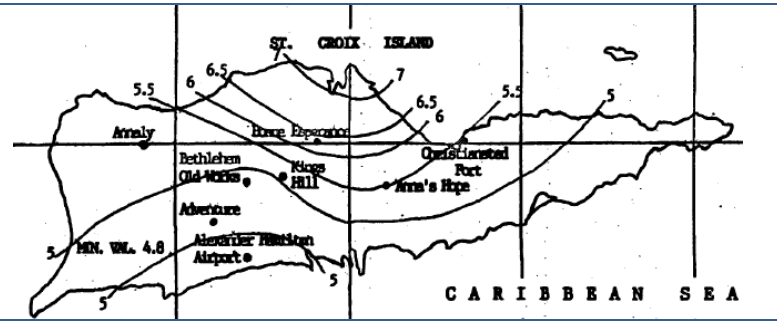
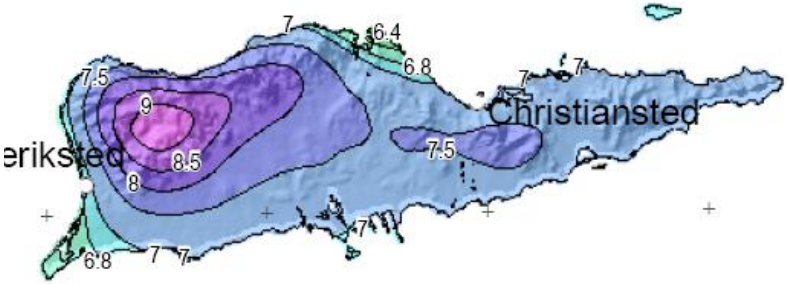
Figure 2.6. Monthly average rainfall at Maria Hill from 1997-2003 (solid line) and from 3 stations on Frederiksted, Chirstiansted, and Kings Hill from 1852-1920 (dashed line) as reported in Gaines (2004).

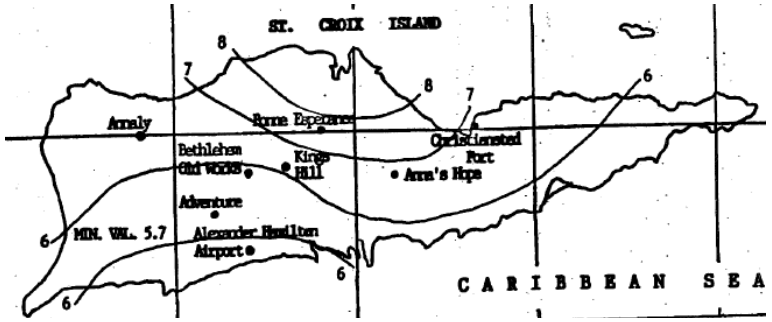
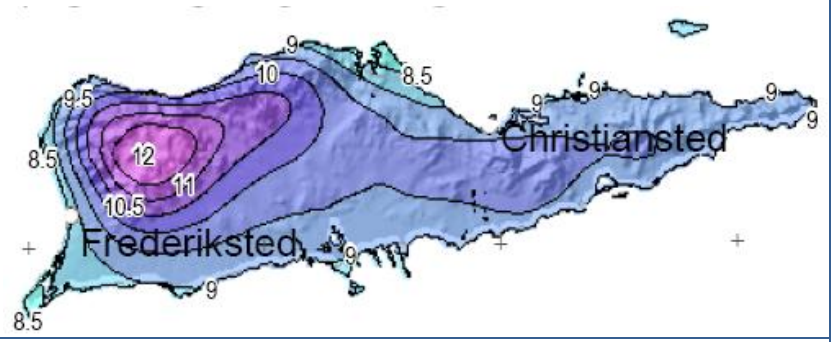
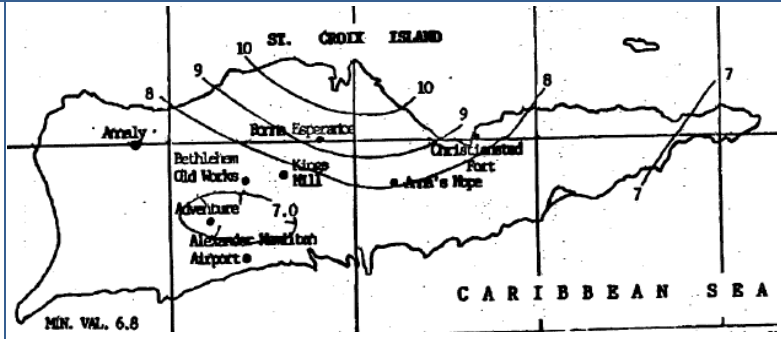
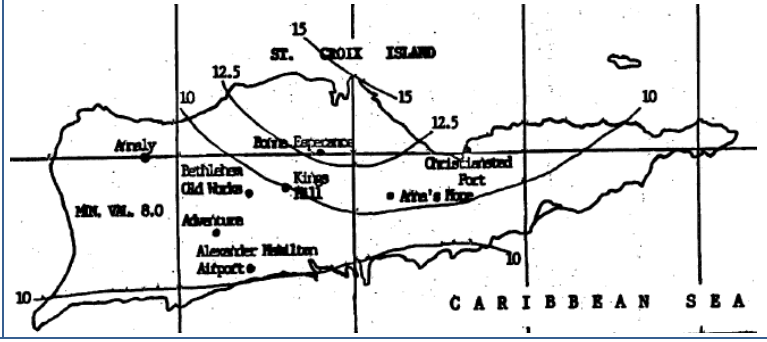
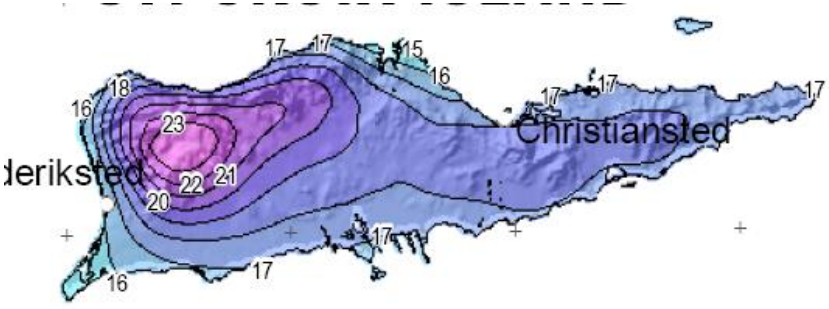
The current stormwater design guidance published in the 2002 USVI Environmental Protection Handbook indicates that the USVI uses a Type III rainfall distribution, and provides precipitation frequency maps for the 1-yr, 2-yr, 5-yr, 10-yr, 25-yr, and 100-yr 24-hour rainfall events, as well as intensity and duration curves (source cited from USDA-SCS, 1986). NOAA (2006) presents updated rainfall frequencies from over 50 years of records through 2004, which show increased rainfall amounts and variations in geographic distribution for all recurrence intervals when compared with the existing stormwater guidance document (Table 2.4). If this data is accurate, there could be a significant impact on current and future sizing of stormwater management practices and culvert designs, among others.

Conveyance and Detention

Stormwater is typically conveyed down the mountains though natural guts, roads, and roadside ditches, carrying eroded sediment and watershed pollutants to ponds or directly to nearshore marine waters. Typically in the USVI, natural guts are steep channels, 3-12 feet wide, with a rocky substrate and little understory vegetation (Nemeth and Platenberg, 2007). Impacted guts often lack vegetated buffers, carry additional stormwater from roads and parking lots, and are prone to active bank erosion, headcuts, and scour. HW is unaware of standards for determining which guts are considered major/minor or those that are mapped/unmapped. HW's revised mapping includes over 17 miles of guts in the East End watersheds (5 miles more than existing gut maps show), but should not be considered all inclusive.

Table 2.4. Updated Isopluvials Indicating Increases in USVI Precipitation Frequencies for Recurrence Intervals of 24-hr Duration

Event	2002 USVI Environmental Handbook (source cited as USDA-SCS, 1986 with data provided by the US Weather Bureau)	2006 NOAA Atlas 14: US Precipitation Frequency Atlas Vol. 3: Puerto Rico and the USVI, Ver. 3 (average of 54 years of daily records through 2004)
1-yr, 24-hr		
2-yr, 24-hr		
5-yr, 24-hr		

Event	2002 USVI Environmental Handbook (source cited as USDA-SCS, 1986 with data provided by the US Weather Bureau)	2006 NOAA Atlas 14: US Precipitation Frequency Atlas Vol. 3: Puerto Rico and the USVI, Ver. 3 (average of 54 years of daily records through 2004)
10-yr, 24-hr		
25-yr, 24-hr		
100-yr, 24-hr		

Gardner et. al. (2008) reports that as late as 1914, guts on St. Croix were observed to flow year round; however, none are perennial now. Some of the guts on St. Croix exhibit intermittent flow during the wet season; however, most guts only flow during and immediately after heavy rain events or during extended periods of saturation. Gut pools can persist where natural springs are intercepted.

In the alluvial/coastal plain along the north and south coast of the East End watersheds are five salt ponds with fringing mangrove communities. Great Pond is the largest of these, followed by Southgate Pond, which is managed by SEA and is separated from Green Cay marina by an earthen embankment. There are two salt ponds in the Solitude watershed: Coakley Bay Pond and a smaller one to the west. Mt. Fancy Pond (or Robin Bay Pond) is the fourth largest, and is located in the Madam Carty watershed. In addition, there are approximately 38 small freshwater impoundments mapped in the East End watersheds, primarily associated with pasture land. In some cases, these farm ponds provide an important source of freshwater for livestock and have been targeted by residents, SEA, and NRCS as restoration priorities. The sediment retention capacity of salt ponds is a highly variable, but important, function often based on wetland fringe, watershed modification, slope, and other factors (Rennis et al., 2006). Smaller impoundments also provide for sediment retention, which is evidenced, if not well documented, by lost storage capacity and required dredging. Only a handful of stormwater detention basins were identified in the East End (e.g., Divi Carina and Reef Golf Course).

Groundwater

Freshwater on St. Croix comes from desalinization plants, rainwater harvesting, and to a limited extent, from groundwater aquifers. According to the 2000 census, over 45% of the island's residents rely on rainwater collection from rooftops and storage in cisterns as their primary, if not sole, source of water (VI RC&D, 2006 and Renken et al., 2002). The VI Water & Power Authority (WAPA) operates a desalination plant (3 million gallons per day with 40 million gallons storage capacity) located in Christiansted, as well as seven well fields in the central portion of the island, that supply freshwater to businesses and residences in the urban centers and supplements cistern use during the dry season. DPW also operates public wells to supplement desalinization operations. About 20% of the island's water supply comes from two principal groundwater aquifers: the Kingshill (predominately limestone) and the alluvial-valley aquifers, which are located on the western and central portions of the island (Figure 2.7). These groundwater supplies are considered relatively small and of poor quality due to high salinity content.

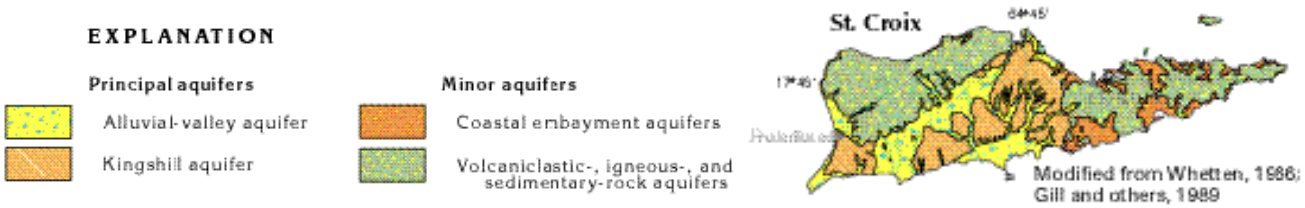


Figure 2.7. St. Croix aquifer map (USGS, 1999).

There are approximately 1078 permitted wells on St. Croix with an estimated total daily pump rate of 3.5 million gallon per day (gpd) (DPNR, 2010). From DPNR GIS mapping data, there appear to be over 60 wells (privately-owned) in the East End watersheds. The Seven Seas Water Company operates the largest private/commercial well estimated to pump about 60,000 gallons per day. According to DPNR (2010), the Wellhead Protection Plan is in the process of being developed; Table 2.5 summarizes wells in the East End that are considered priorities for investigation based on location, pump rate, and potential risks.

Table 2.5. Priority wells for WHPP Investigation (excerpt from DPNR, 2010, Tables IV.C.4-5)

Well Selection by	Property Owner
Daily Pumpage	• Seven Seas Water Corp—60,000 gpd, brackish water wells for RO • Grape Tree Shores, Inc—40,000 gpd • The Reef Association—20,000 gpd • Coakley Bay Condos and Townhouse—15,000 gpd and 12,000 gpd • Candle Reef II Association—6,000 gpd
Risk to Populace	• Southgate Gardens • Divi Carina Bay Resort

Wastewater

There is no central sanitary sewer system in the East End Watersheds. Most residences and commercial properties have individual, on-site septic systems, which are typically one-chamber systems. There are some small package treatment plants associated with resorts and condominiums, as well as some of the businesses (i.e., Divi Carina, Chenay Bay, Carden Beach, Cheeseburgers). Currently, there is not an inventory of septic systems, or an inspection and maintenance tracking system. More information on these small wastewater treatment systems in each watershed can be found in Sections 3-8 of this report.

Water Budget

Gardner (2004) attempted to establish a water budget for the Southgate watershed based on water level fluctuations in Southgate Pond. His study concluded that only 13% of the rain falling in the watershed reached the pond; 80-90% was lost to the soil absorption or by plant uptake; 7% arrived at the pond via surface runoff; and 1- 6% was recharged to groundwater or seeped as subsurface flow to the pond. This study did not account for well pumping. A previous study by Esham (2001), however, estimated that surface runoff accounted for over 50% of the water budget depending on soils. Additional research is needed on this topic before generalizations can be made about the water budget across the East End.

2.3 Natural Resources

There are a number of resource conservation areas associated with St. Croix's East End, including the STXEEMP, Buck Island Reef National Monument, the Green Cay National Wildlife Refuge, Southgate Preserve, and the Fairleigh Dickinson Territorial Park and adjacent property managed by TNC. Each has inventoried habitat types and associated biological communities

within their borders. A brief summary of marine resources within the STXEEMP is provided below, as well as information on terrestrial vegetation, a recent wetland/riparian inventory, and gut ecology, which will be important for watershed restoration project design. We refer the reader to existing inventories by the SEA, TNC, University of the Virgin Islands, US National Park Service, DPNR, and others for more detailed documentation of the island's natural resources, particularly the ecology of salt ponds and mangroves. Recommended resources include:

- East End Marine Park (www.stxeastendmarinepark.org)
- UVI Division of Fish and Wildlife (www.vifishandwildlife.com)
- St. Croix Environmental Association (www.stxenvironmental.org)
- UVI Conservation Data Center (www.uvi.edu/sites/uvi/Pages/ECC-Conservation_Data_Center.aspx?s=CS)
- Island Resources Foundation (www.irf.com)
- USVI Resource Conservation & Development Council (VIRC&D) (www.usvircd.org)

East End Marine Park

The STXEEMP is over 60 square miles and contains a variety of important habitat types including linear and patch coral reefs, sea grass beds, and mangroves. The STXEEMP is divided into a number of use zones intended to protect essential habitats for a variety of species, allow for sustainable fishing practices, and support recreational, tourism, and academic interests (Figure 2.8). An estimated 400 species of fish live in and around the East End (TNC, 2008). The coastal waters of St. Croix are ideal for coral formation because of the warm water temperatures, relative low nutrient concentration, and high water clarity (DPNR, 2002). As such, barrier reef surrounds much of the island, with fringing reef along the narrow coastal shelf surrounding most of the shoreline. There is also an extensive network of seagrass beds, which are recognized as important for breeding and nesting habitat, nutrient attenuation and water clarity. Sea grass communities (primarily turtle grass) in the STXEEMP are among the most productive in the world, and are prime habitat for fish and other marine animals.

St. Croix reefs, like those in other parts of the Caribbean, are dominated by elkhorn and staghorn corals, and various species of brain, lettuce, finger, star and starlet corals. Since the early 1980s, scientists have documented a rapid decline of these hard coral populations, attributed primarily to successive bleaching events from temperature changes, water quality issues, and disease, as well as structural damage from hurricanes. Increased algal growth and reductions in algae-eating fish can inhibit coral recovery. Both seagrass beds and coral reefs rely on high light levels (low turbidity), low nutrients, and low sediment conditions.

The easternmost beaches on the south shore of the East End Watersheds are critical nesting grounds for three species of endangered sea turtles—the Green, Hawksbill and Leatherback—and provide for nesting seabird habitat. There are approximately 17 species of nesting seabirds that rely on the STXEEMP for food and shelter. These seasonal and year-round residents include shearwaters, tropicbirds, boobies, pelicans, frigate birds, gulls and terns (TNC, 2008).

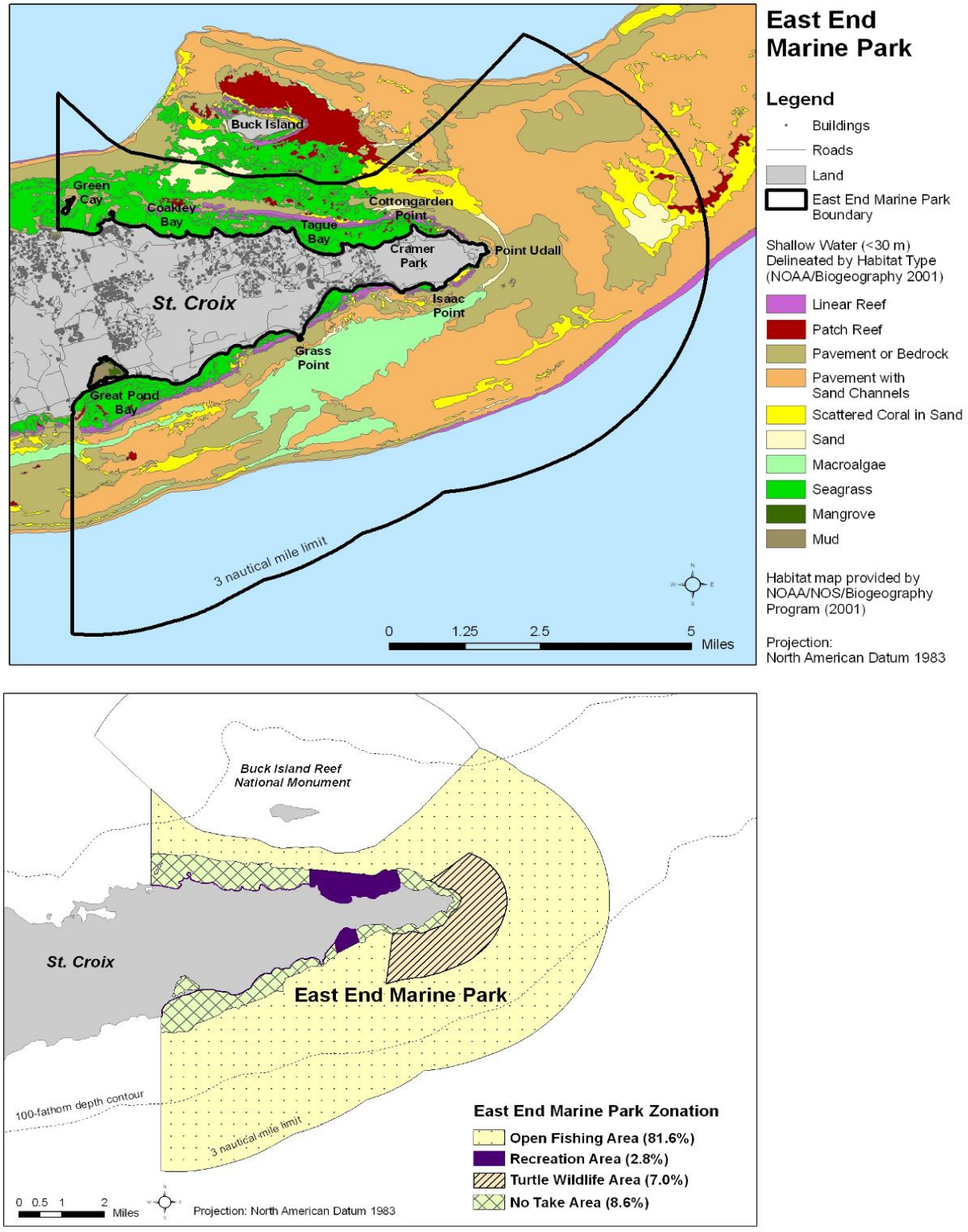


Figure 2.8. Mapped marine habitats surrounding the East End and STXEEMP Park Zonations (taken from the STXEEMP website).

Terrestrial Vegetative Communities

The terrestrial environment of St. Croix was drastically changed by the introduction of exotic plants and animals by the Arawaks, Carib Indians, and European plantation owners, as well as by the clearing of native vegetation for the cultivation of sugarcane and other crops. The East End is now dominated by xeric, or tropical dry forests, thorn woodlands, shrubland, and herbaceous savannahs (Figure 2.9). Vegetation along the coastline is characterized by coastal scrub and low matted areas, with occasional cactuses such as prickly-pear, pipe-organ, Turk's cap, and century plants. Some of the common short trees found on the East End include the manjack, frangipani, manchineel, sea grapes, calabash, and tamarind as well as the highly invasive tan-tan, casha, and acacia. In the USVI, open grass lands are indicative of an early stage of plant succession after land disturbance. Guinea grass is the dominant species in these settings.

Native, drought-tolerant species may be necessary for restoration activities requiring landscaping and erosion control, particularly in areas where access to irrigation is limited. NRCS staff recommend some of the following species for projects on the East End, particulary since they can be found at local nurseries and/or can be easily propogated: column cactus (*Pilosocereus royenii*), century plant (*Agave eggersiana*), barrel cactus (*Melocactus intortus*), torchwood (*Jacquinea arborea*), spider lily (*Hymenocalis caribea*), purple sage (*Lantana involucrata*), and possibly turpentine tree (*Bursera simaruba*). Note that *Agave eggersiana* was has been nominated in 2010 for Endangered Species Act protection. Bermuda grass, rye, and vetiver were recommended for initial erosion control; the native grasses (hurricane, salt grass, sporobolus, etc.) will then eventually take over.

Wetlands

In 2004, DPNR, the Island Resources Foundation (IRF), and the University of the Virgin Islands (UVI) completed a mapping inventory and limited assessment of watershed/wetland ecosystems in 18 priority watersheds throughout the territory. Mapping data can be downloaded from UVI's Conservation Data Center website listed previously. Table 2.6 summarizes wetland/riparian characteristics for each of the East End watersheds. Madam Carty (reference watershed) and Great Pond (intermediately impacted watershed) were included in the 2004 inventory, and used to help develop the USVI Wetlands Conservation Plan (2006). The remaining watersheds are currently being assessed, and will incorporate data related to TMDL development and other water quality concerns.

Figure 2.10 shows the extent of wetland and 100-yr floodplain boundaries, as well as the location of permitted wells based on mapping provided by DPNR. Floodplain boundaries shown here are for informational purposes only. Southgate and Great Pond watersheds have 1/3 to 1/2 of their total drainage area within the 100-yr elevation, respectively, which is particularly important given the potential for new development within this zone. The VI Territorial Emergency Management Agency (VITEMA) is currently undergoing revisions to flood hazards planning.

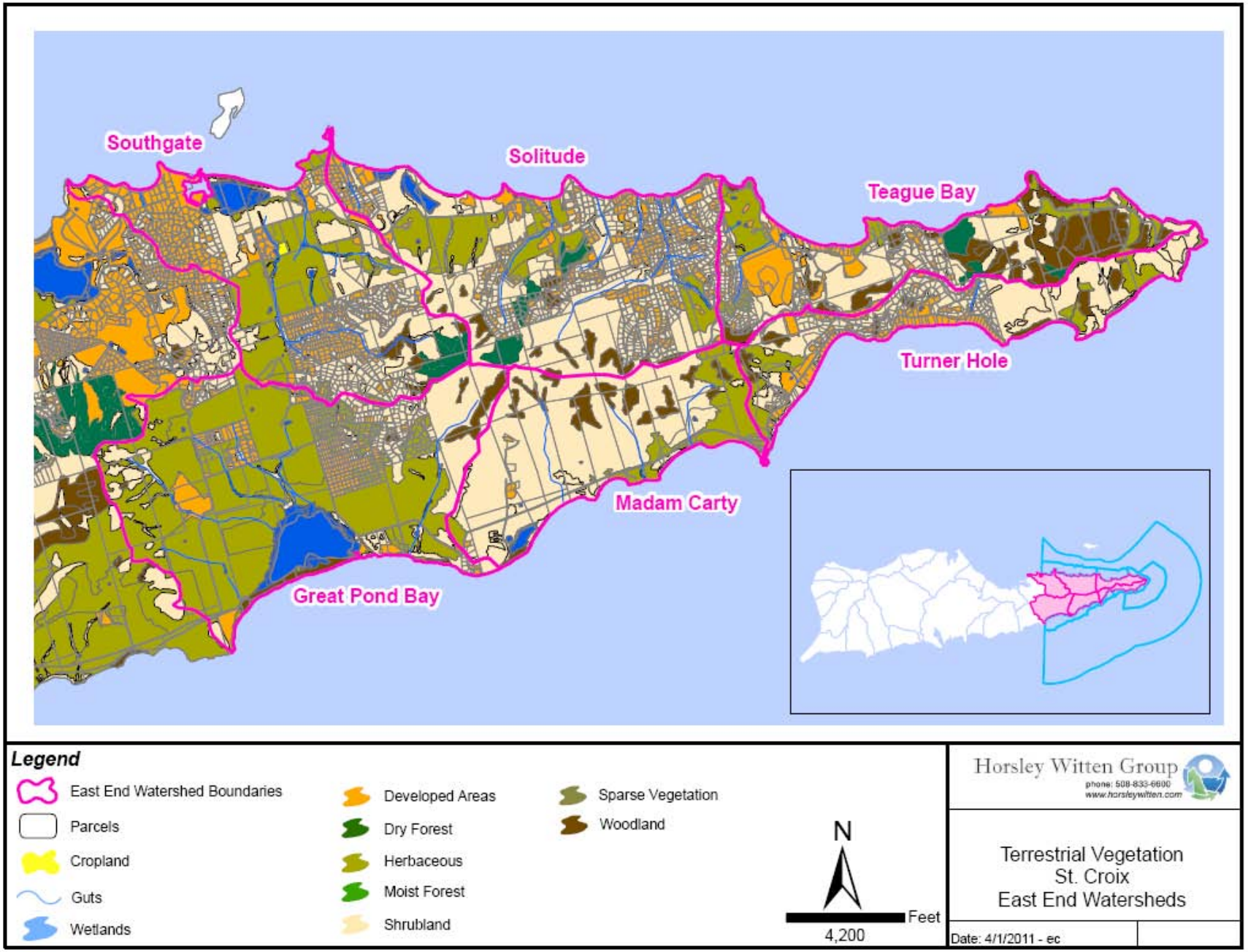


Figure 2.9. Terrestrial Vegetation Communities (based on DPNR vegetation mapping received in 2010).

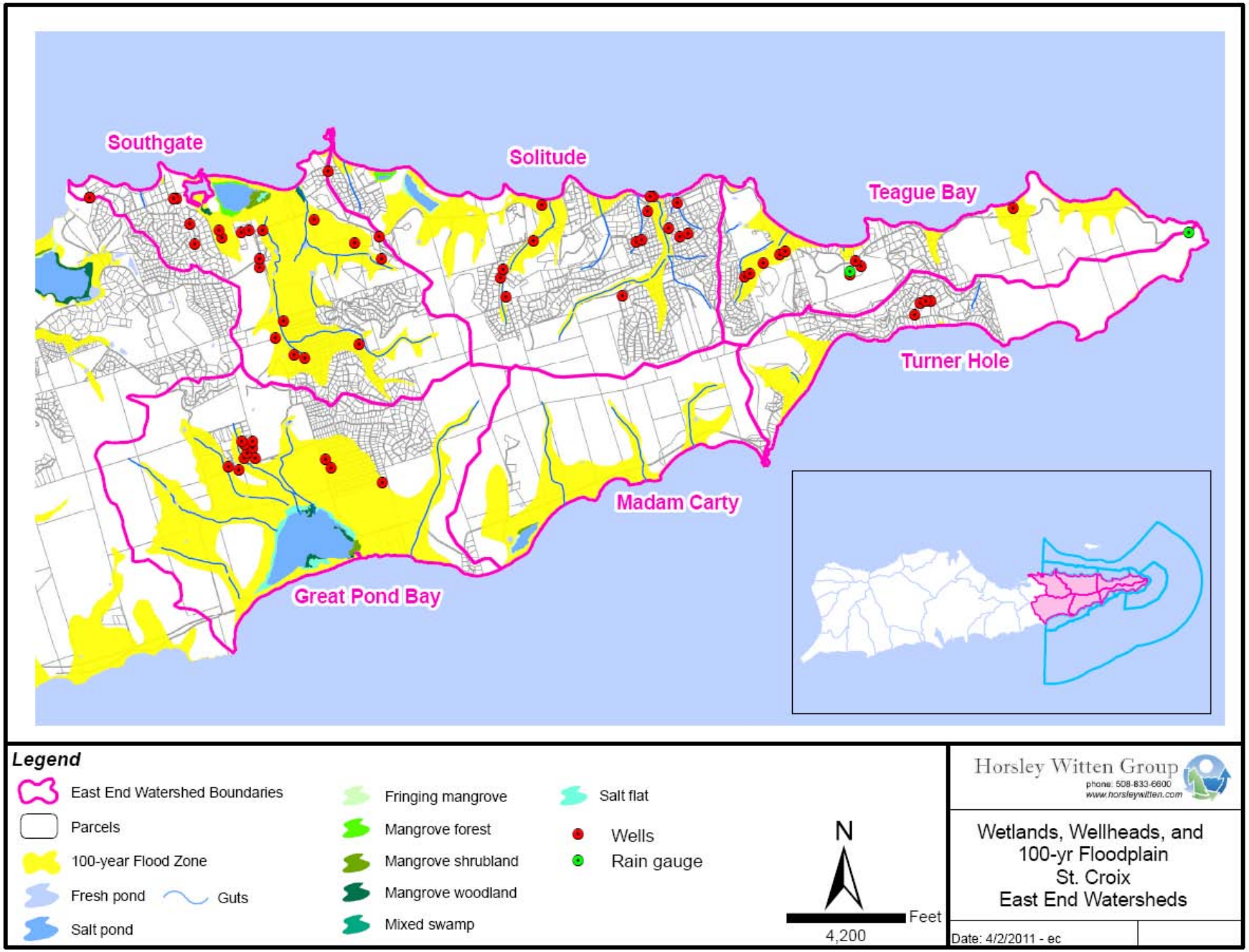


Figure 2.10. Wetlands, Wells, and 100-yr Floodplain boundary (based on DPNR mapping received in 2010 and 2011).

Table 2.6. Wetland Type, Riparian Communities, and 100-yr Floodplain Areas

Category		Great Pond	Madam Carty	Solitude	Southgate	Teague	Turner
Wetland Acres[1]	Fresh pond	3.8	1.59	2.49	3.8	1.29	0.83
	Fringing mangrove		1.27	3.72	2.2		
	Mangrove forest			4.18	6.5		
	Mangrove shrubland	2.7	1.37		6.1		
	Mangrove woodland	8.7			3.5		
	Salt flat	21.8		0.62	1.1		
	Salt pond	98.9	8.30	13.17	23.5		
	Total	135.90	12.54	24.18	46.75	1.29	0.83
	% of Total Watershed	***6.8%***	***1.2%***	***1.5%***	***3.3%***	***0.1%***	***0.1%***
Riparian Acres[1]	Gallery semi-dec. forest	0.00	0	0	23.0	4.20	0.00
	Gallery Semi-dec. woodland	4.0	20.50	8.90	30.9	25.5	3.4
	Gallery shrubland	56.2	0.40	17.60	46.5	1.6	7.8
	Semi-dec. woodland	28.2	3.90	42.60	40.5	111.7	23
	Total riparian	88.40	24.80	69.10	140.90	143.00	34.20
Gut Miles[2]							
100-yr Floodplain[3]	Acres	890.7	280.2	302.8	545.6	164.5	79.9
	% of Total Watershed	***45%***	***27%***	***18%***	***39%***	***16%***	***11%***

[1] UVI Conservation Data Center, 2005
[2] HW revised gut mapping based on 2010 field assessments
[3] DPNR mapping received in 2010

Guts

Gardner et al. (2008) provides a detailed accounting of the state of the knowledge on guts in the USVI. They report that guts are viewed primarily by residents as stormwater conveyances, dumping locations, and as threats to infrastructure and property in areas of active gut erosion. The St. Croix Hiking Association reportedly uses guts on St. Croix for hiking, though primarily on the west side of the island. Little is known about the biological communities associated with these systems, though the following characterizations are made:

- Guts form the most extensive network of freshwater habitat in the USVI and are critical for several species of fish and shrimp requiring both fresh and marine water;
- Guts provide nesting area, foraging habitat, and migration corridors for birds, bats, and other wildlife, and permanent pools are a significant habitat component; and
- Guts provide habitat for a number of known rare and endangered fauna and flora (e.g., Egger's Cock's-spur).

Nemeth and Platenberg (2007) conducted a comparative study of freshwater shrimp and fish diversity and water quality in gut pools of three guts in St. Thomas with various levels of upstream development. They concluded that the most highly developed gut had higher nutrient loading (particularly downstream of residential sewage discharges), fewer fish and shrimp species, and more non-native species (Figure 2.11). The study specifically linked algal growth and sedimentation with declining pool habitat quality in urbanized guts. While the study was limited in scope and results reportedly could have been influenced by physical and hydrological factors downstream, these results are consistent with similar stream research in other parts of the US.

Figure 2.11. Native species found in the guts of St. Thomas include the Atya shrimp (potentially an indicator species for gut quality, the Shirajo goby, and the Mountain mullet (taken from Nemeth and Platenberg, 2007)

It is not clear if any species inventories or on-the-ground habitat assessments have been conducted in guts on the East End of St. Croix. All of the priority guts on St. Croix identified by Gardner (2008) in the proposed gut management strategy for the USVI are on the west end of the island. Regardless, proposed gut stabilization projects should be cognizant of potential habitat protection and restoration opportunities, and should carefully consider riparian and in-stream vegetation maintenance recommendations. DPNR (2010) reported that a contract was awarded to TetraTech, Inc. in 2009-2010 to develop land use coefficients for TMDL data development and gut characterization in priority bays and watersheds in the USVI.

2.4 Land Use and Infrastructure

The majority of the East End of St. Croix is sparsely developed, and consists primarily of agricultural/pasture land; single-family, low density residential; and undeveloped lands (Table 2.7 and Figure 2.12). There are more densely developed areas along the northern shoreline consisting of resorts and condos. Half or more of the land use in all watersheds (except for Teague Bay) is classified as undeveloped; Madam Carty is almost entirely undeveloped. Future zoning maps indicate a number of areas that have been “upzoned” to higher density districts to accommodate future resort and single family residential development (Figure 2.13), primarily in the Great Pond, Madam Carty, and Southgate watersheds.

Roads, roof tops, parking lots, and compacted soils associated with urbanization can result in less infiltration of stormwater runoff into the ground and more surface runoff. This surface runoff can erode conveyances (i.e., guts, roadways), damage infrastructure, and result in increased flood peaks and frequencies. Runoff can convey pollutants to downstream

waterbodies, causing fluctuations in salinity and pond water levels, as well as increased water temperatures. Impervious cover estimates for each watershed are estimated at 10% or less across the East End (see previous Table 2.1). In general, it is estimated that watersheds with 10% or greater imperviousness have observable impacts to water quality, aquatic biota, channel morphology, and hydrologic functions; though more work in tropical systems is needed to verify this threshold.

In the USVI, most of the rooftops do not contribute to stormwater runoff and there is little piped stormdrain network. In some cases, impervious cover may be disconnected (e.g., draining to pervious areas where infiltration and plant uptake can occur rather than direct discharge to a waterbody); however, most roads (paved and unpaved) serve as the informal conveyance network, resulting in direct discharge to guts, ponds, and coastal waters from roadside ditches. Figure 2.14 shows the existing road infrastructure. Very few structural management practices designed to provide storage, increased recharge, or water quality treatment exist in the East End. More detail on the potential sources of LBSP and stormwater issues can be found in Sections 3-8 of this report.

Table 2.7. Land Use Statistics for the East End Watersheds (from 2003 UVI/DPNR mapping data)

Land Use		Acres/% watershed						
		Great Pond Bay	**Madam Carty**	**Solitude Bay**	**Southgate**	**Teague Bay**	**Turner Hole**	**Total East End**
Agriculture		580	0	290	336	66	0	1,272
		29%	*0*	*18%*	*24%*	*6%*	*0*	***16%***
Parks/Rec/ Open Space		19	0	0	7	343	72	422
		1%	*0*	*0*	*0*	*34%*	*10%*	*5%*
Public Facilities		8	0	0	0	9	0	16
		<1%	*0*	*0*	*0*	*1%*	*0*	*<1%*
Residential	Low	186	5	467	302	126	119	1203
		9%	*<1%*	*29%*	*22%*	*12%*	*17%*	***15%***
	Med	0	0	17	0	9	22	31
		0	*0*	*1%*	*0*	*1%*	*3%*	*<1%*
	High	0	0	8	18	10	0	36
		0	*0*	*1%*	*1%*	*1%*	*0*	*<1%*
Hotel/ Resort		0	0	28	10	0	25	25
		0	*0*	*2%*	*1%*	*0*	*4%*	*<1%*
Marina/ Waterfront		0	0	0	0	8	0	8
		0	*0*	0	0	*1%*	*0*	*<1%*
Undeveloped		1104	1032	826	696	446	458	4561
		55%	*>99%*	*50%*	*50%*	*44%*	*66%*	***59%***
Water		101	0	0	23	0	0	23
		5%	*0*	*0*	*2%*	*0*	*0*	*<1%*
Total Watershed		**1,996**	**1,037**	**1,635**	**1,392**	**1,017**	**696**	**7,772**

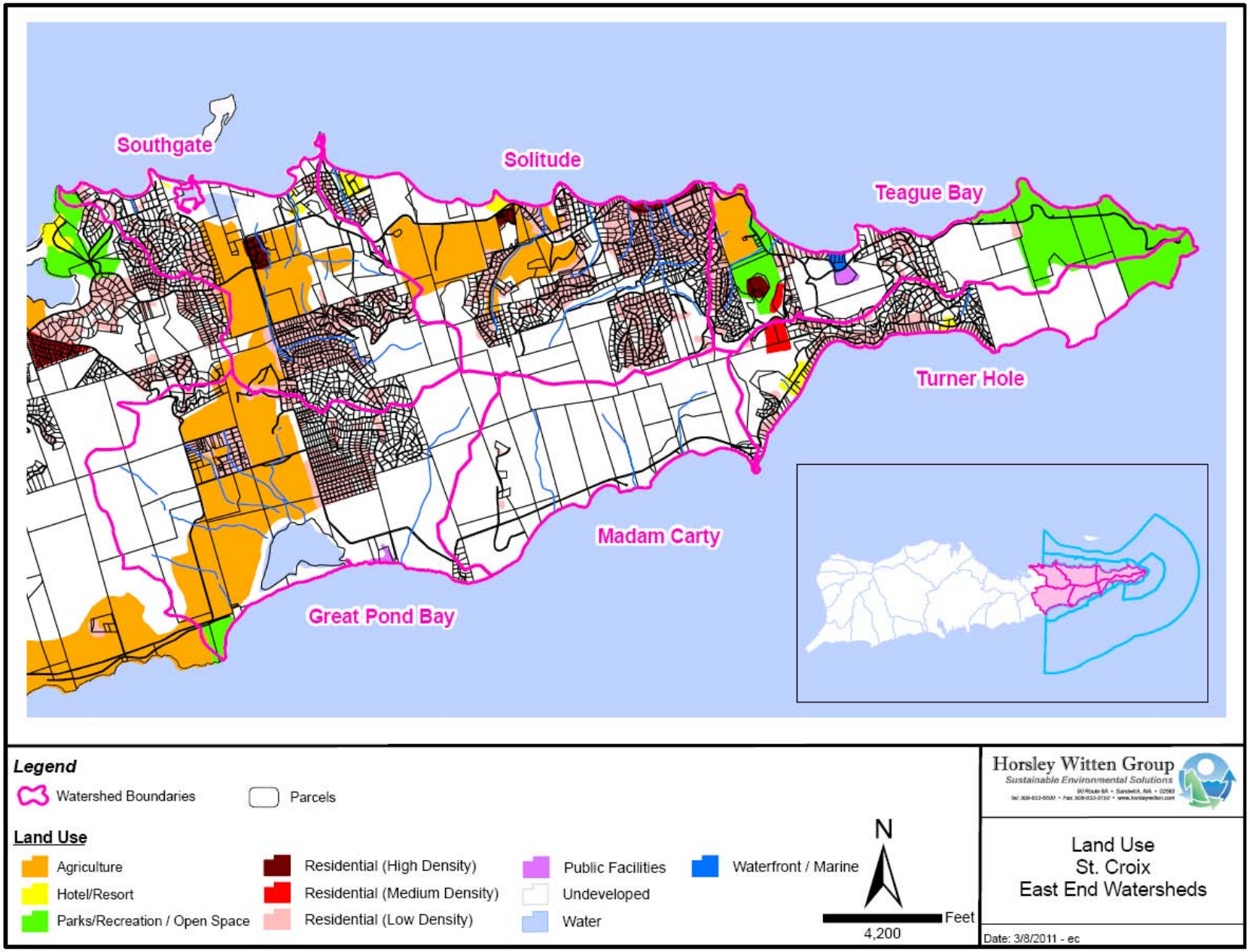


Figure 2.12. Current Land Use Map for the East End Watersheds (data received from DPNR in 2010, source UVI, 2003)

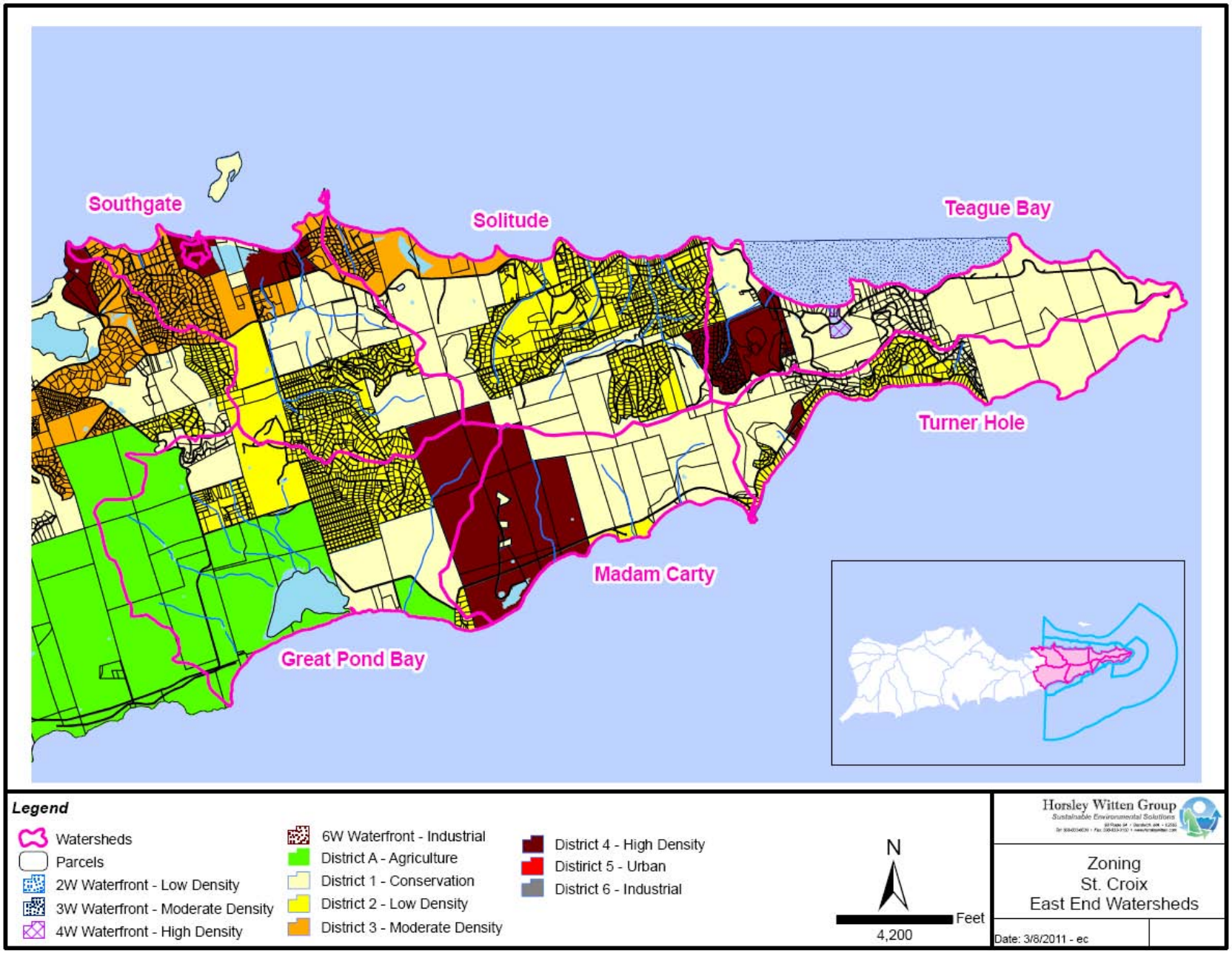


Figure 2.13. Future Zoning Map for the East End Watersheds (data received from DPNR in 2010)

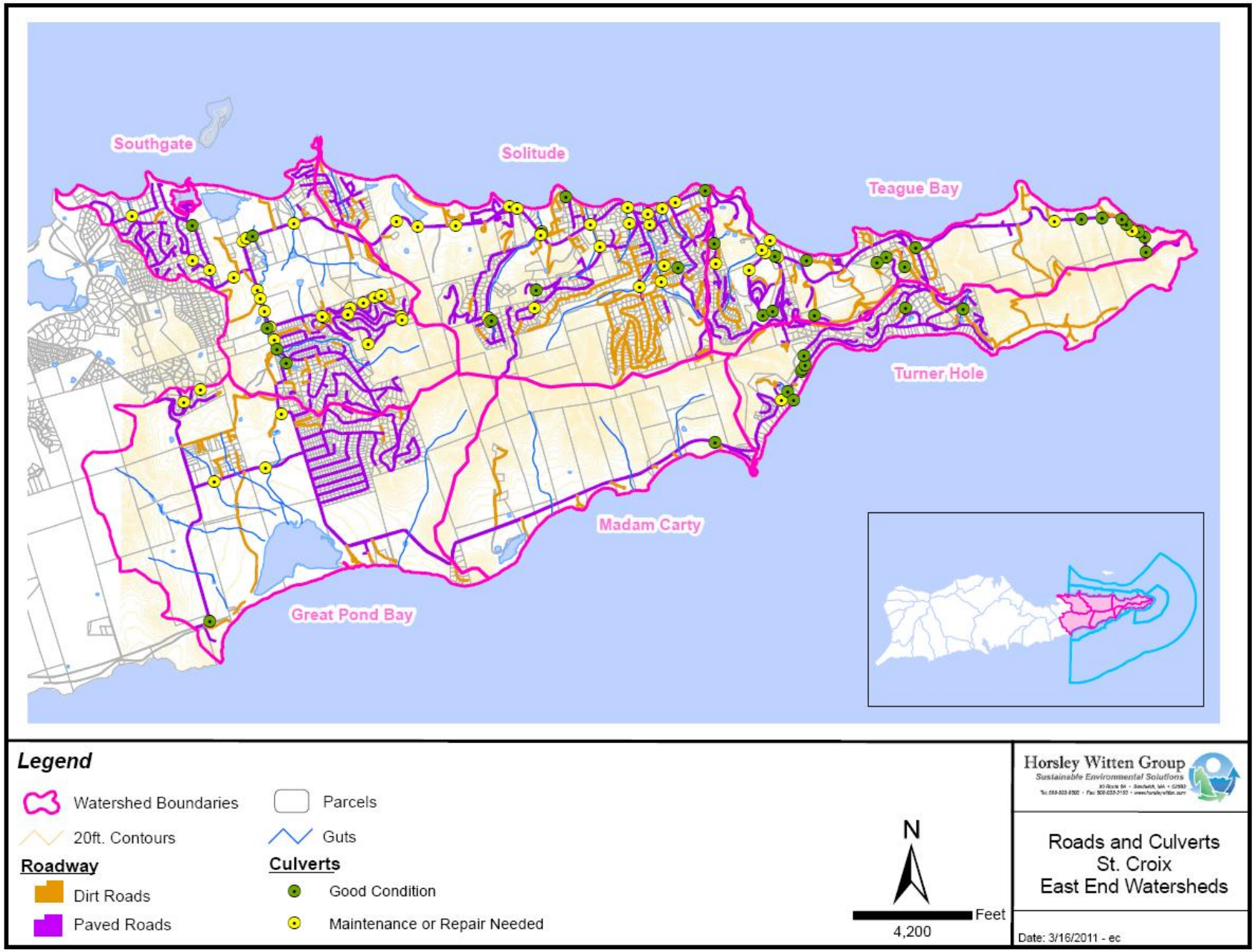


Figure 2.14. Paved and Unpaved Roads and Culvert Locations (data created by HW based on field assessments in 2011)

2.5 Water Quality

DPNR's Water Pollution Control Program (WPC) is responsible for implementing and enforcing Territorial water quality standards and pollution control laws under the Clean Water Act (CWA). The WPC administers two water quality monitoring programs—Ambient and Beach Monitoring—that evaluate a variety of water quality parameters. Data collected in these programs is used to:

- Protect public health and improve notification of beach closures;
- Help determine effluent permit limits;
- Develop various water body impairment listings;
- Re-designate waterbody uses; and
- Develop new water quality standards.

Water Quality Standards

Water quality standards differ depending on the Class of waters being evaluated; all waters surrounding the East End are considered Class A and B waters. Class A waters are outstanding natural resource waters, and existing natural conditions must be maintained. These are the most stringent of the standards. Standards for Class B waters are: (1) designated for the maintenance and propagation of desirable species of aquatic life and primary contact recreation; (2) where virtually all native taxa are maintained with some changes in biomass and/or abundance; and (3) where ecosystem functions are fully maintained within range of natural variability. Table 2.8 summarizes water quality standards applicable to the East End; however, the territorial water quality standards are currently being updated (Nibbs, 2011).

Impairments

There are 19 ambient monitoring assessment units in the East End, and 4 active beach monitoring stations. Of the assessment units, 8 are currently designated as impaired (DPNR, 2010). Table 2.9 summarizes impairment status, water quality parameters of concern, potential sources, and date for establishment of Total Maximum Daily Loads (TMDLs). TMDLs are a modeling/planning effort used to establish how much of a pollutant can be discharged to a waterbody on a daily basis while still meeting water quality standards. TMDLs are scheduled for development in 2011 for three units associated with the Southgate watershed. Figure 2.15 shows the locations of monitoring stations and assessment units.

Additional Monitoring Efforts

There are a number of previous and active sediment and nutrient monitoring studies being conducted in the East End:

- Terrestrial sediment monitoring is being conducted in Turner Hole by UVI and Island Resource Foundation (IRF). A total of 16 sediment traps between 2009 and 2010 were installed at East End Bay. Eight traps collect sediment from undisturbed and moderately-to-well vegetated hill slopes, while four collect sediment from undisturbed but poorly vegetated surfaces in proximity to cliffs on the northern end of East End Bay.

The remaining four collect sediment from the eroded north trail (Ramos-Scharron, 2010). Data from this study are not yet available.

- Brooks et al. (2010) evaluated sediment accumulation rates in a number of bays and wetlands throughout the territory, including Southgate. Anthropogenic impacts revealed increased accumulation rates that were 4-7 times higher than natural rates; however, those anthropogenic traces were more muted in St. Croix than in the other islands.
- Sediment retention in salt ponds was evaluated by Rennis et al. (2006). The study evaluated how pond morphology and watershed characteristics for a number of salt ponds around the territory including Southgate Pond influenced sedimentation.
- A 2003-2005 DPNR nutrient concentration study included six stations in the STXEEMP. Seventy-three percent of nitrogen samples and 52.5% of phosphorus samples were below the selected detection limits. One of the highest observed phosphate concentrations occurred at Great Pond. While no correlations between percent watershed development and nitrogen concentrations was observed, spatial analyses across stations indicated lower nutrient concentrations in coral reef and colonized hard bottom habitats than in open embayments. Overall, threshold concentrations of nitrogen only occurred in 3.6% of samples, while phosphorus thresholds were exceeded in 47.5% of samples.

Table 2.8. Current Water Quality Standards Applicable to the East End (Source: DPNR, 2010)

Water Quality Parameter	Standards	
	Class B	Class A
Dissolved Oxygen	≥ 5.5 mg/L	Existing natural conditions shall not be changed. The biological condition shall be similar or equivalent to reference condition for biological integrity. In no case shall Class B water quality standards be exceeded.
pH	Between 7.0 - 8.3	
Temperature	< 32°C; discharges not to be >1°C above natural	
Bacteria	≤ geometric (log) mean of 70 fecal coliforms/100 ml by MF or MPN count; ≤ 35 enterococci/ 100 ml, not to exceed a single sample max. 104/100 ml.	
Phosphorus	≤ 50 µg/l	
Chlorine	4-day average ≤ 7.5 µg/l; 1-hr. average ≤ 13 µg/l	
Suspended, colloidal, or settleable solids	None from waste water, which would cause deposition or be otherwise deleterious.	
Oil or floating substances	No residue attributable to wastewater. No visible film; no globules of grease	
Radioactivity	**Gross beta:** 1000 picocuries/l, in absence of Sr 90 and alpha emitters; **Radium-226:** 3 picocuries/l; **Strontium-90:** 10 picocuries/l	
Taste and odor producing substances	No interference with primary contact recreation, potability; or undesirable taste or odor for edible aquatic life	
Color and turbidity	Secchi disc depth ≥ 1 m; maximum nephelometric turbidity unit reading of 3 (Except Class B waters listed in Section 186-11(b)(1). For waters where the depth does not exceed 1 m, the bottom must be visible.	

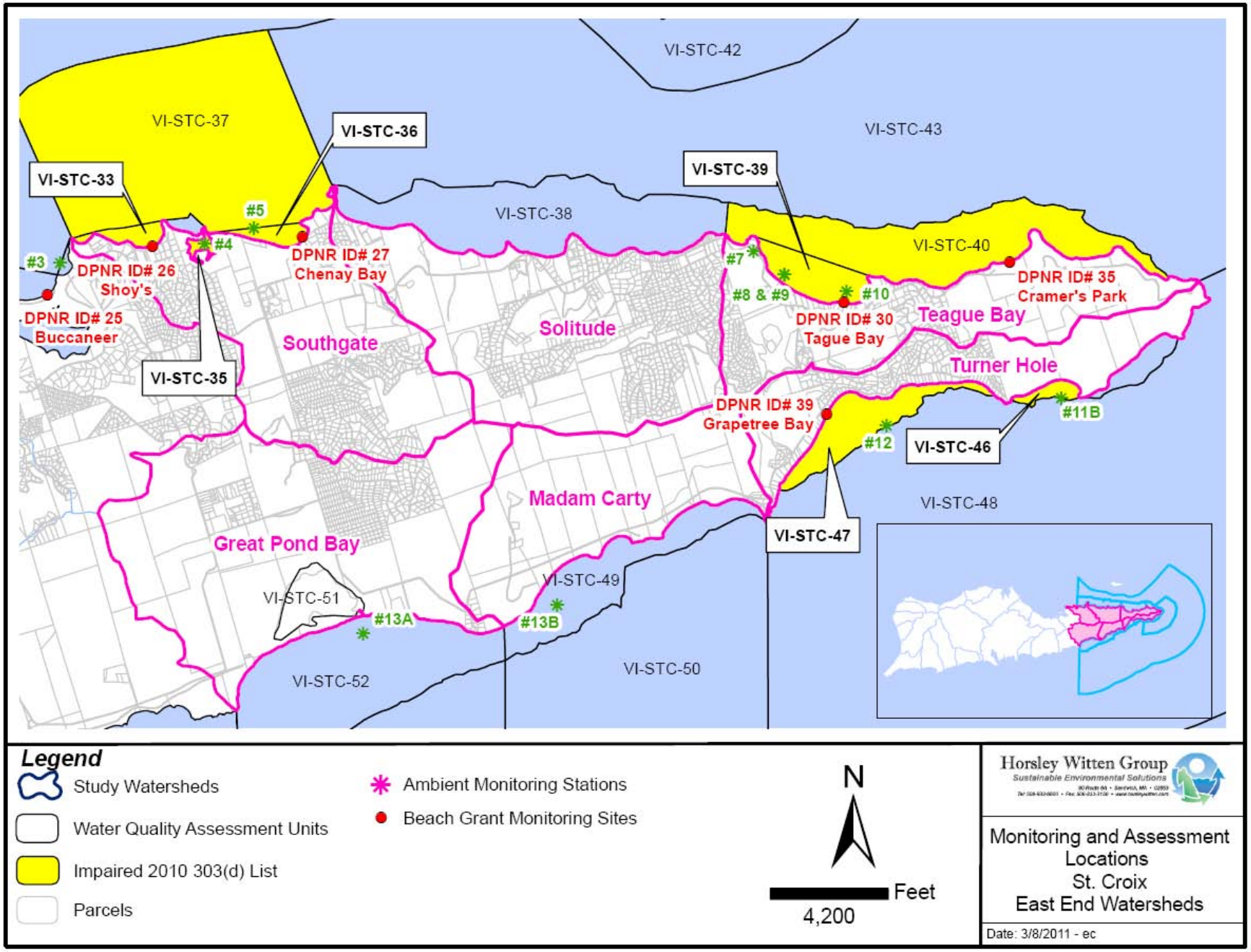


Figure 2.15. Beach Monitoring, Ambient Assessment Units, and Impaired Waters (data received from DPNR, 2010)

Table 2.9. Summary of Impaired Assessment Units

Assessment Unit ID/Name (Monitoring Station)	Impairment	Source of Impairment	TMDL *(Priority/Date)*
VI-STC-33 Punnett Bay; (VI610321 Shoy's)	Turbidity	Land Development, Erosion and Sedimentation	Low/2025
VI-STC-35 Tamarind Reef Lagoon/Southgate Lagoon (STC-4 Tamarind Reef Lagoon)	Dissolved Oxygen, Fecal Coliform, Secchi Depth, Turbidity		High/2011
VI-STC-36 Green Cay Beach; (VI563397 Chenay Bay Beach)	Turbidity	Package Plants (Small Flows), Erosion and Sedimentation	High/2011
VI-STC-37 / Southgate subwatershed, offshore (STC-5 Green Cay Beach)	Dissolved Oxygen, Fecal Coliform, Enterococci, Turbidity	Marina Boat Maintenance, Marina/Boating Sanitary On-vessel Discharges, Non-Point Source Discharges	High/2011
VI-STC-39 / Teague Bay (STC-8 Reef Club Beach; STC-9 St. Croix Yacht Club Beach; VI11381319 Teague Bay/Reef)	Dissolved Oxygen, Turbidity, pH, Fecal Coliform	Highway/Road/Bridge Runoff (Non-construction Related)	Low/2027
VI-STC-40 / Teague Bay Backreef (STC-10 Cramers Park; VI351774 Cramers Park)	Turbidity, pH, Fecal Coliform	Highways, Roads, Bridges, Infrastructure (New Construction), Marina/Boating Sanitary On-vessel Discharges	Low/2027
VI-STC-46 / Grapetree Bay; (STC-11B Isaacs Bay Forereef)	Dissolved Oxygen	Erosion and Sedimentation	Low/2029
VI-STC-47 / Turner Hole Backreef (STC-12 Grapetree Beach; VI297470 Grapetree Beach)	Turbidity	Erosion and Sedimentation	Low/2029
Assessment units not listed as impaired: • VI-STC-34 Punnett Point, East • VI-STC-38 / Solitude Backreef • VI-STC-43/Solitude & Teague Bay subwatersheds, offshore • VI-STC-44/Northeast STX HUC14, offshore; (STC-OFF8 North-3) • VI-STC-45 / Isaac Bay (STC-OFF5 East-2) • VI-STC-48 / Turner Hole subwatershed, offshore • VI-STC-49 / Madam Carty Backreef (STC-13B Robin Bay) • VI-STC-50 / Madam Carty, offshore • VI-STC-51 / Great Pond • VI-STC-52/Great Pond Bay; (STC-13A Great Pond Bay) • VI-STC-53 / Great Pond Bay subwatershed, offshore (STC-OFF13 SE-4)			

2.5 Existing Management Framework

This section summarizes some of the Territorial regulations and programs governing development in the East End and across St. Croix. This review is limited to regulatory programs that watershed stakeholders mentioned as needing to be addressed within the context of the East End watershed planning effort including: zoning and subdivisions regulations, tiered coastal zone system, comprehensive planning, stormwater and culvert design standards, earth change permitting, and septic regulations. Other water resource management programs, such as floodplains, wellhead protection, and endangered species protection are not addressed here. A summary of existing management plans and key implementation stakeholders is also included.

Zoning and Subdivision Regulations (V.I. Code Title 29, Chapter 3) *and "Subdivider's Handbook"*

The most important tools that local governments have to implement long-range land use plans and policies are the zoning and subdivision regulations. Both are currently undergoing a major overhaul by DPNR, with support from Rutger's University and others, primarily due to widespread agency acknowledgement that the application and enforcement of existing zoning and subdivision law was inconsistent (CGS et al., 2009). Subdivision regulations govern the division of land into two or more lots, parcels, or sites for the purposes of development. They are meant to ensure that improvements be constructed and public infrastructure needs be built to be easily and economically maintained. Through the review of the development, the local government can verify that proposed water supply, sewage treatment collection and disposal systems, and stormwater drainage facilities are compliant with applicable health and environmental standards.

The uses allowed within the zoning code for the East End of St. Croix are very broad, and a general lack of design and performance standards makes it difficult to enforce. Today, much of the guidance on subdivision regulation in the USVI is in the Subdivider's Handbook, a guidance document published in 1985, rather than in enforceable code. It is our understanding that this document has not been adopted as a rule or regulation. There are also some discrepancies between the Subdivision regulations and the Subdivision Handbook, and it is difficult to tell whether the Handbook's standards are mandatory, since the language within the Subdivider's Handbook often suggests a standard is "recommended."

One standard that was brought up several times during the HW field assessment, and associated stakeholder meetings in January 2011, was that developers were required to construct paved roads when developing a subdivision. Some stakeholders referenced this as a requirement, while others stated that it was something that developers were "supposed to do"; all agreed that it was not always conducted as practice. Many of these standards can be waived by the Commissioner if a "hardship" is proven by the applicant.

Coastal Zone

During the assessment of the existing Zoning and Subdivision Code Assessment, stakeholders expressed a "general sentiment that the Coastal Zone Management laws are the closest the

USVI has to a current development policy" (CSG, 2009). Oversight of the land development process in the USVI has been divided into two coastal geographic tiers (Figure 2.16). Tier I is comprised of a relatively narrow strip along the coast, excluding all federal land, and all off-shore islands and cays and is within the jurisdiction of the Coastal Zone Management Program. Remaining areas are Tier II and under the jurisdiction of the Division of Environmental Protection. Tier I has Major and Minor projects types which have different requirements and permitting procedures. Minor projects include smaller developments, such as single family dwellings or small piers that have a less significant effect on the coastal environment and the community. Major projects, such as large resort hotels or multifamily dwellings, docks, and dredging, all require an extensive application form, an Environmental Assessment Report (EAR), public notices/hearings and a decision by the appropriate committee of the CZM Commission (a citizen board appointed by the Governor and confirmed by the Legislature). The Commissioner may require that a minor permit be considered as a major permit if significant adverse environmental consequences are anticipated.

Comprehensive Land and Water Use Plan (CLWUP) and Virgin Islands Development Law (proposed for V.I. Code Title 29, Chapter 3)

The CLWUP has proposed to incorporate territorial-wide land and water use guidelines developed by the VI DPNR into the Virgin Islands Code since the 1980's. As DPNR states on their website, "the lack of land and water use planning and/or insufficient planning can result in inappropriate development, land use conflicts, contamination of surface and ground water, erosion, increased flooding, gut and drainage fillings, uncontrolled and excessive exploitation of natural resources, destruction of plant and animal habitats, declines in productivity of the marine environment, pollution, etc." The CLWUP, along with a new Virgin Islands Development Law were last updated in 2003. Neither the plan nor the accompanying Development Law has been formally adopted by the Legislature.

Virgin Islands Territorial Pollutant Discharge Elimination System (TPDES) *Rules and Regulations* (V.I. Code Title 12, Chapter 7 §184)

The DPNR/DEP has oversight of all dischargers into the waters of the USVI through the TPDES permit program, which oversees stormwater management, monitors discharges, and enforces regulations controlling discharges from specific sites, or point sources, including industrial, commercial and some residential sites. US EPA recently approved updates to the TPDES program. Currently, there are no stormwater design or management standards required for new development or redevelopment projects in the USVI. The 2002 Environmental Protection Handbook provides some recommended guidance for site design and stormwater BMPs, but this manual is not mandatory and should be revised to reflect updated rainfall frequencies, modern standards, and island-adapted approaches. Lack of stormwater requirements and clear design guidance is a critical gap in the USVI's capacity to protect natural resources from the impacts of development.

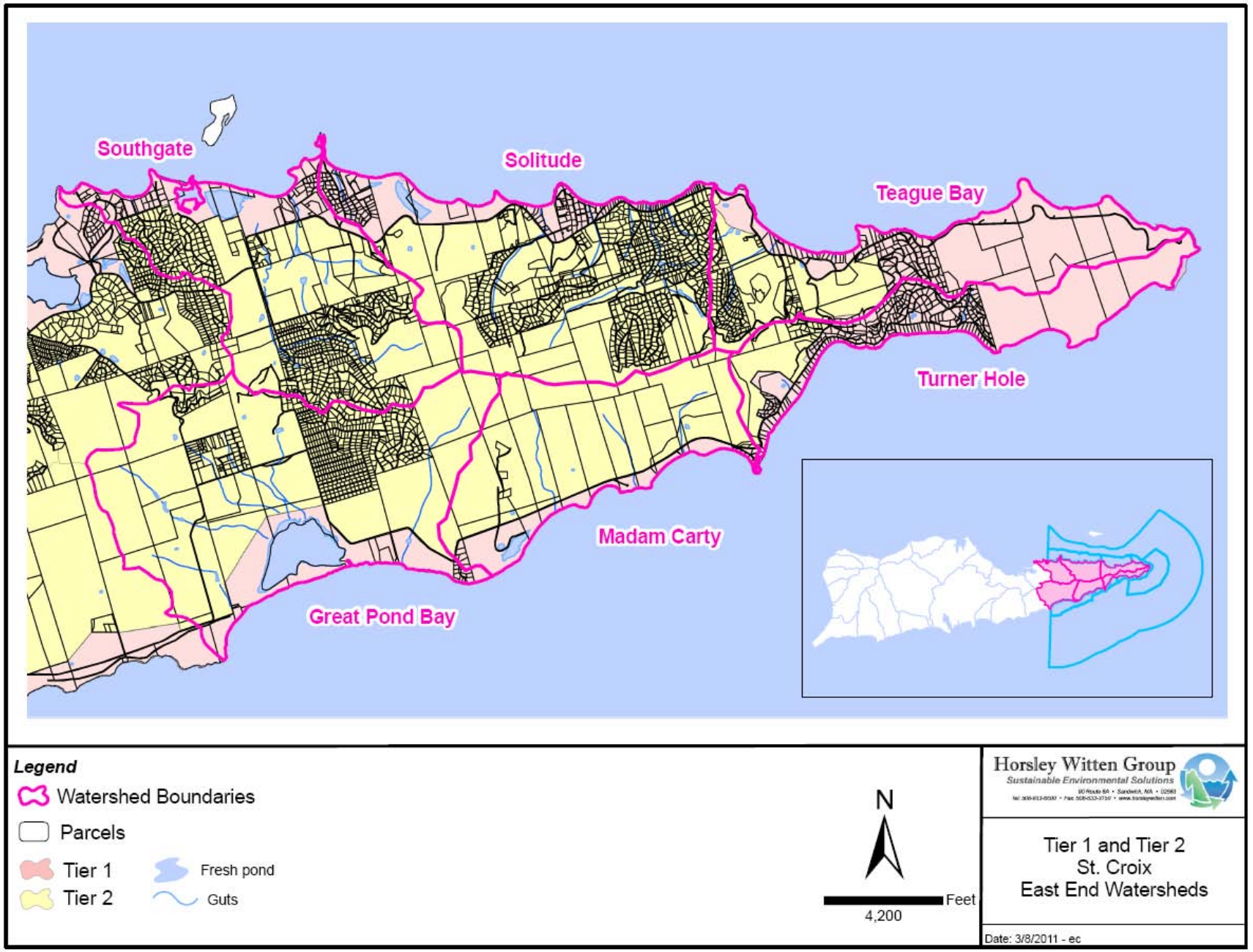


Figure 2.16. Tier 1 and 2 Designated Areas (mapping provided by DPNR in 2011)

Road Drainage and Culvert Design

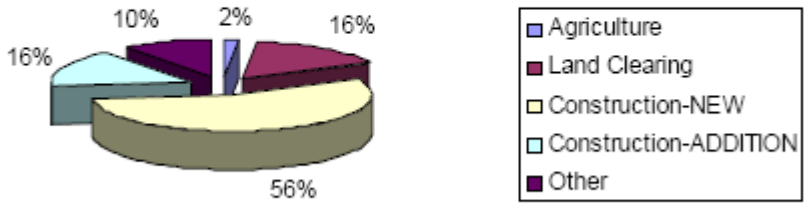
The DPW and the TPDES program have responsibility over street design and drainage. The DPW has established design standards as a matter of policy, but, there are currently no design requirements mandated by the regulations. The 2001 Hydrologic Design of Highway Culverts by US Department of Transportation and the Federal Highway Administration is a reference guide used by DPNR staff.

Earth Change Plan and Permit Program (V.I. Code Title 12, Chapter 13)

Before any land is cleared, graded, filled or otherwise disturbed for any purpose or use, an Earth Change Plan must be approved by DPNR and an Earth Change Permit must be provided by DPNR to the applicant. There are three different types of Earth Change Permits: I (Gut Clearing, Brush Clearing); II (Single Residential Lot); and III (Major Development); most permits are for new construction projects and permits are rarely denied (Figure 2.17). The specific application requirements are different for each of the categories; however, site plans are required for all applications. Required erosion control requirements are not specified for any of the categories, although the applicant is asked to sketch and identify areas to be cleared and proposed Erosion and Sediment Control (ESC) practices to be installed. The 2002 USVI Environmental Handbook includes recommended ESC practice standards and describes predictive models that can be used to estimate erosion and runoff, although there is no required design manual at this time. Many problems associated with ESC at construction sites were noted during HW field assessments in 2011.

In addition, for Category III applications, soil percolation test results may be needed in TMDL watersheds. The VI Onsite Sewage Treatment Systems Handbook is referenced for standards and specifications of conventional and alternative septic systems. Hydrology Reports and DEP Road and Driveway permits may also be needed for a Category III permit application.

Earth Change by Category FY08



Earth Change Summary

District	Earth Change Applications Reviewed	Earth Change Applications Approved	Earth Change Applications Denied
St. Croix	10/08-9/09: 408 10/07-9/08: 512	10/08-9/09: 408 10/07-9/08: 512	10/08-9/09: 0 10/07-9/08: 0

Figure 2.17. Statistics for FY08 and FY09 Earth Change Applications (excerpt from DPNR, 2010)

Onsite Sewage Disposal Regulations (V.I. Code Title 19, Chapter 53 §1404); *Onsite Sewage Disposal Regulations for the Coastal Zone* (V.I. Code Title 12, Chapter 21 §910); *and the accompanying "United States Virgin Islands Handbook on Onsite Sewage Treatment Systems"*

All single family homes on the East End of St. Croix discharge sewage through onsite sewage disposal systems (OSDSs), such as septic tanks, and seepage pit systems. These OSDSs are governed by the USVI rules and regulations that specify criteria for the siting and design of conventional systems, as well as some requirements for alternative systems. The USVI Handbook on Onsite Sewage Treatment Systems is referenced within the regulations for requirements, such as test pit sampling procedures, and sizing criteria.

DPNR (2010) states that septic system regulations and regulatory authority needs to be better defined for second tier of the coastal zone due to overlapping and conflicting jurisdictions between the Waste Management Authority, Department of Health, and DPNR in the various statutes and regulations. There is a need to develop the permitting process to include monitoring and pump out requirements. It is thought that conventional septic tank/ seepage pit systems are inadequate due to the shallow soils, steep slopes and also the increasing numbers of these systems. Residents attending the watershed planning stakeholder meeting in January 2011 indicated that they could tell which seaside homes' septic systems were failing by the amount of algae that was growing along the shoreline. Agency staff also proposed an alternative, three chambered septic design that would enhance performance without significantly increasing costs.

Buffer Protection Regulations (V.I. Code Annot. Title 12, sections 121-125)

Currently, there is a minimum 30-ft protective buffer zone for guts in the US Virgin Islands. The regulation prohibits *"…the cutting or injury of any tree or vegetation within 30' of the center of any natural watercourse, or within 25' of the edge of such watercourse, whichever is greater."*

Existing Management Plans

There are a number of existing management plans and current planning initiatives that should be integrated as much as possible with the East End watershed planning efforts. These plans and activities are as summarized in Table 2.10.

Table 2.10. Summary of Existing Management Plans

Report	Relevant Findings
USVI Coral Reef Management Priorities (NOAA, 2010)	• Top 5 goals include supporting activities to reduce sediment and pollutant loading to priority reefs and education and outreach. • Objectives include development of watershed and stormwater master plans and installation of island-appropriate stormwater BMPs, culverts, and catchbasins. • Supports stricter permitting conditions for new developments and activities to improve constituency and enforcement of regulatory programs.

Report	Relevant Findings
Framework for management of wetlands in the USVI (UVI-CDC, 2010); and 2006 Draft Wetlands Conservation Plan (Platenberg, 2006)	• There is currently no wetlands program in the USVI. • DPNR is in process of developing a coherent management policy based on a Territorial wetland inventory and assessment effort started in 2004, draft conservation plan by Division of Fish and Wildlife, and other input. • Framework document includes list of agencies and regulatory programs with some wetland oversight.
A Strategy for Management of Ghuts in the USVI (Gardner, 2008)	• None of the priority guts of interest studied to date are located in the East End watersheds. • Document provides recommendations for a process for establishing a Territorial gut management strategy, including the formation of an inter-agency working group, data collection and research needs, and building local support.
Area of Particular Concern (APC) and Area of Preservation and Restoration (APR) Studies (DPNR, 1993)	• Southgate Pond/Chenay Bay, Great Pond, and East End Bays designated as APCs/APRs in 1979. • Each plan describes the natural, historic, and urban characteristics of the areas and presents recommended management approaches for land conservation, development, wastewater, and other LBSP. • While plans are outdated (e.g., pending developments, regulations, and conservation planning goals have changed), some recommendations are still valid (see Section 3, 6, and 8 for specific recommendations) particularly as they relate to concerns with septic systems, ESC, and buffers. • APCs are part of the Coastal Barrier Resources System (1990) which prohibits the use of federal monies for development projects in designated areas.
East End Marine Park Management Plan (2002)	• Identifies the major threat from urban development as being sedimentation from earth change activities and loss of wetland habitat from land reclamation; both observed. • Supports more stringent review, inspection, and enforcement of development activities in the STXEEMP watersheds, particularly those impacting guts and wetlands.

Stakeholder Involvement

Interested stakeholders in the East End include a number of project partners, business owners, residents, landowners, agency staff, and others. Table 2.10 summarizes many of the individuals HW has met with during field assessments on-site, in public meetings, or indirectly via email or conference calls. Stakeholder support has been critical in supplying this effort with mapping and modeling data, providing information on existing efforts and projects, and identifying and providing access to problem areas in the watershed. Many of the individuals listed in Table 2.11 have played key roles in developing the scope of this effort, coordinating meetings and field work, and communicating project findings and schedules with the broader community. Continued participation of stakeholder groups will be critical to the implementation success of the ultimate watershed plan.

Table 2.11. Summary of Stakeholders Involved

Watershed	Stakeholders
East End-wide	NOAA: Marlon Hibbert, Rob Ferguson, Jennifer Kozlowski DPNR-STXEEMP: Paige Rothenberger, John Farchette, Migdalia Roach DPNR-DEP: Anita Nibbs, Syed Sydali, Benjamin Keularts, Alexi, Diane Capehart, Courtney Dickenson, Emanual Liburd USDA/NRCS: Julie Wright, Rudy O'Reilly, Amanda Gagnon DPW: Roberto Cintron TNC: Jeanne Brown, Richard Gideon NPS: Zandy Hillis-Starr UVI: Bernard Castillo, Kynoch Reale-Munroe, Stuart Ketcham
Great Pond Bay	Residents: Terry Chrieten, Michael Dance
Madam Carty	Robin Bay: David Kagan
Solitude Bay	Carden Beach: Don Sallach Fire Station: Michael Henry Blue Water Terrace: Pauli (owner) Ziggy's: Mike Ziegler Candle Reef II: Kay Green Farchette and Hanley Storage: Gilmore Erikson Other: Budget Marine, Topside Restaurant HOA: Josh Tate (Hope and Carton), Bill Flynn (Sierra Verde) Residents: Rubin Roebuck; Raymond Berkeley (Hope & Carton); Bill and Meredith Flynn, Martha Tribolet, Nora Santana (Cotton Valley); Rick Byrem (Coakley Bay)
Southgate	STX Environmental Association: Carol Cramer-Burke, Paul Chakroff, Ken Haines Chenay Bay: Mirko Restivic, Diane Yost Green Cay Marina: Ronda Dossman Other: Cheeseburgers, Southgate Plantation Residents: May Cornwall and Family, Robert Schuester
Teague Bay	Duggins/Reef Golf Course: Mike Hanne STX Yacht Club: Kiomi Pedrini, Julie San Martin REEF Condominium Association Residents: Carlos Skov, George and Judith Enhert (Reef)
Turner Hole	HOA: Dave Rivers (Grapetree Society) Other: Divi Carina Resort Residents: Clayton and Gail Lincoln; EE Bay Trail Demonstration: Greg Miller
Additional stakeholders attending public meetings	Alda Forte, Eileen Huggins, Lee Elvins, Joy Blackburn, Brian Leung, Percival Edwards, Myron Alleck, Jeneva Lawrence, Kemit-Amon Lewis , J.H. Isherwood, Al and Ann Lang, Brian Daley, Ditty Layton, Sue Ridgway, Scott Atkinson (VIRC&D), Joanne Coughlin, Dianne Chandler, Margi Levi, Fran Smith
Additional GIS and Monitoring Data	DPNR: Pedro Nieves UVI: Stevie Henry IRF: Carlos Ramos-Scharron

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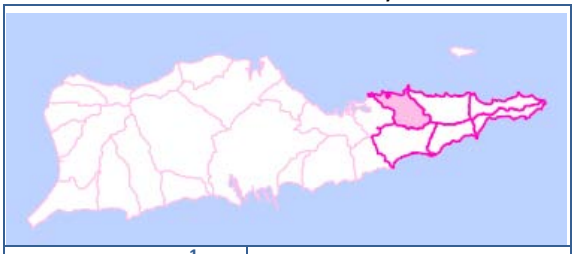
3.0 Southgate Watershed

This section summarizes baseline information specifically for the Southgate Watershed and includes a description of the unique watershed features, a summary of existing water quality conditions, descriptions of potential restoration sites investigated during field assessments, and neighborhood descriptions. Table 3.1 summarizes basic watershed features.

Appendix A contains a basemap of the Southgate watershed depicting locations of water quality impairments, roads, hydrology, topography, and potential restoration sites.

Table 3.1. Watershed Summary



Drainage area[1]	1,398 acres; 2.2 sq miles
Length of guts[2]	3.79 miles
Road length[2]	16.4 paved miles; 4.2 unpaved miles
# Road culverts[2]	27 mapped culverts
Impervious Cover[3]	126 acres; 9% of watershed
Dominant land use %[4]	Undeveloped: 50%
	Ag: 24%
	LDR: 22%
Area within 100-yr floodplain[5]	546 acres; 39% of watershed
# Small ponds[4]	9 (does not include Southgate Pond)
# Mapped wells[6]	22
Watershed erosion potential[7]	Vulnerability: Med-High
	Road-based: Med-High
	Mean Relative: High
2010 WQ Impairments[8]	4 of 5 assessment units listed as impaired (turbidity, bacteria, DO); 2011 TMDL priorities

[1] IRF/UVI/USGS 2001 watershed boundaries
[2] HW revised/or created, 2011
[3] NOAA CSC, CCAP data, 2005
[4] UVI-CDC data 2003 (land use) and 2001 (ponds)
[5] DPNR, dated 2005
[6] Received from DPNR Feb, 2011
[7] WRI/NOAA, 2005
[8] DPNR, 2010 Integrated Waters Report

3.1 General Description

The Southgate watershed is the northwestern-most of East End watersheds, is the closest to Christiansted, and contains the Southgate Pond—one of the largest salt ponds and ecologically significant habitats in the USVI (Figure 3.1). The Southgate Pond/Chenay Bay area was designated in 1979 and officially established in 1991 as an Area of Particular Concern (APC) and an Area of Preservation and Restoration (APR). It was also designated as a Significant Natural Area in 1982. The APC/APR extends from Shoy's (Punnett Point) to Pull Point, including Green Cay National Wildlife Refuge, Southgate Pond's eastern avian habitat, and the recreationally important Chenay Bay.

The Green Cay Marina at Tamarind Reef was created in the 1960's on the western portion of the Pond by a constructed embankment. There are two primary guts draining the watershed: the West Gut, which discharges into Southgate Pond; and the East Gut, which discharges between the Chenay Bay Resort and the Southgate Reserve (Figure 3.2). Average rainfall is 35 in/yr.

The main roads in the watershed are the East End Rd. (Rt. 82), which runs east/west along the northern coast, and South Shore Rd. (Rt. 60), which is the main north/south corridor. The central portion of the watershed is relatively flat and consists mostly of large parcels of

undeveloped pasture land, some of which has been subdivided or planned for future development, and low density residential neighborhoods. The southern and eastern boundaries of the watershed are more mountainous. Seven of nine small impoundments in the watershed are associated with pasture land—the other two are found at Plantation Condos and in the Tipperary area.

Land Use

There are several single family neighborhoods in the watershed: All for the Better and Tipperary; Seven Hills; Parara; a portion of Union & Mt. Washington; Southgate Farm/Anna's Hope, and a portion of Punnett Bay (Shoy's). There are two multi-family condominiums: Southgate Condos and the Plantation. Commercial properties of interest include Cheeseburgers, the Seven Seas Water Supply Company, Chenay Bay Resort, Tamarind Reef, and the businesses at the Green Cay Marina. The Southgate Baptist Church is also a watershed landmark. Like the rest of the East End, there are no central sewer lines located in the watershed; therefore residential and small commercial areas rely on individual on-site septic systems, with small package plants used at resorts and condos. Cheeseburgers shares a wastewater system with the Southgate Condos.

Figure 3.1. Southgate Pond and Reserve, an ecologically sensitive wildlife area managed by the St. Croix Environmental Association.

Figure 3.2. East gut below East End Rd. culvert (left) and at the discharge location between the Chenay Bay Resort and Southgate Pond (right). Green Cay NWR can be seen in the distance.

Water Quality

Of the five water quality assessment units associated with this watershed, four are listed by the USVI DPNR as impaired in the 2010 Integrated Waters Report (DPNR, 2010). Three of the impairment areas are designated as high priorities for development of a Total Maximum Daily Load (TMDL) in 2011 (Table 3.2).

Table 3.2: Water Quality Impairments (derived from DPNR, 2010)

Assessment Unit ID/Name	Monitoring Stations	Impairment	Source of Impairment	TMDL (Priority)
VI-STC-33 Punnett Bay	VI610321 Shoy's	Turbidity	Land Development, Erosion and Sedimentation	Low/2020
VI-STC-34 Punnett Point, East	None	(N/A)	(N/A)	(N/A)
VI-STC-35 Tamarind Reef Lagoon (Southgate Lagoon)	STC-4 Tamarind Reef Lagoon	Dissolved Oxygen, Fecal Coliform, Secchi Depth, Turbidity	unknown	High/2011
VI-STC-36 Green Cay Beach	VI563397 Chenay Bay Beach	Turbidity	Package Plants (Small Flows), Erosion and Sedimentation	High/2011
VI-STC-37 / Southgate subwatershed, offshore	STC-5 Green Cay Beach	Dissolved Oxygen, Fecal Coliform, Enterococci, Turbidity	Marina Boat Maintenance, Marina/Boating Sanitary On-vessel Discharges, Non-Point Source Discharges	High/2011

3.2 Potential Watershed Restoration/Project Sites

A number of sites were identified by project partners, local residents, and field assessment teams as potential sources of pollution or as drainage improvement opportunities. Table 3.3 summarizes candidate projects to be considered during the watershed planning process. A more detailed description of existing conditions and potential opportunities at these sites is provided below.

Table 3.3. Summary of Candidate Restoration/Project Sites

Project ID/Site Name[1]	Description	Initial Ranking
Gut/Pond Restoration		
East Gut-Adam's Family Farm (SG-G-2)	Active head cut and channel erosion, potentially a significant source of sediment loading to receiving waters; threat to property and infrastructure.	High
Southgate Pond/Reserve (SG-1)	SEA has a project to raise the embankment, expand pond and restore wetlands. Also potential construction of permeable parking lot and drive.	High

Project ID/Site Name[1]	Description	Initial Ranking
West Gut-Schuster (SG-G-3)	Gut stabilization project previously evaluated by North Carolina State University; appears relatively stable now.	Low
West Gut/behind Cheeseburger's (SG-G-1)	Small area upstream of culvert for bank stabilization to protect infrastructure and private property	Low
Road Improvements		
Seven Hills Rd. and Gut (SG-RC-22)	Address gut erosion by installing roadside swales, drain inlet, and stabilize outlet structure	Low
Stormwater Retrofits/Pollution Prevention		
Green Cay Marina (SG-R-3)	Retrofits to capture and treat polluted parking lot runoff; dumpster management	High
Chenay Bay Retrofits(SG-R-20)	Retrofit parking lot, restaurant, and trash cleanup	High
Green Cay Marina/Road (SG-R-4)	Retrofit to improve drainage and provide treatment along main road; highly visible	Medium
Tamarind Reef/Road (SG-R-5)	Retrofit to improve drainage and provide treatment along main road; highly visible demonstration site at tennis court	Low
Southgate Baptist Church (SG-R-6)	Potential rain garden demonstration; tree planting	Low
Cheeseburger Parking lot (SG-R-1)	Potential to capture/treat parking lot runoff in front along ditch; highly visible location	Low
Southgate Condos (SG-R-2)	Small rain gardens to capture and treat parking lot runoff	Low
Culvert Maintenance and Repair		
East Gut/East End Rd. Culvert (SG-RC-21)	Blocked and deteriorating infrastructure; on DPW project list for replacement	High
South Shore Rd/Tipperary New Culverts (SG-RC-31/32)	New culverts installed with no stabilized outlet structure or erosion/sediment control, wetland encroachment. Stabilize site, provide water quality device, replant wetland buffer.	High
Cheeseburger culvert (SG-RC-1)	Complete blockage/crushed on downstream end of double 18" RCP in ditch in front of Cheeseburgers	Medium
Seven Seas Culvert (SG-RC-2)	36" CMP is failing/evidence of piping and is blocked at downstream end with vegetation	Medium
Seven Hills Culverts (SG-RC-7)	Ten culverts, all require basic maintenance; private roads	Medium
Crescent Beach Rd. Culvert (SG-RC-6)	an undersized 24"RCP culvert has caused erosion and bank failure of a gut; private road	Medium
Southgate Baptist Church/East End Rd. Culvert (SG-RC-20)	Clean out 15" RCP that is almost completely blocked	Low
South Shore Rd./ West gut culverts (SG-RC-4; SG-RC-5; SG-RC-30)	Culverts need basic vegetative maintenance and debris removal. There will be continued issues in locations where the gut crosses/parallels South Shore Rd., particularly if additional area in the subwatershed is developed.	Low
Southgate Farm Culverts (SG-RC-35/36)	Two small culverts blocked in residential area	Low

[1]ID matches basemap locations and field sheets in the Appendix.

East Gut – Adams Family Farm (SG-G-2)

The East Gut flows east to west, draining the hillside into a small farm pond on the Ridgeway property, which overflows and re-concentrates across the Adams Family Farm property before crossing under East End Rd. and discharging at Chenay Bay. A severely eroded headcut and highly incised section of the gut was observed beginning just west of the cattle and horse stables (Figure 3.3). The headcut spans approximately 20-40 feet in width and 10-15 feet deep, and consists of three main branches which point in north-easterly, easterly, and southerly directions. The Adams family reported that the headcut has moved upstream from the Schuster property boundary since the 1970s at an estimated rate of 10-15 feet per year, although a more rapid migration has occurred since September, 2010. The most significantly eroded section of the gut is approximately 1,500 feet in length and ends just down gradient of the Adams-Schuster property boundary. The gut is highly incised and full of debris (i.e., cars, appliances, roofing tin), which are remnants of unsuccessful attempts to slow bank erosion over the years. At the end of this reach, the gut appears to be in a more stable condition with minimal bank erosion and no obvious signs of incision. Much of the upstream eroded sediments have been deposited at this location. It should be noted that the east gut does not connect with the Schuster's farm pond.

The Adams' primary concern with the gut erosion is that it will soon bisect their property and prevent access. Evidence of sedimentation from gut erosion is observable at the culvert on East End Rd. The ultimate discharge location is into Chenay Bay, which is impaired for turbidity. Due to these concerns, this site is likely a high priority restoration site. There are a number of potential restoration designs that could be used here, including construction of a concrete headwall structure to stop headcut migration, in channel step-pool drop structures to stabilize steep grades, reconnection to floodplain to reduce erosive velocities, and redesign of a new channel.

Figure 3.3. Top of East Gut headcut (left) and debris remnants in incised channel (right)

East Gut/East End Rd. Culvert (SG-RC-21)

After passing through the Adams' property, East Gut flows to the north and crosses beneath East End Rd. through a three culvert drainage system. The primary culverts are twin corrugated

metal pipe (CMP) arches with a 57" span and 38" rise which are highly deteriorated, partially submerged, and partially obstructed with detritus. There is a third 18" reinforced concrete pipe (RCP) culvert that appears to be a more recent installation than the twin CMPs. The invert of this culvert is at a slightly higher elevation than the others. Upstream of the culvert headwall, a thick layer of deposited fine sediments was observed. It is likely that flow restriction has caused eroded sediment from the Adams' property to fall out of suspension at this location. Sediments that do pass through the culvert system may be a significant portion of the sediment affecting Chenay Bay. Downstream is a large scour hole and sediment deposition. Deterioration of the headwalls, sinkholes between the road and headwalls, and damaged/loose guardrails were observed. The DPW identified this culvert as the next one scheduled for replacement in the East End, in a similar fashion to the one on the West gut behind Cheeseburgers. Culvert replacement at this location can have a significant impact on the stability of the East gut by establishing grade control and should be designed in combination with gut restoration activities.

Southgate Pond Preserve

According to the St. Croix Environmental Association, there are a number of restoration activities being pursued at the Preserve including: 1) Raising the existing embankment which separates Southgate Pond from the marina, 2) removing the existing building near East gut, and 3) installing permeable pavers on the entrance road and relocated parking area (Figure 3.4). Raising the embankment is intended to increase capacity of the pond and help expand fringing vegetation and associated habitat. Reconnecting the floodplain of the East gut on the Preserve property may also be a restoration opportunity.

Figure 3.4. Standing water in the current road/parking area (left); the embankment (right).

Chenay Bay Hotel (SG-R-20)

The Chenay Bay Hotel is a 50 unit, beachfront hotel comprised of small, detached housing cottages connected by paved paths. The resort includes a restaurant, package wastewater treatment plant and disposal area, onsite well for drinking water, paved parking lot, swimming pool, and tennis courts. The existing wastewater system, which is supposed to be a sequencing

batch reactor, handles 2,000-5,000 gpd and has been modified over the years and is currently inadequate. It is in the process of being upgraded (i.e., extended aeration, new pumps and blowers, upgraded float system, raised electric) to meet Biological Oxygen Demand (BOD) and solid removal requirements. The resort lacks significant drainage infrastructure, except for a newly installed culvert and concrete swale near the restaurant. Unlike many buildings on St. Croix, the roofs are not connected to rainwater cisterns. The general topography of the resort is moderate to steep. The only roadway is the access road from East End Rd. which is paved.

The wastewater system, parking lot, and lawns directly abut the East gut, and in some cases are within 25-feet from the wetland resource. There is a lot of trash and debris in the wetland. Very little erosion was found at the site; however, two locations for potential stormwater retrofits were identified including at the paved parking lot and near the restaurant, as well as trash and buffer management recommendations (Figure 3.5).

Figure 3.5. Two locations to capture and treat stormwater runoff (top); active upgrade of wastewater system (bottom ,left); and trash/debris in adjacent wetland (bottom, right).

South Shore Rd./Tipperary New Culverts(SG-RC-31/32)

New culverts were recently installed along South Shore Rd. to assist in draining the saturated residential area from heavy rains and groundwater seepage. In both cases, a ditch was

excavated to expedite flow to the nearest gut/wetland. There was a missed opportunity to install water quality structures into the design, such as a sediment forebay or check dams. The outfall was not stabilized with riprap. Exposed soils, channel bottom, and sideslopes were not stabilized to prevent erosion. In addition, buffer vegetation was cleared up to the wetland boundary and no protective sediment barriers were installed to prevent sediment from migrating into the wetland vegetation (Figure 3.6).

Figure 3.6. Missed opportunity to demonstrate water quality designs and proper soil stabilization techniques at newly installed culverts.

Seven Hills Road/Gut near Good Hope (SG-RC-22)

A previously unmapped gut originates at a low point between the All for the Better and Seven Hills neighborhoods and flows into the Schuster property (Figure 3.7). The drainage area to this gut includes a portion of both neighborhoods, and the road draining here shows signs of degradation. Erosion gullies were present leading from the road into the gut with headcuts of approximately three feet deep. Minor bank erosion in the gut was also identified. The unnamed gut appeared stable beyond the confluence with the erosion gullies from the roadway, though it was not walked completely. Continued headcutting may eventually jeopardize the integrity of the road. Installation of concrete swales and dips, drop inlet, and stabilized outfalls from the road would help reduce gut erosion and road surface deterioration.

Figure 3.7. Road drainage from residential areas leading to gut erosion.

West Gut- Schuster Farm/South Shore Rd. Culverts (SG-G-3; SG-RC-4/5/30)

The West gut flows from the south to the north while paralleling and crossing South Shore Rd. in a number of locations, flowing in and out of the Schuster Family Farm prior to emptying into a series of farm ponds south of East End Rd. Several bank failure locations along South Shore Rd were observed, which were likely the result of erosive flows downstream of road culvert crossings and in areas where the stream was channelized in association with the former road construction (Figure 3.8). There are a number of culverts along South Shore Rd. where the West gut was crossed; some are partially or significantly blocked with sediment and vegetative debris and will require active monitoring and repair over the long-term. Approximately 400 feet of gut within the Schuster property exhibited severe channel incision of 8-10 feet. Well established bank vegetation indicates that channel erosion may not be active and that this reach may not currently be a significant source of sedimentation. The gut empties into two farm ponds prior to reaching East End Rd., which serve as sediment traps. According to the owner, one pond was dredged in the 1980's and a large amount of sediment was removed. A restoration concept was developed by North Carolina State University and USDA-NRCS, but never implemented.

Figure 3.8. Well vegetated banks of west gut on Schuster's property (left) and example of on-going road repair and bank stabilization efforts along South Shore Rd. (right).

West Gut/East End Rd. Culvert (SC-RC-3; SC-G-1)

The West gut crosses beneath East End Rd. near Cheeseburgers after passing through the Schuster farm and several condominium properties. The culvert was replaced three years ago with three, eight-ft by 8-ft concrete box culverts to alleviate flooding. The DPW reports this culvert was intentionally oversized to carry greater than the 25-yr storm. Some bank erosion was observed at the upstream end of the culverts which has resulted in a minor loss of property. A small-scale gut stabilization project could be designed here. There is a considerable amount of live vegetation at the upstream culvert end which may be limiting the available flow area and increasing velocities. Selective plant cutting and detritus removal may be an appropriate management strategy to improve flow conditions at this location; although,

there are habitat and water quality benefits of vegetation in guts and we would not recommend extensive clearing, particularly of canopy cover. Approximately three-five inches of deposited sediment was observed within all three culverts which may be a product of localized bank erosion.

Cheeseburgers Restaurant Parking Lot and Culvert (SG-R-1, SC-RC-1)

A popular local restaurant south of Southgate Pond, Cheeseburgers has a large gravel parking area that drains to the grassed roadside swales along East End Rd. that ultimately discharge through two small culverts under the street or directly to the West gut. The culverts under East End Rd. are completely blocked and crushed on the downstream end. When repaired, there is potential to easily retrofit the roadside swales to enhance water quality treatment, or to install a rain garden in the front corner of the parking lot to provide a landscaped stormwater demonstration, but these are low priorities. Drainage from the concrete pad under the dumpster appears to be causing minor erosion in the parking lot. Dumpster juice and other potential pollutants from the adjacent outdoor storage area may be coming into contact with stormwater (Figure 3.9).

Figure 3.9. Evidence of dumpster juice in stormwater runoff (left); location for swale enhancement to increase water quality treatment.

Southgate Condos (SG-R-2)

Adjacent to Cheeseburgers are the Southgate Condos. These units share a small wastewater treatment system that was installed within the last few years. The two open cells of the wastewater system separate the solids and provide for chlorination. The system should be covered. Effluent is stored in an adjacent pond, then spray-irrigated across the lawn area. A small channel was cut to improve drainage of saturated areas, with an ultimate discharge to the West gut from a white perforated pipe. The West gut has a narrow vegetated buffer, and bank sloughing was observed in one isolated area. This could be a remnant feature of back up conditions prior to culvert replacement; though it appears that erosion may still be active. This

could be a relatively minor bank stabilization effort using “soft” engineering practices. In addition, there are two open turf areas in the front and rear corners of the parking lot/drive aisles for the Condos where installation of a rain garden could be installed to capture and treat runoff (Figure 3.10).

Figure 3.10. (From top left to bottom right) Wastewater system, drainage channel and pipe, gut erosion, and potential location for a rain garden at the Southgate Plantation Condos.

Seven Seas Culvert (SC-R-2)

Across the street from Cheeseburgers is the entrance drive to the Seven Seas Water Supply Company. The culvert under this driveway is a large, 36-inch corrugated metal pipe capturing a significant amount of drainage area. On inspection, it was noticed that there is pipe failure below the driveway (Figure 3.11).

Figure 3.11. Pipe failure evidenced in culvert.

Southgate Baptist Church (SG-R-6, SG-RC-20)

There was no evidence of erosion in the gravel/grassed parking lots, around the basketball court, or along the site entrance. There are two large drain inlets in the lower parking lot that drain directly to the blocked/corroded culvert along East End Rd. (SG-RC-20). The lower parking lot sits above/behind a large concrete revetment along East End Rd. and appears to have been originally gravel, but now has extensive grass cover. Rooftop runoff is primarily collected in cisterns with the exception of a downspout at the entryway to the property, which could easily be converted into a demonstration rain garden (Figure 3.12). The Church could provide a convenient meeting location for watershed meetings. The area around the basketball court may be suitable for tree planting.

Figure 3.12. Drain inlet in lower parking lot (left); downspout to existing flowerbed that could be converted to a rain garden or collected for irrigation (middle); almost completely blocked culvert (right).

Green Cay Marina and Tamarind Reef Hotel (SG-R-3, SG-R-4, and SG-R-5)

Green Cay Marina and the Tamarind Reef Hotel are located west of Southgate Pond and north of the Southgate Farm neighborhood. The hotel and marina occupy separate parcels but are run under the same corporate name and management personnel. Tamarind Reef is a 38 unit, beachfront hotel that is comprised of three main two-story housing structures. The resort includes a restaurant/bar, a package wastewater treatment plant and disposal area, several paved parking areas, a swimming pool, and tennis courts. Greywater is used to irrigate landscaping. The resort lacks significant drainage infrastructure which has contributed to standing water problems near the tennis court area.

Green Cay Marina is an active marina that contains 154 boat slips, about eight of which host 'live-aboard' residents, according to management. The marina provides a number of boater services including a refueling station, a sewage pump-out facility, and member washroom facilities. This marina does not provide boat maintenance and repair services. The marina is also host to a restaurant-dining facility. Employees are aware of, and able to quickly produce the marina Spill Prevention, Control & Countermeasure Plan. Field crews observed the oil spill containment measures at the refueling station. The paved parking lot has some drainage infrastructure including a drain inlet, piping, and a concrete flume that directs runoff to the marina/wetlands untreated. Poor runoff management from the docks at the southern section of the marina has contributed to an eroding embankment. Dumpsters located near the site

entrance were uncovered and contributing garbage to the adjacent wetlands. Standing water problems along the main road were described by marina administrative staff during the site visit. HW identified several retrofit locations at the marina facility and along the road to help with drainage problems and improve water quality. The proposed BMPs include a bioretention area, wet swales, oil-grit separators, dumpster management, and bank stabilization measures to reduce mass wasting at the marina docks (Figure 3.13).

Figure 3.13. (Top left to right) Areas for bioretention and oil grit separator, (middle left to right) dumpster management and bulkhead stabilization, and (bottom left to right) areas for road drainage improvements (SG-R4-5).

Private/Neighborhood Culverts (SG-RC-6, SG-RC-35/36, Seven Hills)

There are a number of private culverts that require maintenance in residential areas that are not the responsibility of DPW. In Punnett Bay, there is an undersized culvert at the northern end of the community that has caused erosion and bank failure of a gut (SG-RC-4). There are two culverts in Southgate Farm that are almost completely clogged (SG-35/36), and there were ten culverts in the Seven Hills neighborhood, all of which need basic maintenance (Figure 3.14).

Figure 3.14. Examples of collapse at road edge in the Punnet Bay area (left), and a completely clogged culvert in Southgate Farm/Anna's Hope (right).

3.3 Neighborhood Summaries

A summary of general neighborhood conditions is provided below in order to identify which neighborhoods are likely to generate pollutants of concern, what the common sources are, and which areas/sources should be targeted for watershed stewardship activities. Unless otherwise noted, it is assumed that neighborhoods consist of single-family, detached residences, with cisterns, on-site septic systems, and open section/drainage roads (without curb and gutter). Table 3.4 is a comparative summary of each neighborhood, and more detail is provided below. Pollution source is determined by number of observed pollutants (1-2=Medium; >2 = High).

Table 3.4. Neighborhood Summaries

Name	Road/Driveway Condition	% Lots Un-developed	Pollution Source	Potential Stewardship Activities
Punnett Bay (Shoy's)	Paved, Good condition	<25%	Med	Better lawn care/landscaping; on-lot demonstrations; culvert replacement
Southgate Farm/Anna's Hope	Paved, Good condition	50%	Med	Better lawn care/landscaping; on-lot demonstrations; ROW retrofits
All for the Better/ Tipperary	Paved/ dirt; some deterioration	<25%	Med	Road drainage improvements; household hazardous waste; better lawncare/landscaping; gut buffer management; septics

Name	Road/Driveway Condition	% Lots Un-developed	Pollution Source	Potential Stewardship Activities
Seven Hills	Steep, paved roads in adequate condition	75%	Low	Culvert maintenance
Parara	Mostly unpaved	>50%	Low	Household hazardous waste
Mt. Washington (portion of Union & Mt. Washington)	Steep, Paved, good condition	>75%	Low	Trash cleanup; Single lot construction BMPs

Punnett Bay (Shoy's)

Access to this neighborhood is granted through security gates at the Buccaneer Resort. The neighborhood is located directly west of Southgate Farm and consists of similar topography. One portion of the neighborhood is built in the hills and reaches elevations up to 200 feet. The second area is located near the ocean and is relatively flat. The parcels in the steeper terrain are one-half to three-quarter acres in size and are at least 75% developed. The parcels in the lowlands are larger one-acre parcels and also primarily developed. Most of the undeveloped parcels in the hills remain as forested land; whereas much of the area in the lowlands has been cleared and vegetated with grasses. The roadways are paved and most driveways are either paved or gravel. Some basic drainage infrastructure exists including paved swales, speed bumps, and culverts. Most of the roadways were in good condition, but an undersized culvert at the northern end of the community has caused erosion and bank failure of a gut (SG-RC-6).

Southgate Farm/Anna's Hope

The Southgate neighborhood is a gated community located southwest of Southgate Pond on the way to the Tamarind Reef Hotel and Green Cay Marina. The neighborhood includes some steep topography, reaching up to 200 feet in elevation, and also flat topography in the lowlands near Southgate Pond. It consists of primarily one-acre lots that are approximately 50% developed. Developed lots generally have large homes, with swimming pools, extensive turf grass and landscaping features. Most of the natural forested area has been cleared and revegetated with tall grasses. The roadways are paved and most driveways are either paved or gravel. The main road is open section with shallow swales to convey stormwater. Some basic drainage infrastructure exists including paved swales, speed bumps (which provide similar benefits to waterbars), and driveway culverts. Most of the roadways are in good condition, but several gravel driveways are eroding and contributing sediment to a regional low-point near the entrance to the Green Cay Marina. Culvert maintenance is needed. There are examples of permeable pavers used in this neighborhood and opportunities for residential rain gardens.

All for the Better/Tipperary

The All for the Better neighborhood is located north of Tipperary and south of the Schuster property. This area is very flat with about 25% remaining undeveloped lots. About half of the

parcels are one-quarter acre lots and the remainder is half acre lots. The developed parcels are primarily impervious or grass area and the undeveloped parcels are mostly forested. The roadways are generally paved. There are a few main roads that are unpaved. Minimal drainage infrastructure exists except for newly installed culverts that pass underneath South Shore Rd. Standing water was observed on individual lots, and upwelling was observed under roads and driveways. This is likely due to saturated soils, high groundwater, and seepage resulting from a lengthy and heavy rainy season. The constant flow of water has caused minor erosion gullying along roadway ditches, yard flooding, pavement heave, and the installation of new culverts to alleviate drainage. The DPW recently installed the culverts to help with the groundwater seepage issue; these installations have contributed to sediment loading into guts and wetlands. Soils in this portion of the watershed are not ideal for septic infiltration. Problems with systems are likely given the high water table and groundwater seepage occurring over the past few months (Figure 3.8). Water was observed flowing across South Shore Rd., likely the result of residential pumping. The constant flow of water has caused algae to grow on the road surface and minor erosion gulling along roadway ditches.

Figure 3.8. Green rectangular indicators of septic system on single family lot (left). Record high groundwater tables and resulting surface seepage in Tipperary/All for the Better residential areas may have resulted in failing septic systems (right).

Seven Hills

The Seven Hills neighborhood is located atop the third highest peak in the Southgate Watershed and exhibits some of the steepest terrain. Elevations range from 200 to 570 feet above sea level. Approximately 75% of the parcels remain undeveloped and well-vegetated. The majority of the parcels are about one-half acre in size but range between one-third and one acre. Land clearing within the developed parcels is typically limited to the building, driveway, and septic construction. Nearly all roadways and driveways throughout the neighborhood are paved, and most are in adequate condition; although some raveling and potholes were observed. Roadways are typically graded into the cut-slopes with drainage primarily flowing in ditches along the cut-slopes. Culverts strategically placed at regional low-points allow the water to flow off of the roadways. Most culverts within the neighborhood are in need of

maintenance; partial blockage with rock and/or detritus was a common occurrence. Some erosion immediately downstream of culverts was found, but the existing vegetation limited the extent of the problems.

Parara

The Parara neighborhood is located between Mt. Washington and Tipperary Rd. It can be broken into two distinct sections based on topography and development. The lowlands are flat, one-half to three-quarter acre parcels which are almost all developed. Much of the forested area in this location has been cleared and vegetated with grass. The roadways in the lowlands are primarily unpaved. Minimal drainage infrastructure exists but no major erosion problems were identified. A residential lot with an automobile maintenance garage was identified in this neighborhood. The upland portion of the Parara area is primarily undeveloped, forested land with moderate slopes. The parcels are mostly three-quarter to one acre in size. The roadways in the upland section of mostly paved. Minimal drainage infrastructure exists but no major problem areas were identified.

Union & Mt. Washington

The Mt. Washington portion of this area is located atop the second highest peak in the Southgate Watershed and directly borders/crosses into the Great Pond Watershed. The Union portion of the community is considered part of the Great Pond Watershed. The topography is steep with elevations ranging from 200 to 500 feet. At least 90% of the parcels in this neighborhood remain undeveloped and well forested. The majority of the parcels are about one to one-and-one-half acres in size. Land clearing within the developed parcels is limited. Most of the roadways are paved, but with minimal drainage infrastructure.

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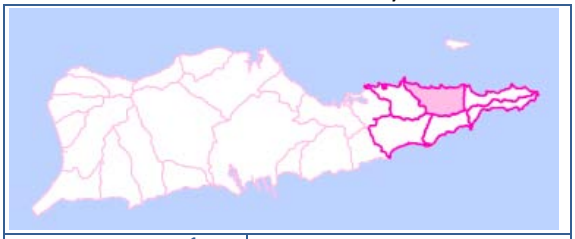
4.0 Solitude Bay Watershed

This section summarizes baseline information specifically for the Solitude Bay Watershed and includes a description of the unique watershed features, a summary of existing water quality conditions, descriptions of potential restoration sites investigated during field assessments, and neighborhood descriptions. Table 4.1 summarizes basic watershed features.

Appendix A contains a basemap of the Solitude Bay Watershed depicting locations of water quality impairments, roads, hydrology, topography, and potential restoration sites.

Table 4.1. Watershed Summary



Drainage area[1]	1,641 acres; 2.6 sq miles
Length of guts[2]	4.9 miles
Road length[2]	14.6 paved miles; 12.4 unpaved miles
# Road culverts[2]	28 mapped culverts
Impervious Cover[3]	153 acres; 9%
Dominant land use %[4]	Undeveloped: 50%
	LDR: 29%
	Ag: 18%
Area within 100-yr floodplain[5]	303 acres; 18% of watershed
# Small ponds[4]	8 (not including Coakley Bay and unnamed pond near Candle Reef condos)
# Mapped wells[6]	16
Watershed erosion potential[7]	Vulnerability: Med-High
	Road-based: High
	Mean Relative: High
2010 WQ Impairments[8]	None listed

[1] IRF/UVI/USGS 2001 watershed boundaries
[2] HW revised/or created, 2011
[3] NOAA CSC, CCAP data, 2005
[4] UVI-CDC data 2003 (land use) and 2001 (ponds)
[5] DPNR, dated 2005
[6] Received from DPNR Feb, 2011
[7] WRI/NOAA, 2005
[8] DPNR, 2010 Integrated Waters Report

4.1 General Description

The Solitude Bay Watershed is the north-central portion of the East End watersheds and is the second largest of the six. Topography within the watershed ranges from 0 feet (ft) in elevation at the northern shoreline to upwards of 800 feet in elevation at the southern ridge of the watershed. The center of the watershed is relatively flat; however, the majority of the area is made up of steep hills and ridges. There are six gut systems within the watershed. There are many small ponds located along these guts, some of which hold water into the dry season (Figure 4.1). There are also two larger ponds in the northwest portion of the watershed: Coakley Bay Pond and an unnamed pond.

Land Use

The main road that runs through the watershed is the East End Road (Rt. 82), which runs east/west along the northern coast. There are eight distinct residential neighborhoods within the watershed that can be accessed via East End Rd.: Sierra Verde, Yellow Cliff North, Hope and Carton Hill, Cotton Valley, Solitude North, Seven Flags, Pleasant Valley, and Green Cay/Prune Bay. Most of the neighborhoods consist of single family homes on one-acre lots, and around 40% or 50% developed; there are also a few areas that have been been subdivided or planned for future development. Most neighborhoods within the watershed extend from the generally flat areas along East End Rd. up through the steep hilly areas to the south (Figure 4.2). The

roads within these neighborhoods vary from dirt or gravel to paved roads. The condition of the roads fluctuates as well, but there are many dirt and gravel roads that are significantly eroded. Three condominium complexes exist within the watershed: the Candle Reef (I and II) Condominiums within the Prune Bay neighborhood; the Carden Beach Condominiums off East End Rd. to the north; and the Coakley Bay Condominiums, which are across East End Rd. from the Carden Beach Condominiums to the south.

Commercial (including municipal services) and some industrial uses also exist within the watershed. Commercial/municipal properties of interest include Ziggy's Island Market and Gas Station, the Fire Station, Blue Water Terrace Restaurant and Deli, and Top Side Restaurant. There is also an industrial area on a portion of Seven Flags Rd.; current tenants include a self-storage facility, Budget Marine boat and marine equipment retailer, and a tile storage area, among others.

Agricultural uses make up a substantial portion of the watershed as well. The majority of the agricultural land is part of the Roebuck Goat Farm. This farm was one of the first settled areas of the East End Watershed. The major crop has changed over time – it has been a sugar cane farm, as well as a dairy farm in the past. Today, the primary use of the agricultural property is for raising goats.

Like the rest of the East End, there are no central sewer lines located in the watershed; therefore, residential and small commerical areas rely on individual on-site septic systems, with small package plants used at condos.

Figure 4.1. Pond along gut in Cotton Valley Neighborhood (left) and culvert at East End Road discharge location to Yellowcliff Bay (right).

Figure 4.2. Characteristic landscape of Solitude Bay Watershed; views from Pleasant Valley and Hope and Carton Hill neighborhoods (left to right).

Water Quality

There is one water quality assessment unit associated with this watershed, and it is not listed in the 2010 Integrated Waters Report (DPNR, 2010) as impaired.

Table 4.2. Water Quality Impairments (derived from DPNR, 2010)

Assessment Unit ID/Name	Monitoring Station Name	Impairment	Source of Impairment	TMDL (Priority)
VI-STC-38 / Solitude Backreef	None	(N/A)	(N/A)	(N/A)
VI-STC-43 / Solitude & Teague Bay subwatersheds, offshore	None	(N/A)	(N/A)	(N/A)

4.2 Potential Watershed Restoration/Project Sites

A number of specific sites were identified by project partners, local residents, and field assessment teams as potential sources of pollution or as drainage improvement opportunities. Table 4.3 summarizes candidate projects to be considered during the watershed planning process. A more detailed description of existing conditions and potential opportunities at these sites is provided below.

Table 4.3. Summary of Candidate Restoration/Project Sites

Project ID/Site Name[1]	Description	Initial Ranking
Road Improvements		
Private Unnamed Rd. off Sierra Verde – Bajamar Rd. (SB-RC-1)	Erosion observed on dirt road; candidate for paving	Low
Hope and Carton Hill Neighborhood Road Network (SB-RC-8)	Entire neighborhood is candidate for paving; Implement and/or improve existing drainage facilities, such as water bars and roadside swales, at time of paving	Medium
Seven Flags Road (SB-RC-9)	Significant erosion and gullying of dirt roadway within downstream end of major gut; candidate for paving, and drainage improvements.	High
Pollution Prevention		
Blue Water Terrace (SB-H-1)	Restaurant cleaning area, dumpster, and storage area management required to prevent pollution from entering the adjacent gut	High
Fire Station (SB-H-2)	Construct shelters at Cotton Valley Dumpster Site; improve maintenance and public education to prevent pollution from entering the adjacent gut	High
Stormwater Retrofits		
Fire Station (SB-R-1)	Retrofit to improve drainage and provide treatment along main road; adjacent to gut, and susceptible to flooding; highly visible demonstration site	Medium
Blue Water Terrace (SB-R-2)	Retrofits to capture and treat polluted parking lot runoff; public education opportunity	Medium
Seven Flags Road Housing Development (SB-R-3)	Housing was built within gut up-gradient of already highly eroded Seven Flags Road; On-site storage retrofits to help slow/reduce runoff	High
Ziggy's Island Market (SB-R-4)	Swale retrofit to treat gas station/market parking lot runoff; culvert maintenance; public education opportunity	Low
Coakley Bay Condos (SB-R-5)	Retrofits to capture and treat polluted parking lot runoff	Medium
East End Road - Dirt Road Discharge across from Coakley Bay Condos (SB-R-6)	Retrofit to capture roadway runoff and divert drainage from eroding dirt access road; public education opportunity	Medium
Carden Beach (SB-R-7)	Maintenance and improvement of existing stormwater management facilities	Low
Candle Reef II Condos Cul-de-sac (SB-R-8)	Retrofits to capture and treat polluted roadway and parking lot runoff; public education opportunity	Low
Culvert Maintenance and Repair		
Private Rd. between Sierra Verde and Yellow Cliff North Culvert (SB-RC-2)	Two culverts; both 24" corrugated metal pipe (CMP); need basic vegetative maintenance and debris removal.	Low
Pony Club Trail (Tr)Culvert (SB-RC-3)	30" CMP; Bent from weight of road; 15' deep / 20' wide scour hole at downstream end; tire dumping	High
Cotton Valley Neighborhood Southeast Culvert (SB-RC-4)	24" DIP; significantly corroded; downstream scour hole	Medium

Project ID/Site Name[1]	Description	Initial Ranking
Cotton Valley Neighborhood Northeast Culvert (SB-RC-5)	Two culverts; 24" DIP; downstream scour hole and erosion of channel; grated structures placed on upstream end	Medium
East End Rd. Major Gut East Culvert (SB-RC-6)	Two culverts; one on East End Rd. (30" CMP/RCP) and one on north side on private property (15" CMP); not sized/ maintained properly; structural issues; ponding	High
East End Rd. near Blue Water Terrace Culvert (SB-RC-7)	15" CMP; blocked; causing road flooding issues; conveyance directly to ocean via concrete swale above culvert; need maintenance and debris removal	Medium
Seven Flags Road Culverts (SB-RC-9)	Three culverts; two on East End Rd. (24" reinforced concrete pipe (RCP)/CMP), which are mostly blocked by sediment. The CMP culvert is damaged on downstream end. Both need to be replaced by larger culverts. One culvert on Cotton Valley Trail (unknown diameter circular CMP). The downstream end of this culvert is likely completely clogged.	High
Solitude Road Culvert (SB-RC-10)	Two culverts on Solitude Rd. (30" CMP). Some erosion issues.	Low
East End Rd. Culverts near Ziggy's and Top Side (SB-RC-11)	Four culverts; one on Solitude Rd. (30" CMP) that frequently becomes blocked with sediment/debris from Solitude Rd. and needs regular maintenance; two on East End Rd. (30" CMP) that become blocked with sediment/debris from Solitude Rd., and require regular maintenance; and one culvert on East End Rd. (30" CMP), in good condition.	Medium
Large Culvert to Coakley Bay from Ziggy's/Top Side (SB-RC-12)	One culvert off East End Rd. (48" CMP) with multiple manhole covers missing along the length of the pipe; outlet submerged.	High
Unnamed Rd. Culvert near Fire Station (SB-RC-13)	One culvert near the fire station (24" CMP/DI); could not locate upstream end due to vegetation at edge of pond; downsteam end scoured and clogged with vegetation. Appears to be blocked.	High
East End Rd. Culvert near Fire Station (SB-RC-14)	One culvert on East End Rd. (30" RCP); downstream end is mostly submerged; scour hole present; gabion baskets need repair	Medium
East End Rd. Culverts – West (SB-RC-15)	Three culverts along East End Rd. between Prune Bay and Coakley Bay Condos (SB-R-5); from west to east: 18" RCP needing riprap, with scouring on downstream end; 18" RCP with some chipping of pipe and blockage; 15" RCP with upstream blockage (sediment/vegetation.	Low
East End Rd. Culvert – Coakley Bay Condos (SB-RC-16)	One culvert along East End Rd. just northeast from the entrance to Coakley Bay Condos (SB-R-5); 18" RCP needing stabilization and/or larger culvert with scour hole at downstream end and dry weather flow from discharge.	High
East End Rd. Culvert–East of Coakley Bay Condos (SB-RC-17)	One culvert along East End Rd., east of Coakley Bay Condos; 15" RCP with upstream blockage (sediment/vegetation).	Low

Project ID/Site Name[1]	Description	Initial Ranking
Seven Flags Neighborhood Culvert (SB-RC-18)	12” CMP on Seven Flags Rd.; appears to be completely blocked.	Medium
East End Rd. Culverts – East (SB-RC-19)	3 culverts on East End Rd. just west of Sierra Verde Road; one 24” CMP, and two 8” PVC; septic smell coming from downstream end; two PVC pipes from unknown source.	High (septic?)

[1] ID matches basemap locations and field sheets in the Appendix

Private Unnamed Road off Bajamar Road (SB-RC-1)

This private road currently serves two houses in the Sierra Verde Neighborhood. While the individual driveways are paved, the private road is unpaved and eroding. Concentrated runoff flows from the southwest side of the road to the northeast where the surface transitions from paved to unpaved, creating deep ruts and gullies (see Figure 4.3). This gully continues along the side of the road, eventually discharging to a small gut that crosses East End Rd. near the intersection with Sierra Verde Road. This eroding road may serve as a source of sediment into Yellowcliff Bay.

Some minor, low maintenance improvements could be conducted along the road. A water bar and stabilized swale along each side of the road would reduce erosion and, therefore, the associated potential sediment load from this area would be reduced.

Figure 4.3. Erosion gully at the transition from paved driveway to unpaved private road looking up-gradient (left) and down-gradient (right).

Hope and Carton Hill Neighborhood Road Network (SB-RC-8)

The roads in the Hope and Carton Hill Neighborhood are in general very steep, mountainous, and unpaved. The roads of interest include Yellow Cliff Trail, Coral Reef Trail, Divi Divi Trail, and Pony Club Trail. The roads have many deep ruts and gullies that carry stormwater and large amounts of sediment during rain events. An extremely steep, unpaved cell tower access road at the southeastern edge of the neighborhood is particularly in need of maintenance. All of this

runoff and sediment load ultimately discharge to the main gut at the Pony Club Trail Culvert (SB-RC-3; described in detail below). Large quantities of sediment can be seen along the road at this location. At some point, paved water bars and swales were constructed to try to reduce the erosion issue on these roads, but runoff has bypassed and scoured around these structures. Only one section of this road network, a portion of Divi Divi Trail, is relatively flat; this section has issues with ponding water during and after storms due to poor drainage.

In general, the roads in this neighborhood likely provide a large sediment source to the gut, the associated ponds, and eventually Yellowcliff Bay. These steep roads are ideal candidates for paving to stabilize the roads and reduce the sediment load to the gut. Drainage infrastructure should be constructed at the time of paving.

Figure 4.4. Roads in the Hope and Carton Neighborhood are unpaved and very steep (left). Runoff from this road bypasses and undermines the paved swale (right).

Seven Flags Road (SB-R-3 and SB-RC-9)

Seven Flags Road is bordered on the east side by commercial land uses. It appears as though this road and commercial properties were built along a historic gut that discharges into Solitude Bay. The unpaved road (approximately 1,000 feet) is experiencing extreme erosion between the commercial properties and the road (see Figure 4.5). The two culverts that receive and discharge flow from Seven Flags Road are significantly blocked with sediment (See Figure 4.6). The eroded gully is actively undercutting the road and threatening the surrounding infrastructure. The 50-acre drainage area consists of steep, paved mountainous roads and residential properties. Six new houses have been built recently just southwest of the commercial properties, further encroaching on the gut (Figure 4.7). In addition, there is a culvert of unknown size and material that is completely blocked on the corner of Cotton Valley Tr. and Seven Flags Rd.

This stretch of road is an ideal candidate for paving and constructing proper stormwater infrastructure. The culverts under East End Rd. and at the corner of Cotton Valley and Seven Flags should be replaced with properly sized pipes. In addition, the gut behind the new houses should be retrofitted into a series of stepped depressions to allow for more storage and reduced velocities to help protect the downstream road and infrastructure.

Figure 4.5. Erosion gullies are undermining the unpaved Seven Flags Rd. (left), scouring around and under existing infrastructure (middle), and creating dangerous public hazards (right).

Figure 4.6. The two culverts that carry flow from Seven Flags Rd. and a portion of East End Rd. to Solitude Bay blocked with sediment on both the upstream (left) and downstream ends (right).

Figure 4.7. New homes were built in the gut upstream from the Seven Flags Rd. erosion (left). The areas behind the houses should be retrofitted to create a series of terraced depressions to help provide more storage and decrease velocities (right).

Fire Station (SB-R-1), Dumpster Site (SB-H-2) and culverts (SB-RC-13 and 14)

The fire station/dumpster site is an ideal location for a demonstration project, since it is a very visible community area, located on the southwest corner of the East End Rd. and Cotton Valley Trail intersection. The dumpster area is an important amenity to the surrounding community since it is the only disposal area in the East End (Figure 4.8). It is also utilized as an informal swap shop where people leave items out for others to reuse. The fire station is located next to the dumpster area to the south in a very flat, grassy area. Just south of the fire station entrance is a bus stop, which is heavily used by the community. A short paved road borders the site to the south and a small, extremely overgrown gut provides the western bound. A pond with a permanent pool of water is just upstream from the site, separated from the gut by the short road. Residents have stated that this pond overflows the road during storm events, causing erosion alongside the road. There is a 24-inch culvert connecting the pond area to the gut that may be corroded and/or blocked on the southern end. The gut ultimately discharges to Yellowcliff Bay via a 30-inch culvert, which is mostly submerged on the downstream end and in need of repair.

The retrofit for the site is comprised of four parts: 1) a bioretention facility located in front of the bus stop to treat runoff from up-gradient roads and to provide an education opportunity with signage (Figure 4.9); 2) a linear bioretention between the fire station property and the dumpster area to manage runoff from the fire station driveway, building, and some of the roadway (Figure 4.9); 3) covered lean-tos for the dumpsters as well as for an official "swap shop" area and educational signage about pollution prevention and the adjacent gut; and 4) repairing/replacing the culverts and stabilizing the gut.

Figure 4.8. The rebuilt dumpster site is an important resource for the community (left). However, the dumpsters are uncovered, overflowing, and located directly adjacent to a gut (middle). Potentially hazardous materials are left in this area (right).

Figure 4.9. The area in front of the bus stop could be retrofitted to manage stormwater from the roadway (left). Stormwater from the fire station could be managed in a retrofitted bioretention system in the existing depression before discharging into the gut behind the property (right).

Blue Water Terrace (SB-R-2) and (SB-H-1)

The Blue Water Terrace is a new (opened in 2010) restaurant, deli, and market in the Sierra Verde neighborhood. It currently has a large unpaved parking lot to the south of the main building, as well as some unpaved parking along the road to the east and in front of the building, to the north. A small gut is located along the west side of the property. Currently, all of the runoff from this site flows in a northeastern direction to the gut, which eventually crosses East End Rd. via a culvert that discharges into Yellowcliff Bay. While there were no signs of major erosion at the site during the field visit, the unpaved parking area is a constant source of sediment to the bay. In addition, this site was identified as a potential hotspot due to an uncovered outdoor cleaning area, uncovered dumpster, and potentially hazardous storage area (see Figure 4.10). Because of the restaurant's proximity to a gut, septic system discharge at the site is also an important concern; however, in order to evaluate the septic system, more information is needed regarding the system's design and performance.

Figure 4.10. Blue Water Terrace has an uncovered area where cleaning products appear to be rinsed (left) and an uncovered dumpster/materials storage area with evident leaking and staining (right).

The proposed retrofit at the site includes directing runoff from the southern entrance and parking area into a bioretention facility constructed in an existing grassy area alongside the gut. In addition, runoff from the roadside parking, the parking in front (north) of the building, and the driveway along the west of the building can be directed into a shallow grass swale leading to a bioretention facility (Figure 4.11). Soils in this area do not appear to be highly infiltrative, so overflow from the bioretentions would flow into the adjacent gut. Since the contributing drainage area is unpaved, these stormwater retrofits would need frequent maintenance (removal of sediment) to ensure long-term viability. Paving of the parking lot and driveways would reduce this sediment source. The hotspot issues at the site should be addressed by educating the staff on the proper pollution prevention procedures related to cleaning products, washwater, and storage of hazardous materials; as well as ensuring that the dumpster is covered at all times.

Figure 4.11. The grassy area in the far left of this photograph is a good location for a bioretention facility for runoff from the parking area (left). This depression on the north side of the building could also be converted to manage stormwater from the property (right).

East End Rd. near Blue Water Terrace Culvert (SB-RC-7)

The gut located along the Blue Water Terrace property joins with another gut and crosses the East End Rd. through a 15-inch RCP (Figure 4.12), where flow enters Yellowcliff Bay between the homes at addresses 22 and 21 Cotton Valley. This culvert appears to be mostly blocked (Figure 4.13), and homeowners have constructed a concrete swale on top of the culvert, seemingly to handle stormwater that flows over East End Rd. onto their property.

Possible options for this site are to 1) create additional storage in the gut upstream of the culvert, allowing sediment to settle out before flowing to the bay; and 2) repair and/or enlarge existing culvert and concrete swale by working with the adjacent homeowners who are affected by this problem.

Figure 4.12. View upstream along one fork of the gut system (left). Concrete headwall for 15-inch reinforced concrete culvert (right).

Figure 4.13. The outlet of the culvert is barely visible from the beach, with a crumbling concrete swale on top of it (left). Better view of the concrete swale constructed to convey runoff that overflows over East End Rd. between two private residences, bypassing the culvert (right).

Ziggy's Island Market (SB-R-4) and Culverts (SB-RC-11, and 12)

Ziggy's Island Market is located near several culverts that eventually discharge into Coakley Bay. One 30-inch culvert crosses underneath Solitude Rd., and then two 30-inch culverts continue under East End Rd. (Figure 4.14). The two 30-inch culverts converge with a 30-inch pipe from a catch basin in front of Ziggy's at a large manhole, where a 48-inch culvert then carries flow approximately 1,000 ft down to the bay. The culvert under Solitude Rd. and the two under East End Rd. often become clogged with sediment flowing down from Solitude Rd. Manhole covers all along the 48-inch culvert have deteriorated, creating safety hazards (Figure 4.15).

Regular maintenance is needed at these culverts to prevent flooding and keep sediment out of Coakley Bay. The manholes along the 48-inch culvert should be repaired as soon as possible. In addition, there is an opportunity to retrofit Ziggy's Island Market in a highly visible location where public education would be possible. As shown in Figure 4.15, a strip of pavement in front of the site could be removed to construct a treatment swale for this drainage area, creating two discrete access points for the market. In this way, sediment and other pollutants could be removed prior to discharging into the existing catch basin.

Figure 4.14. 30-inch culvert under Solitude Rd (left) and two 30-inch culverts under East End Rd., leading to a 48-inch culvert that discharges to Coakley Bay (right).

Figure 4.15. Some pavement could be removed at the gas station to create a treatment swale (shown in green) up-gradient from the existing catch basin indicated with an arrow (left). Manhole covers are missing all along the 48-inch culvert leading out to Coaklely Bay, creating a safety hazard (right).

Coakley Bay Condos (SB-R-5)

The Coakley Bay Condominiums are located on a very steep slope to the south of East End Rd. There are 14 buildings, including a restaurant and a pool, and several parking areas connected by two extremely steep driveways. The existing stormwater management at this site is very minimal, comprised of various shallow, paved conveyance channels along the driveways (Figure

4.16). Some of the runoff is directed into the vegetation on either side of the development, but the majority of runoff is carried down to the entrance and discharged into the shallow roadside swale on the south side of East End Rd. (Figure 4.17). Stormwater retrofits should be implemented throughout this site to direct runoff into stabilized treatment areas along the pavement edges.

Figure 4.16. Coakley Bay condos are located on a steep hillside overlooking Coakley Bay (left). Stormwater is conveyed through the site via paved swales (middle and right).

Figure 4.17. The majority of uncontrolled stormwater from the site flows down to the entrance and then along the edge of East End Rd. (left). This is an area in the southwest corner of the upper parking area where water would puddle after rain events. Small PVC pipes have recently been added to drain this area, creating an ideal location for a retrofit BMP (right).

East End Road - Dirt Road Discharge across from Coakley Bay Condos (SB-R-6 and SB-RC-16)

Runoff from this section of East End Rd. as well as Coakley Bay Condos (see above) should be carried into Coakley Bay via an existing 18-inch RCP culvert (Figure 4.18). However, over time, the roadside swale has filled in, resulting in much of the runoff to flow across East End Rd. and down an unpaved beach access road (Figure 4.19). As a result, this road has severely eroded, rendering it unpassable, and a significant amount of sediment likely transported into Coakley Bay.

The retrofit for this site should include the construction of a stabilized conveyance swale on the south side of East End Rd. to carry runoff down to the culvert (SB-RC-16) instead of the beach access road. The access road itself should be stabilized using large boulders to prohibit vehicular entrance, but encouraging pedestrian access. The existing culvert should be replaced by a new culvert sized properly for the contributing drainage area, and should have a stabilized outlet. In addition, we observed a black plastic pipe discharging dry weather flow into this culvert (Figure 4.18): this pipe should be investigated to find the owner and source of flow.

Figure 4.18. Arrow indicates PVC pipe discharging dry weather flow into culvert (left). Dry weather flow observed at downstream end (right).

Figure 4.19. Runoff from Coakley Bay Condos flows across East End Rd. and down a beach access road (left) causing erosion gullies (middle), and this sediment-laden runoff enters Coakley Bay (right).

Carden Beach (SB-R-7)

This site focuses on the eastern portion of Carden Beach. Currently, runoff from the entrance driveway and half of the western driveway flows across the pavement and down into a grassy depression (wetland?) that was formerly a storage pond (Figure 4.20). This grassy area is also an undeveloped lot. Stormwater flows across the cul-de-sac at the far eastern edge of the site

and into a riprap-lined channel with a sediment forebay that carries flow out to Coakley Bay (Figures 4.21 and 4.22). This channel is experiencing erosion at the downstream end. Residents at the stakeholder meeting indicated that this area has experienced flooding recently due to new construction.

Recommendations for this site are to 1) construct a bioretention facility at the edge of the parking area near the dumpster to treat flows from that area; 2) perform regular maintenance at the sediment forebay in the riprap-channel; 3) stabilize the channel to prevent further erosion along the sides; and 4) protect the existing grassy area from future development, preserving it for stormwater treatment and storage.

Figure 4.20. Stormwater runoff is conveyed across the entrance road with a shallow water bar (left) and continues towards the parking area near the dumpster (middle), eventually, flowing down into a grassy depression that exists in an undeveloped lot (right).

Figure 4.21. Stormwater flows from the grass depression and the cul-de-sac to a riprap-lined channel (left). A sediment forebay was constructed with a rock weir (right).

Figure 4.22. The channel flows directly to Coakley Bay (left). A portion of the downstream end of the channel has eroded (right).

Candle Reef II Condos Cul-de-sac (SB-R-8)

The Candle Reef II Condominiums are located in the west edge of the Solitude Bay watershed. This location is ideal for a demonstration project to not only improve water quality but also help to educate the residents about the East End Marine Park, stormwater pollution, and how they can help reduce land-based sources of pollution to the marine environment. The proposed BMP includes a bioretention area in or around the cul-de-sac providing access to Prune Bay (Figure 4.23).

Figure 4.23. Prune Bay can be seen just beyond this large cul-de-sac near Candle Reef Condos II (left) and the drainage area to the cul-de-sac , consisting of roadway, parking areas, and walkways (right).

Private Road between Sierra Verde and Yellow Cliff North Culvert (SB-RC-2)

An unpaved private road that connects the Sierra Verde and Yellow Cliff Neighborhoods crosses a gut with a drainage area of roughly 60 acres of mostly farmland and low-density residential lots. There are two 24-inch CMP culverts (see Figure 4.24) that are in relatively good condition with little blockage and only slight scouring at the downstream end. The upstream end is a depression that dries out in the dry season. While these culverts are not currently a significant problem, issues could arise if the upstream watershed becomes more developed.

Figure 4.24. Two 24-inch CMP culverts that cross an unnamed road (left). A depression exists at the upstream end that only holds water in the wet season (right).

Pony Club Trail Culvert (SB-RC-3)

The Pony Club Trail culvert is located at a major crossing point of the main gut in this area. It is a 30-inch CMP that appears to be greatly undersized given the large upstream drainage area (450 acres) and resulting large scour hole at the downstream end (15 ft deep, 20 ft wide, and 50 ft long). This is also an area where a great deal of sediment is deposited from the up-gradient Hope and Carton Neighborhood road network (SB-RC-8). Sediment builds up on the road at this low point and is then pushed off into the gut to clear the road (see Figure 4.25). Tire dumping was also observed at the site. The recommended actions at this site are to 1) replace the damaged, undersized culvert with one appropriately sized for the drainage area and gut characteristics; 2) provide a stabilized outfall on the downstream end of the culvert to reduce further erosion in this area; and 3) perform regular road maintenance that removes sediment from the area rather than depositing it directly into the gut. Educational signage in this area could also help reduce dumping.

Figure 4.25. The arrow shows the sediment that gets cleared off Pony Club Trail and pushed into the gut (left). The upstream end of the culvert is clear of debris and is in generally good shape (middle); however, a large scour hole has formed at the downstream end (right).

Cotton Valley Neighborhood Southeast Culvert (SB-RC-4)

The Cotton Valley Neighborhood Southeast Culvert is a 24-inch ductile iron pipe that carries flow from an unnamed gut underneath an unpaved road and discharges to a pond that holds water year-round. This culvert has corroded and deformed over time (see Figure 4.26). This culvert should be replaced by an appropriately sized culvert, and the outlet should be stabilized.

Figure 4.26. The upstream end of this ductile iron culvert is completely blocked (left). The downstream end is corroded and disintegrating (right).

Figure 4.27. Scouring was observed downstream of this culvert (left), which leads to sedimentation of the large pond downstream (right).

Cotton Valley Neighborhood Northeast Culvert (SB-RC-5)

The Cotton Valley Neighborhood Northeast Culvert consists of two 24-inch ductile iron pipes that carry flow from the major gut in this area underneath a partially paved road. These pipes have corroded and deformed over time and have become clogged with sediment and vegetation (see Figure 4.28). A small pond that dries out during the dry season is located upstream from the culverts (Figure 4.29). A scour hole has formed downstream. The road in

this area is deteriorating, creating a sediment source to the gut. The culverts should be replaced by appropriately sized culverts that maintain or increase the amount of storage in the upstream pond system. Regular road and culvert maintenance should be performed in this area to reduce the sediment load into the gut.

Figure 4.28. The two 24-inch ductile iron culverts have damaged trash racks – one made of rebar grate and one made of wire fencing and sticks (left). The downstream end is clogged with vegetation (right).

Figure 4.29. A pond is located upstream from the culverts – dry at the time of observation (left). The road itself is deteriorating and providing a sediment load to the gut (right).

East End Rd. Major Gut East Culvert (SB-RC-6)

The major gut system in this watershed carries flow from an approximately 600-acre area and channels it under East End Rd. through a 30-inch CMP culvert into a private lot at 30 Cotton Valley (Figure 4.30), where it then flows under a private driveway through a 15-inch CMP culvert before discharging to Yellowcliff Bay (Figure 4.31). The resident at 30 Cotton Valley indicated that the now permanent pool of water in the swale is a nuisance, and breeds

mosquitoes. She is eager to have conditions restored to a functioning conveyance system that does not maintain standing water year-round. Runoff from East End Rd., and most likely from the gut itself when it overflows during large storm events, flows into a grassy depression on the south side of the road, and then into a swale and depression on the north side of the road on an adjacent private lot (Figure 4.32). Potential projects at this location include 1) analyzing the existing culverts to ensure they are sized correctly and fix as needed; 2) perform simple maintenance to remove sediment and stabilize outfalls; 3) convert the stagnant swale into a functioning stormwater treatment practice such as a constructed wetland or filtering practice; and 4) convert the grassy area to the south of East End Rd. into a bioretention area to manage road runoff.

Figure 4.30. The gut upstream from the culvert (left). The downstream end of the culvert (middle). Ponded water in the front of a private residence (right).

Figure 4.31. The second culvert underneath a driveway (left) leads to a shallow channel out to Yellowcliff Bay (right).

Figure 4.32. Runoff from the East End Rd. flows into the grassy depression along the south side of the road (left) as well as the swale and depression between and to the left of the driveways, respectively (right).

Solitude Rd. Culverts (SB-RC-10)

The Solitude Rd. Culverts consist of two 30-inch corrugated metal pipes that carry flow from the southern portion of the Pleasant Valley Neighborhood into a gut. These pipes have corroded and deformed over time and have caused substantial erosion along the road in these areas (see Figure 4.32). The culverts should be replaced by appropriately sized culverts and be maintained regularly.

Figure 4.32. Erosion caused by deteriorating culverts in the southern portion of Pleasant Valley.

East End Rd. Culverts - West (SB-RC-15)

The East End Rd. Culverts - West consist of three RCP culverts between Prune Bay and Coakley Bay Condos. The first (starting from the west), an 18-inch culvert, has some downstream scouring that needs to be stabilized. The second, an 18-inch culvert, is deteriorating and needs maintenance to remove sediment and vegetation. The third, a 15-inch culvert, needs maintenance to clear blockages on the upstream end (see Figure 4.33).

Figure 4.33. Erosion downstream from the first culvert (left); the second, chipped culvert (middle); and the partially blocked third culvert (right).

East End Rd. Culvert – East of Coakley Bay Condos (SB-RC-17)

This culvert is a 24-inch RCP culvert that has a large scour hole at the downstream end. The outlet area should be stabilized and a larger culvert may be needed in this area (see Figure 4.34).

Figure 4.34. Upstream end of culvert has large headwall separating it from an unpaved drive (left); the downstream end is scoured out and clogged with vegetation (right).

Seven Flags Neighborhood Culvert (SB-RC-18)

This culvert is a 12-inch CMP culvert that appears to be completely blocked. In addition, the downstream end of this culvert should be located and stabilized. This culvert should have regular maintenance to prevent complete bypass, which would cause further erosion problems down-gradient on Seven Flags Rd. (see Figure 4.35).

Figure 4.35. Blocked inlet to this culvert on Seven Flags Rd.

East End Rd. Culvert - East (SB-RC-19)

The East End Rd. Culvert - East consist of one culvert and two additional pipes near the intersection with Sierra Verde Rd. The main culvert is a 24-inch CMP culvert for road runoff. In addition, two 8-inch PVC pipes were observed, as well as a strong septic odor, at the downstream end of the culvert (see Figure 4.36). The ultimate discharge to Yellowcliff Bay was not observed. The PVC pipes should be inspected for illicit discharges from upstream septic systems and disconnected as necessary.

Figure 4.36. Upstream end of 24-inch culvert and headwall; Sierra Verde Rd. in the background (left); the two PVC pipes in the drainage structure at the downstream end of the culvert (middle); and the ultimate discharge pipe to the bay where runoff leaves the drainage structure (right).

4.3 Neighborhood Summaries

A summary of general neighborhood conditions is provided below in order to identify which neighborhoods are likely to generate pollutants of concern, what the common sources are, and which areas/sources should be targeted for watershed stewardship activities. Unless otherwise noted, it is assumed that neighborhoods consist of single-family, detached residences, with cisterns, on-site septic systems, and open section/drainage roads (without curb and gutter). Table 4.4 is a comparative summary of each neighborhood, and more detail is provided below. Pollution source is determined by number of observed pollutants (1-2=Medium; >2 = High).

Table 4.4. Summary of Neighborhood Restoration Opportunities

Name	Road/ Driveway Condition	% Lots Un-developed	Pollution Source	Potential Stewardship Activities
Sierra Verde	Mixed, mostly paved; good/mostly good condition	60%	Low	On-lot demonstrations; regular road maintenance of the unpaved roads
Yellow Cliff North	Mixed, mostly unpaved; significant maintenance issues	65%	Medium	Regular road maintenance
Hope and Carton Hill	Unpaved; most road sections need attention	60%	High	ROW retrofits; road repair and regular road maintenance; riparian buffer protection
Cotton Valley	Mixed, mostly paved; some road sections need attention	60%	High	Trash clean-up; regular road maintenance; riparian buffer protection; septic survey
Solitude North	Mixed, mostly paved; good/mostly good condition	70%	Low	Residential construction management
Seven Flags	Mixed, mostly paved; good/mostly good condition	50%	Low	On-lot demonstrations; road repair and maintenance for unpaved portion; ROW retrofits
Pleasant Valley	Mixed, mostly paved; good/mostly good condition	60%	Low	Better lawn care/landscaping; on-lot demonstrations; ROW retrofits; riparian buffer protection
Green Cay/ Prune Bay	Mixed, mostly paved; some road sections need attention	45%	Low	Better lawn care/landscaping; on-lot demonstrations; ROW retrofits; regular road maintenance of the unpaved roads

Sierra Verde

The Sierra Verde neighborhood (approximately 85 acres) is the eastern-most neighborhood within the Solitude watershed. The neighborhood is accessed primarily by East End Rd. to the north. The neighborhood sits upon a steep hilly area, reaching up to about 370 feet in elevation at the steepest points. About 40% of the neighborhood is developed, and many homes are gated and set back from the street. At the northern entrance to the neighborhood, and base of the neighborhood's hill, the recently established Blue Water Terrace restaurant is located at the intersection of East End Rd. and Sierra Verde Road (The Blue Water Terrace Restaurant is discussed as a retrofit project under Section 4.3).

Roadways within the neighborhood are a mix of paved and dirt/gravel. Driveways are mostly paved; however, the parking lot of the Blue Water Terrace restaurant is dirt. The main road is open section, with some water bars, and at least one identified culvert. The paved roads are in good condition; although, significant erosion was observed on the dirt roads, contributing sediment to the neighborhood's low-point near the Blue Water Terrace restaurant. A gut was identified, which flows from the south-eastern portion of the neighborhood, through the neighborhood, and eventually towards the Cotton Valley neighborhood. A separate, but potentially connected gut, was also identified at the northwestern end of the neighborhood, which parallels Sierra Verde Road, and is adjacent to the Blue Water Terrace restaurant.

Figure 4.37. Erosion along private road within Sierra Verde neighborhood at meeting point between paved and gravel roadways (left) and water bar installed along main dirt road in Sierra Verde neighborhood.

Yellow Cliff North

The Yellow Cliff North neighborhood is a small (approximately 20-acre) residential area, sandwiched between the Sierra Verde, Cotton Valley, and Hope and Carton Hill neighborhoods. The neighborhood is generally comprised of a horseshoe shaped road, Yellow Cliff Trail and Hibiscus Circle/Dustie Rhode. The neighborhood is characterized by topography ranging from 100- to 200-foot elevations. Homes in the neighborhood are single-family detached homes on about an acre of land. Most of the neighborhood is unpaved, although a small section of the roadway is paved. Erosion was observed along the dirt roads and driveways, which has caused some substantial gullies.

Hope and Carton Hill

The approximately 100-acre Hope and Carton Hill neighborhood is made up of mostly dirt/gravel roads and is about 40% developed, with single-family detached homes on one-acre lots. The neighborhood is primarily accessed by Pony Club Trail through the Cotton Valley neighborhood, which is located off of East End Rd. There is also an entrance from the east via the Sierra Verde neighborhood. The neighborhood has an active Homeowners Association (HOA), and at the time of this report, the Chairman of the HOA was Josh Tate. Mr. Tate suggested that the dirt roads are graded on at least an annual basis. The HOA has hired multiple contractors for the grading over the last several years and has been having trouble finding a contractor that grades the roadways properly. The HOA has also been having trouble with receiving payment from members, which according to Mr. Tate, has also led to the HOA being unable to afford adequate grading or paving services.

There is a Pony Club and associated horse pasture within the northwestern portion of the Hope and Carton Hill neighborhood. The horse pasture lies within a gut that flows from the west, along the northern end of the neighborhood and crosses Pony Club Trail through a culvert, and eventually flows north to Yellowcliff Bay. Sizing and maintenance issues were observed at the Pony Club Trail culvert, and there was a significant scour hole on the downstream end of the culvert (The Pony Club Trail culvert is discussed as a retrofit project under Section 4.3).

Figure 4.38. Concrete swale installed along dirt road in Hope and Carton Hill neighborhood (left) and erosion along dirt road where a paved swale ends (right).

Cotton Valley

The 140-acre Cotton Valley neighborhood is located off East End Rd. There is a Fire Station and adjacent public dumpster area at the entrance to the Cotton Valley neighborhood located at the intersection of Cotton Valley Trail and East End Rd. The roadways are a mix of paved and unpaved roads. The neighborhood is 40% developed; homes within the neighborhood are single-family detached on an average of ½-acre lots.

Two portions of the neighborhood, the western side and the central/eastern side, are distinct from each other with respect to road layout design, topography, and roadway surfacing. The western end of the neighborhood is comprised of a long dirt/gravel road, which remains largely undeveloped. This roadway cuts across a steep slope, where topography on the adjacent lots varies from about 150 to 300 feet in elevation. One gut parallels this road to the southeast for almost the entire length, and a second gut crosses the road on the northern end. This roadway is significantly eroded and is a sediment source to the adjacent guts.

The central/eastern side of the neighborhood is comprised of multiple dirt/gravel and paved roads in somewhat of a grid layout. The topography on this side of the neighborhood is much flatter, with elevations ranging from about 20 to 80 feet. Both aforementioned guts also transect the central/eastern side of the neighborhood from south to north, eventually crossing East End Rd. and discharging to Yellowcliff Bay. Some culverts were identified within this area of the neighborhood where the guts cross roads. It was observed that horses are kept on at least one of the small residential lots.

The gut on the western side of the neighborhood flows behind the Fire Station and adjacent public dumping area. Trash and debris were observed within this gut. A representative at the Fire Station noted that the station has experienced some flooding in recent years. He also suggested that the Fire Department would be interested in education related to how they should manage the areas adjacent to the gut. There is also great interest in getting the Fire Department more involved with the community, constructing demonstration projects on the property, and perhaps hosting public meetings.

Three pond areas were also observed within the neighborhood, two of which had standing water. One of the ponds with standing water was located along the gut on the western side of the neighborhood, and the other was located along the gut on the eastern end of the neighborhood. Wildlife, such as deer and waterfowl, were observed at both ponds.

Figure 4.39. Horse kept on private lot (left) and pond with standing water (right) within Cotton Valley neighborhood.

Solitude North

The approximately 55-acre Solitude North neighborhood is set atop a hilly peninsula located to the north of East End Rd., terminating at the coastline of Solitude Bay. The neighborhood is comprised of two distinct road networks: one to the west, which is primarily dirt/gravel; and one to the east, which is primarily paved. The neighborhood, which is made up of single-family detached homes, is only about 30% developed, and most of the lots are over an acre in size. Most of the roadways within the neighborhood are considered to be in very good condition; however, there are a few dirt road segments which could use maintenance.

Seven Flags

The approximately 120-acre Seven Flags neighborhood is accessed primarily off East End Rd. via Seven Flags Road. The neighborhood is about 50% developed and is currently comprised of single-family detached homes on lots over one acre in size. There are a few large industrial/commercial properties located at the entrance to the neighborhood, at the intersection of East End Rd. and Seven Flags Road. Current tenants or uses of these properties include a self-storage facility, Budget Marine boat and marine equipment retailer, and a tile storage area, among others.

Topography within the neighborhood varies greatly from about 30 feet in elevation at the northernmost end to about 810 feet in elevation at the southern terminus, which is one of the highest points on the East End of St. Croix. There is a gut that transects the neighborhood and flows parallel to Seven Flags Road.

Roadways within the Seven Flags neighborhood are a mix of paved and unpaved roads. The approximately 1,000-foot road segment of Seven Flags Rd. at the entrance from East End Rd. is unpaved and is significantly eroded. There are two partially clogged culverts at the intersection of Seven Flags Rd. and East End Rd. The owner of the Seven Flags Rd. industrial properties has also installed large concrete culverts beneath their driveways to divert drainage off the road and driveways and through these culverts. Despite these drainage facilities, the roadway is significantly eroded and contains large gullies. Roadway conditions are much better throughout the rest of the neighborhood.

Figure 4.40. View from Rt. 82 south of dirt portion of Seven Flags Road (left) and new single family dwellings constructed along steep paved portion of Seven Flags Road (right).

Figure 4.41. View from paved road within Seven Flags neighborhood (left) and posted Neighborhood Watch sign and Earth Change permit (right).

Pleasant Valley

The Pleasant Valley neighborhood is accessed via Solitude Road, which is off East End Rd. It is comprised of single-family detached homes on approximately one-acre lots. Topography in the neighborhood ranges from about 60 feet in elevation up to 500 feet in elevation. Most of the roadways are paved, with just a few sections being gravel. The roadways are generally in good condition, and culverts have been installed at a few locations at the southern end of the neighborhood. There were some observed sizing and maintenance issues with these culverts that should be repaired. These culverts are further discussed under Section 4.3. Without including the Roebuck Goat farm, which is a large agricultural property located adjacent to Solitude Road, the neighborhood is about 75 acres. About 40% of the residential lots have been developed. In addition, there is a large undeveloped parcel on the southwestern end of the neighborhood where a paved roadway has been constructed. Signs at the entrance to this parcel indicate that it is a new subdivision, "Estates Solitude." There is a gut that flows through the Pleasant Valley neighborhood from south to north. Some clearing and farmland activity were observed in the gut area.

Figure 4.42. Single-family home built on steep slope within Pleasant Valley neighborhood (left) and paved Solitude Rd. adjacent to Roebuck Goat Farm in Pleasant Valley neighborhood (right).

Figure 4.43. Entrance to undeveloped Estate Solitude Ridge subdivision (left) and paved roadway within undeveloped Estate Solitude Ridge subdivision (right).

Green Cay (Prune Bay)

The approximately 100-acre Green Cay neighborhood is situated between East End Rd. and Prune Bay. The neighborhood is accessed by Ms. Bea Road. Topography varies from 0 to about 200 feet in elevation, but most developed areas are relatively flat. The neighborhood is about 50% developed, with mostly single-family detached dwellings on one-acre lots. There is also a condominium complex, Candle Reef I and II, located within the neighborhood on the northeastern end adjacent to Prune Bay. Roadways within the neighborhood are mostly paved, with some sections of unpaved roads. The paved roads are in good condition; although, there are some unpaved areas that could use maintenance. There are also some gravel spurs that focus drainage from the roadways directly to the beach, creating an active sediment source to the Bay.

Figure 4.44. Entrance to Green Cay neighborhood (left) and manicured grass field within the neighborhood; high-end residential properties on peninsula within the community with Prune Bay in the distance (right).

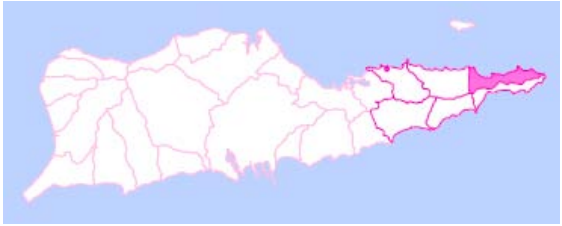
Figure 4.45. Entrance to Candle Reef condominium complex (left) and paved road leading to condominium units (right).

5.0 Teague Bay Watershed

This section summarizes baseline information specifically for the Teague Bay Watershed and includes a description of the unique watershed features, a summary of existing water quality conditions, descriptions of potential restoration sites investigated during field assessments, and neighborhood descriptions. Table 5.1 summarizes basic watershed features.

Appendix A contains a basemap of the Teague Bay watershed depicting locations of water quality impairments, roads, hydrology, topography, and potential restoration sites.

Table 5.1. Watershed Summary



Drainage area[1]	1021 acres; 1.6 sq miles
Length of guts[2]	0.8 miles
Road length[2]	10.4 paved miles; 6.6 unpaved miles
# Road culverts[2]	25 mapped culverts
Impervious Cover[3]	84 acres; 8%
Dominant land use %[4]	Undeveloped: 44%
	Park/Open Space: 34%
	LDR: 12%
Area within 100-yr floodplain[5]	165 acres; 16% of watershed
# Small ponds[4]	7 (this includes 3 unmapped ponds on the golf course)
# Mapped wells[6]	9 (plus a rain gauge)
Watershed erosion potential[7]	Vulnerability: High
	Road-based: High
	Mean Relative: High
2010 WQ Impairments[8]	2 of 3 assessment units impaired

[1] IRF/UVI/USGS 2001 watershed boundaries
[2] HW revised/or created, 2011
[3] NOAA CSC, CCAP data, 2005
[4] UVI-CDC data 2003 (land use) and 2001 (ponds)
[5] DPNR, dated 2005
[6] Received from DPNR Feb, 2011
[7] WRI/NOAA, 2005
[8] DPNR, 2010 Integrated Waters Report

5.1 General Description

The Teague Bay watershed is in the northeastern portion of the East End watersheds and Point Udall is considered the eastern-most point in the U.S. Atlantic coast and the most arid region of St. Croix. Annual rainfall for this part of the island is less than 30 inches/year. The East End was designated as an Area of Particular Concern in 1979.

Land Use

The watershed's main access road is the East End Rd. (Rt. 82), which runs east/west along the northern coast to Point Udall. Most of the watershed is steep terrain, except for the northwestern coast. Land use in the western portion of the watershed consists of a large goat farm, low density residential areas, the St. Croix Yacht Club, and the Reef golf course. There are two distinct condominium units in the golf course. Much of the eastern portion of the watershed is park/open space including Cramer Park and the lands associated with Point Udall and East End Bay. The southern ridge line is shared with Turner Bay. There are a number of impoundments in the watersheds, three at Skov goat farm and three on the golf course.

There are several single family neighborhoods in the watershed: Hilltop Circle, the residences along Maggie Hill Rd., the Mooring Rd. neighborhood, and a portion of Catherina's Hope. There are two multi-family condominiums: the Reef Golf Condos (Section 1 and Section 2) and the

Villa Madeline. Commercial properties of interest include Reef Golf, Duggan's Restaurant, and St. Croix Yacht Club. Like the rest of the East End, there are no central sewer lines located in the watershed; therefore residential and small commercial areas rely on individual on-site septic systems, with small package plants used at resorts and condos, as at Reef Golf.


Figure 5.1. Overlooking Teague Bay and the St. Croix Yacht Club (left); Point Udall view of Buck Island (right).

Water Quality

Of the three ambient water quality assessment units associated with this watershed, two are listed in the 2010 Integrated Waters Report (DPNR, 2010) as impaired. UVI is conducting sedimentation studies at Boiler Bay.

Table 5.2: Water Quality Impairments (derived from DPNR, 2010)

Assessment Unit ID/Name	Monitoring Station Name	Impairment	Source of Impairment	TMDL (Priority)
VI-STC-39 / Teague Bay (STC-8 Reef Club Beach; STC-9 St. Croix Yacht Club Beach;	VI11381319 Teague Bay/Reef)	Dissolved Oxygen, Turbidity, pH, Fecal Coliform	Highway/Road/Bridge Runoff (Non-construction Related)	Low/2027
VI-STC-40 / Teague Bay Backreef	STC-10 Cramers Park; VI351774 Cramers Park	Turbidity, pH, Fecal Coliform	Highways, Roads, Bridges, Infrastructure (New Construction), Marina/Boating Sanitary On-vessel Discharges	Low/2027
VI-STC-43 / Solitude & Teague Bay subwatersheds, offshore	(N/A)	(N/A)	(N/A)	(N/A)

5.2 Potential Watershed Restoration/Project Sites

A number of specific sites were identified by project partners, local residents, and field assessment teams as potential sources of pollution or as drainage improvement opportunities. Table 5.3 summarizes candidate projects to be considered during the watershed planning process. A more detailed description of existing conditions and potential opportunities at these sites is provided below.

Table 5.3. Summary of Candidate Restoration/Project Sites

Project ID/Site Name[1]	Description	Initial Ranking
Gut/Pond Restoration		
Gut at Reef Golf (TB-GR-1)	Gut on western boundary of fairway has significant bank failure and downcutting; source of sediment to downstream culverts and waters.	High
Road Improvements		
Ridge Rd. at Rte. 82 (TB-RC-3)	Large gullies and erosion observed on first segment of roadway; significant source of sediment accumulating at base of road. Candidate for paving.	High
Goat Hill Rd./TNC (TB-RC-4)	Install water bars along road to avoid sheet flow and direct stormwater to swale along Route 82. Create breaches in dirt berm on roadside.	High
Stormwater Retrofits		
East End Beach Parking (TB-R-1)	Unrestricted vehicle access to beach causing erosion and gullying and is source of sediment to beach. Install vehicle barrier to limit to foot traffic.	High
St. Croix Yacht Club (TB-R-2)	Stormwater sheet flows over parking, boat storage, and operational areas. High erosion and source of sediment to nearshore waters. Construct swales and rain garden.	Medium
Reef Golf Course (TB-R-3)	Gut erosion has occluded downstream culverts. Replace culverts, construct micropools, low flow channels, and a wetland marsh system/ area to receive water from gut.	High
Culvert Maintenance and Repair		
Duggan's Entrance (TB-RC-1)	Culvert crossing entry drive is occluded. Replace with larger box culvert.	Medium
Culvert at Reef Admin. Building bisecting Rte. 82 from gut to Duggan's (TB-RC-2)	Culvert inlet/headwall completely buried from gut sediment and outlet completed crushed and rusted. Relocate and replace with larger box culvert.	High
[1]ID matches basemap locations and field sheets in the Appendix		

Skov Goat Farm Ponds (TB-ID)

The Skov property is undeveloped, except for the houses/structures at the top of the driveway and barns/sheds housing the goats. The issues identified for this property consisted of accelerated erosion from a gut draining into the upper pond (see Figure 5.2). In addition, while

the vegetation on the property is clearly affected by the grazing of the goats, erosion of the property itself appeared to be minimal. The farm ponds have limited capabilities to hold water, with the down-gradient pond being more permeable the up-gradient pond. Future management would require installation of either a clay or synthetic liner. There has been previous discussion on techniques to better manage erosive hillside runoff from Buena Vista Rd. by stabilizing drainage outlets and installing erosion control checks along the flow path.

Figure 5.2. Skov farm ponds. The pond on the left is leaking, the one on the right is receiving sediment from hillside erosion.

Reef Golf Course (TB-R-3, TB-GR-1, TB-RC-1, TB-RC-2)

Reef Golf is located along East End Rd. (Route 82) at Teague Bay. The property currently supports a nine-hole golf course, driving range, two sections of condominiums, a winding series of paved curbed roadways, administrative building, small clubhouse, and parking. A series of three water features are located on the fairway, which collect all roof runoff via piping from the gutters that run beneath the golf course. These ponds also receive a portion of stormwater collected by a large catch basin semi-enclosed with a headwall and flared concrete wingwalls located in the fairway southeast of the ponds as well as sheet runoff from Maggie Hill Rd. and the condominium areas. The ponds are connected to one another via culverts and spillways and provide a source of water for irrigating the fairways, greens, and landscaping. The lowest pond in the series also receives treated wastewater effluent from the Reef's treatment facility which is discharged via irrigation waters onto the golf course.

A gut along a steep valley wall on the western boundary of the fairway flows north to a culvert beneath East End Rd., immediately west of the Reef administrative building. The drainage area to this gut is comprised of agricultural lands (from the Skov farm) as well as residential neighborhoods. The culvert inlet (24" CMP; TB-RC-2) and headwall at East End Rd. have been completely buried by sediment conveyed through the gut and outlet of this culvert is also rusted and crushed and needs to be replaced. The gut is severely eroded along the right bank and significant downcutting was also observed. The average channel width was three to four feet along the base and eight to twelve feet along the top with an average riparian width of less than 25 feet. If this gut continues to erode, it will pose a threat to the surrounding property

and Reef Golf infrastructure. The erosion and sediment loading have already resulted in the failure and total impairment of the culvert downstream that crosses East End Rd. If the right (east) bank of this gut were breached, it would flow onto the fairways and greens of Reef Golf.

In order to prevent further erosion of the gut and sediment loading down-gradient, the banks of the gut could be regraded and stabilized with soil amendments and suitable vegetation that would establish within the arid soil. The installation of a series of check dams within the channel would decrease the velocity of flow through the channel, thereby reducing the potential for further erosion and sedimentation. Flows up-gradient from the current erosion area could also be diverted to a new water feature within the western fairway. The culvert beneath East End Rd. will also need to be replaced and relocated slightly and will flow into a potential constructed wetland (see description below Figure 5.3).

Figure 5.3. One of three golf course ponds (top left) covered in highly invasive water hyacinth; eroded gut along western edge of Reef property (top right); potential location for constructed wetland retrofit (bottom left); and parking lot retrofit location at Duggan's (bottom right).

Duggan's Restaurant Entrance Rd. Culvert (TB-RC-1)

A 22-inch, single-barreled, ductile iron culvert is located beneath the entry drive at Duggan's Restaurant. The culvert is in a state of disrepair and needs to be replaced. The culvert is partially filled with sediment and is causing problems both upstream and downstream. There is

evidence of sediment deposition along with a downstream scour hole and failing embankments. Potential steps to restore this failing culvert include replacing the existing pipe and headwall with a much larger box culvert and constructing micropools at the inlet and outlet of the culvert. A low flow meandering wetland channel is also proposed.

St. Croix Yacht Club (TB-R-2)

The St. Croix Yacht Club is located on the north side of Route 82 on Teague Bay. A clubhouse and storage shed are located along the beach front. The paved entry drive leads to four paved parking bays, all with turf parking spaces. The areas surrounding the clubhouse and parking lot are designated for boat storage and maintenance activities and are primarily in turf with eroded, unimproved dirt roadways. Stormwater currently drains from the roadway and other up-gradient areas over-land through the boat storage and parking space to a channel immediately west of the clubhouse. Trash, debris, and significant erosion exposed soils were observed. The eroded areas and exposed soils could be restored and stabilized with soil amendments or gravel (Figure 5.4). The construction of a road-side swale would facilitate the flow of runoff into a proposed sediment forebay structure adjacent to the existing gut channel. The sediment forebay would increase the on-site stormwater storage capabilities and greatly improve water quality by reducing the amount of sediment and marine/boat associated toxins and debris reaching the nearshore waters.

Figure 5.4. Drainage from a large portion of the watershed comes through this swale (top left); Stormwater flows overland across unvegetated/muddy boat storage/parking areas (top right and bottom photos).

East End Rd. Beach Parking (TB-R-1)

This area provides informal unpaved parking and beach access at Boiler Bay. A series of rusted guardrails were originally installed to restrict vehicular access for two paths to the beach. The eastern path (Figure 5.5) no longer has a vehicular barrier and serves as a roadway in lieu of a footpath. Vehicles have widened and compacted the soils over time, significantly increasing erosion and sediment delivery to the nearshore waters. This source of sediment could be easily remediated through the installation of a new guardrail or other barrier at the entrance to the eastern access way. Some of the existing eroded ruts and gullies could be backfilled with a suitable soil or gravel.

Figure 5.5. Open guardrail off East End Rd.

Cramer Park

No significant drainage problems or obvious pollution sources were observed at Cramer Park, though project partners mentioned the potential to test an alternative septic system at park restrooms. A concrete stormwater swale bisects East End Rd. and conveys stormwater along the eastern end of Cramer Park, but was not deemed an erosion or sediment source. At the time of the field reconnaissance, no trash or debris were observed. Trash receptacles were present in multiple locations at the park.

Goat Hill Rd./TNC (TB-RC-4)

Goat Hill Rd. is located along the south side of East End Rd. (Rt. 82) across from Cramer Park and immediately east of the base array telescope located on lands owned by The Nature Conservancy (TNC). Goat Hill Rd. begins at the base of the hill on East End Rd. and traverses up the hill through a series of switchbacks up and over the ridge line. The road is an unimproved dirt roadway. The base of the road is owned by the Department of Housing, Parks, and Recreation and the remainder (after the first hill break) is owned by TNC. Unauthorized road maintenance and access improvements were conducted by others in the fall of 2010. This resulted in substantial widening of the road to nearly twice its previous width and the creation of a dirt/gravel berm on the valley side of the roadway. This berm prevents stormwater from flowing off the road and instead directs it within the graded area of the road. Large portions of the road are highly eroded with deep ruts and gullies. At the base of the road, stormwater generally flows west into a shallow swale and then into a concrete swale that crosses East End Rd. to Cramer Park. This road may serve as a primary source of sediment into Cottongarden Bay (Figure 5.6).

A series of minor, low maintenance improvements could be conducted along Goat Hill Rd. Multiple water bars and outlets (i.e., breaches in the dirt berm on the road shoulder) would

reduce the velocity of the water and redirect flows into the forested valley for infiltration and sediment attenuation. This would also alleviate the potential for flooding and pooling at the base of Goat Hill Rd. along East End Rd.

Figure 5.6. View of Cottongarden Bay from the Goat Hill Rd. (left); the base of Goat Hill Rd. (photo courtesty of TNC and UVI) (right).

Ridge Rd. at East End Rd. (TB-RC-3)

The lower portion of Ridge Rd. immediately off East End Rd. (east of Reef Golf) is unpaved and severely eroding along the first segment of road up to the first switchback (Figure 5.6). Sediment was observed to be accumulating at the base of Ridge Rd. at East End Rd. This section of Ridge Rd. is a candidate for paving to alleviate erosion. The remainder of Ridge Rd. (up-gradient) is paved. The installation of water bars or paving are options to control the flow of runoff and reduce erosion.

Figure 5.7. Gullying and erosion observed along Ridge Rd.

5.3 Neighborhood Summaries

A summary of general neighborhood conditions is provided below in order to identify which neighborhoods are likely to generate pollutants of concern, what the common sources are, and which areas/sources should be targeted for watershed stewardship activities. Unless otherwise noted, it is assumed that neighborhoods consist of single-family, detached residences, with cisterns, on-site septic systems, and open section/drainage roads (without curb and gutter). Table 5.4 is a comparative summary of each neighborhood, and more detail is provided below. Pollution source is determined by number of observed pollutants (1-2=Medium; >2 = High).

Table 5.4. Summary of Neighborhood Restoration Opportunities

Name	Road/ Driveway Condition	% Lots Un-developed	Pollution Source	Potential Stewardship Activities
Hilltop Circle (TB-RES-1)	Mixed, Mostly Paved/Good Condition	<50%	Low	No Action
Reef Condos (TB-RES-2)	Paved, Curbed/Good Condition	0%	Low	No Action
Catherina's Hope (TB-RES-3)	Mixed, Mostly Paved/Good Condition	<60%	Low	Single, residential construction site management

Hilltop Circle/Hummingbird Rd. (TB-RES-1)

The Hilltop Circle/Hummingbird Rd. neighborhood (approximately 55 acres) is the eastern-most neighborhood within the Teague Bay watershed. One portion of the neighborhood is accessed either by Hummingbird Rd. on East End Rd. or from Rt. 60 to the south. The remaining residences are located on Hilltop Circle, accessed by Ridge Rd. via Rt. 60. The neighborhood sits atop a steep hilly area, reaching up to about 380 feet in elevation at the steepest points. About 50% of the neighborhood is developed, and many homes are gated and set back from the street. Roadways within the neighborhood are a mix of pavement (40%) and dirt/gravel (60%) and driveways are mostly paved. Hilltop Cir. and Hummingbird Rd. are open section, with some water bars, and at least three identified culverts. The paved roads are in good condition and the dirt roads were observed to be very stable with little to no erosion.

Reef Golf Condominiums (TB-RES-2)

The Reef Bay Condominiums are comprised of both Section 1 and Section 2 condo units (approximately 6 acres and 9 acres, respectively) located above the golf course. The Section 1 condo units are one-bedroom residences, located in the southeast corner of the property, immediately below Maggie Hill Rd. The Section 2 condos are two-bedroom units and are located immediately south of the fairway atop a small hill. This condominium community is the only one entirely within the Teague Bay watershed. This residential area is accessed via a small gatehouse and private drive off East End Rd.

Roadways within the condominium complexes are entirely paved and curbed and in good condition. Road runoff is diverted through gutters and catchments to the ponds within the fairway, along with all roof runoff, which is piped from the gutters through an underground drainage network to the ponds. There is a small gravel parking area at the outdoor pool at the Section 2 condos. Average lot cover is approximately 20% turf, 25% landscaping, 40% rooftop, and 15% driveway and walkways. All sewage is directed to an on-site small package treatment plant located on the north side of East End Rd., immediately east of Duggan's Restaurant. This residential community is not a source of pollutants and/or sediment and no recommendations are suggested.

Figure 5.7. View of Section 2 condos from golf fairway.

Catherina's Hope (TB-RES-3)

The Catherina's Hope neighborhood (approximately 90 acres) is the western-most neighborhood within the Teague Bay watershed, and is also partially located within the Solitude watershed. The neighborhood is accessed either by Sierra Verde Rd. or East End Rd./Rt. 82. The neighborhood sits on a steep hilly area, and reaches about 5000 feet in elevation at the steepest points. About 40% of the neighborhood is developed, and many homes are gated and set back from the street.

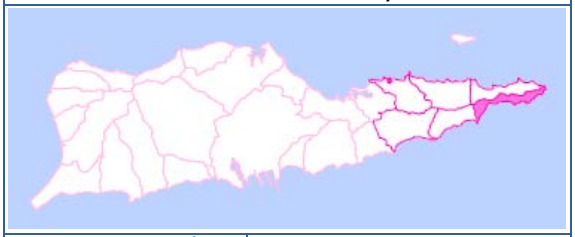
Roadways within the neighborhood are a mix of paved and dirt/gravel. The majority of the main access roadway is in the process of being paved with concrete. The roads are open section, with no identified water bars or culverts. The paved roads are in good condition; minimal erosion was observed for the dirt roads.

6.0 Turner Hole Watershed

This section summarizes baseline information specifically for the Turner Hole watershed and includes a description of the unique watershed features, a summary of existing water quality conditions, descriptions of potential restoration sites investigated during field assessments, and neighborhood descriptions. Table 6.1 summarizes basic watershed features.

Appendix A contains a basemap of the Turner Hole watershed depicting locations of water quality impairments, roads, hydrology, topography, and potential restoration sites.

Table 6.1. Watershed Summary



Drainage area[1]	714 acres; 1.1 sq miles
Length of guts[2]	0.3 miles mapped
Road length[2]	7.0 paved miles; 3.6 unpaved miles
# Road culverts[2]	9 mapped culverts
Impervious Cover[3]	70 acres; 10%
Dominant land use %[4]	Undeveloped: 66%
	LDR: 17% %
	Park/Open Space: 10%
Area within 100-yr floodplain[5]	80 acres; 11% of watershed
# Small ponds[4]	3
# Mapped wells[6]	4 (plus a rain gauge)
Watershed erosion potential[7]	Vulnerability: High
	Road-based: High
	Mean Relative: High
2010 WQ Impairments[8]	Two impaired areas subject to TMDLs

[1] IRF/UVI/USGS 2001 watershed boundaries
[2] HW revised/or created, 2011
[3] NOAA CSC, CCAP data, 2005
[4] UVI-CDC data 2003 (land use) and 2001 (ponds)
[5] DPNR, dated 2005
[6] Received from DPNR Feb, 2011
[7] WRI/NOAA, 2005
[8] DPNR, 2010 Integrated Waters Report

6.1 General Description

The Turner Hole watershed is in the southeastern portion of the East End watersheds and Point Udall is considered the eastern-most point on the U.S. Atlantic coast and the most arid region of St. Croix. Annual rainfall for this part of the island is less than 30 inches/year. Turner Hole is part of the East End APC that was designated in 1979 and adopted in 1991. The watershed drains to East End, Issac, Jack, and Grapetree Bays. There were no mapped guts in this watershed, based on the data provided by DPNR; however two small reaches were added after 2011 field assessments.

Land Use

The watershed's main access road is the South Shore Rd. /Rt. 60. Most of the watershed is very steep terrain with small low-laying portions of land along the south coast. Turner Hole has the highest percentage of watershed impervious cover than all other East End watersheds and has relatively high erosion potential. Land use in the western portion of the watershed consists of low density residential areas, Divi Carina Bay Resort and Casino, and the Villa Madeline condominium complex. The majority of the eastern portion of the watershed is park/open space and the lands associated with Point Udall and East End Bay. In fact, Turner Hole has the second highest overall percentage of watershed open space next to Madam Carty. Much of the open land is maintained by The Nature Conservancy (TNC). A low-density residential area is also located within the central portion of Turner Hole above Grapetree Bay.

Single family neighborhoods in the watershed are limited to Grapetree Bay. There is one multi-family condominium complex: Villa Madeline. Commercial properties of interest include Divi Carina Bay Resort and Casino and a small miniature golf course. Like the rest of the East End, there are no central sewer lines located in the watershed; therefore residential and small commercial areas rely on individual on-site septic systems, with small package plants used at resorts and condos.

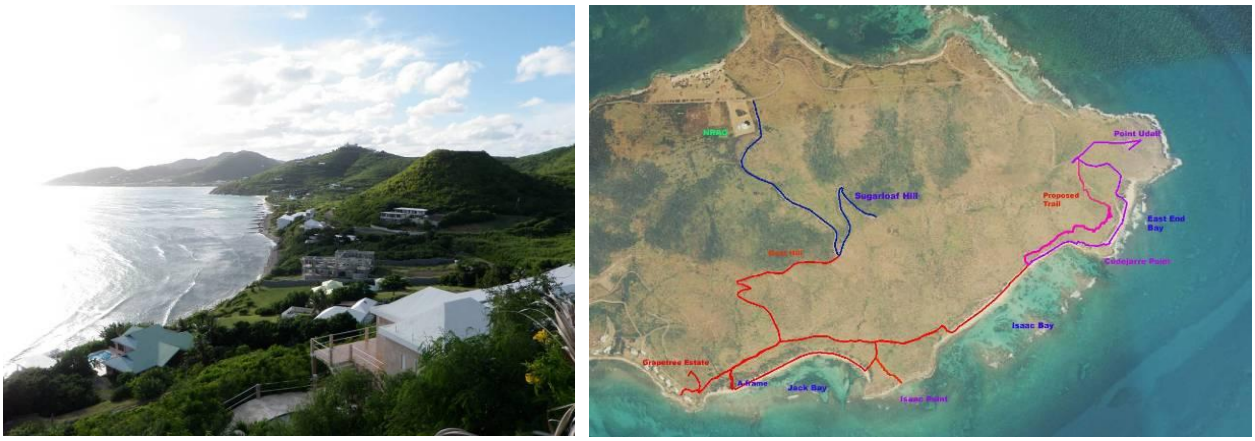


Figure 6.1. Looking west across Grapetree Bay and the Turner Hole watershed (left). The system of TNC hiking trails to Turner Bay beaches (right).

Water Quality

There are five water quality assessment units associated with this watershed, and two are currently listed in the 2010 Integrated Waters Report (DPNR, 2010) as impaired for Erosion and Sedimentation. VIRC&D is conducting sedimentation studies at East End Bay Trail with NOAA funding as part of the trail restoration project completed in 2011.

Table 6.2. Water Quality Impairments (from DPNR, 2010)

Assessment Unit ID/Name	Monitoring Station Name	Impairment	Source of Impairment	TMDL (Priority)
VI-STC-44 / Northeast St. Croix HUC14, offshore	STC-OFF8 North-3	(N/A)	(N/A)	(N/A)
VI-STC-45 / Isaac Bay	None	(N/A)	(N/A)	(N/A)
VI-STC-46 / Grapetree Bay	STC-11B Isaacs Bay Forereef	Dissolved Oxygen	Erosion and Sedimentation	Low/2029
VI-STC-47 / Turner Hole Backreef	STC-12 Grapetree Beach; VI297470 Grapetree Beach	Turbidity	Erosion and Sedimentation	Low/2029
VI-STC-48 / Turner Hole subwatershed, offshore	STC-OFF5 East-2	(N/A)	(N/A)	(N/A)

6.2 Potential Watershed Restoration/Project Sites

A number of specific sites were identified by project partners, local residents, and field assessment teams as potential sources of pollution or as drainage improvement opportunities. Table 6.3 summarizes candidate projects to be considered during the watershed planning process. A more detailed description of existing conditions and potential opportunities at these sites is provided below.

Table 6.3. Summary of Candidate Restoration/Project Sites

Project ID/Site Name[1]	Description	Initial Ranking
Stormwater Retrofits		
Point Udall (TH-R-1)	Surface runoff from road and parking area flowing to the East End Trail are causing erosion. Install arid rain garden and ditch at trail head adjacent to roadway.	High
Divi Casino (TH-R-2)	Stormwater sheet flows over parking to swales into detention pond. Retrofit detention pond and repair swales.	Medium
Divi Hotel & Resort (TH-R-3)	Existing drainage pipes direct water to detention basin. Enhance existing basin and install rain gardens in nearby parking areas.	Medium
Grapetree Bay Hotel Restoration (TH-R-4)	Stormwater flows over existing parking with construction related debris. Construct small bioretention area to collect sheet flow from parking lot.	Medium
Villa Madeline (TH-R-5)	Drainage sheet flows from development south to small bioretention area with 2 flumes. Enhance existing bioretention and construct forebay and raised berm.	Low
Culvert Repair/Maintenance		
New culvert/piped gut at South Shore Rd.	Investigate need for additional outlet stabilization from newly installed culvert to prevent slope erosion at discharge location	High

[1] ID matches basemap locations and field sheets in the Appendix.

Point Udall (TH-R-1)

The easternmost point in the U.S. Atlantic seaboard is Point Udall. NOAA and VIRC&D are currently sponsoring/managing a trail restoration project involving the closing and stabilization of an existing trail and the construction of a small parking lot and new pedestrian trail. Parking lot construction is almost complete and trail stabilization features (i.e., water bars, traps, and bleeders) have been installed. Drainage from the road and the parking lot currently drain to the trailhead. There is potential for a small arid rain garden facility to be installed adjacent to the parking area to capture and treat stormwater using a xeriscaped landscape design, serve as a highly visible demonstration project, and protect the trailhead from erosion (Figure 6.2).

Figure 6.2. Construction of small parking lot at East End Bay Trailhead (left). Rendering of xeriscaped bioretention facility adjacent to parking lot (right).

Divi Carina Bay Casino (TH-R-2)

The Divi Carina Bay Casino is a feature of the larger Divi Carina Bay Resort. The Divi Casino is located along the north side of South Shore Rd. (Rt. 60) and is located in a generally low-laying flat area. The casino and surrounding paved parking lots comprise approximately 5 acres in impervious area—the largest concentration of impervious cover in the East End. The rear parking lot, to the northwest of the casino, drains over land to a small paved flume in the southeastern corner of the parking lot. This water is then directed through a shallow swale (gravel accumulation was observed at flume outlet). Runoff flows eastward behind the casino to a storm drainage inlet/pipe that discharges to the drainage channel that flows along the eastern edge of the main parking area to a detention basin on the southwest corner of the casino property, adjacent to the Divi Management Office. Stormwater from the detention basin is discharged through twin reinforced concrete culverts that merge into one 24-inch ductile iron pipe that leads to the beach immediately east of the Divi Hotel complex.

Stormwater management in the rear parking lot may be improved by constructing additional paved flumes that will discharge to an existing shallow swale along the east edge of the parking lot (Figure 6.3). Additional stormwater management can be provided within the primary parking lot via installation of several rain gardens and/or bioswales between parking aisles, in existing grass areas. This would aid in disconnecting impervious area, reduce the velocity of stormwater, and would help to reduce sediment and other pollutants.

The existing drainage channel between the parking lot and roadway is filled with sediment. Modifying the existing detention basin to create a micropool wetland with a long flow path and baffle would increase storage and would help capture higher amounts of sediment. This would be an excellent location for a demonstration project, as the nearby facilities receive high amounts of public use.

Figure 6.3. Existing parking facilities at Divi Carina Bay Casino (top left and right). Existing detention basin at southwest corner of main parking lot (bottom left). Drainage channel around casino parking lot to the east and south (bottom right).

Divi Carina Bay Hotel & Resort (TH-R-3)

The Divi Hotel and Resort is located on the shores of Turner Hole in the western region of the watershed on South Shore Rd. The hotel, parking, and other appurtenant structures comprise approximately 4 acres of impervious area. An existing stormwater detention basin (one of the few in the East End) is located in front of the southwestern end of the main hotel building (Figure 6.4). A series of pipes convey drainage from the parking area as well as from a gut across the road. This gut flows between the tennis courts and Divi residential properties through three 16-inch PVC pipes beneath South Shore Rd. to the detention basin. The basin outlet is comprised of a 16-inch PVC pipe that discharges to the beach area behind the hotel.

The existing stormwater basin may be enhanced by expanding the basin to southwest, as feasible, then over-excavating and replacing excavated material with an organic soil to increase infiltration and storage capabilities. Expansion of the basin would require modification and relocation of the outlet structure.


Figure 6.4. Detention basin at Divi Carina Bay Hotel & Resort (left). View of Divi Hotel parking areas along South Shore Rd and potential area for a rain garden/swale (right).

Grapetree Bay Hotel Restoration (TH-R-4)

The existing Grapetree Bay Hotel building is located on South Grape Tree Rd. in the central portion of the Turner Hole Watershed overlooking Grapetree Bay and is currently in the process of being renovated. Extensive debris and demolition material from the interior of the building are being stockpiled in the parking lot. Stormwater sheet flows over this impervious area towards the ocean. There are currently no stormwater practices present on site. Installation of a rain garden within or adjacent to the parking area would assist in the treatment and attenuation of stormwater discharging to nearshore waters and would serve as a highly visible demonstration project for educational and outreach purposes, particularly since residential construction projects are also challenged by proper management of construction debris and material storage (Figure 6.5).


Figure 6.5. Parking lot and construction materials/debris storage at the Grapetree Bay Hotel (left). Material storage and staging at small residential construction site in Turner Hole (right).

Villa Madeline Condominiums (TH-R-5)

Villa Madeline is located along the ridgeline between Teague Bay and Turner Hole watersheds, with most of the area draining towards Turner Hole. Villa Madeline is accessed by Maggie Hill Rd. off East End Rd./Rt. 82 on the north shore, and by South Ridge Rd. of South Shore Rd./Rt. 60. Stormwater flows from the top of the development south to the base of the hill into an existing detention basin via two paved inlet flumes (Figure 6.6). The existing detention facility may be enhanced through minor improvements and maintenance activities. The existing basin seems to be undersized for the contributing drainage area; raising the berm surrounding the basin by approximately two feet would increase the storage capacity. In addition, a new forebay at the inlet location would facilitate easier maintenance and sediment removal.

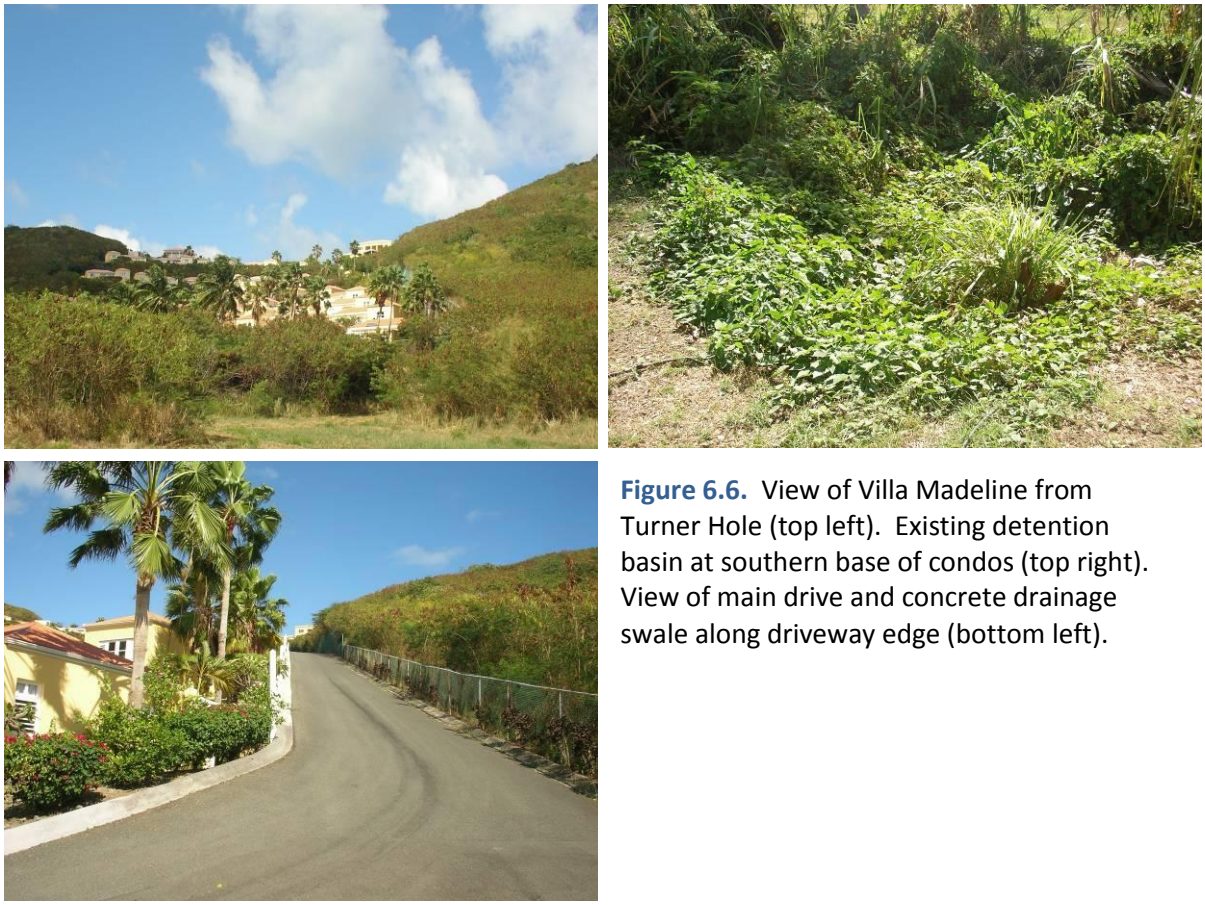


Figure 6.6. View of Villa Madeline from Turner Hole (top left). Existing detention basin at southern base of condos (top right). View of main drive and concrete drainage swale along driveway edge (bottom left).

TNC Easement

The TNC easement and hiking trails are well maintained and in very good condition (Figure 6.7). TNC personnel have been installing old marine mooring ropes anchored by rebar as water-bars to stabilize footpaths and prevent erosion. We have no recommendations for TNC trail management.

Figure 6.7. The Nature Conservancy signage and trail on the East End in Turner Hole.

New Culvert Installation/Gut Piping

Figure 6.8. Sediment plume in Grapetree Bay in July 2010 (photo courtesy of Kathy LeGrange/Dave Rivers)

A new culvert was installed in July, 2010 on a residential lot in an effort to reduce active erosion of an existing gut, which accepts drainage from South Shore Rd. A sediment plume in Grapetree Bay observed by residents during the heavy rain events on July 19-20, 2010 was reported to have originated from this location (Figure 6.8). Property owners report that since culvert installation was completed, no additional sedimentation issues have occurred. HW did not visit this site during our field assessment and are unable to verify these reports; however, EEMP staff did conduct a follow-up site visit in March to document conditions (Figure 6.9). Property owners report that because this culvert accepts secondary drainage from the road, the DPW was actively involved in the design/permitting of the project. HW has not reviewed hydrologic/hydraulic calculations used to size the culvert. From the photos, it is not clear if adequate outfall protection has been provided at the discharge location to prevent further erosion, although the property owners have indicated that during active construction, berms, rip rap, and haybales were used to prevent erosion and that the outfall is stable. This is another example illustrating a number of issues that should be addressed during the development of a comprehensive gut management strategy for the territory including policies related to piping of natural guts; gut buffer management; land subdivision, and permitting in relation to natural drainages.

Figure 6.9. (From top left to bottom right) Parcel location; aerial photo of site with location along channel/culvert where photos were taken by EEMP staff; looking at gut above road crossing; new culvert inlet on property, and culvert discharge to bay (photos from EEMP staff on March 14, 2011).

6.3 Neighborhood Summaries

A summary of general neighborhood conditions is provided below in order to identify which neighborhoods are likely to generate pollutants of concern, what the common sources are, and which areas/sources should be targeted for watershed stewardship activities. Unless otherwise noted, it is assumed that neighborhoods consist of single-family, detached residences, with

cisterns, on-site septic systems, and open section/drainage roads (without curb and gutter). Table 6.4 is a comparative summary of each neighborhood, and more detail is provided below. Pollution source is determined by number of observed pollutants (1-2=Medium; >2 = High).

Table 6.4. Summary of Neighborhood Restoration Opportunities

Name	Road/ Driveway Condition	% Lots Un-developed	Pollution Source	Potential Stewardship Activities
Villa Madeline	Paved/ Good condition	0%	Low	Enhance bioretention facility
Grapetree Bay	Mostly Paved/Good Condition	<50%	Med	Manage Residential Construction

Villa Madeline

The Villa Madeline luxury condominiums are located on the ridgeline between the Teague Bay and Turner Hole watersheds. Villa Madeline is a gated community and is accessed by Maggie Hill Rd. off East End Rd./Rt. 82 on the north shore, and by South Ridge Rd. of South Shore Rd./Rt. 60. Approximately six of the 43 units are located on the Teague Bay side of the drainage divide, and all runoff from these units and the community building and management office drain north to Maggie Hill Rd. above Reef Golf. The remaining units are located within the Turner Hole watershed and drain to a small detention structure located behind the condo units, east of the tennis court. Roadways within the condominium complex are entirely paved and curbed and in good condition. Road runoff is either diverted to a small shallow concrete swale that runs the length of the west side of the main drive or sheet flows over land downhill to the bioretention area. Runoff from the rooftops and gutters appears to discharge directly on the paved surfaces, though this could not be fully confirmed. It mostly likely sheet flows over the roadways to the existing detention facility. Average lot cover is approximately 10% turf, 20% landscaping, 60% rooftop, and 10% driveway and walkways. All sewage is directed to an on-site wastewater treatment system. This residential community does not appear to be a source of significant pollutants and/or sediment and no recommendations are suggested (Figure 6.10).

Figure 6.10. Condominium units and portion of parking area at Villa Madeline.

Grapetree Bay

The Grapetree Bay residential area (approximately 80 acres) is the eastern-most neighborhood within the Teague Bay watershed. This area may be accessed by South Shore Rd. to Sea Grape Rd. from the south, or by East End Rd. to Rt. 60 to either Deer Hill Rd. or Hibiscus Rd. from the north. The primary roadways within this residential area include Sea Grape Rd., South Grape Tree Rd., Bayview Rd., Sugarbird Rd., Deer Hill Rd., Terrace Rd., and Hibiscus Rd.. This area is sparsely developed, with most lots on the coast developed. A portion of the neighborhood sits atop a steep ridgeline, reaching up to about 270 feet in elevation at the steepest points, the remainder of the residences and vacant lots fill the valleys between these ridges. About 40% of the neighborhood is developed, and most homes are gated and set back from the street. There was one lot under construction along South Grape Tree Rd., east of the Grapetree Bay Hotel Restoration. No evidence of erosion or sediment control barriers or other sediment trapping practices were observed. The entire lot was comprised of exposed and unstabilized soils.

Roadways within the neighborhood are a mix of pavement (75%) and dirt/gravel (25%) and driveways are mostly paved. The roads are all open section, with no observed water bars, however at least two culverts were identified along with a concrete swale. The paved roads are in good condition and the dirt roads were observed to be very stable with little erosion. In addition, a gut runs from the ridgeline down across the terminus of Deer Hill Rd. down through a channel to a culvert (21-inch reinforced concrete pipe) at the bend on Sugarbird Rd. The culvert, gut channel, and outfall all appear to be in stable condition. The dirt roads and unmanaged construction sites may pose a source of sediment and other pollutants to Grapetree Bay.

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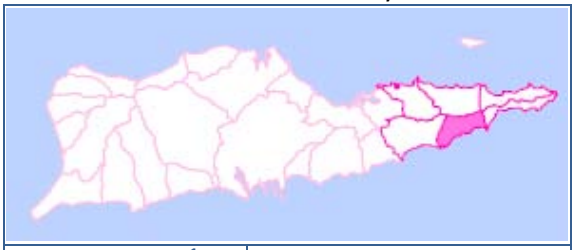
7.0 Madam Carty Watershed

This section summarizes baseline information specifically for the Madam Carty Watershed and includes a description of the unique watershed features, a summary of existing water quality conditions, descriptions of potential restoration sites investigated during field assessments, and neighborhood descriptions. Table 7.1 summarizes basic watershed features.

Appendix A contains a basemap of the Madam Carty watershed depicting locations of water quality impairments, roads, hydrology, topography, and potential restoration sites.

Table 7.1. Watershed Summary



Drainage area[1]	1043acres; 1.6 sq miles
Length of guts[2]	1.9 miles mapped
Road length[2]	2.6 paved miles; 1.5 unpaved miles
# Road culverts[2]	1 mapped culvert
Impervious Cover[3]	14.6 acres; 1%
Dominant land use %[4]	Undeveloped: 99.5%
	LDR: 0.5%
Area within 100-yr floodplain[5]	280 acres; 27% of watershed
# Small ponds[4]	4 (not including Mt. Fancy pond)
# Mapped wells[6]	0
Watershed erosion potential[7]	Vulnerability: High
	Road-based: Low
	Mean Relative: High
2010 WQ Impairments[8]	None

[1] IRF/UVI/USGS 2001 watershed boundaries
[2] HW revised/or created, 2011
[3] NOAA CSC, CCAP data, 2005
[4] UVI-CDC data 2003 (land use) and 2001 (ponds)
[5] DPNR, dated 2005
[6] Received from DPNR Feb, 2011
[7] WRI/NOAA, 2005
[8] DPNR, 2010 Integrated Waters Report

7.1 General Description

The Madam Carty watershed is in the south-central portion of the East End watersheds, and is undeveloped, with the exception of the recent single family home construction at Grass Point (Figure 7.1). Most of the watershed consists of steep hillsides, drained by three main guts across South Shore Rd. (Rt. 60) to Robin and Rod Bays. There are a number of unpaved, access roads connecting the South Shore Rd. and the beach. Given the undeveloped condition of the watershed, further study of the hydrogeomorphic and biological conditions of the guts in this area may prove useful in establishing reference reaches for steep, ephemeral guts on St. Croix. Mt. Fancy pond (also called Robin Bay Pond) is located in the western portion of the watershed, just south of South Shore Rd., which is the only public road in the watershed.

Land Use

The western portion of the watershed has been upzoned to high density use to accommodate the proposed Robin Bay Resort, which is a large resort development consisting of hotels, condos, a golf course, and other features (Figure 7.2). Additional single lot construction activities are planned for the Pt. Elizabeth residential development on Grass Point.

Figure 7.1. Looking out from Grass Point towards Robin Bay (left) and Mt. Fancy pond.

Figure 7.2. Reviewing development plans for the Robin Bay Resort.

Water Quality

There are two water quality assessment units associated with this watershed, and neither is listed in the 2010 Integrated Waters Report (DPNR, 2010) as impaired (Table 7.2).

Table 7.2. Water Quality Impairments (from DPNR, 2010)

Assessment Unit ID/Name	Monitoring Station Name	Impairment	Source of Impairment	TMDL (Priority)
VI-STC-49 / Madam Carty Backreef	STC-13B Robin Bay	(N/A)	(N/A)	(N/A)
VI-STC-50 / Madam Carty, offshore	None	(N/A)	(N/A)	(N/A)

Madam Carty was identified as a reference watershed during UVI's recent wetlands inventory, and it may be useful to more fully evaluate the ecology and geomorphology of guts in this watershed to establish baseline and reference conditions in this particular microclimate/topographical setting.

7.2 Potential Watershed Restoration/Project Sites

No specific restoration sites were identified in this watershed, however, routine maintenance of numerous dirt access roads to beach along South Shore Rd. may be necessary to prevent sedimentation in the nearshore area.

In addition, stormwater management for the proposed Robin Bay Resort should maximize treatment and recharge and serve as a model for innovative practices for the island. While the current plans indicate a range of practices offering promise (e.g., residential rain gardens, wet basins for irrigation, etc.), the plans will need to be more fully developed in order to ensure proper installation and protection of Mt. Fancy pond and nearshore marine environments. In addition, HW recommends that applicant fully evaluate a range of site design strategies to minimize earth disturbance, disconnect impervious cover and incorporate low impact development (LID) strategies into the project. Long-term maintenance of this system will be critical.

7.3 Neighborhood Summaries

No specific neighborhoods currently exist in this watershed, though the Pt. Elizabeth community on Grass Point is anticipated. Septic standards and ESC requirements for new single lot development of the Elizabeth Point community should be enforced, particularly given the extremely shallow and stony nature of the soils of Grass Point and proximity to the Bay (Figure 7.3).

Figure 7.3. Residential construction (left) and ESC practices (right) on Grass Point associated with the Pt. Elizabeth development.

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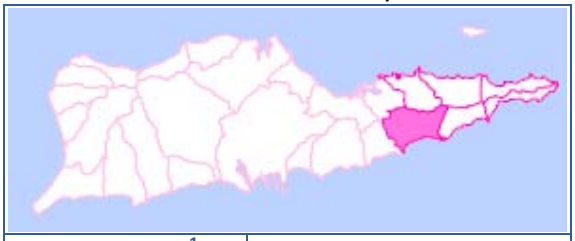
8.0 Great Pond Bay Watershed

This section summarizes baseline information specifically for the Great Pond Bay watershed and includes a description of the unique watershed features, a summary of existing water quality conditions, descriptions of potential restoration sites investigated during field assessments, and neighborhood descriptions. Table 8.1 summarizes basic watershed features.

Appendix A contains a basemap of the Great Pond Bay watershed depicting locations of water quality impairments, roads, hydrology, topography, and potential restoration sites.

Table 8.1. Watershed Summary



Drainage area[1]	2000 acres; 3.1sq miles
Length of guts[2]	5.5 miles mapped
Road length[2]	11.8 paved miles; 4.5 unpaved miles
# Road culverts[2]	12 mapped culverts
Impervious Cover[3]	69 acres; 3%
Dominant land use %[4]	Undeveloped: 55%
	Ag: 29% %
	LDR: 9%
Area within 100-yr floodplain[5]	891 acres; 45% of watershed
# Small ponds[4]	7 (not including Great Pond)
# Mapped wells[6]	12
Watershed erosion potential[7]	Vulnerability: High
	Road-based: Med
	Mean Relative: Med-High
2010 WQ Impairments[8]	None

[1] IRF/UVI/USGS 2001 watershed boundaries
[2] HW revised/or created, 2011
[3] NOAA CSC, CCAP data, 2005
[4] UVI-CDC data 2003 (land use) and 2001 (ponds)
[5] DPNR, dated 2005
[6] Received from DPNR Feb, 2011
[7] WRI/NOAA, 2005
[8] DPNR, 2010 Integrated Waters Report

6.1 General Description

The Great Pond Bay watershed is in the southwestern portion of the East End watersheds and is the largest of the six watersheds. It contains Great Pond, the largest salt pond in the USVI, which was identified as an Area of Particular Concern in 1979 and fully designated in 1991. The pond is essentially closed by a baymouth bar, supporting a substantial mangrove community, and providing habitat for resident and migratory birds as well as juvenile fish. It is also serves as a sediment trap from watershed sources. The water in the pond is brackish during the rainy season and hyper saline during the dry season. Like Southgate, this area was also designated as an Area of Preservation and Restoration, as well as a Significant Resource Area. Great Pond was recommended for conservation and education by the National Park Service (1960), the VI Territorial Park Service (1981), and by the Island Resources Foundation (1991).

Also like Southgate, the Great Pond area was included in the Coastal Barrier Resources System (1990), which prohibits federal funding and insurance for development projects within designated areas in order to: halt development in low-lying areas subject to flooding, protect natural resources, and reduce wasteful government spending. The central portion of the watershed is a shallow-sloping, alluvial plain surrounding the pond. Great Pond has the largest

number of wetland acres in the East End watersheds and is mostly undeveloped (55%). Over 45% of the watershed area lies within the 100-year floodplain. There are six major guts that drain the hillside on the northern watershed boundary. The Great Pond watershed receives an average of 40 inches of rain annually (DPNR, 1993).

Land Use

Three main roads effectively separate the Pond and surrounding lowlands from the steeper terrain: South Shore Road in the east, Southside Road (Rt. 62) in the west, and Route 624 connecting the two. Land use in the watershed consists of a large Boy Scouts of America Camp in the west, a public camping ground (Arawak) and the East End Marine Park (EEMP) Offices in the east, and a small grocery store (Milgie's). Several low-density, single family neighborhoods are located in the watershed: Union & Mt. Washington, Marienhoj, and Sally's Fancy. The watershed is mostly zoned for agriculture and low density residential; however, a portion of the watershed was up-zoned high density, associated with the proposed Robin Bay Resort development and, presumably, the Wyndham Golf Resort/Casino (Figure 8.1). North of Rt. 624 is a proposed commercial retail center, the Muddy Mongoose.

Like the rest of the East End, there are no central sewer lines located in the watershed; therefore, residential and small commercial areas rely on individual on-site septic systems. The soils in the central portion of the watershed are limited for septic disposal systems, which will become a bigger issue as the area continues to develop.

Figure 8.1. Overlooking Great Pond and the Union neighborhood from Mt. Washington (left), and signage indicating new proposed development (right).

Water Quality

There are three water quality assessment units associated with this watershed; none are listed in the 2010 Integrated Waters Report (DPNR, 2010) as impaired.

Table 8.2. Water Quality Impairments (from DPNR, 2010)

Assessment Unit ID/Name	Monitoring Station Name	Impairment	Source of Impairment	TMDL (Priority)
VI-STC-51 / Great Pond	None	(N/A)	(N/A)	(N/A)
VI-STC-52 / Great Pond Bay	STC-13A Great Pond Bay	(N/A)	(N/A)	(N/A)
VI-STC-53 / Great Pond Bay subwatershed, offshore	STC-OFF13 SE-4	(N/A)	(N/A)	(N/A)

8.3 Potential Watershed Restoration/Project Sites

A number of specific sites were identified by project partners, local residents, and field assessment teams as potential sources of pollution or as drainage improvement opportunities. Table 8.3 summarizes candidate projects to be considered during the watershed planning process. A more detailed description of existing conditions and potential opportunities at these sites is provided below.

Table 8.3. Summary of Candidate Restoration/Project Sites

Project ID/Site Name[1]	Description	Initial Ranking
Gut/Pond Restoration		
West Gut at Southside Rd. (GP-G-1)	Lack of drainage infrastructure has caused significant erosion at the West Gut in the northwest corner of the Sally's Fancy neighborhood. A portion of the roadway (Southside Road) and several large trees have been undermined as a result. Headcutting, bank erosion, and property loss have occurred. Curbing, a paved flume, and riprap is proposed to collect road runoff and stabilize gut.	High
Sally's Fancy East Gut (GP-G-2)	Remove the dirt being stockpiled in the gut.	High
Road Improvements		
Milgie's Grocery (GP-RC-2)	Construct a concrete v-ditch channel to collect gut flows and convey it across Route 624, near Milgie's Grocery. Water currently ponds at Milgie's Grocery, causing erosion and property damage.	Medium
Unnamed Rd. (GP-RC-33)	Eroding, steep, unpaved road in Mt. Washington/Union area discharging sediment across South Shore Rd. Flows contributing to raveling and potholes on South Shore Rd. Proposed installation of waterbars, swale, deep sump inlet, and stabilized outfall.	Low
Stormwater Retrofits/ Pollution Prevention		
Great Pond Parking Lot (GP-R-1)	Significant dumping of trash and debris at pond along beach access road. Substantial erosion and stormwater sheet flows over debris to pond and ocean. Restrict vehicle access and discontinue dumping.	High
EEMP Office (GP-R-2)	Potential area for growing native plants for restoration projects.	Low
Parking Lot/Trail Repair (GP-R-3)	Retrofit dirt parking area and stabilize eroding trail to beach near EEMP offices.	Medium

Project ID/Site Name[1]	Description	Initial Ranking
Culvert Maintenance and Repair		
Eastern culvert on Rt. 624 near proposed Muddy Mongoose (GP-RC-1)	Large scour hole below culvert splash pad. The curb-cut at the culvert headwall is bypassed by much of the road runoff, causing significant erosion. Curbing should be extended west to convey the road runoff to the existing curb-cut at the culvert headwall. Riprap should be placed at the end of the concrete splash pad to stabilize the scour hole formation. The culverts are in need of maintenance. Culvert replacement may be necessary if the proposed retail construction directs additional runoff here.	Medium
West culvert on Rt. 624 (GP-RC-3)	Twin 36" CMP culverts with downstream scour hole. Stabilize downstream with riprap to prevent further erosion.	Low
Marienhoj north culvert/ East Maria Ln. (GP-RC-4)	24" CMP is partially clogged with eroding outfall and downstream scour observed. Culvert is 'hanging' by ~3 feet. Concrete dumped at outfall for stabilization has failed. An improved paved drainage flume shall be installed to adequately collect the road runoff. Culvert maintenance and outfall stabilization is required. Possible culvert resizing may be necessary with future development. Culvert may be contributing to road erosion downgradient. Road/driveway stabilization measures may be necessary.	Medium
Marienhoj west culvert (GP-RC-5)	Culvert completely blocked and not functioning. Size and type are unknown. Culvert to be flushed and possibly replaced.	Medium
South Shore Rd. culvert (GP-RC-34)	12" culvert on South Shore Rd. completely blocked with sediment. Space available to install concrete drain box with sump behind existing pipe and stabilized outlet. Pipe to be flushed or replaced.	Low
[1]ID matches basemap locations and field sheets in the Appendix.		

Unnamed Road (GP-RC-33)

Just off of South Shore Rd., north of the Union neighborhood area, is a private unpaved road that is contributing sediment across South Shore Rd. and contributing to pavement degradation (Figure 8.2). The road is approximately 600 ft. long, currently serving four to five houses. A number of strategically placed water bars could help prevent erosion of the road surface by breaking up the flow and conveying it to a stabilized concrete swale. There is room to collect flow at the base of the slope in a drop inlet structure and pipe it under South Shore Rd. to a stabilized outfall. The inlet sump could help trap sediment, but would require maintenance.

Figure 8.2. Unnamed, unpaved road (top photos) draining to South Shore Rd. deposits sediment across South Shore Rd. into vegetated area and is contributing to road surface degradation (bottom photos).

Culvert on South Shore Rd. (GP-RC-34)

At the bend on South Shore Rd., on the northern watershed boundary, there is an existing 12" RCP that was recently excavated, presumably because lack of maintenance or undersizing of the culvert has led to the culvert being completely buried (Figure 8.3). Sediment was removed from behind the culvert headwall, however no formal box structure or roadside drainage ditch exists. This area will likely continue to be a maintenance issue. The installation of a concrete box structure with stabilized ditch inlets and outlet structure (riprap) may provide a sump for sediment that can be removed with a back hoe. Increased pipe capacity may also be recommended, depending on an analysis of the drainage area to this point.

Figure 8.3. Unnamed road draining to South Shore Rd. deposits sediment across street into vegetated area and is contributing to road surface degradation.

Great Pond Bay Parking Lot (GP-R-1)

The parking area at Great Pond Bay is currently used as a dump site for trash and other refuse and debris (Figure 8.4). Evidence of soil staining from unknown discarded materials and/or liquids was also observed. Stormwater flows down the existing dirt road and paths, through the dump debris to the pond and beach area. The roadway and paths are highly eroded with deep ruts and gullies. The soil is also highly compacted from vehicular traffic and dumping activities. This area likely conveys large amounts of sediment and other pollutants to Great Pond Bay.

Figure 8.4. Dumping and debris at the Great Pond parking area

A series of minor site improvements at this property could alleviate dumping and reduce the threat of pollutant loading to the coastal waters. Installation of a guardrail or other suitable barrier at the entrance would restrict vehicle access and limit traffic to pedestrian use only. Sections of fencing or placement of large boulders at either end of the barrier may also be useful, to prevent visitors from bypassing the barrier in their vehicles. Limited vehicle access would, presumably, reduce the amount of dumping and introduction of potentially hazardous waste materials, and allow the area along the pond to naturally re-stabilize and re-vegetate. Large ruts and gullies may be backfilled with an appropriate soil or gravel to reduce further erosion. Restricted access should be accompanied with education and outreach including "no dumping" signage and trash cleanup events linked to the cleanup of Great Pond Bay.

Road Drainage Issues on Rt. 624 (GP-RC-2, GP-RC-1, GP-RC-3)

Several potential retrofit/drainage improvement sites were identified along Rt. 624 in the Great Pond Watershed. The most significant problem was identified near Milgie's Grocery (GP-RC-2) where drainage from the adjacent gut is not properly managed. Currently, water from the gut flows south until it reaches Rt. 624, where it then flows east along the road shoulder toward Milgie's before passing over the pavement and flowing to the south. Minor road flooding was witnessed during the site visit, but chronic flooding at the Milgie's Grocery property was reported (Figure 8.5). Erosion and undermining of the asphalt pavement at this location was also observed. Suggested drainage improvements include construction of a concrete drainage channel along the north side of Rt. 624 to direct runoff to the lowpoint in front of Miligie's. The existing drainage channel across Rt. 624, as well as the shoulder along the southern side, should be excavated and lowered to improve flow away from the roadway. Relocating the existing chainlink fence for the Wyndham property and selective vegetation management may also be necessary to address the drainage problem.

Figure 8.5. Road drainage issue in front of Milgie's Grocery.

Two drainage improvement projects were identified at road culvert crossings along Rt. 624: GP-RC-1 and GP-RC-3. The GP-RC-1 culvert (located south of the proposed Muddy Mongoose commercial development) is an eroding culvert network in need of maintenance and stabilization (Figure 8.6). Currently road runoff bypasses an existing curb-cut in the downstream headwall and is causing erosion at the west end of the headwall. Additional curbing should be installed to convey runoff to the existing curb-cut. Riprap stabilization at the existing culvert splash pad is also recommended to impede further scour hole formation. General debris removal and vegetation management is suggested.

The GP-RC-3 culvert is located west of Milgie's Grocery and east of Southside Road. This site includes two 36-inch CMP culverts that direct gut drainage to the south of Rt. 624. The culverts are currently in good condition but a scour hole has formed at a concrete splash pad at the culvert outfall. Riprap stabilization is recommended to impede further scour hole formation. General debris removal and vegetation management is suggested at the culvert inlet location.

Figure 8.6. Culvert near Muddy Mongoose proposed development.

West Gut at Southside Rd. (GP-G-1)

The West gut begins at Southside Road and passes through the Sally's Fancy neighborhood. A gut restoration/road improvement site was identified where the West gut begins at site GP-G-1. At this location, the gut receives runoff from Southside Rd. and the Marienhoj neighborhood. The runoff is not properly collected in drainage infrastructure; instead it flows off of the shoulder and into the gut. Significant gut erosion has occurred and the roadway has been undermined as a result of improper stabilization. Boulders had previously been placed at this location to impede the erosion but the attempt failed. Several nearby, large trees have been uprooted. The bank erosion in the gut is so great that considerable property loss has occurred at the neighboring properties. Curbing should be added along the roadway at this location and a paved flume installed to collect the runoff. A riprap splash pad should be placed in the gut to minimize the erosive forces of the runoff. Bank stabilization measures in the gut are also recommended to prevent further property loss (Figure 8.7).

Figure 8.7. West gut erosion and trash.

Marienhoj East Maria Lane Culvert (GP-RC-4)

A 24-inch CMP culvert was identified on East Maria Lane at the GP-RC-4 site. The culvert inlet is partially clogged which has contributed to runoff bypassing the culvert and flowing off the roadway to the south. Significant erosion has resulted due to the steep terrain and improper stabilization. Concrete had been placed in an attempt to manage the road runoff but it is bypassed on both sides (Figure 8.8). The culvert is currently 'hanging' about three feet above ground. An improved paved drainage flume and curbing should be installed to adequately collect the road runoff and convey it to the outfall. Riprap should be placed at the outfall to arrest the existing bank erosion and scour hole formation. The culvert should be shortened to conform to the existing topography. Debris removal at the culvert inlet is recommended.

Figure 8.8. Attempt at concrete flume to manage runoff on East Maria Lane above culvert (GP-RC-4).

Boy Scout Property/Great Pond West

The Boy Scout camp contains a drainage outfall-grassed swale system, a gut that runs through the property, a mangrove forest, and recent excavation of drainage channels and detention ponds (Figure 8.9). All developed areas throughout the Boy Scout property were found to be in good condition. The outfall-swale system that drains to the property from Southside Rd had no signs of erosion and ample grass coverage. The gut downstream of the swale was also very stable. Bank stabilization was adequate due to the thick mangrove-manchineel forest downstream and the tall guinea grass upstream.

West of Great Pond there was recent excavation of earthen drainage channels and detention ponds for controlling water and runoff from the proposed Wyndham Resort development (see Figure 8.8). The drainage channels are simply trenches that were dug to redirect water to the constructed ponds. Excess soil from the excavation remained on-site, adjacent to the basins. Since that time, guinea grass was able to establish on the bare soil which appears to have kept erosion and sedimentation down. If the resort project does not take shape in the near future, consideration should be given to filling in the trenches and basins to restore more natural drainage patterns.

Figure 8.9. Clockwise from top left: Culvert leading from Southside Rd. to grass swale at Boy Scouts site; Grass swale leading from culvert outfall to Great Pond on Boy Scouts property; Detention pond adjacent to Great Pond near Boy Scouts property; Soil mounds from Wyndham excavation.

East End Marine Park (EEMP) Office (GP-R-2)

The EEMP office is a small, two-story building just east of Great Pond, adjacent to the historic Great House. Since rooftop runoff is collected in cisterns, the area is generally flat, and there is limited erosion evident in the parking lot or immediate vicinity, no stormwater drainage demonstration projects were identified. However, the park office is surrounded by a lot of open area, which could potentially be converted into a demonstration/study area for growing native plants for use in demonstration projects elsewhere on island (Figure 8.10). Part of the educational program of the EEMP could include how to convert residential lawns to native landscaping.

Figure 8.10. Eastern side of EEMP office building is a potential location for demonstration garden.

Proposed Arawak Campground/Eroded Trail near EEMP Office (GP-R-3)

The adjacent open area north of the EEMP is currently being considered for a large campground. In the northeastern corner is an active parking area that connects to an eroded trailhead leading down to the beach. EEMP staff indicated that observable erosion occurs during rain events and that trail stabilization and parking management at this location would help reduce sedimentation. The trail is approximately 150 feet long at a 2:1 to 3:1 slope. Deep gullying has occurred in the trail (Figure 8.11). Basic trail stabilization techniques including waterbars and steps, as well as management of flow from the parking area could help stabilize the trail. Ownership of the trail is uncertain.

Figure 8.11. Eroded trail to beach (left) and parking area (right)

8.3 Neighborhood Summaries

A summary of general neighborhood conditions is provided below in order to identify which neighborhoods are likely to generate pollutants of concern, what the common sources are, and which areas/sources should be targeted for watershed stewardship activities. Unless otherwise noted, it is assumed that neighborhoods consist of single-family, detached residences, with cisterns, on-site septic systems, and open section/drainage roads (without curb and gutter). Table 8.4 is a comparative summary of each neighborhood, and more detail is provided below. Pollution source is determined by number of observed pollutants (1-2=Medium; >2 = High).

Table 8.4. Summary of Neighborhood Restoration Opportunities

Name[1]	Road/ Driveway Condition	% Lots Un-developed	Pollution Source	Potential Stewardship Activities
Sally's Fancy	Unpaved, turf & dirt/ moderate to good	<50%	Medium	Education – Yard cleanup and pet waste; buffer protection
Marienhoj	Paved/good condition		Medium	ESC for Residential construction
Union (portion of Union & Mt. Washington)	Paved/mod erosion of pavement	<25%	Low	Septic survey (poor soils)

[1]See Southgate watershed (Section 3.0) for Mt. Washington description.

Sally's Fancy

The Sally's Fancy neighborhood is located northeast of the Southside Rd./Rt. 624 intersection. The neighborhood includes a mix of topography, landuse, and parcel size and has two guts flowing through it (Figure 8.12). The topography varies from moderate in the north and very flat topography in the south. The parcels, which are primarily developed, range from quarter-acre to three-acre lots. The larger parcels are primarily brush or tall grass that may include some agricultural activities. At least two lots were identified as possible automobile junk yards. Other than the two highways that border the neighborhood, the roads are mostly dirt or gravel. Severe rutting was observed in the low-lying areas. Some of the ruts were in the process of repair with crushed stone. A high density of dogs was observed in this neighborhood.

An area of future concern near Sally's Fancy is the proposed Wyndham Golf Resort & Casino, which is directly across from Milgie's Grocery. The local gut flows directly into this property and the topography is extremely flat. Any impoundment to the gut will likely contribute to more severe flooding problems in Sally's Fancy neighborhood. Any future downstream development should evaluate these potential impacts during the planning phase.

Figure 8.12. Sally's Fancy neighborhood (left); sediment dumping in gut (right).

Marienhoj

The Marienhoj neighborhood is located in the northwest corner of the watershed and is accessed by Southside Rd. It is primarily located in the hills and consists of large parcels on steep terrain. Few of the parcels are developed, with the majority remaining forested. There is some new construction currently taking place. At one recently cleared lot (Figure 8.13), no erosion/sediment control practices were installed and much soil was exposed, creating high potential for down-gradient sedimentation. Most of the roadways are paved but with minimal drainage infrastructure. A culvert was found with significant erosion at the outfall. An ineffective attempt was made to manage the runoff at the outfall by pouring a concrete

drainage flume/splash-pad. This measure failed due to water bypassing and scouring beneath the flume. Some dirt driveway erosion was identified that was contributing sediment onto the roadways.

Figure 8.13. Slope clearing at residential construction site in Marienhoj.

Union

The Union area is the flatter portion of the greater Union/Mt. Washington neighborhood. It is located northeast of Great Pond and off of South Shore Rd, and is relatively flat compared to many of the other residential areas in the East End (Figure 8.14). The primary roadways within this area are Sunset Road, Corry Road, Tamarind, David Oliver, Seaview, Blue Dolphin, Kenjo, and Acacia. The Union area is approximately 115 acres with 302 lots, less than 25% of which remain undeveloped. Average lot size for the single family homes in this neighborhood is around 0.25 acres, however, there are larger lots. Average lot cover is 70% turf, 25% rooftop, and 5% bare soil. Wastewater is managed via on-site septic systems and no problems with septic were observed. Road cover was mixed, but mostly paved. One section of Kenjo Road was unpaved and eroded with large ruts. All roads had open drainage and there was no evidence of water bars or culverts. A few roads had shallow grass swales on the road shoulder. This neighborhood does not appear to pose as a source of pollutants or sediment to down-gradient resources.

Figure 8.14. Street view of the Union area.

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9.0 General Findings

General watershed findings to advance development of watershed goals and priority recommendations are presented below in no particular order. These findings are based on: (1) existing management plans or planned capital improvements; (2) input from residents and other stakeholders; and (3) direct observations made by field assessment teams.

1. **Addressing Water Quality Impairments:** There are three TMDLs being developed for the northern shore of the East End in 2011. Pollutant load modeling under our planning effort should track closely with land use coefficients, rainfall distributions, drainage area delineations, and the load allocations established through the TMDL process. Prioritization of implementation activities should integrate with TMDL reduction goals where practical, understanding that current efforts to update/revise the water quality standards may result in eventual delisting of some impaired waters (e.g., Isaac Bay).
2. **Managing Unpaved Roads:** Unpaved roads have the potential to be the most significant source of sediment loading in the East End and were identified as potential restoration sites in all of the watersheds. There are a number of privately-owned roads and residential streets that should be high priorities for repair, paving, or other drainage improvements (e.g., Cotton Valley area and Seven Flags Rd.). The DPW does not extend maintenance authority to most of the private roads; therefore, watershed managers and homeowner associations will likely have to play a large role in securing funding for any road improvement project. The watershed plan should highlight the most cost-effective alternatives for road improvement in priority areas and target educational efforts and grant opportunities, respectively.
3. **Drainage Infrastructure Improvements:** Evidence of erosion, sediment transport, and wetland habitat loss from new culvert installations and unstable outfall discharges was observed in a number of the East End watersheds (e.g., Southgate, Turner Hole). Many existing culverts were completely blocked, crushed, or undersized. New or replacement culverts should be sized for the appropriate storm return frequency, watershed build out, gut grade control issues, downstream water quality, and potential fish/invertebrate migration. Rainfall statics should be updated and applied. Incorporation of water quality structures and stabilization techniques into culvert design and construction may help reduce sediment loading and long-term maintenance needs. Recommendations for culvert installation, sizing, and maintenance will be important, particularly for areas in the East End where DPW is planning improvements (i.e., Rt. 624 in Great Pond and the East gut in Southgate).
4. **Supporting a Unified Gut Management Strategy:** There appears to be a nominal amount of scientific information regarding the ecological functions of guts in the East End, and as the East End continues to develop, additional degradation of guts is likely (e.g., buffer encroachment, increased stormwater discharge, and continued erosion). Watershed plan recommendations should support the establishment of a unified gut management policy for

the Territory, encourage the inventory and ecological assessment of East End guts, and provide design examples for gut stabilization and restoration projects. An overall strategy should address gut piping, new discharges, buffer protection, and invasive species/vegetative management; as well as enforcement of minimum 30-ft buffer zones.

5. **Managing New Development:** Major development projects proposed in Madam Carty, Great Pond, and Southgate watersheds may merit a more thorough review of site design/layout, construction site ESC, and post-construction stormwater management plans before Earth Change/TPDES/CZM permits are issued. These projects, if caught early enough in the planning stage could incorporate low impact development (LID) techniques, enhance water management and hydrologic balance, and serve as demonstration projects. The watershed plan should support efforts to update development regulations and stormwater standards to protect water resources (e.g., require installation of drainage infrastructure in addition to paving of roads for subdivision projects). Even for minor permits and small site construction, proper ESC should be enforced. Consider administering a local contractor and equipment operator ESC certification or required licensing program. Most of the existing neighborhoods have remaining undeveloped lots, and much of the land designated for residential development remains undeveloped. It will be important to ensure that existing and proposed roads and drainage infrastructure are replaced/designed to accommodate future conditions.
6. **Minimizing Flood Hazards:** The USVI Territorial Emergency Management Agency is currently updating hazard mitigation plans and should weigh-in on new development and drainage infrastructure priorities. A significant portion of the Southgate and Great Pond watersheds, and some of the proposed new developments, are within the 100-yr floodplain. Therefore, future development proposed around existing guts and wetlands will likely need to meet existing (or more stringent) setback requirements. The setback distance (or buffer zone) should be determined through consideration of slope, aspect, vegetative cover, and other relevant factors. Despite the 1993 Great Pond APC Management Report discouraging development in the pond floodplain, a resort/casino development is proposed, and land reclamation activities are reportedly underway. Development here will not only have a significant risk of flooding, but will potentially have an adverse effect on hydrology in upstream residential areas and on the pond itself. Channelization, filling, and piping of guts for flood control should be avoided wherever possible.
7. **Improving Wastewater Treatment:** There is no central sewer system in the East End; and other than a few small package plants at resorts and condos, everyone is on individual onsite disposal systems. The soils in many areas in the East End are not ideal for septic systems, particularly the single tank and seepage pits typically used. Also, there are no inspection and maintenance requirements to identify areas where system failure is high. Soils, high groundwater elevations, and percentage of undeveloped lots could be factors used to identify which neighborhoods may be higher priorities for promoting free septic inspections, subsidizing maintenance, or requiring new septic designs. Continued monitoring of small package systems, particularly in Chenay Bay, should be encouraged. Requiring more advanced treatment systems for new developments may be recommended, as well as capacity upgrades for systems that manage infrequent, but large events.

Consideration should be given for single lot construction standards regarding advanced systems, setbacks from guts, and minimized limits of clearing. A standard engineering design (e.g., three-chambered, prefabricated system with appropriate distribution and disposal) could be developed as part of the watershed planning process.

8. **Supporting Residential Stewardship:** Neighborhoods were evaluated to determine which type of restoration activities should be specifically targeted to individual communities (e.g., road improvement, septic inspections, and pollution prevention). The watershed management plan could support the coordination of efforts with Condo Associations and HOAs on education and outreach, grant solicitation, and other implementation activities, where there is interest. Use of existing island media outlets such as the public TV station, radio, and local newspaper could provide for broader messaging. A guide for homeowners could be developed that would illustrate watershed best management practices on small lots (e.g., construction, septics, pet waste, vegetation management, driveway management, and rain gardens).
9. **Maintaining Impoundments:** Farm ponds in the East End detain runoff, retain sediment, and provide drinking water for livestock; however, the influence of these small impoundments on the overall water budget has not been documented. Existing farm ponds require routine and non-routine maintenance including vegetation management, sediment removal and impoundment management (e.g., liners, spillway systems, etc.). The USDA typically provides grant monies for restoration activities, which could be viable when coupled with gut restoration, buffer reforestation, and other agricultural best management practices.
10. **Supporting Wellhead Protection Efforts:** The watershed plan could support DPNR with their ongoing effort to identify threats to wells and groundwater supplies from land-based contaminants. There are over 60 permitted wells in the East End watershed (according to DPNR mapping). At a minimum, a mapping analysis could be conducted to determine potential land use threats within a 1000-foot radius of permitted wells.
11. **Pollution Prevention:** A few locations where trash and other pollutants have a high potential to be conveyed into guts, wetlands, or coastal areas were identified. Illicit dumping, improper waste management, exposed storage of materials, pet waste, and landscape maintenance all can contribute to polluted stormwater. Solid waste management is a challenge in the USVI; however, any structural projects that could reduce pollution should be considered high priorities (e.g., signage, blocking vehicular access to areas of frequent dumping, household hazardous waste pickup days, covering and/or relocating dumpsters, and providing secondary containment for outdoor storage).
12. **Land Conservation and Restoration:** The East End is such a remarkable resource for residents and visitors. The watersheds' inextricable tie to the quality of the marine resources within the STXEEMP, as well as other unique island habitats, is unquestionable. Avoiding impacts to these areas is of the utmost importance, and the watershed plan should prioritize land acquisition opportunities, if available, and support those who actively manage conservation lands and open space (e.g., TNC, SEA, USVI Department of Housing, Parks and Recreation, and others).

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Appendix A:

11x17 Watershed Baseline Maps

Appendix B:

Field Forms