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)	*(mi²)*	*(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).

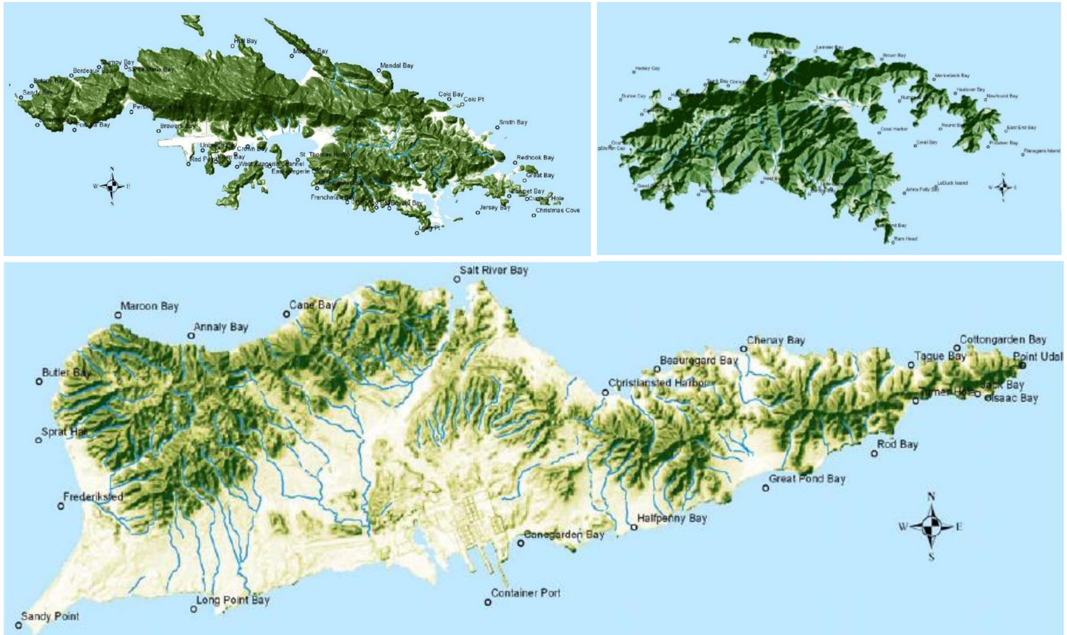


Figure 2.1. Digital terrain model of St. Thomas, St. John, and St. Croix, not to scale (Gardner et. al. 2008)

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

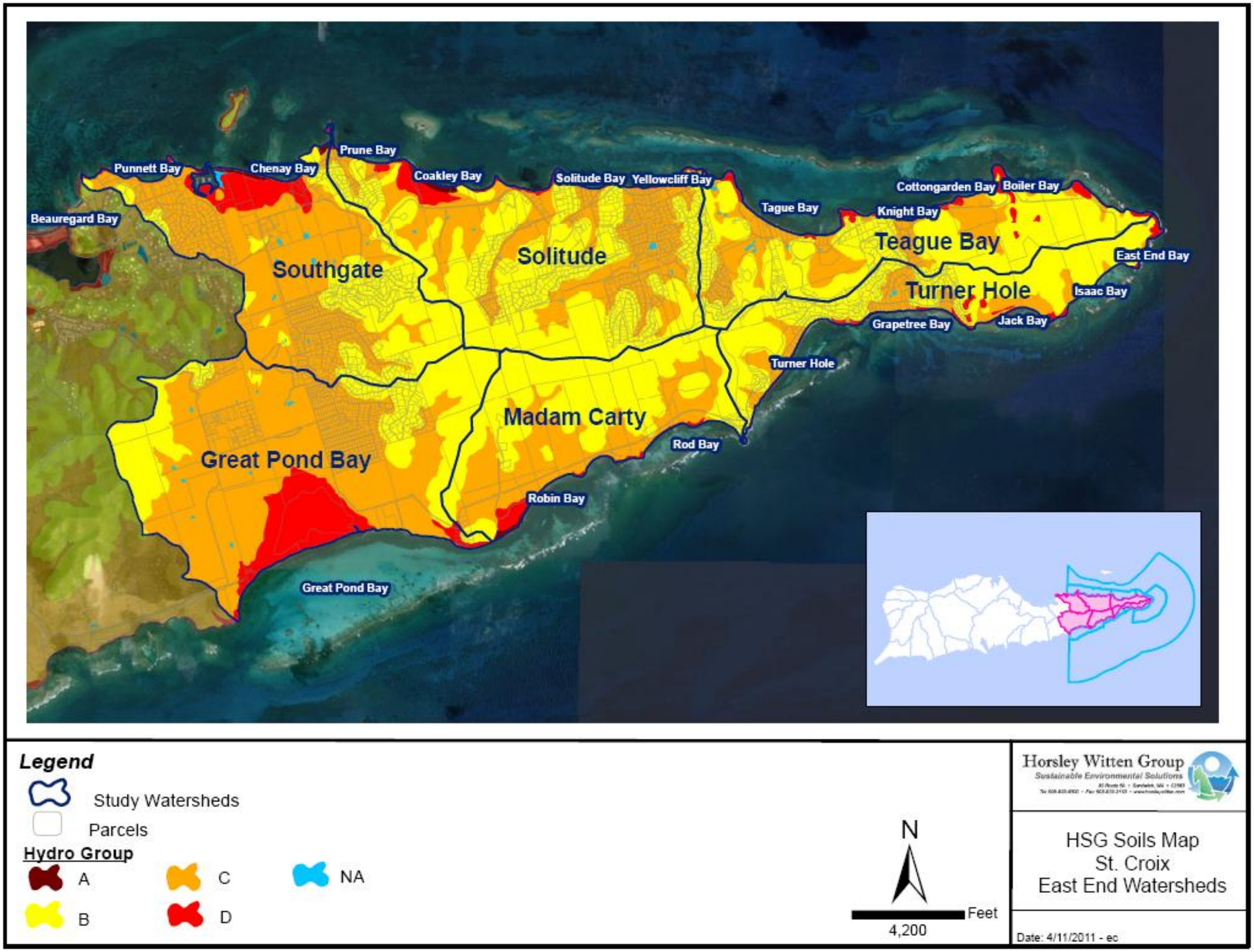


Figure 2.2. Soils map of the East End of St. Croix depicting HSG classifications

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.

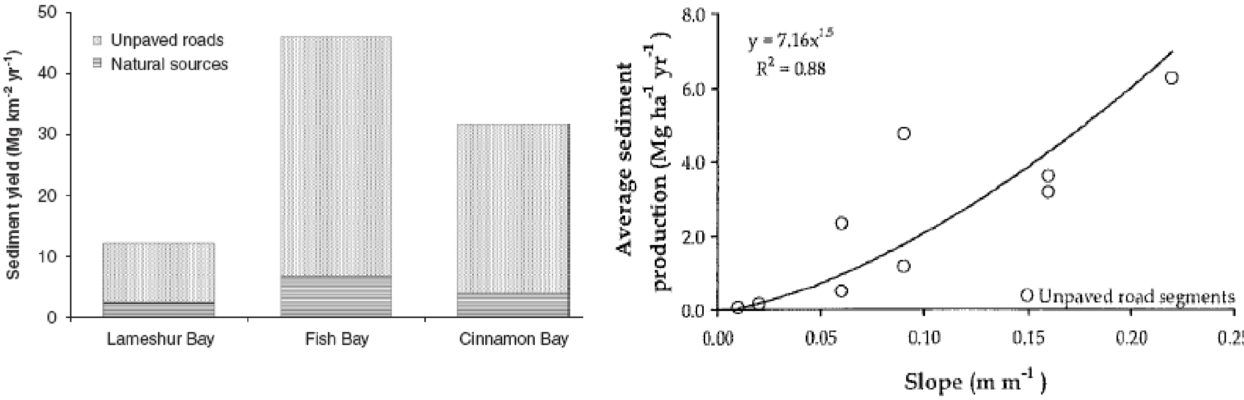


Figure 2.3. (Left) Total sediment yield comparison between unpaved roads and natural sources such as gut erosion, tree throw, and direct hillside erosion in three watersheds on St. John (Ramos- Scharrón and McDonald, 2006). (Right) Increased sediment production curve for unpaved roads as slope increases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

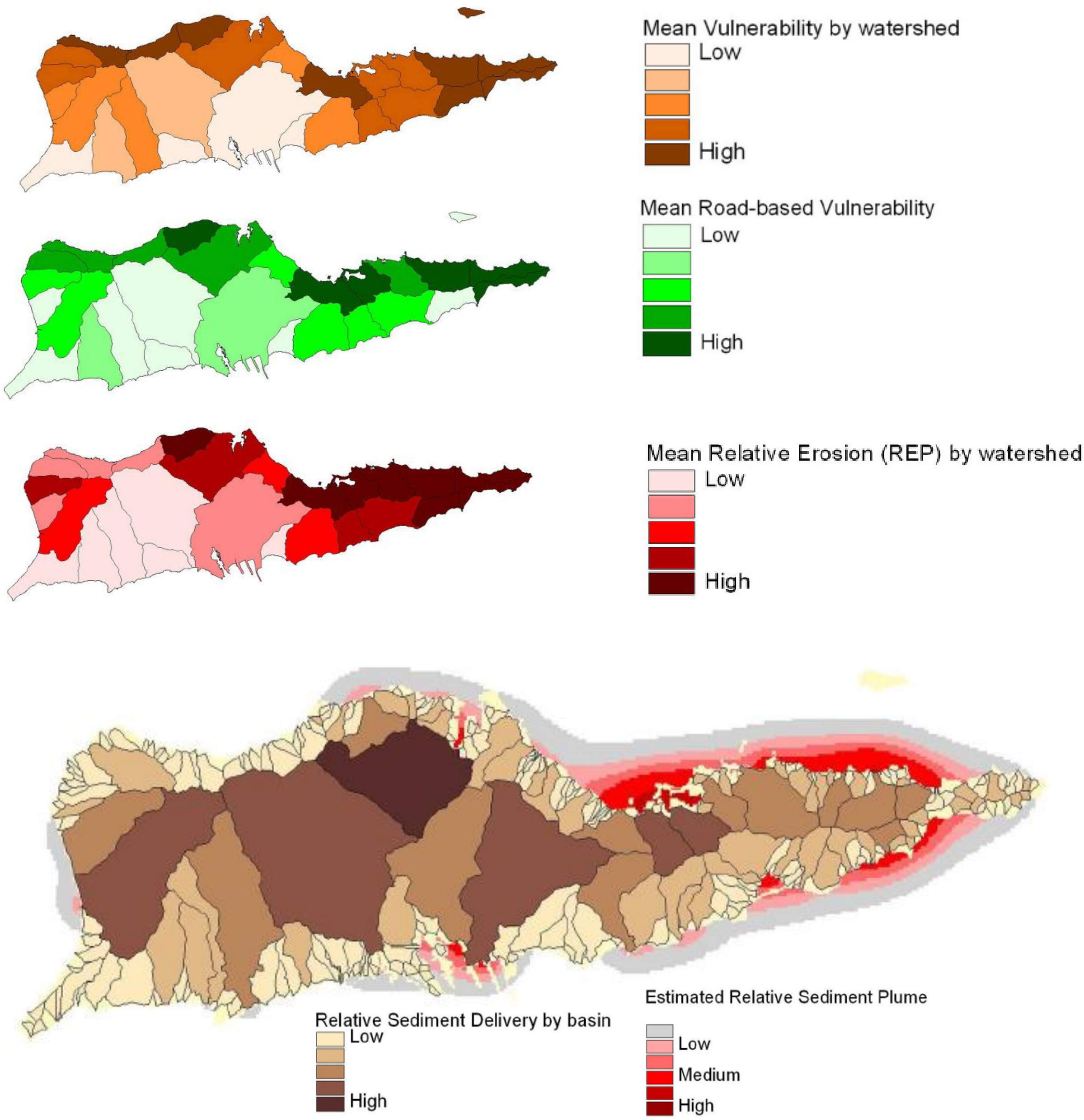


Figure 2.4. N-SPECT model results (from top to bottom) show a high vulnerability of four East End watersheds to erosion based on slope, soil erosivity, rainfall, and land cover conditions; a high road-based vulnerability to erosion in three of East End watersheds based specifically on road slopes, soil 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).

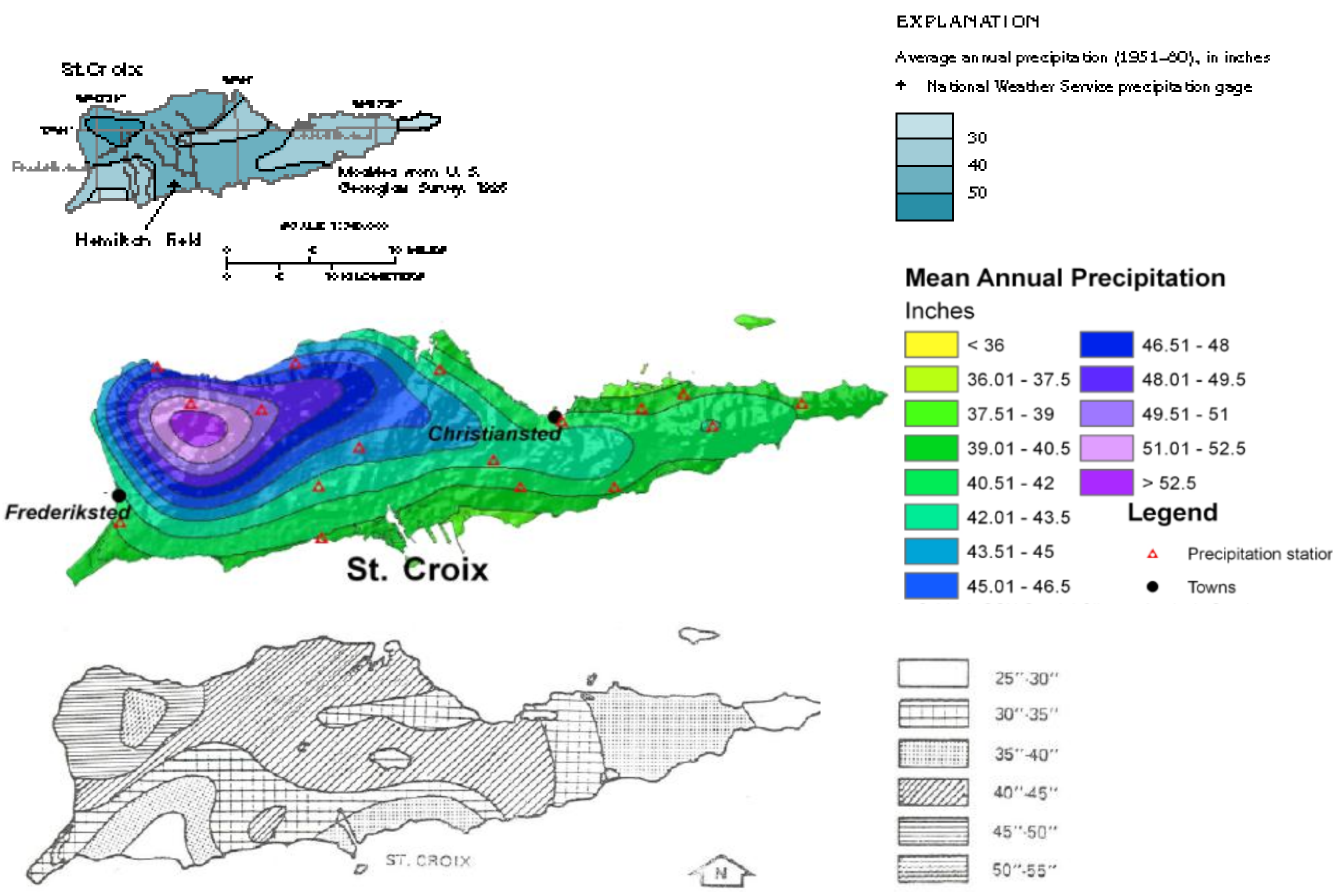


Figure 2.5. Differences in rainfall patterns in three Annual Precipitation Maps: (Top) based on data collected from 1951-1980 by Miller and Whitehead (1999) (in USGS,1999); (Middle) based on over 50 years of records through 2004 (in NOAA, 2006); and (Lower) precipitation data from the 1970's from M.J.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

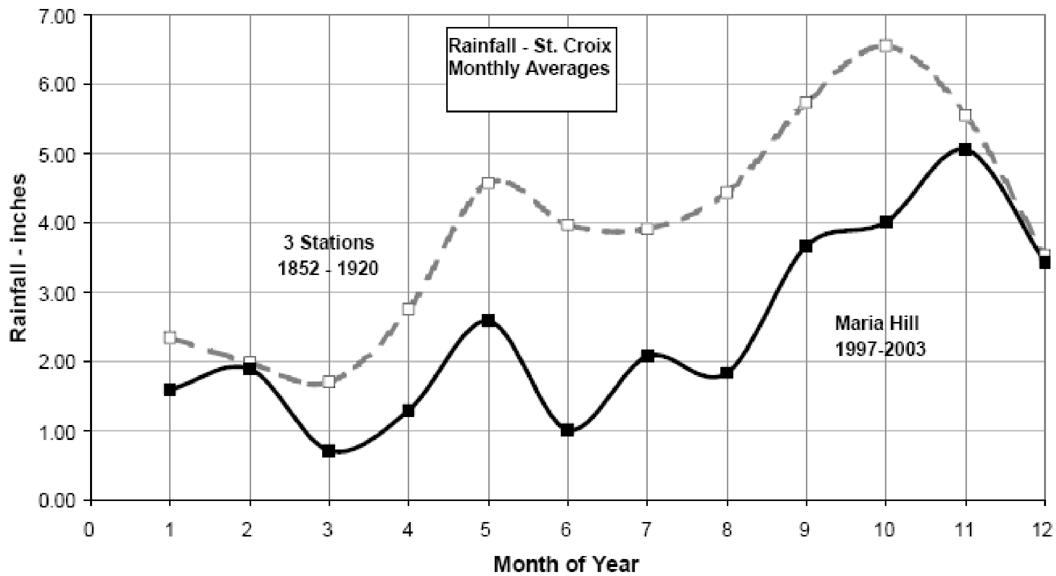


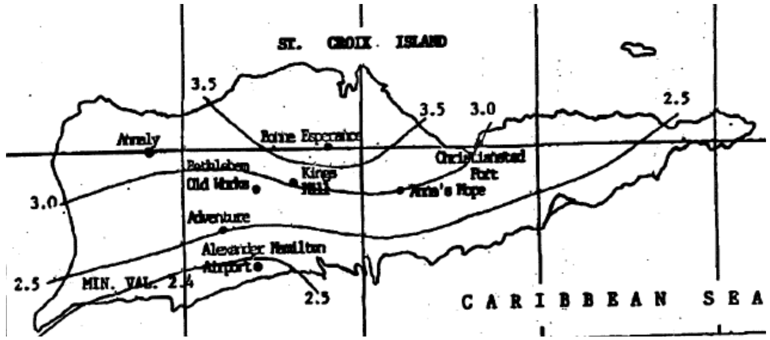
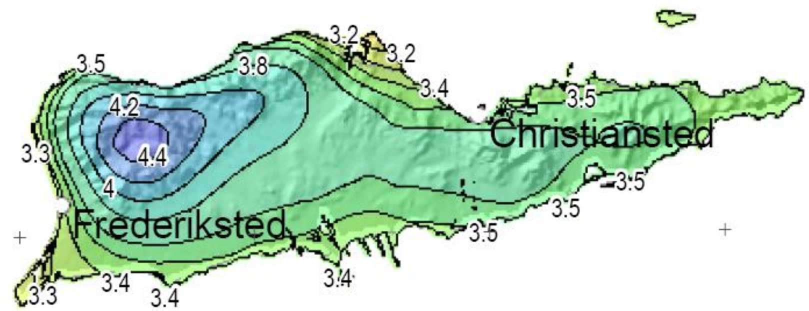
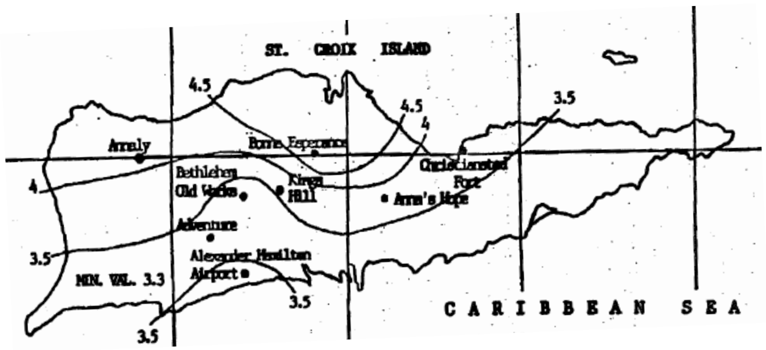
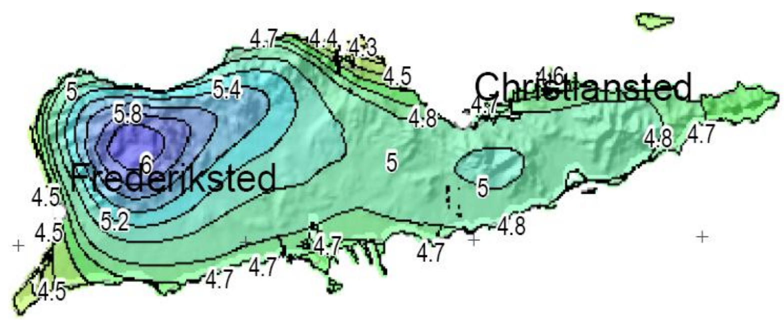
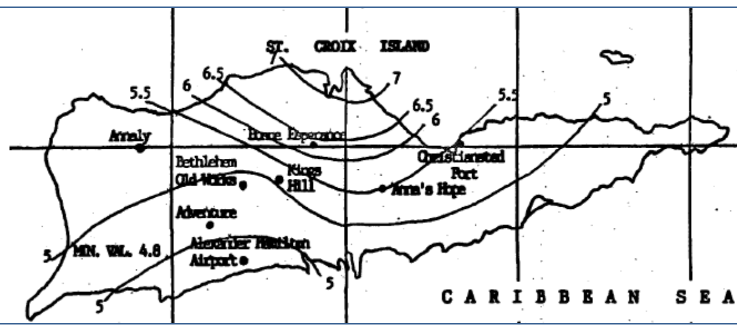
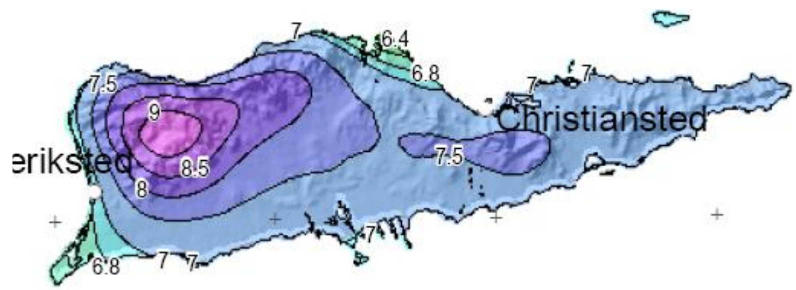
Figure 2.6. Monthly average rainfall at Maria Hill from 1997-2003 (solid line) and from 3 stations on Frederiksted, Chirstiansted, and Kings Hill from 1852-1920 (dashed line) as reported in Gaines (2004).

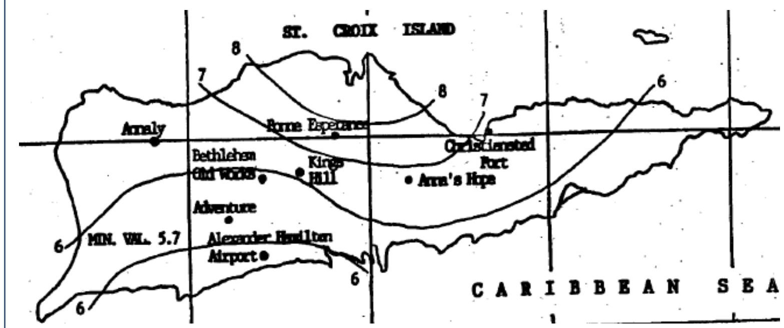
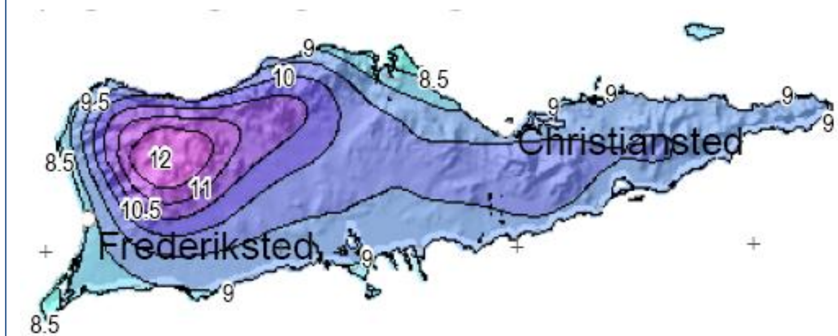
The current stormwater design guidance published in the 2002 USVI Environmental Protection Handbook indicates that the USVI uses a Type III rainfall distribution, and provides precipitation frequency maps for the 1-yr, 2-yr, 5-yr, 10-yr, 25-yr, and 100-yr 24-hour rainfall events, as well as intensity 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		

<table>
<tr><th>Event</th><th>2002 USVI Environmental Handbook
(source cited as USDA-SCS, 1986 with data provided by the US Weather Bureau)</th><th>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)</th></tr>
<tr><td>10-yr, 24-hr</td><td>
</td><td>
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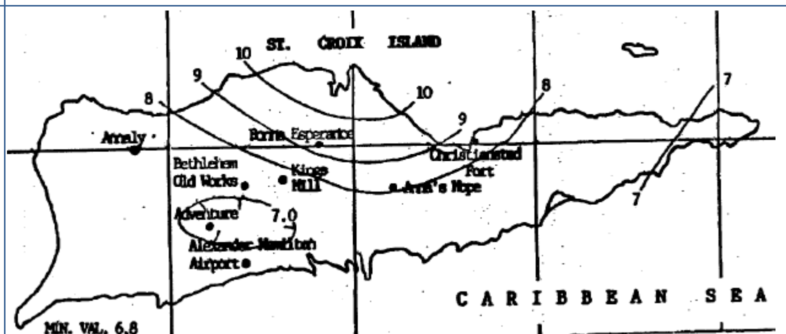
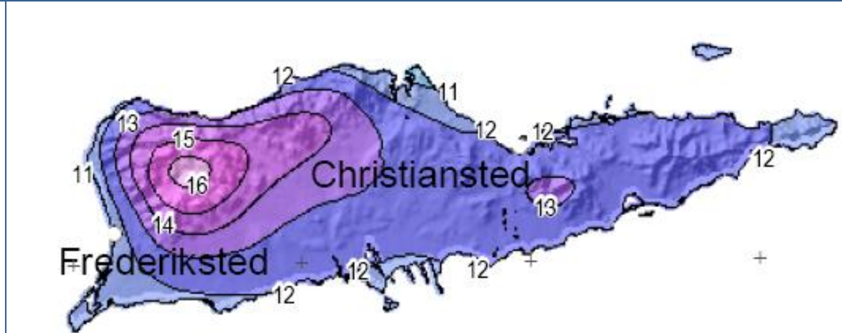
<tr><td>25-yr, 24-hr</td><td>
</td><td>
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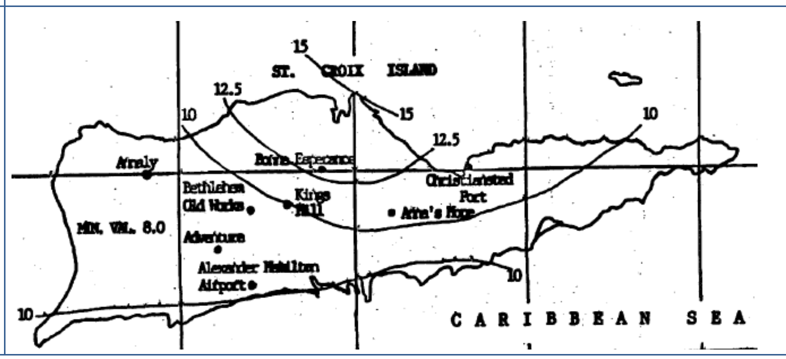
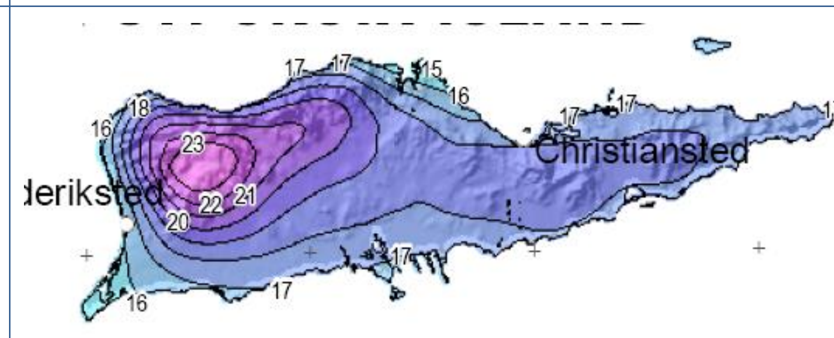
<tr><td>100-yr, 24-hr</td><td>
</td><td>
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Gardner et. al. (2008) reports that as late as 1914, guts on St. Croix were observed to flow year round; however, none are perennial now. Some of the guts on St. Croix exhibit intermittent flow during the wet 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.

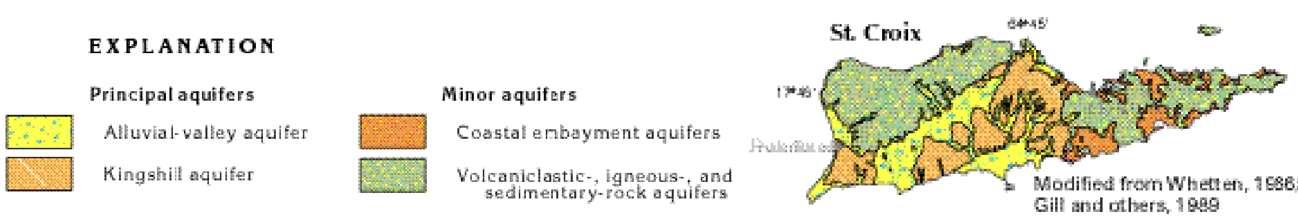


Figure 2.7. St. Croix aquifer map (USGS, 1999).

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).

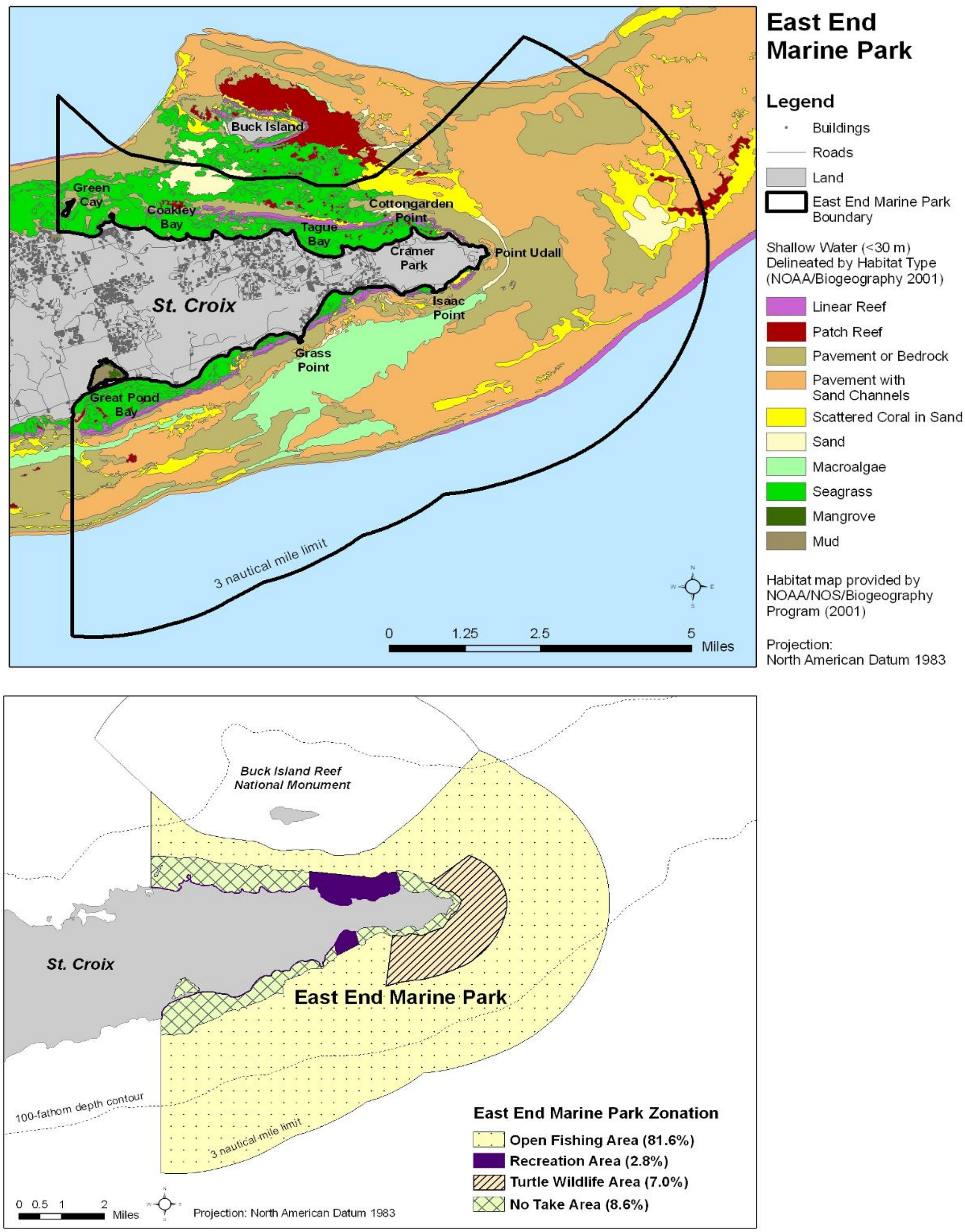


Figure 2.8. Mapped marine habitats surrounding the East End and STXEEMP Park Zonations (taken from the STXEEMP website).

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.

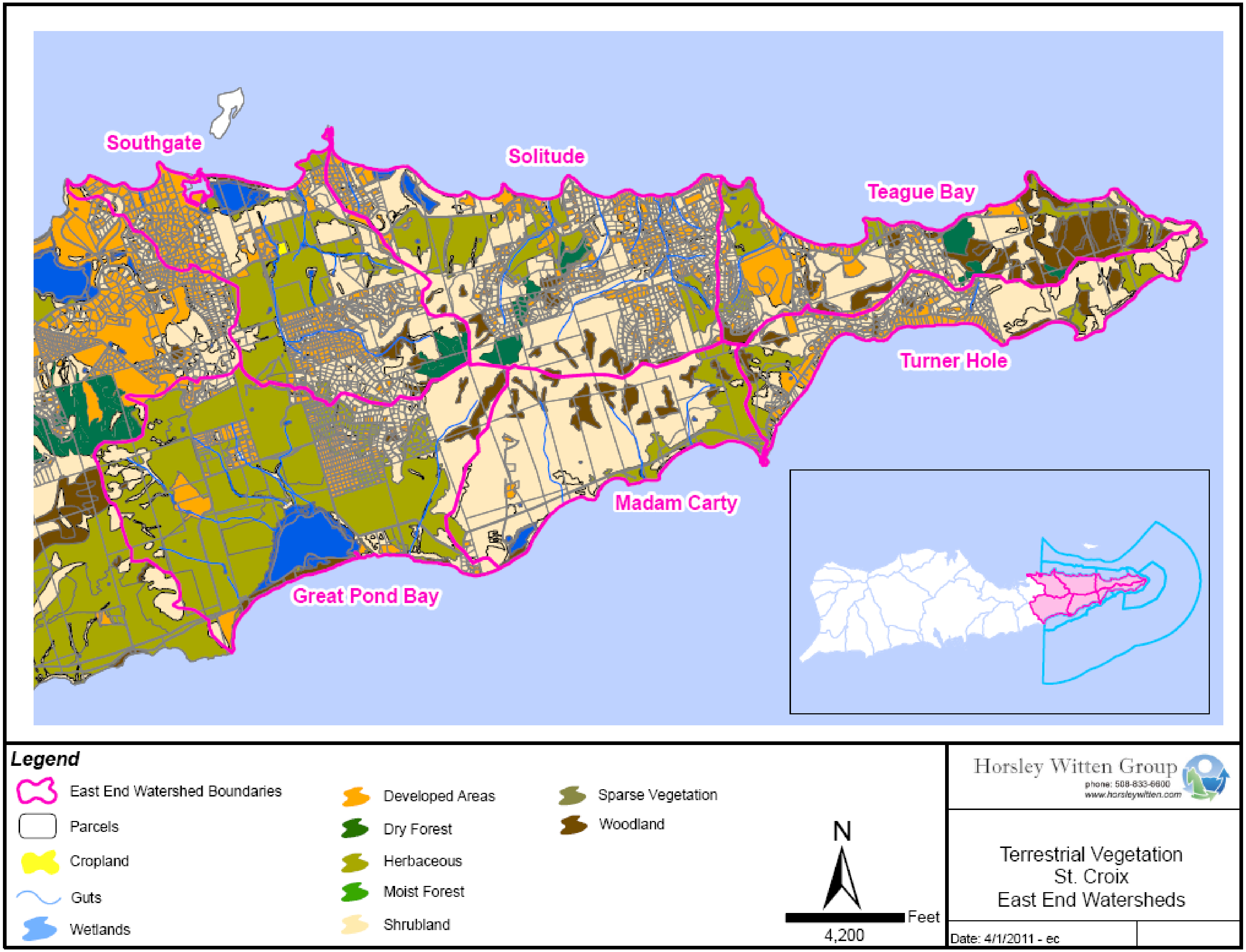


Figure 2.9. Terrestrial Vegetation Communities (based on DPNR vegetation mapping received in 2010).

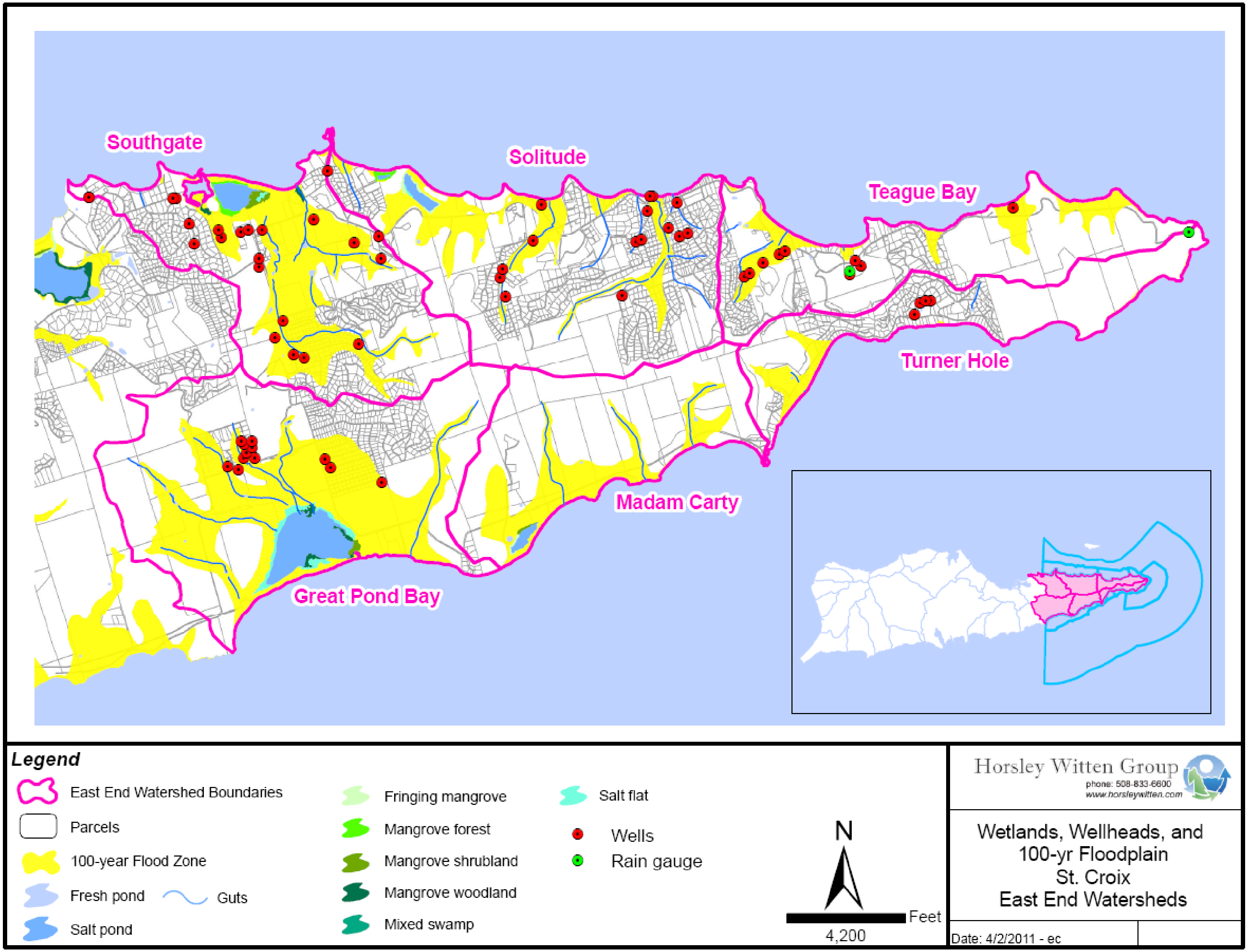


Figure 2.10. Wetlands, Wells, and 100-yr Floodplain boundary (based on DPNR mapping received in 2010 and 2011).

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**

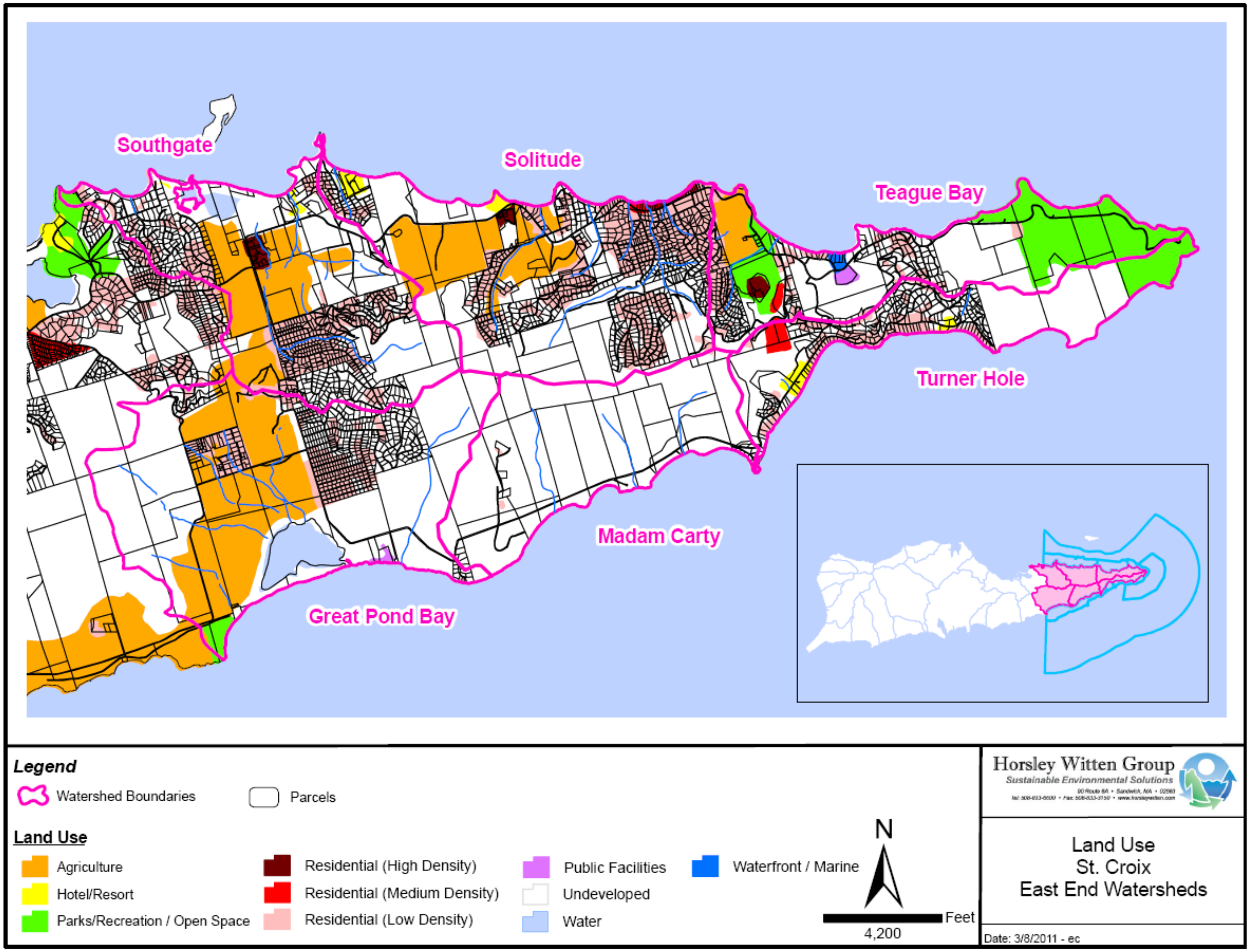


Figure 2.12. Current Land Use Map for the East End Watersheds (data received from DPNR in 2010, source UVI, 2003)

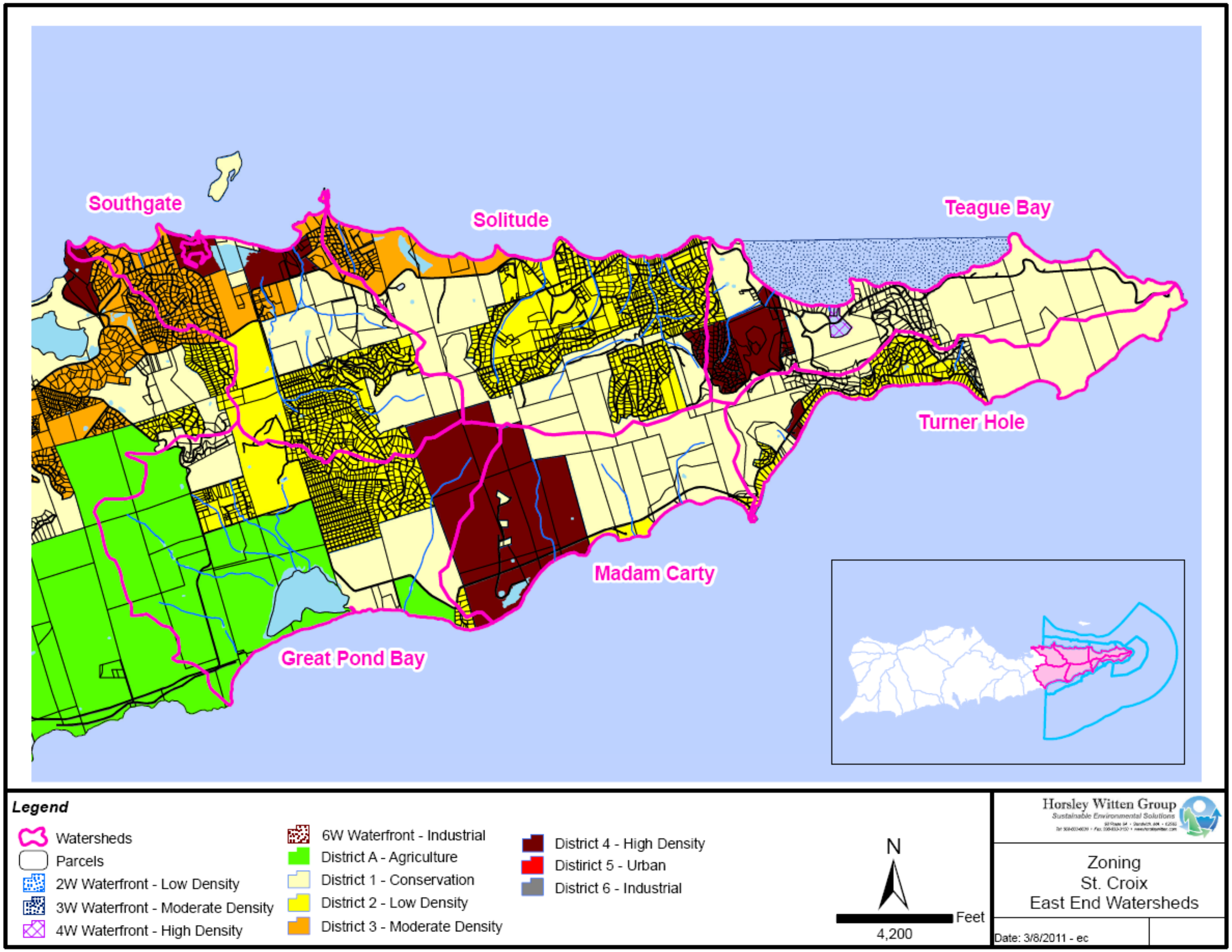


Figure 2.13. Future Zoning Map for the East End Watersheds (data received from DPNR in 2010)

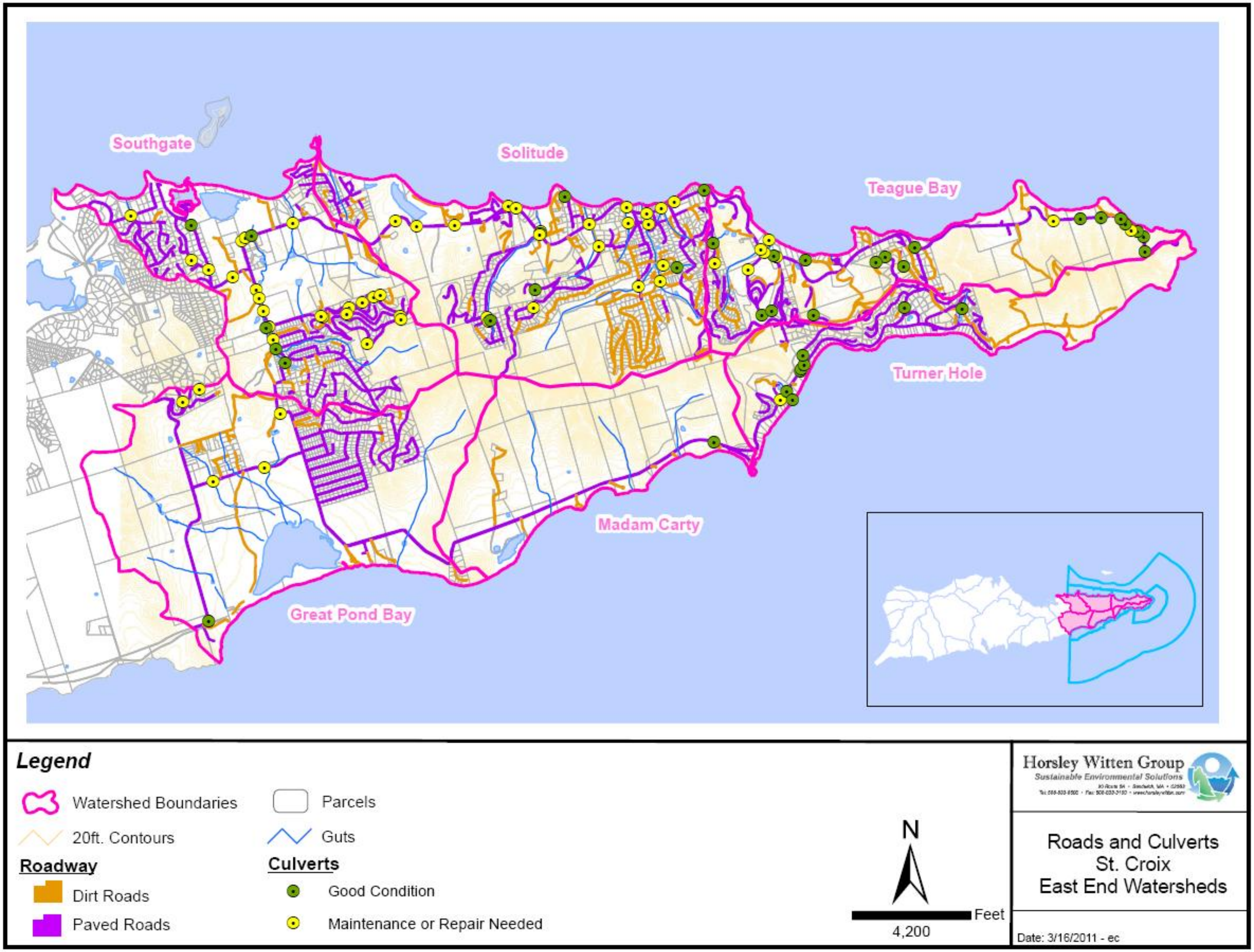


Figure 2.14. Paved and Unpaved Roads and Culvert Locations (data created by HW based on field assessments in 2011)

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)

<table>
<tr><th rowspan="2">Water Quality Parameter</th><th colspan="2">Standards</th></tr>
<tr><th>Class B</th><th>Class A</th></tr>
<tr><td>Dissolved Oxygen</td><td>≥ 5.5 mg/L</td><td rowspan="11">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.</td></tr>
<tr><td>pH</td><td>Between 7.0 - 8.3</td></tr>
<tr><td>Temperature</td><td>< 32°C; discharges not to be >1°C above natural</td></tr>
<tr><td>Bacteria</td><td>≤ 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.</td></tr>
<tr><td>Phosphorus</td><td>≤ 50 µg/l</td></tr>
<tr><td>Chlorine</td><td>4-day average ≤ 7.5 µg/l; 1-hr. average ≤ 13 µg/l</td></tr>
<tr><td>Suspended, colloidal, or settleable solids</td><td>None from waste water, which would cause deposition or be otherwise deleterious.</td></tr>
<tr><td>Oil or floating substances</td><td>No residue attributable to wastewater. No visible film; no globules of grease</td></tr>
<tr><td>Radioactivity</td><td>Gross beta: 1000 picocuries/l, in absence of Sr 90 and alpha emitters; Radium-226: 3 picocuries/l; Strontium-90: 10 picocuries/l</td></tr>
<tr><td>Taste and odor producing substances</td><td>No interference with primary contact recreation, potability; or undesirable taste or odor for edible aquatic life</td></tr>
<tr><td>Color and turbidity</td><td>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.</td></tr>
</table>

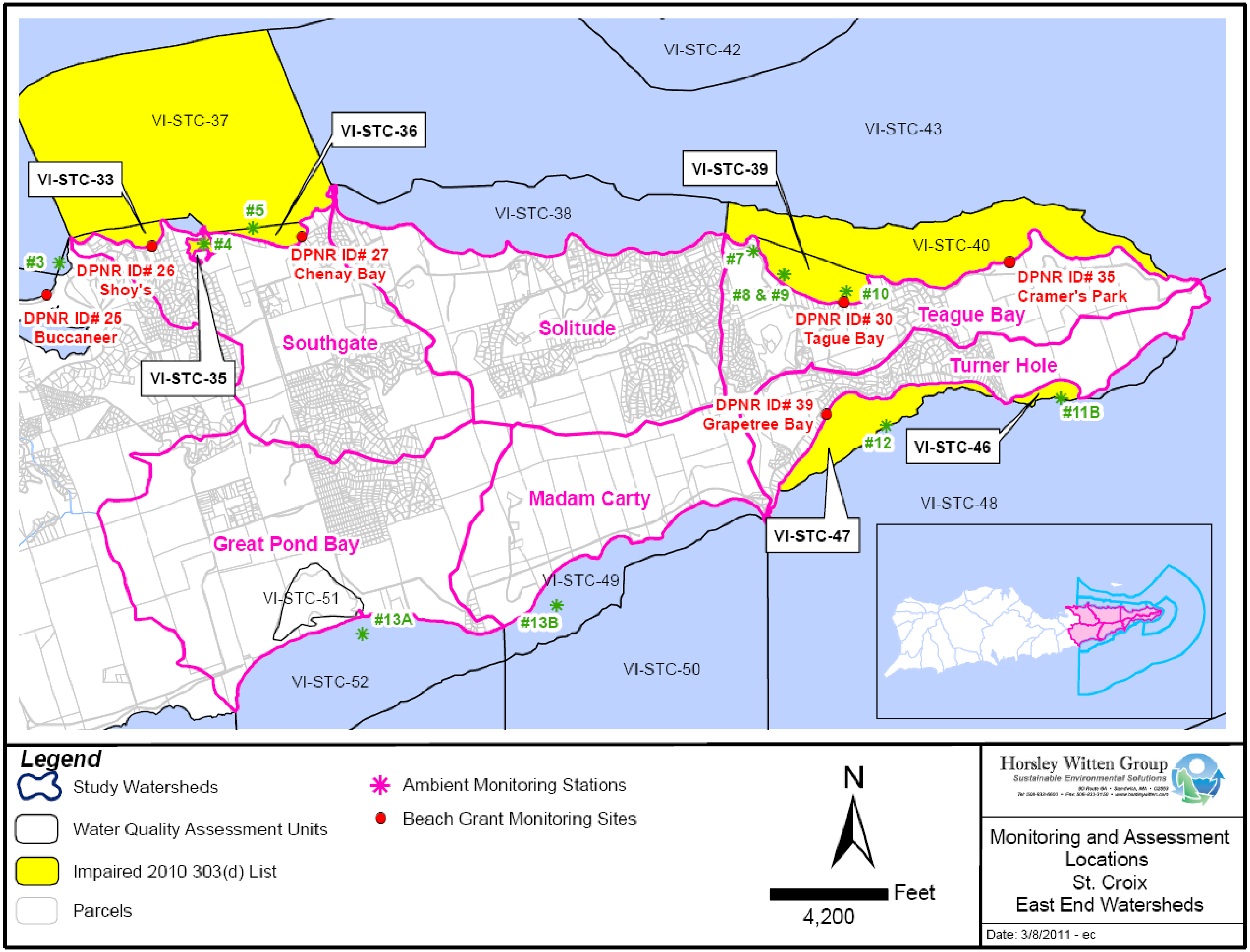


Figure 2.15. Beach Monitoring, Ambient Assessment Units, and Impaired Waters (data received from DPNR, 2010)

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.

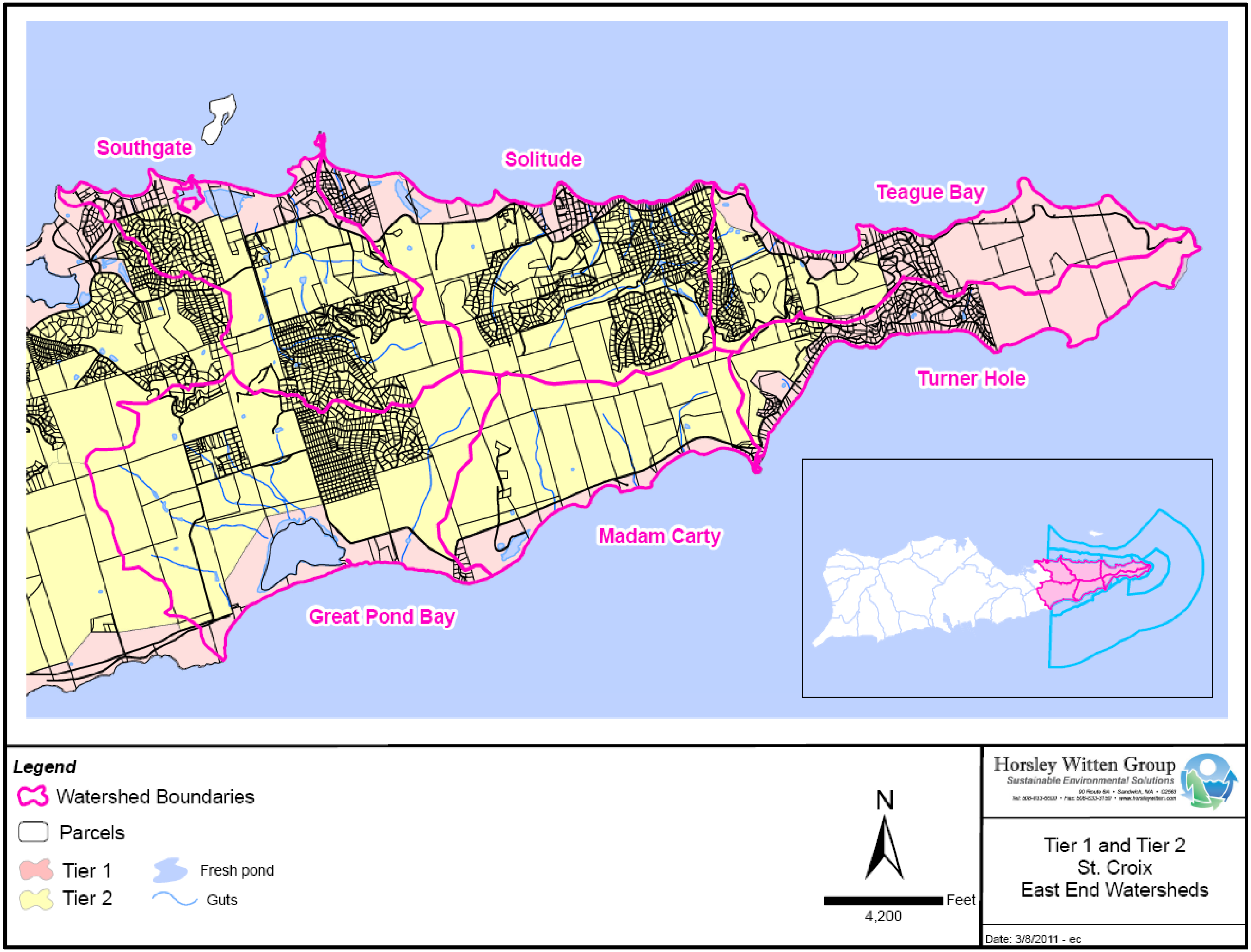


Figure 2.16. Tier 1 and 2 Designated Areas (mapping provided by DPNR in 2011)

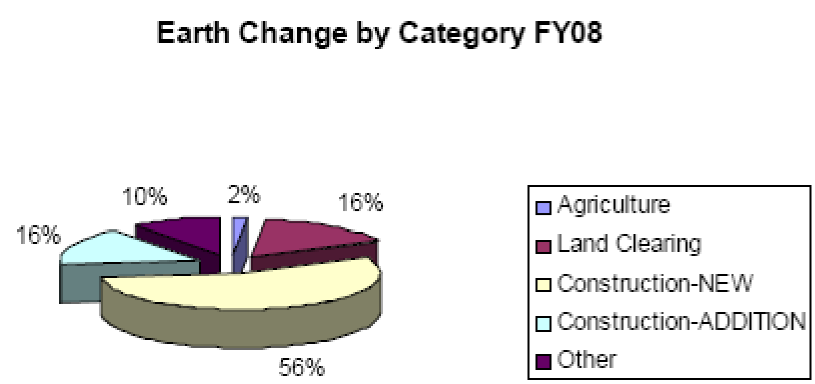
Road Drainage and Culvert Design

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 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) Residents: Clayton and Gail Lincoln; Other: Divi Carina Resort 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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