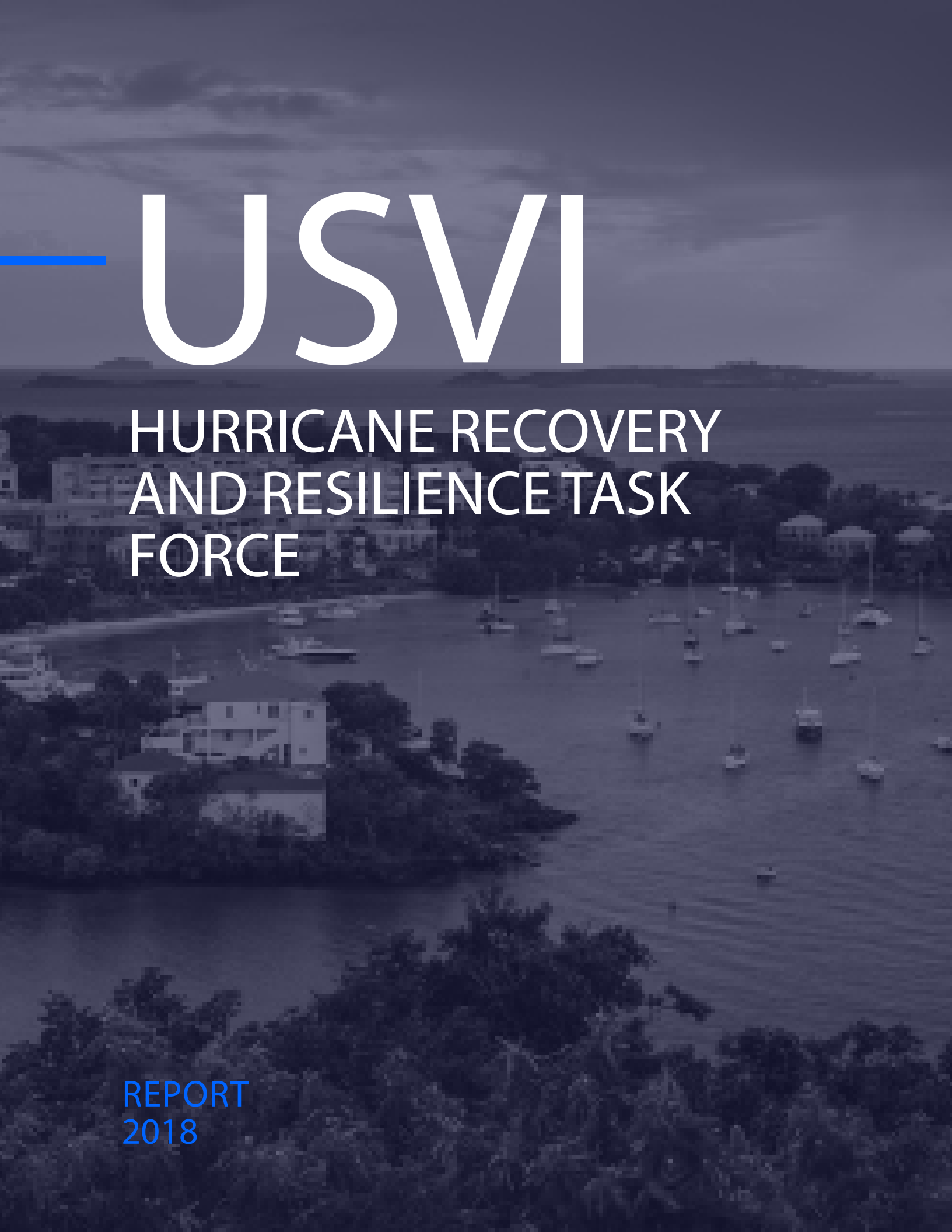


An aerial photograph of a harbor filled with numerous sailboats. The shoreline is lined with houses and trees. The sky is overcast. The image is in a dark, monochromatic blue-grey tone.

USVI

HURRICANE RECOVERY AND RESILIENCE TASK FORCE

REPORT
2018



This report is dedicated to the Virgin Islanders who lost their lives during and as a result of Hurricanes Irma and Maria, and to their loved ones. No written report could ever accurately or even approximately convey the destruction, loss and pain brought to US Virgin Islands communities by the 2017 hurricanes. These pages also recognize the strength, resilience and resourcefulness of the Virgin Islanders working hard to rebuild and recover. **We are Virgin Islands Strong.**

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LIST OF ACRONYMS

AMI	Advanced Metering Infrastructure	ECC	Emergency Communication Center
ASA	Alternative Support Apparatus	ED	US Department of Education
BIT	Bureau of Information Technology	EDA	Economic Development Authority
BVI	British Virgin Islands	EDC	Economic Development Company
CAI	Community Anchor Institutions	EHRVI	Emergency Home Repairs Virgin Islands
CASPER	Community Assessment for Public Health Emergency Response	EMAC	Emergency Management Assistance Compact
CBP	US Customs and Border Patrol	EMS	Emergency Medical Services
CDBG	Community Development Block Grant	EPA	US Environmental Protection Agency
CDBG-DR	Community Development Block Grant-Disaster Recovery	EPAP	Emergency Prescription Assistance Program
CDC	US Centers for Disease Control and Prevention	ESC	Emergency Support Coordinators
CPB	Corporation for Public Broadcasting	ESG	Emergency Solutions Grants
DBP	Division of Building Permits	FAA	Federal Aviation Administration
DHS	US Department of Homeland Security	FAP	Fiber Access Points
DLCA	Virgin Islands Department of Licensing and Consumer Affairs	FCCA	Florida Caribbean Cruise Association
DOE	Department of Energy	FCC	Federal Communications Commission
DOH	US Department of Health	FEMA	Federal Emergency Management Authority
DOI	Department of Interior	FEMA IA	Federal Emergency Management Authority Individual Assistance
DOT	US Department of Transportation	FEMA PA	Federal Emergency Management Authority Public Assistance
DPNR	Department of Planning and Natural Resources	FHWA	Federal Highway Administration
DPP	Virgin Islands Department of Property and Procurement	FIT	Feed-In Tariff
DPW	Virgin Islands Department of Public Works	FQHC	Federally Qualified Health Centers
		FTA	Federal Transit Administration

GTP	Gross Territorial Product	STX	St. Croix Henry E. Rohlsen Airport code; also shorthand for St. Croix
GVI	Government of the (U.S.) Virgin Islands	TCO	Territorial Coordinating Officer
HHS	Health and Human Services	TSA	Transportation Security Administration
HMGP	Hazard Mitigation Grant Program	USACE	US. Army Corps of Engineers
HUD	US Department of Housing and Urban Development	USCG	US. Coast Guard
ILEC	Incumbent Local Exchange Carrier	USDA	US Department of Agriculture
ISP	Internet Service Provider	USDOC	US Department of Commerce
JFLH	Juan F. Luis Hospital	USVI	US Virgin Islands
LEAC	Leveled Energy Adjustment Clause	USDA	US Department of Agriculture
LIHTC	Low-Income Housing Tax Credit	USVIBER	US Virgin Islands Bureau of Economic Research
LMI	Low and Moderate-Income	UVI	University of the Virgin Islands
LPG	Liquefied Petroleum Gas	VIBE	Virgin Islands Board of Education
MRE	Meals Ready to Eat	VIDOE	Virgin Islands Department of Education
NERC	North American Electronic Reliability Council	VIDOH	Virgin Islands Department of Health
NHC	National Hurricane Center	VIDOL	US Virgin Islands Department of Labor
NOAA	National Oceanic and Atmospheric Administration	VIEMS	Virgin Island Emergency Medical Services
NOS	National Ocean Service	VIEO	Virgin Island Energy Office
NREL	National Renewable Energy Laboratory	VIFA	Virgin Islands Finance Authority
NWS	National Weather Service	VIHA	Virgin Islands Housing Authority
POTS	Plain Old Telephone System	VIHFA	Virgin Islands Housing Finance Authority
PPA	Power Purchase Agreement	VING	Virgin Islands National Guard
PSA	Public Service Announcement	viNGN	Virgin Islands Next Generation Network
PSC	US Virgin Islands Public Service Commission	VIPA	Virgin Islands Port Authority
PURPA	Public Utility Regulatory Policies Act	VIPD	Virgin Islands Police Department
QF	Qualified Facility	VITEMA	Virgin Islands Territory Emergency Management Agency
RUS	Rural Utility Service	VOIP	Voice Over Internet Protocol
SBA	Small Business Administration	VSAT	Very Small Aperture Terminal
SCADA	Supervisory Control and Data Acquisition	WAPA	US Virgin Islands Water and Power Authority
SE	Stakeholder Engagement	WICO	West Indian Company Limited
STEP	Sheltering and Temporary Essential Power		
STP	Sewage Treatment Plant		
STJ	Shorthand for St. John		
STT	St. Thomas Cyril E. King Airport code; also shorthand for St. Thomas		

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GOVERNOR'S ADDRESS

September 2017, the Virgin Islands of the United States experienced some of the most powerful and destructive hurricanes in the Atlantic's recorded history. Within two weeks, hurricanes Irma and Maria barreled across the Territory with catastrophic consequences, damaging our homes, businesses and critical infrastructure.

As we witnessed the devastation with disbelief and sadness, we realized what significant rebuilding challenges lay ahead and we went to work. The storms did not weaken our spirit or resolve; power was restored, the functions of our government continued, cruise ships returned and our economy is beginning to rebound.

In fact, this crisis has afforded us the opportunity to build our communities better and stronger than ever.

We are fortunate to have a significant amount of resources coming into the Territory to help, including \$8 billion in federal funding. We must use this money wisely—not only to recover and improve our communities, but also to prepare for the future threats that climate change will inevitably bring. Studies suggest hurricanes will become more intense and there is scientific consensus that we will experience sea level rise of up to two feet by 2050. It is important for us to acknowledge this and to use this rare opportunity to rebuild for long-term success.

In the storms' aftermath, I called for the USVI Hurricane Recovery and Resilience Task Force to examine our response and to use the lessons learned and best practices from around the world to guide our rebuilding process. The 20+ member Task Force included Territorial agency heads, senators, federal partners, business leaders, subject matter experts and active members of our community. Their mandate was to present a report that lays out the best path forward to rebuilding and protecting our communities for the long term.

I thank and commend the Task Force members for their tireless service and commitment in this endeavor. Rebuilding will not be easy, but I have the utmost faith that using this report as a blueprint, we will recover fully from the storms and emerge stronger than ever before.



– Governor Kenneth E. Mapp



INTRODUCTION

In September 2017, two catastrophic Category 5 hurricanes tore through the U.S. Virgin Islands with 14 in days of each other. On September 6, hurricane Irma made landfall in the St. Thomas/St. John district; on September 20, hurricane Maria bore down on St. Croix. The storms stripped the Territory's lush flora, destroyed communications, power grid, and other infrastructure, and demolished homes and businesses.

Recovery efforts in the territory started the moment it was safe to venture outside. Large amounts of aid arrived from off-island, and more is yet to come, especially from the U.S. government. Yet recovery will be long and difficult, and, as The territory rebuilds, the question also stands: how do we prevent similar destruction from happening again in future storms, especially as climate change potentially makes storms stronger?

ABOUT THE TASK FORCE AND THIS REPORT

In October 2017, Governor Kenneth Mapp called for the Hurricane Recovery and Resiliency Task Force to develop a comprehensive report on the 2017 hurricanes' impact, as well as produce recommendations for effective recovery and resilience. Specifically, the report was to answer three questions for each of several sectors:

1. What happened during the hurricanes and why?
2. How will climate change affect the sector in the future?
3. What will the Territory do?

The report was to be data-driven, implementation oriented, and conscious of funding constraints. It was also to be supported by thorough stakeholder and community engagement work.

Nearly 10 months later, the report is being presented to the public. It builds on and complements the work that different governmental agencies and non-governmental organizations have been doing since the storms and will continue to do in the future. It also covers areas that no single organization is responsible for (like Private Telecommunications), includes information on future climate risks developed in collaboration with regional climate scientists (University of the Virgin Islands), and provides in one place a list of recovery and resilience initiatives across all of the report's 14 sectors (Energy, Public and Private Telecommunications, Transportation, Water, Solid Waste and Wastewater, Housing, Health, Education, Economy,

HARDENING, MITIGATION, RESILIENCE

These three terms have distinct meanings, although they are sometimes used interchangeably.

Hardening The narrowest of the three terms: preparing existing assets for the impacts of natural disasters (e.g. elevating a transformer substation)

Mitigation The middle definition: lessening the impact of disasters on systems by hardening existing assets, by ensuring those assets are not damaged in the first place (e.g. by moving them), or, if they are damaged, ensuring the systems have enough redundancy to keep working (e.g. by making sure a segment of a power system does not have a single point of failure)

Resilience The broadest of the three terms: engaging in mitigation, while also ensuring systems can recover quickly even if they are disrupted, and minimizing the impact of a disruption so the impact on the communities they serve is as small as possible. Another still broader definition of resilience is the capacity of individuals, communities, institutions, businesses and systems to survive, adapt, and thrive no matter what kinds of chronic stresses and acute shocks they experience

Vulnerable Categories, Philanthropy, Nonprofit and Volunteer Organizations, Government Response, and Funding). Each chapter relies on quantitative information to the greatest extent that was realistic within the Task Force's timeframe (meaning, usually, that if data was available, it was used, but that no new data was collected specifically for the report). Each chapter also takes account of funding and implementation constraints and is supported by extensive stakeholder engagement described later in this chapter.

Each sector's data and content was developed by a sector lead—typically a member of the related agency (Bureau of Information Technology and viNGN for Public Telecommunications; Department of Public Works and Virgin Islands Port Authority for Transportation; Virgin Islands Water and Power Authority for Water; Waste Management Authority for Solid Waste and Wastewater; Housing Finance Authority for Housing; Departments of Health and Education for the respective sectors; Department of Human Services for Vulnerable Categories; and Virgin Islands Territorial Emergency Management Agency for Government Response). Outside expert consultants served as sector leads for Energy, Private Telecommunications, Economy, and Philanthropy; work on the climate chapter was led by the scientists at the University of the Virgin Islands (UVI).

The work of sector leads was supported day to day by a group of staff working in "lite" mode between December 2017 and February 2018 and in full development between March and

August 2018. The overall effort was guided by the 19-member Task Force Advisory Group that included local government officials, private enterprise leaders, community members, and subject matter experts from around the United States. Clifford Graham, President and CEO of the West Indian Company (WICO), served as Chairman of the Task Force and Dina Leroy, who previously served as a senior advisor to Governor Mapp, was the effort's CEO.

Work on this report was funded by a grant from the Community Foundation of the Virgin Islands (CFVI), a local 501(c)(3) non-profit organization. CFVI had no say over the report's content. Task Force Advisory Group members and the Task Force's Chairman did not receive compensation.

STAKEHOLDER ENGAGEMENT

An important part of the Task Force's mandate was to engage stakeholders from around the USVI in its work and make sure that the report reflected their concerns and experiences. To fulfill this mandate, the Task Force created a Stakeholder Engagement (SE) group that functioned as the community relations arm of the Task Force, creating a two-way information flow in order to share with the public key information about the sectors covered in this document and collect information from the public to share with the Task Force. Members of the public provided a "boots on the ground" view of the disasters, providing

a picture of both the devastation and response for the report. The public also shared their visions for what the USVI could become by building on knowledge gained from the experience of 2017 storms in order to create a better prepared, more resilient territory across all sectors and for all citizens.

SE's work took place in three different formats: Community Meetings, Resiliency Training Workshops, and Special Interest Group Meetings. Across St. Croix, St. John, and St. Thomas, well over 500 members of the public participated.

Community meetings in collaboration with FEMA Long Term Recovery Groups (LTRGs)

On each island, FEMA created Long Term Recovery Groups (LTRGs) to bridge the transition from emergency response to post-storm recovery and help guide FEMA's efforts on a local level. LTRGs are local teams embedded in each community for a number of years that help identify and facilitate long-term projects that will help each community thrive each community as it works toward full recovery. A seven person board leads each LTRG, and general membership is between 75-100 local members. Members come from diverse communities, neighborhoods, and interest groups.

The SE group met with each island's LTRG in advance of community meetings to ensure that the collaboration between the Task Force and LTRGs

brought transparency and built trust into the community engagement process. Together, they provided community members a forum to share their experiences and opinions about the recovery. LTRGs hosted the SE team for several community meetings and included SE in ongoing LTRG meetings. This partnership offered an additional feedback mechanism, as the LTRGs collected response from individuals after community engagement events and shared them with the SE group.

In addition to collaborating with LTRGs on community events, the SE group engaged individuals from each community in less formal meetings through island-specific Community Liaisons—local individuals intimately familiar with the workings and concerns of each community. The liaisons gathered feedback and disseminated information on the Task Force's efforts to those unable to attend the larger events in order to maximize SE reach and gain a better understanding of hyperlocal issues.

Resiliency training workshops

In order to gain a clearer understanding of the community's priorities related to resilience, the SE group held two half-day Resiliency Workshops, one on St. Thomas and one on St. Croix. Facilitated by Task Force member Harriet Tregoning, a planning expert and former Deputy Director of the U.S. Department of Housing and Urban Development (HUD), the workshops served to inject resiliency values into the recovery conversation.

Resiliency Workshop attendees listened to presentations by subject matter experts and participated in breakout groups to generate and discuss ideas that would contribute to a more resilient territory. Three experts led presentations and workshop exercises on the following topics:

- Future Climate Risks to the U.S. Virgin Islands, led by Dr. Greg Guannel, Ph.D., Resiliency and Sustainability Chair and Caribbean Green Technology Director, University of the Virgin Islands (UVI)
- Resilient Recovery and Best Practices, led by Jonathon Halfon, FEMA
- Defining Resiliency Values: U.S. Virgin Islands' Risks and Vulnerabilities, led by Harriet Tregoning

The first workshop was held on January 29, 2018 on St. Thomas and included 40 attendees from St. Thomas and St. John; 52 attendees participated in the St. Croix workshop held on March 12. Workshop participants were asked to consider rebuilding opportunities that would make the islands more resilient in the face of severe climate risks like more powerful storms, rising sea levels, and other extreme weather risks.

Workshop attendees developed the following value statement to address these concerns: "Invest in the people of the territory and their health, safety, and well-being now and in the future. Build on the spirit of the cooperation and partnership in the aftermath of recent disasters to support a diverse and robust economy that is sustainable and resilient; a built and natural environment that is adaptable and well-maintained;

and a unique culture and quality of life.”

Special interest group meetings

In order to gain a deeper understanding of the distinct communities on each island and their unique concerns, the SE

group met with various special interest groups, faith groups, nonprofit organizations, chambers of commerce, and businesses to discuss specific sector issues. These groups helped foster dialogue and communicate Task Force news to their respective constituents (see table: [U.S. Virgin Islands organizations engaged with the Task Force](#)).

Economic Round Table

On June 14, 2018, the Task Force invited over 100 St. Thomas and St. John business leaders to an Economic Round Table facilitated by Task Force member Vivek Daswani. Professional associations, including the Virgin Islands Charter Yacht League, the VI Hotel and Tourism Association, and all of the USVI Rotary Club chapters, helped to expand the Task Force’s original invitation footprint. Over 50 business representatives from St. Thomas, St. Croix and St. John participated. Telecommunications, sustainable energy production, hospitality, retailers, legal, medical, insurance, grocers, beverage distributors, professional fishing companies, agriculture, shipping agents, finance, and their corresponding federal and territorial partners, among others, participated in this economically focused meeting. The top three issues shared in the Economic Round Table meeting were challenges with communications, business, and government continuity issues resulting from the lack of power and communications and the need to streamline processes. As word of mouth spread about the meeting, companies that had been unable to attend earlier events also shared feedback.

Territory-wide	St. Croix	St. Thomas	St. John
Moravian Churches in the Virgin Islands	St. Croix Chamber of Commerce	Downtown Revitalization Inc.	St. Thomas/ St. John Chamber of Commerce
New York State Black and Latino Elected Officials	St. Croix Foundation	Environmental Association of St. Thomas (EAST)	Coral Bay Community Council
Congresswoman Stacey Plaskett	St. Croix Landmark Society	Island Roads Corporation	Love for Love City
Community Foundation of the Virgin Islands	Club Comanche Hotel	St. Thomas Recovery Group	St. John Community Foundation
Government Employee Retirement System (GERS)	Big Beard’s Adventure Tours	St. Thomas East End Medical Center Corporation	St. John Long Term Recovery Group
USVI Legislature	St. Croix Long Term Recovery Group	St. Thomas/St. John Chamber of Commerce	
VI Housing Finance Authority (VIHFA)	Crucian Heritage and Nature Tourism (CHANT)	Paul Ferreras PE/ Engineer	
Virgin Islands Clergy Peace Coalition			
UVI Center for the Study of Spirituality and Professionalism			
VI Unity Day Group			
VI Domestic Violence & Sexual Assault Council (VIDVSAC)			
Clinical Providers			
Red Cross			
WTJX (Channel 12 Television)			

U.S. Virgin Islands organizations engaged with the Task Force



Stakeholder engagement outcomes

Nearly 500 members of the public engaged directly with the Task Force via community meetings, workshops, and other interactions. The public prioritized themes of Economy, Waste, Education, Health, and Housing. The table below details common concerns voiced within these sectors:

Sector	Priorities
Economy	• Bring back tourism
Waste	• Establish household waste recycling • Continue with debris removal
Education	• Set up resilient temporary classrooms for education continuity
Health	• Improve access to healthcare and prescriptions • Create afterhours access to emergency medical care on St. John
Housing	• Provide affordable housing options for potential and current homeowners • Rebuild homes and roofs before the 2018 hurricane season

Public comment period

Prior to its final publication, this report was released for public comment from July 20-27, 2018.



Over 110 residents attended St. John’s community meeting on April 24th at the Julius E. Sprauve School Cafeteria; Source: USVI Government House



Over 175 attendees came to the May 2, 2018 community meeting at Charlotte Amalie High School Auditorium (St. Thomas). Source: Natalie Suna, USVI Task Force



St. Croix residents participate in a community meeting on April 17, 2018. St. Croix held three meetings; March 16th, 17th, and the 18th in Frederiksted, Mid-Island, and Christiansted, with a total of over 130 attendees. Source: Natalie Suna, USVI Task Force

EXECUTIVE SUMMARY

HURRICANES IRMA AND MARIA

In the span of 14 days in September 2017, two Category 5 hurricanes, Irma and Maria, hit the U.S. Virgin Islands and caused catastrophic damage across the entire Territory and neighboring Caribbean islands. Irma struck first, largely sparing St. Croix and Puerto Rico, but pummeling St. Thomas, St. John and the British Virgin Islands. Maria came second, striking St. Croix and moving on to devastate Puerto Rico. By the time Maria had passed, U.S. Virgin Islander lives had been lost, and many of the Territory's 110,000 residents were without power, phones, food or running water. Ports and airports were closed for weeks. All three major hospitals and critical care centers across the territory were damaged and patients flown to Puerto Rico after Irma had to again be moved to the U.S. mainland; most have not been able to return.

HURRICANE RECOVERY AND RESILIENCE TASK FORCE

Following the storms, Gov. Kenneth Mapp called for the creation of an independent hurricane task force to evaluate the damage and response, and to propose solutions for rebuilding a more resilient Territory to withstand the increasing impacts of climate change. The Task Force was made up of 20 volunteers from the public and private sectors; it also included members of all major government agency heads, business and community leaders, as well as many of the outside experts who helped with the immediate response and long-term rebuilding in the months to follow. This report is the result of their work.



STORM DAMAGE

The storms severely damaged the islands' critical infrastructure, knocking out electricity and telecommunications for months, blocking roads, shutting down ports and airports, damaging water and wastewater facilities, generating hundreds of thousands of tons of debris, and damaging more than half of the Territory's housing stock. Total damage is estimated at \$10.8 billion: \$6.9 billion to infrastructure, \$2.3 billion to housing, and \$1.5 billion to the economy. Specific damage included:

- **ENERGY:** More than 90 percent of above-ground power lines were damaged and more than half of all poles were completely knocked down. Customers on all three large islands experienced total service outages, most for at least several weeks. The vast majority of customers were restored by January 1, 2018

- **TELECOMMUNICATIONS:** Cell service was taken out completely on St. John and 80 percent of cell sites were out of service on St. Croix and St. Thomas. The government phone system went out of service and some government data was lost to server damage. Public radio and television stations were out for months; public safety radio was degraded and only partly operational. 80 percent of customer connections to the viNGN fiber network were damaged or destroyed. Connectivity issues led to problems with administering medical and food assistance programs.
- **TRANSPORTATION:** Airports on St. Croix and St. Thomas closed for two weeks and reopened with limited capacity as airlines suspended many flights. Seaports closed for three weeks due to the sinking of more than 400 vessels; roads blocked with debris and the loss of power to traffic lights—or the lights themselves resulted in a more than a sevenfold increase in crashes at intersections.
- **WATER:** Potable water reserves dropped to only a three-day volume after production in reverse osmosis facilities stopped for two days on St. Croix and 10 days on St. Thomas; most storage tanks and pumping stations were damaged and water mains throughout the territory saw widespread leaks. Service was restored within one month.
- **WASTE MANAGEMENT:** Local landfill capacities were exceeded with more than 800,000 cubic yards (y³) of debris caused by the storms; some waste was shipped off-island. Damaged pump stations and sewer lines resulted in raw sewage being discharged into streets and coastal water.
- **HOUSING:** 52 percent of all housing stock was damaged (12 percent damaged severely); renters and low-to-moderate income (LMI) households were disproportionately affected. Senior centers were closed and homes for the elderly were damaged.
- **HEALTHCARE:** Both of the Territory's main hospitals were severely damaged to the point of becoming non-operational for most services; total daily inpatient capacity across the territory was down 50 percent and hundreds of patients were evacuated to the mainland and have been unable to return because services like dialysis and cancer treatments are no longer available.
- **EDUCATION:** All public schools closed for over a month, with 17 of 31 schools more than 50 percent damaged. Once open, most public schools operated on split sessions until the end of the academic year, and private schools saw steep enrollment drops.
- **ECONOMIC IMPACTS:** Hotel reservations saw a 78 percent drop in December 2017 compared to a year before; by June 2018, major airlines were still reporting a 43 percent drop in flight seats available compared to a year before. There were 4,300 additional jobless claims after the storms, with roughly 8 percent of all jobs lost, comparatively marking the third worst job loss from a US hurricane in the last 30 years.

Of the three major islands, the impact was particularly severe on St. John, where restoration of power and cell phone connectivity took the longest; the first customers had power restored 49 days after Hurricane Irma because St. John receives its power from St. Thomas and lines on St. Thomas had to be reconstructed first. Residents on the island's west end had to wait for 100 days for the first customer's power to be restored.

FACTORS CONTRIBUTING TO THE DAMAGE

While any place in the world would struggle to handle the damage from two Category 5 hurricanes in 14 days, several existing factors in the USVI made the impact of the storms worse than it could have been. A though not applicable to all sectors, those often included:

- Physical state of infrastructure: Decades of underinvestment combined with poor maintenance
- Infrastructure standards: Not stringent enough, not enforced enough, or both
- Regulation: Not addressing storm resilience or not covering some sectors (like private telecom) almost at all
- Planning for storms: No plans, old plans (22 years had passed since the previous devastating hurricane), or plans were not followed

- Pre-storm preparation:
Precautions like generator fuel top-up or vehicle dispersion were not taken.

By sector, some specific issues included:

- **ENERGY:** The USVI energy system relies on an overly centralized grid with many single points of failure (if one link fails, many customers are out), and a large amount of its infrastructure is aboveground and connected to old wooden poles. Backup generators were not designed to run for extended periods of time.
- **TELECOMMUNICATIONS:** Some national telecom carriers have long treated the USVI as a lower priority for hardening and restoration efforts compared to bigger markets and continued to do so after the storms. Public telecommunication systems also failed because of an obsolete public radio system and limited availability of satellite phones for government operations. A lack of communications back-up hindered continual administration of programs like Medicaid and food assistance (SNAP); there is no electronic health records system.
- **TRANSPORTATION:** Roads have been poorly maintained and there is an over-reliance on traffic lights instead of more efficient roundabouts. A lack of facilities to safely store boats onshore, and insufficiently hardened air-traffic control towers and terminals, resulted in major airport cancellations and delays.
- **WATER:** There was a major lack of back-up generators at water pump stations and extremely old and fragile pipes in the distribution system; private cisterns were also dependent on electric pumps, which was a problem when the power was out.
- **WASTE MANAGEMENT:** Wastewater pump stations are old and required electric power where gravity feeds could be used instead. Landfills were overflowing before the storms—partly because there is no meaningful recycling or composting infrastructure.
- **HOUSING:** Most buildings were not strong enough to withstand Category 5 storm damage—they had been built before Hurricanes Hugo and Marilyn and were not required to do retrofits to meet updated codes. That was also the case for the main hospital buildings and schools.
- **ECONOMY:** The territory was already in economic decline before the storms: between 2006 and 2016, real Gross Territorial Product (GTP) dropped 27 percent, and 6,000 jobs and 11,000 population were lost. The territory also relied heavily on tourism as its biggest industry, especially on St. Thomas and St. John.

FUTURE RISKS FROM CLIMATE CHANGE

As the climate changes, hurricanes will become stronger and hurricane-associated rainfall will increase. By 2050, sea levels

are estimated to rise by 1.5 to 2 feet, the number of hot days will increase, rainfall will vary more than in the past and seasons overall will become drier. That all means a greater risk for USVI residents, as built structures face the impact of hurricane winds and low-lying infrastructure (including buried power and communications cables) are hit with storm surges. Higher temperature will increase energy demand, and changes in rainfall will create water supply problems for those reliant on cisterns.

TASK FORCE RECOMMENDATIONS: INCREASING RESILIENCE AND SPEEDING RECOVERY

To help the USVI in its rebuilding, this report outlines four major strategies, many of which are already in the implementation process.

The first calls for hardening and fortifying existing physical infrastructure by strengthening buildings, roads, communication towers, power lines, and other facilities against hurricane winds and storm surge. Specifically:

- Bury power lines where feasible and use composite poles otherwise; fortify power plants and substations against storm surge and hurricane damage

- Strengthen telecom towers against high winds and bury the remaining aerial portions of viNGN network
- Rebuild seaports, expand container ports and Red Hook customs clearance
- Expand, strengthen, and modernize both airport terminals
- Harden and rehabilitate the existing water distribution system, including replacing old pipes
- Rebuild schools and hospitals to endure future storms
- Develop a housing retrofit program for buildings built prior to the stronger building codes adopted in 1996.
- Increase options for pedestrians and alternative transit; install roundabouts instead of street lights
- Conduct a Territory-wide drainage study
- Add redundancies to the wastewater system, eliminate some pump stations, and separate wastewater from storm water systems
- Close Anguilla landfill, with Bovoni landfill to follow
- Mandate a Territory-wide recycling program
- Expand water system to serve isolated communities
- Introduce electronic health records Territory-wide.

The second strategy recommends several ways the Territory can reconfigure systems and create new ways of delivering critical services, while simultaneously adding renewable energy components. Specifically:

- Diversify the energy system by adding 50 megawatts of renewable generation supported by battery storage onto the grid by 2025 (with a 20 megawatt goal in the near-term); make St. John independent of St. Thomas for energy supply; tie critical infrastructure like hospitals and telecom towers into microgrids that can operate independently even if another part of the system fails
- Set up cloud-based backup for government data and applications; switch to buried fiber cables instead of aerial cables of any sort, and install a new public safety communications system

The third recommendation includes strengthening governance and regulation, focusing especially on energy, buildings, and healthcare. Specifically:

- Reform the energy power purchasing process, update tariff structures, and improve and clarify system governance
- Update building codes based on what was learned in the hurricanes and improve capacity to enforce them
- Lobby Congress to pass a better Medicaid reimbursement rate with the federal government; reform the system for hospital boards and reconsider creating a territorial healthcare exchange.

Finally, the report suggest ways to better plan and prepare for future storms. Specifically:

- Install back-up power generation at critical facilities

designed to function over long periods of time; make sure generators are filled up and maintained

- Create an Emergency Operations Center (EOC) for the Territory as a whole; review agency emergency plans; develop pre-hurricane checklists that agencies must follow; equip key government workers with satellite phones.

FUNDING AND IMPLEMENTATION

Most of the initiatives will be paid for with federal recovery funding. The two major sources are Community Development Block Grants—Disaster Relief (CDBG-DR) from the U.S. Department of Housing and Urban Development (HUD) and various funds from FEMA. As of June 2018, the USVI is counting on \$1.86 billion in HUD money (\$1.09 billion for unmet needs and \$0.77 billion for mitigation) and \$2.47 billion in FEMA money.

Implementation of the report will be led by a separate office. The office will release annual progress reports discussing the progress of implementation of initiatives in this report through 2021.



Hurricane Irma gathering strength off of the USVI Source: NASA Earth Observatory

HURRICANES IRMA AND MARIA

HURRICANES IRMA AND MARIA

Hurricanes Irma and Maria, both Category 5 storms with wind gusts of up to 178 mph at their centers, impacted the USVI within two weeks of each other on September 6 and September 20, 2017. Hurricane Irma most affected the St. Thomas/St. John district and damaged St. Croix as well; Hurricane Maria most affected St. Croix, which by then had become the staging ground for recovery operations for areas damaged by Irma, and further damaged what was already damaged on St. Thomas and St. John. The hurricanes caused five direct deaths in the territory.



SAFFIR-SIMPSON SCALE: CATEGORY 5 DEFINITION

Catastrophic damage will occur:

A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

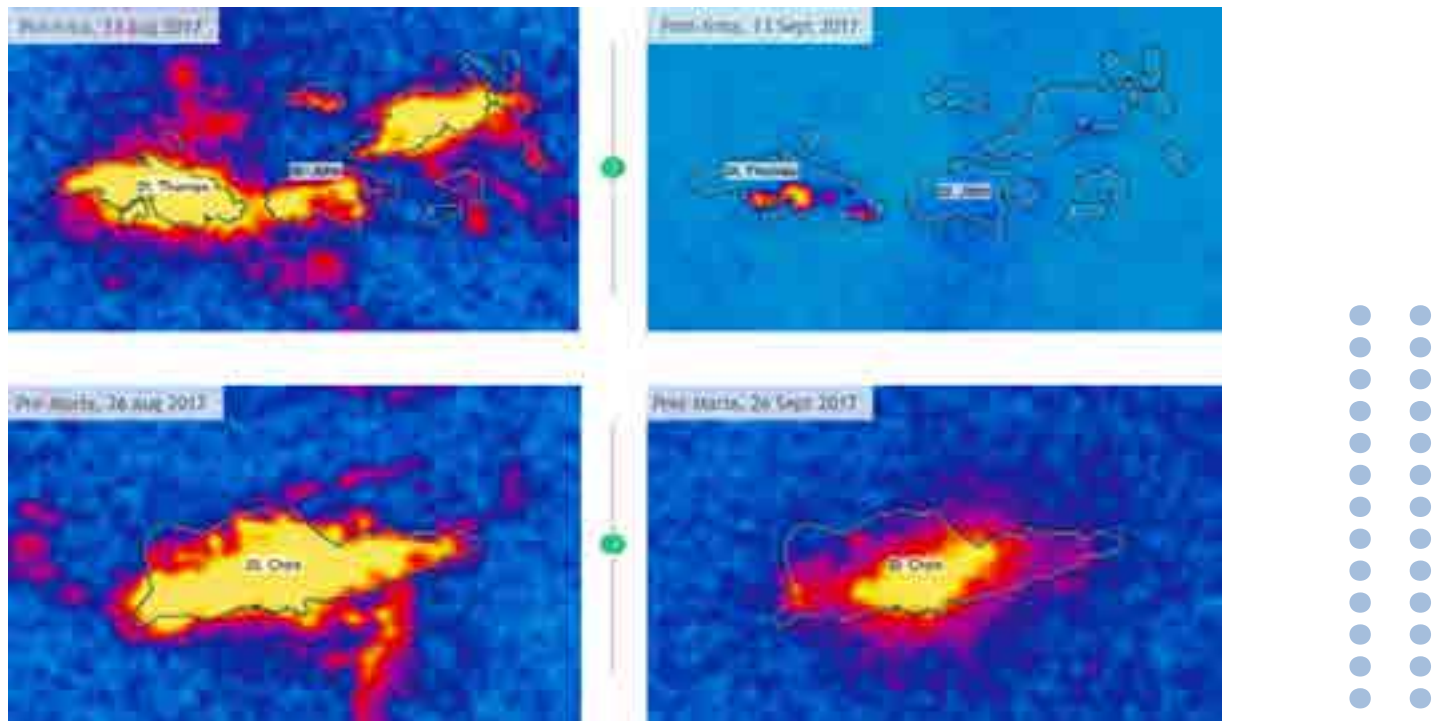
Wind speeds: 157 mph or higher

Source: National Hurricane Center

	Hurricane Irma	Hurricane Maria
Category	5	5
Landfall date	September 6	September 20
Landfall location	St. Thomas / St. John	St. Croix
Worst affected areas	St. Thomas / St. John District	St. Croix District
Maximum measured sustained wind speeds	106 mph*	107 mph*
Maximum measured wind gusts in the USVI	137 mph*	137 mph*
Rainfall	Data not available*	5 in.+*
Storm surge	0.60 – 2.28 ft.+*	1.48 – 2.85 ft.+*
Storm tide	0.50 – 1.7 ft.+*	1.61 – 3.17 ft.+*
Direct deaths	3	2

*Precipitation and tide measuring instruments were knocked off-line or destroyed

Hurricanes Irma and Maria



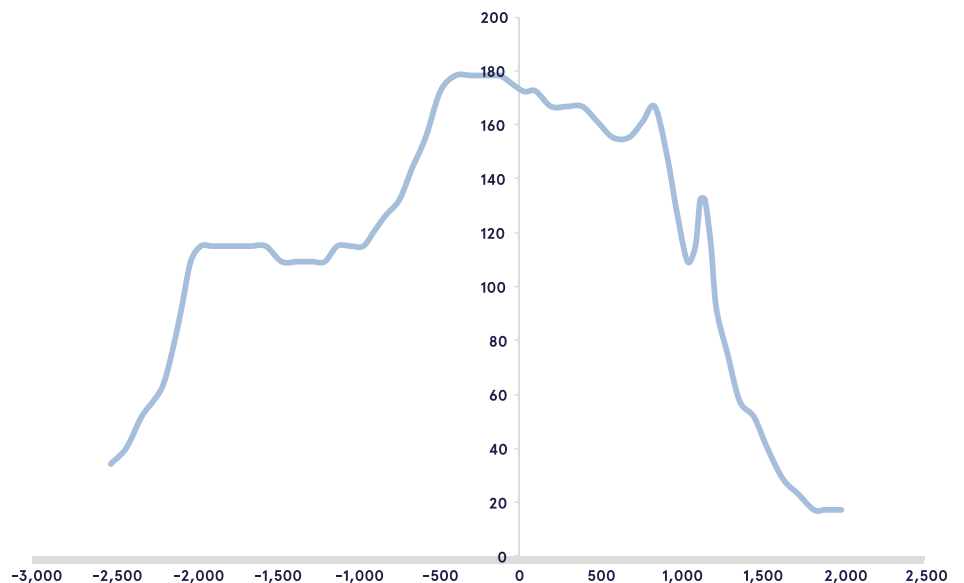
Hurricanes Irma and Maria, pre and post event night lights variation
Source: NASA

HURRICANE IRMA

Hurricane Irma approached the U.S. Virgin Islands as a Category 5 hurricane with sustained winds of 178 mph at its center. On September 6, the storm's center passed just north of St. Thomas around 2 p.m. AST, leading to sustained winds of 106 mph and gusts of up to 137 mph as measured by surface observation stations. Irma moved northwest and passed roughly 50 miles north of Puerto Rico around 8 p.m. AST on September 6. The final path of the hurricane was west of the National Hurricane Center's (NHC) predictions, which had also predicted the storm

would turn northward earlier than it did.¹ The wind at the hurricane's center attained near maximum strength as the hurricane

approached St. Thomas (see chart: Wind speed at Hurricane Irma center vs. distance to downtown Charlotte Amalie, St. Thomas).



Wind speed at Hurricane Irma center (mph, vertical axis) vs. distance to downtown Charlotte Amalie, St. Thomas (miles, horizontal axis)
Source: Task Force analysis based on NHC data

¹ Cangialosi, John P., Andrew S. Latta, and Robbie Berg. Tropical Cyclone Report: Hurricane Irma. Report no. AL112017. National Hurricane Center, National Oceanic and Atmospheric Association | National Weather Service. May 30, 2018. Accessed June 15, 2018. https://www.nhc.noaa.gov/data/tcr/AL112017_Irma.pdf.



The NHC began providing Impact-Based Decision Support Services (IDSS) for Hurricane Irma starting on September 1; IDSS included briefings coordinated through the FEMA Hurricane Liaison Team and included the USVI and Puerto Rico, as well as several states. The NHC issued the first Hurricane Watch for Irma to the USVI at 3 p.m. AST on September 4; this changed to a Hurricane Warning issued on September 5 at 3 p.m. AST. The Hurricane Warning was discontinued on September 7 at 3 a.m. AST (see table: [Timeline of Hurricanes Irma and Maria](#)).

Irma produced significant storm surge in the St. Thomas-St. John District. While the National Ocean Service (NOS) tide gauge on St. Thomas (Charlotte Amalie) went offline during the hurricane and could not transmit a peak storm surge level, NHC estimated a surge of at least 2.3 ft. and possibly greater.

Hurricane Irma caused extensive damage throughout St. Thomas, St. John, Water Island and the district's surrounding smaller islands. Across the territory, high wind speeds stripped foliage, brought down power and telephone lines, sheared off roofs, and turned debris into projectiles. Residents who followed instructions to shelter in place found themselves in a fight for survival as powerful winds sucked furniture out of homes after windows or doors blew out. People reported crawling atop their refrigerator to hide in the space between the fridge and cabinetry,

or piling furniture against doors and lying on their back to press against the blockade with their feet. Although the damage to St. Croix was not so extensive as that in the St. Thomas / St. John District, roughly 70 percent of St. Croix's homes and structures still suffered some damage from the storm.

STORM SURGE, STORM TIDE AND INUNDATION

According to the NHC, "storm surge is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tide, and is expressed in terms of height above normal tide levels. Because storm surge represents the deviation from normal water levels, it is not referenced to a vertical datum. Storm tide is defined as the water level due to the combination of storm surge and the astronomical tide, and is expressed in terms of height above a vertical datum, i.e. the North American Vertical Datum of 1988 (NAVD88) or Mean Lower Low Water (MLLW). Inundation is the total water level that occurs on normally dry ground as a result of the storm tide, and

is expressed in terms of height above ground level. At the coast, normally dry land is roughly defined as areas higher than the normal high tide line, or Mean Higher High Water (MHHW)."

Irma was responsible for three direct deaths in the USVI.² Extensive damage to power, Internet and cable lines resulted in an almost territory-wide communications and power blackout. Residents of St. John, Water Island and the USVI's other smaller islands were stranded for days as ports were closed, ferries were not running and sunken vessels made navigation treacherous. The damage to airports on St. Thomas and St. Croix effectively stranded the entire USVI population for weeks following Hurricane Irma—in many cases, trapping people who'd lost everything in the hurricane and were ready to leave the USVI STET, only to endure a second hurricane just two weeks later. Private individuals and charters alike began to run boats between the USVI and Puerto Rico to give people a chance to get to the still-open San Juan airport (SJU).



² Direct deaths are defined by the National Hurricane Center as "occurring as a direct result of the forces of the tropical cyclone... These include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths."

August 25



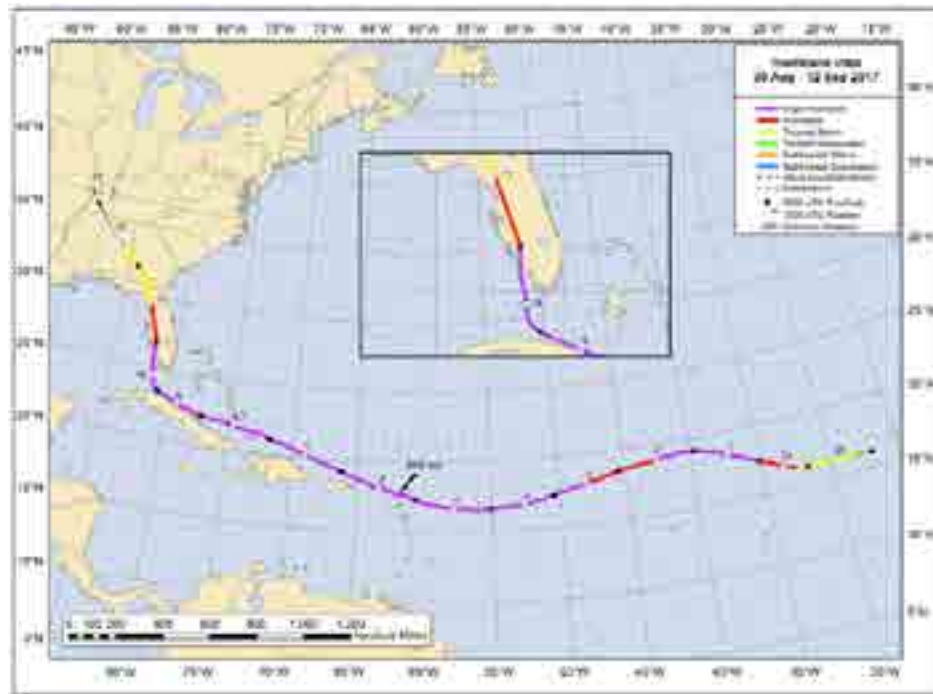
September 10



Hurricane Irma stripped nearly every leaf from trees and plants
Source: NASA

Timeline of Hurricanes Irma & Maria

September 1	IDSS for Irma
September 4	Hurricane Watch issued for Irma
September 5	Hurricane Warning issued for Irma
	Seaports closed
September 6	Airports closed
	Hurricane Irma landfall STET USVI
September 7	Hurricane Warning lifted for Irma
September 14	IDSS for Maria
September 17	Hurricane Watch issued for Maria
September 18	Hurricane Warning issued for Maria
September 20	Hurricane Maria landfall on USVI
September 20	Hurricane Warning lifted for Maria
September 28	STT airport reopened (limited)
October 5	STX airport reopened



Best track positions for Hurricane Irma, August 30 – September 12, 2017.
Source: NOAA

HURRICANE MARIA

Just 14 days after Hurricane Irma hit St. Thomas and St. John, Hurricane Maria bore down on St. Croix. Starting on September 11, it took only five days for a tropical wave to form into Hurricane Maria on September 16, and

by September 18, Maria was a Category 5 storm. The hurricane made landfall on St. Croix early in the morning on September 20 with peak wind speeds at its center of 172 mph, as it passed roughly 25 nautical miles south of the island. Peak sustained winds of 107 mph, with gusts of 137 mph were reported on St. Croix near the northeast edge of Maria's eyewall. Maria continued west-northwestward toward Puerto Rico, where it made landfall late in the morning of September 20, causing catastrophic damage. The hurricane attained nearly maximum strength when it was nearest to St. Croix most closely (see chart: [Wind speed at hurricane center vs. distance to Christiansted](#)).

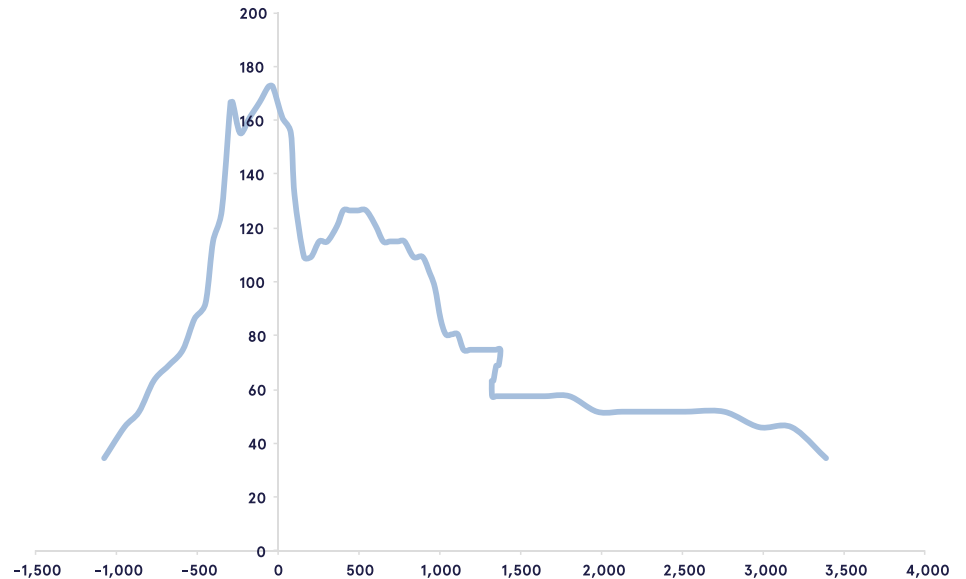
The NHC began providing Impact-Based Decision Support Services (IDSS) starting on September 14; IDSS included briefings coordinated through the FEMA Hurricane Liaison Team and included the USVI and Puerto Rico. The NHC issued the first Hurricane Watch for Maria to the USVI at 9 p.m. AST on September 17; this upgraded to a Hurricane Warning issued on September 18 at 3 p.m. AST. The Hurricane Warning was discontinued on September 20 at 9 p.m. AST.

Although the tide gauge at Lime Tree Bay on St. Croix measured a peak water level of 2.8 ft. relative to Mean Higher High Water (MHHW), the sensor went offline during the storm and likely did not record the actual highest water level. NOAA surge simulations suggest maximum inundation levels of 1-3 ft. above ground level on St. Thomas and St. John.

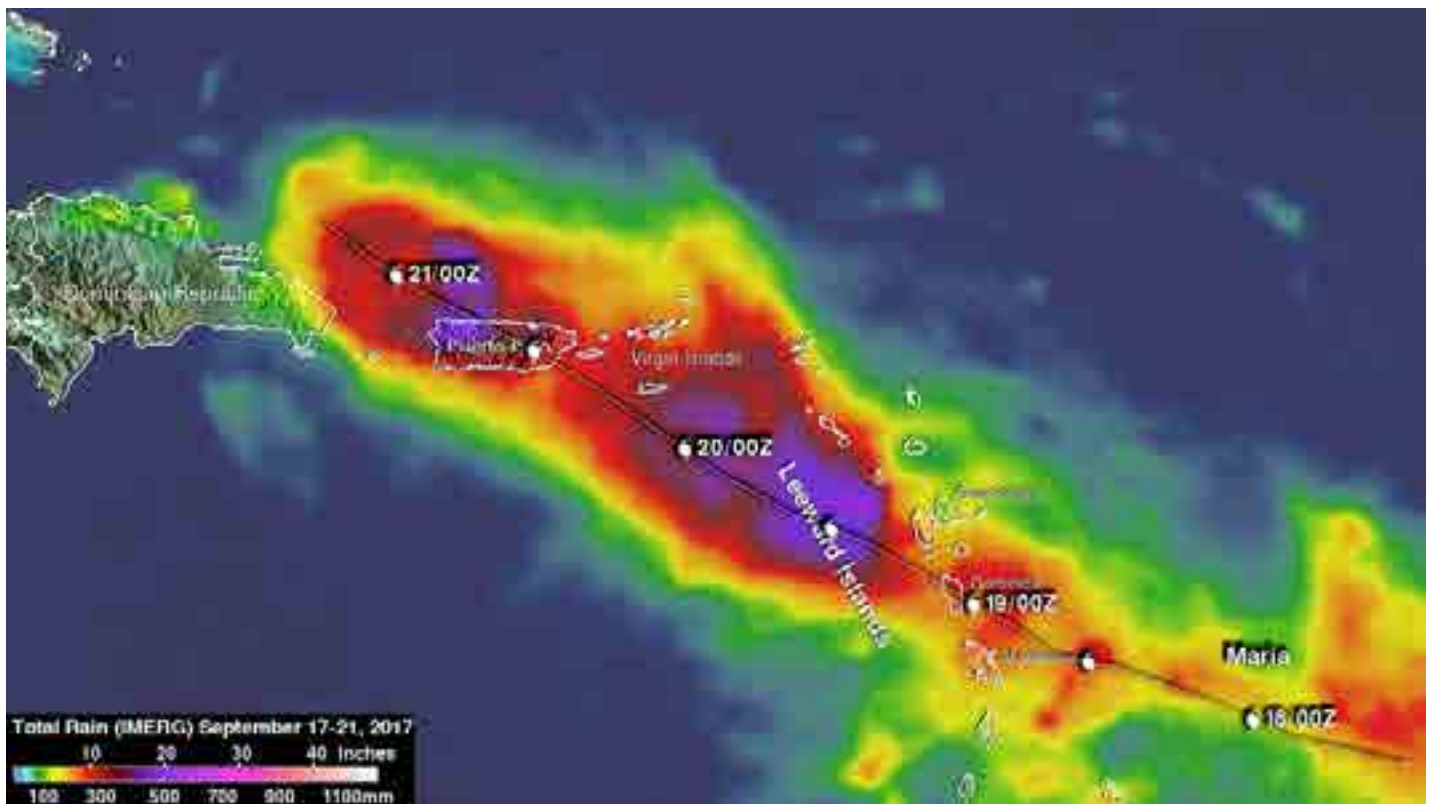
Hurricane Maria affected all of the USVI, but St. Croix most

severely, causing significant wind damage to roofs, structures, foliage and aerial power and phone lines. Deluges of rain from Maria resulted in widespread flooding and mudslides throughout the territory. St. Croix experienced at least an estimated 5-7 inches of rainfall; throughout the USVI—and especially in the St. Thomas/St. John district—the rain further damaged structures already damaged in Hurricane Irma (see graphic: [Hurricane Irma rainfall patterns](#)).

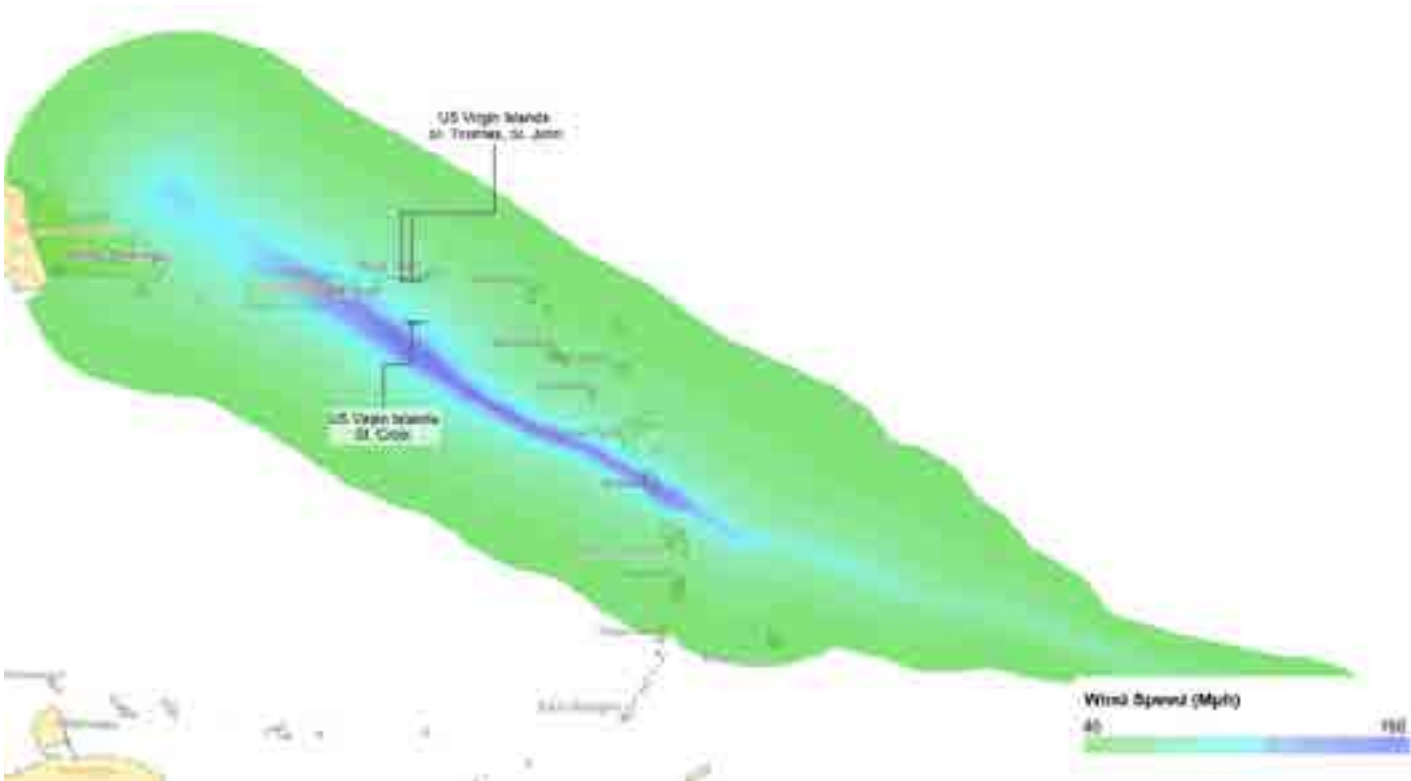
In the USVI, the hurricane was responsible for the direct deaths of two people.



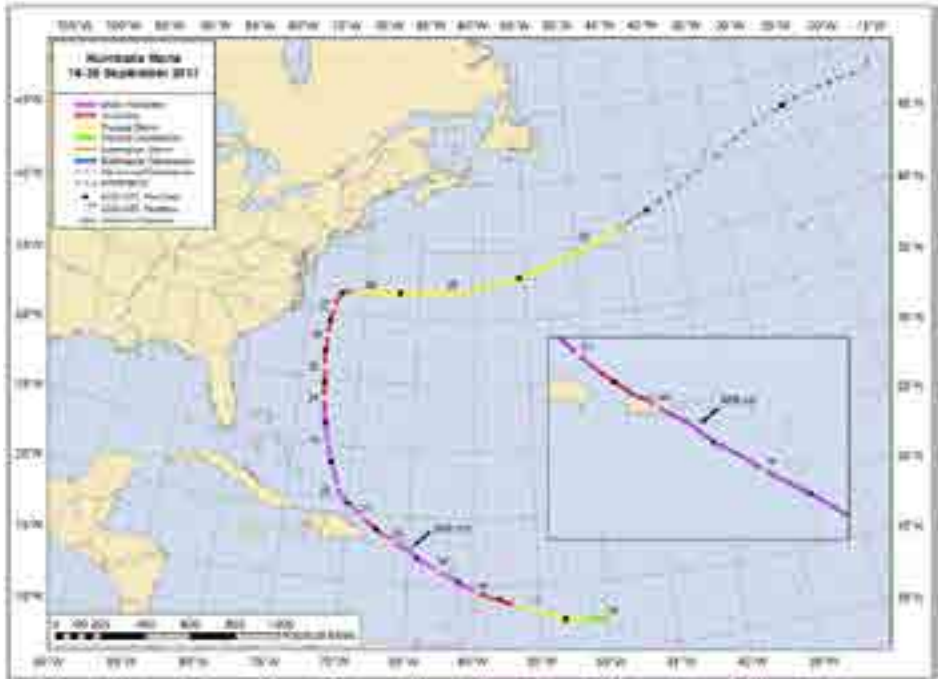
Wind speed at Hurricane Maria center (mph, vertical axis) vs. distance to downtown Christiansted (miles, horizontal axis)
Source: Task Force analysis based on NHC data.



Hurricane Maria rainfall patterns.
Source: NASA



Hurricane Maria wind gust footprint
Source: Pan American Health Organization/World Health Organization and Applied Research Associates.



Best track positions for Hurricane Maria, September 16 – September 30, 2017.
Source: NOAA

IRMA	Instrument and identifier	Coordinates	Minimum sea level pressure		Maximum surface wind speed			Flooding and precipitation				Knot data for wind speed - ignore. 1 kt = 1.15078 mph	
			Date/time (UTC)	Pressure (mb)	Date/time (UTC)	Sustained (mph)	Gust (mph)	Storm surge (ft)	Storm tide (ft)	Estimated inundation (ft)	Total rain (in)	Sustained (kt)	Gust (kt)
St. Thomas	Cyril E. King Airport (TIST)	18.33N 64.97W			06/1153	59 [^]	87 [^]					51	76
	NOS site at Charlotte Amalie, St. Thomas (CHAV3)	18.34N 64.92W	06/1742	967.5	06/1736	63	98	1.45**	1.71**	1.30**		55	85
	Weatherflow site at Savana Island (XSAV)	18.34N 65.08W			06/1815	58	89					50	77
	Weatherflow site at Buck Island (XBUK)	18.28N 64.90W	06/1653		06/1723	106	137					92	119
	Weatherflow site at Rupert Rock (XRUP)	18.33N 64.93W			05/1750	83	132					72	115
St. John	NOS site at Lameshur Bay, St. John (LAMV3)	18.32N 64.72W	06/1736	945.1				1.62	1.6	1.2			
St. Croix	Henry E. Rohlsen Airport (TISX)	17.68N 64.90W	06/1653	969.6	06/1843	38	63					33	55
	NOS site at Christiansted Harbor, St. Croix (CHSV3)	17.75N 64.70W	06/1706	995	06/1642	38	58	2.28	2.01	1.7		33	50
	NOS site at Lime Tree Bay, St. Croix (LTBV3)	17.70N 64.75W	06/1706	996.4	06/1848	49	61	0.6	0.8	0.5		43	53
	Weatherflow site at Sandy Point NWR, St. Croix (XCRX)	17.68N 64.90W			06/1903	41	59					36	51
MARIA													
St. Thomas	Weatherflow site at Rupert Rock, St. Thomas (XRUP)	18.33N 64.93W	20/0701	993.6	20/0201	45*	64					39	56
St. John	CarlCOOS buoy south of St. John (41052)	18.25N 64.76W	20/0700	992.5	20/0830	47	64					41	46
	NOS site at Lameshur Bay, St. John (LAMV3)	18.32N 64.72W	20/0612	998.2				1.48	1.61	1.2			
St. Croix	Christiansted, St. Croix (CVAV3)	17.74N 64.62W			20/0613	99	136				5.03	86	118
	NOS site at Christiansted Harbor, St. Croix (CHSV3)	17.75N 64.70W	20/0518	978.4	20/0142	49	75	2.27	2.36	2		43	65
	NOS site at Lime Tree Bay, St. Croix (LTBV3)	17.70N 64.75W	20/0342	976.1	20/0330	69*	102	2.85*	3.17*	2.80*		60	89
	Weatherflow site at Sandy Point NWR, St. Croix (XCRX)	17.68N 64.90W	20/0538	950.1	20/0618	107	137					93	119

* Incomplete data

[^] Site damaged during storm

** Station went offline and did not transmit a peak water level during the event. Peak values represent the highest transmitted prior to outage.

Selected surface observations for Hurricanes Irma and Maria

Source: NHC reports for Hurricanes Irma and Maria

CLIMATE ANALYSIS

The USVI climate is changing and will continue to change, and the impacts of natural hazards will become more intense. Firstly, temperatures are rising. Rainfall patterns are, and will continue to be highly variable. The territory will get drier by the end of the century. Seas are rising, and they will submerge, intermittently at first but eventually permanently, economically and culturally important coastal areas such as beaches, buildings, critical infrastructure, and roads. Lastly, it is expected that hurricanes and swells will become more powerful—not necessarily more frequent—causing more wind damage, longer and more intense rainstorms, larger inundation and more severe coastal erosion.

WHAT IS CLIMATE CHANGE?

Weather patterns are driven by differences in temperature of the Earth's surface, leading to changes in pressure, wind, humidity and, ultimately rainfall patterns. Climate refers to the long-term regional or even global average of temperature, humidity and rainfall patterns over seasons, years or decades.¹ The earth's climate is affected by solar cycles, changes in ecosystems, or volcanic eruptions. Due to the global increase of temperatures, climate in different parts of the world has been changing for at least for the past 100 years.

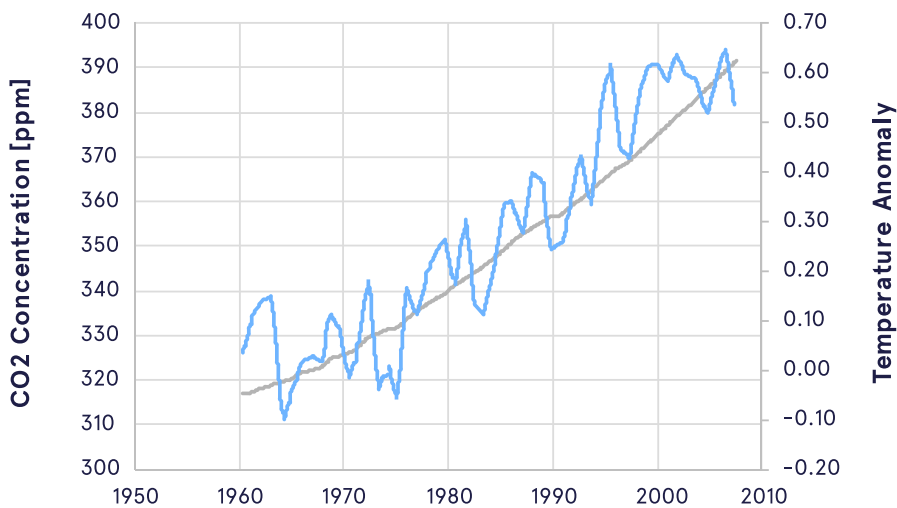
Indeed, for more than 100 years, humans have emitted vast amount of greenhouse gases in the atmosphere. These gases, which are common gases (e.g., carbon dioxide, methane, water vapor, etc.) and lesser-known gases (e.g., fluorinated gases), usually trap heat in the atmosphere and help maintain livable temperatures on earth.² However, excess emissions by humans, mostly carbon dioxide through the burning of fossil fuels, have caused more heat to be trapped and global temperatures to slowly increase. The steady increase in global temperature, known as global warming, is leading to disturbances around the world that change weather patterns, and thus also change climate. As a result, many places in the world have experienced long-term changes in the frequency, intensity and duration

¹ "What's in a Name? Weather, Global Warming and Climate Change" NASA, January 20, 2016, Accessed June 2018. <https://climate.nasa.gov/resources/global-warming/>.

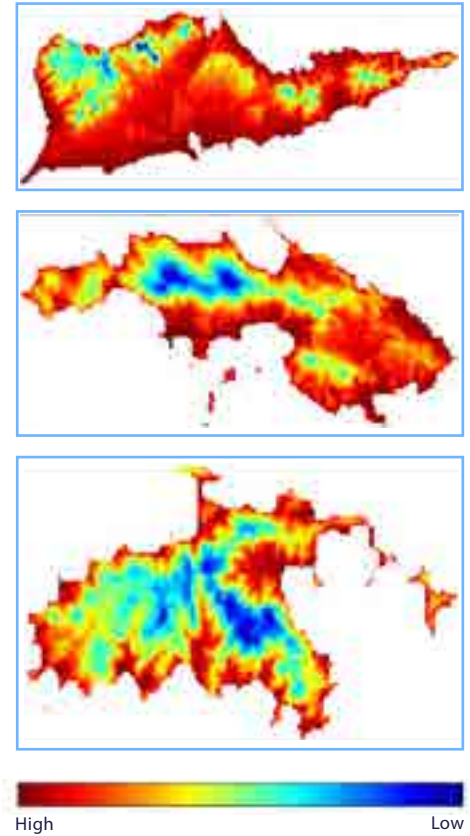
² "Greenhouse Gas (GHG) Emissions," EPA, June 04, 2018, accessed June 2018. <https://www.epa.gov/ghgemissions>.

of weather events—meaning that their climate has changed. These changes, and the impacts of these events, have been exacerbated by a global rise in sea level caused by the melting of glaciers; these land-based reserves of water are melting due to increased global temperatures.

night, with some variations within and among the different islands in the territory. The warmer period lasts from May to November, with highs around 89 degrees fahrenheit; the cooler period lasts from December to April, with average highs around 83 degrees fahrenheit. Temperatures can sometimes reach above 95 degrees fahrenheit, but the heat is often tempered by the nearly constant sea breeze. Minimum temperatures can reach below 70 degrees fahrenheit, but such occurrences are rare.



Observed global temperature and carbon dioxide increases (1881-1910 baseline) (adapted from: <http://www.climatecentral.org/gallery/graphics/co2-and-rising-global-temperatures>)

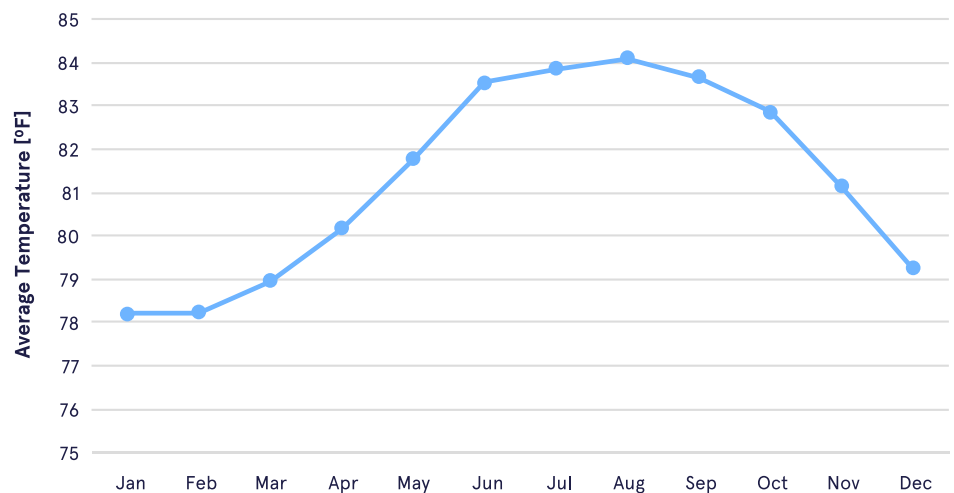


Average temperature distribution on St. Thomas (top), St. Croix (center) and St. John (bottom) Source: Eric Harmsen.

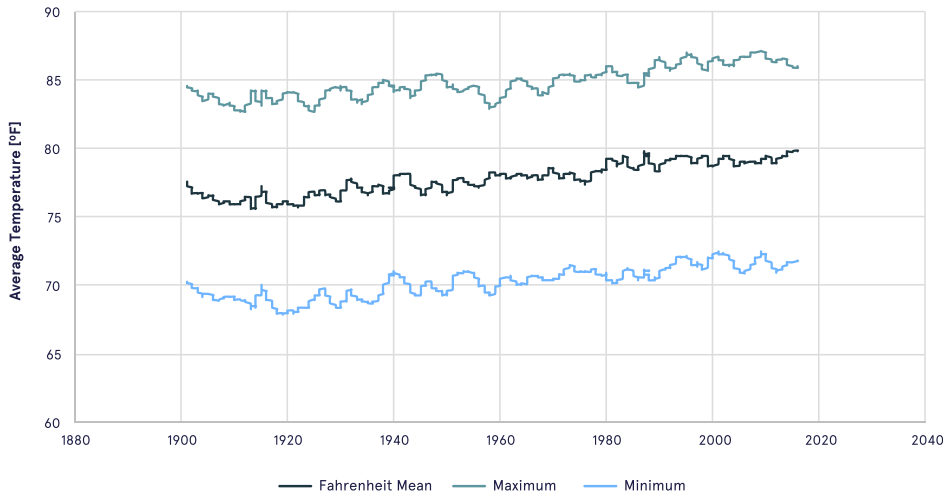
CLIMATE OF THE USVI

Temperatures

The US Virgin Islands (USVI) has a tropical climate, characterized by warm temperatures and rainy and dry seasons. Temperatures in the USVI vary with location and altitude, but they average around 88°F during the day, cooling to around 76 degrees fahrenheit at



Mean temperatures at St. Croix Airport (UVI & UWI, 2018).



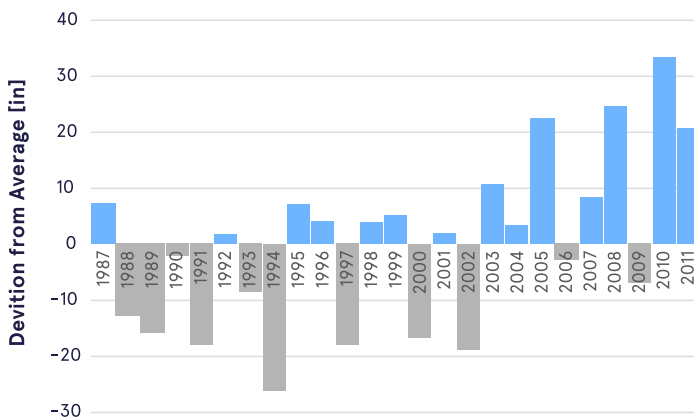
Annual minimum, average and maximum temperatures in the USVI (UVI & UWI, 2018).

These patterns feel somewhat predictable, but since 1901, average annual temperatures have increased by approximately four degrees fahrenheit. This rate of increase has been consistent and similar for both maximum and minimum average temperatures. As a consequence, there are more warm days, and most notably, more warm nights.

Rainfall

Rainfall in the USVI averages around 39 inches per year, with significant differences within the geography of an island and on the

different islands. Nevertheless, the typical dry season lasts from January to April, with a smaller dry season in June and July. The wettest months are September to November. However, rainfall patterns have been extremely variable from year to year: USVI can experience above average precipitation and flooding one year and drought or near drought conditions the following year. The causes of this annual variability are still unclear, as some already known factors and several obscurely known processes drive rainfall patterns.

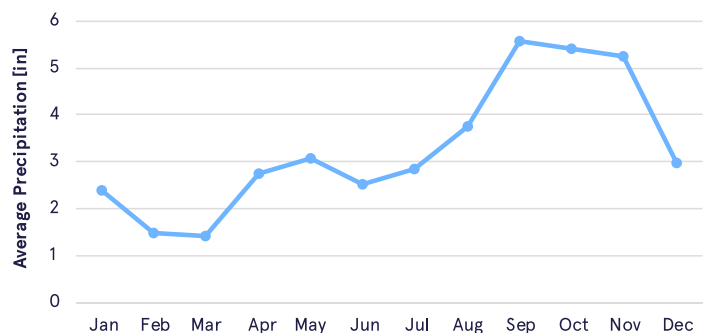


Average rainfall patterns at the St. Thomas Cyril E. King Airport

Climate-induced natural hazards in the USVI

The USVI and its history, like other places in the Caribbean, have been shaped and formed by natural disasters. The territory is susceptible to the impacts of nearly six out of 10 of climate-induced natural hazards that can occur. The most recurrent and devastating events are hurricanes, which induce coastal flooding, riverine (rain-driven) flooding and destructive winds; rain storms, which induce coastal flooding; and droughts. Heat waves are not common occurrences in the USVI. Nevertheless, of all the hazards that can affect the USVI, several have the potential to be changed by the unfolding consequences of climate change: days that feel extraordinarily hot, rainfall patterns, hurricanes, large swells from distant ocean storms, and wildfires.

The USVI regularly experiences flooding during rainstorms, or riverine flooding. Between 1997 and 2016, the National Oceanic and Atmospheric Administration (NOAA)³ recorded nearly 37 riverine flooding events in the territory, nearly two events per year. Major rainstorms also caused severe damage prior to



Deviation of rainfall total from average values Source: Stuart Weiss

these NOAA measurements, such as the extreme rainstorms of 1983 and 1974.⁴ On the other side of the spectrum, droughts are also common occurrences in the Territory and—similar to flooding—can cause a fair amount of economic damage to the Territory. A severe drought in 1733 all but wiped out the ability of St. John to produce food; the droughts of 1967-1968⁵, and 1994-1995 severely impacted the agriculture sector and people's ability to secure freshwater for their daily needs. Finally, since 1997, NOAA⁶ recorded two droughts (2002, 2005), but this is likely an under-estimation, as it does not, for example, include the 2015 drought.

Hurricanes are also common occurrences in the territory. The Great Hurricanes of 1780s were some of the most devastating and consequential hurricanes in the recorded history of the Caribbean.⁷ Since then, at least 110 hurricanes have travelled within 120 miles of the USVI⁸—winds will often still have tropical storm strength at this distance away from the hurricane's eye.⁹ On average, the USVI has been within the zone of influence of approximately two hurricanes per year, and has experienced damaging hurricanes

Category	Maximum sustained wind speed		Minimum surface pressure
	mph	kt	mb
1	74-95	64-82	greater than 980
2	96-110	83-95	979-965
3	111-130	96-113	964-945
4	131-155	114-135	944-920
5	156+	136+	less than 920

Saffir-Simpson Hurricane Wind Scale

approximately every six years. Since 1950, when the modern era of naming and tracking hurricanes more precisely began, the USVI has been in the zone of influence of an average of three hurricanes per year, and has suffered of nearly half of the hurricanes that were within 120 miles.¹⁰ Most of these storms were Category 3 or 4, until 2017.

Hurricanes Irma and Maria were the only two of these types of hurricanes of the modern era. However, it is too early to tell whether these events are the result of climate change. Indeed, the impacts of climate change on hurricanes genesis and pathways is still an active subject of research. According to NOAA¹² "it is premature to conclude that human activities [...] have already had a detectable impact on Atlantic hurricane [...] activity.

That said, human activities may have already caused changes that are not yet detectable [...], or are not yet confidently modeled." Also, it is worth noting that since hurricanes have only been tracked and recorded accurately for slightly more than 60 years, there isn't enough data to discern trends.

Aside from hurricanes, riverine flooding and droughts, the USVI experiences high surf and swells, large powerful waves generated by distant storms in the Atlantic which can cause significant coastal erosion. NOAA has recorded 11 since 1997.¹³ The USVI, and St. Croix specifically, can also experience wildfires (19 since 1997, most of them on St. Croix).¹⁴ It is likely these fires were triggered by droughts, although this has not been confirmed. It is important to remember

³ "Storm Events Database," National Climatic Data Center, accessed June 2018, <https://www.ncdc.noaa.gov/stormevents/>.

⁴ Richard W. Paulson, Edith B. Chase, Robert S. Roberts, and David W. Moody, National Water Summary 1988-89: Hydrologic Events and Floods and Droughts (Washington, D.C.: U.S. Government Printing Office, 1991).

⁵ Paulson, Chase, Roberts, and Moody, National Water Summary 1988-89.

⁶ "Storm Events Database," National Climatic Data Center, accessed June 2018, <https://www.ncdc.noaa.gov/stormevents/>.

⁷ Stuart B. Schwartz Sea of Storms: A History of Hurricanes in the Greater Caribbean from Columbus to Katrina. (Princeton, NY: Princeton University Press, 2015).

⁸ "National Hurricane Center, Data Archives," NOAA, accessed June 2018, <https://www.nhc.noaa.gov/data/>.

⁹ Schwartz, Sea of Storms.

¹⁰ Schwartz, Sea of Storms

¹¹ Paulson, Chase, Roberts, and Moody, National Water Summary 1988-89.

¹² "Global Warming and Hurricanes" National Oceanic and Atmospheric Administration, accessed June 2018, <https://www.gfdl.noaa.gov/global-warming-and-hurricanes/>.

¹³ "Global Warming and Hurricanes." National Oceanic and Atmospheric Administration, accessed June 2018, <https://www.gfdl.noaa.gov/global-warming-and-hurricanes/>.

¹⁴ "Storm Events Database," National Climatic Data Center, accessed June 2018, <https://www.ncdc.noaa.gov/stormevents/>.

that these extreme events are independent events, and there can be many events within the same year. For example, in 2017, heavy rains caused heavy flooding in July, and subsequently two hurricanes struck the Territory in September. In 1994-1995, the USVI experienced damaging droughts before suffering from the impacts of Hurricanes Luis and—even more destructive—Marilyn in 1995. In 1867, a tsunami followed a hurricane that had devastated the islands less than three weeks earlier.¹⁵ Lastly, in 1733, a severe drought was followed by a devastating hurricane.^{16 17}

FUTURE OF CLIMATE IN THE USVI

Climate predictions

As time passes and the effects of a warming planet continue to unfold, temperatures in the USVI will continue to increase. Recent results from global projections for the region indicate that compared to the past decade (2000-2010), temperatures are likely to increase by 1.4-2.6 degrees fahrenheit by 2050s,

and 1.4-5.2 degrees fahrenheit by 2100.¹⁹ In addition, the number of days with maximum temperatures above 90 degrees fahrenheit will increase, and the number of warmer nights will also increase slightly: the USVI will experience more frequent daily and nightly temperature records. The Territory will continue to experience greater variability in rainfall from year to year; however, trends indicate the USVI will become drier both during the wet and dry seasons.

Rising sea levels are another important impact of climate change. A variety of factors affect sea levels, including evaporation and input of freshwater from melting glaciers, global and local oceanic currents, and vertical movement of land masses due to tectonic and resource extraction processes. In the USVI, sea levels have increased steadily over 40 years: on St. Croix, the sea level has risen by approximately four inches in 40 years, while on St. Thomas the increase is closer to 3.3 inches. The reasons for the difference in rates between the two islands are not known, yet they are probably linked to oceanographic circulation processes. As a consequence, anecdotal evidence has indicated that some of the few coastal aquifers and wells in the territory have become more saline. Sea level rise also causes shoreline erosion, and increases the

landward extent of hurricane storm surge inundation. Finally, even though the generation of earthquakes are not impacted by climate change processes, it is possible that an increase in mean sea level will lead to an increase to the tsunami landward inundation limit;¹⁸ more research is needed.

Looking into the future, the rate of increase of sea level will accelerate. The U.S. Army Corps of Engineers (USACE; 2014) predicts a mean sea level increase of 1.6 feet by 2050, and up to five feet by 2100. For St. Thomas, sea level is predicted to rise by 1.5 feet by 2050, and 4.8 feet by 2100. A recent report by Hall et al.¹⁹ states it is possible that sea levels will reach 2.1 feet by 2050, and 6.6 feet by 2100 on St. Croix, and 1.9 feet by 2050 and 6.4 feet by 2100 on St. Thomas.

Impacts of climate change on hazards

The previous section discussed the role of natural hazards in USVI history, how climate change is already affecting the Territory as a consequence, and some of the hazards that may impact the USVI. As the 21st century progresses, climate change will continue to affect natural processes, thus changing the nature of the hazards the USVI will face.

¹⁵ R.A. Watlington, E. Lewis, and D. Drost "Coordinated Management of Coastal Hazard Awareness and Preparedness in the USVI," PLOS Biology, April 30, 2014, Accessed June, 2018, <https://doi.org/10.5194/adgeo-38-31-2014>.

¹⁶ D Knight, "A Documentary History of the Cinnamon Bay Plantation 1718-1917" (St. Thomas: Virgin Islands Historical and Genealogical Resource Center, 1999).

¹⁷ Holly Kathryn Norton, "Estate by Estate: The Landscape of the 1733 St. John Slave Rebellion" (Ph.D. Dissertation, Syracuse University, 2013).

¹⁸ "Hawai'i Sea Level Rise Vulnerability and Adaptation Report," Hawai'i Climate Change Mitigation and Adaptation Commission, prepared by Tetra Tech, Inc. and the State of Hawai'i Department of Land and Natural Resources, Office of Conservation and Coastal Lands, under the State of Hawai'i Department of Land and Natural Resources Contract No: 64064, 2017.

²¹ J.A. Hall, S. Gill, J. Obeysekera, W. Sweet, K. Knuuti, and J. Marburger, U.S. Department of Defense, Strategic Environmental Research and Development Program, Regional Sea Level Scenarios for Coastal Risk Management: Managing the Uncertainty of Future Sea Level Change and Extreme Water Levels for Department of Defense Coastal Sites Worldwide, 2016.

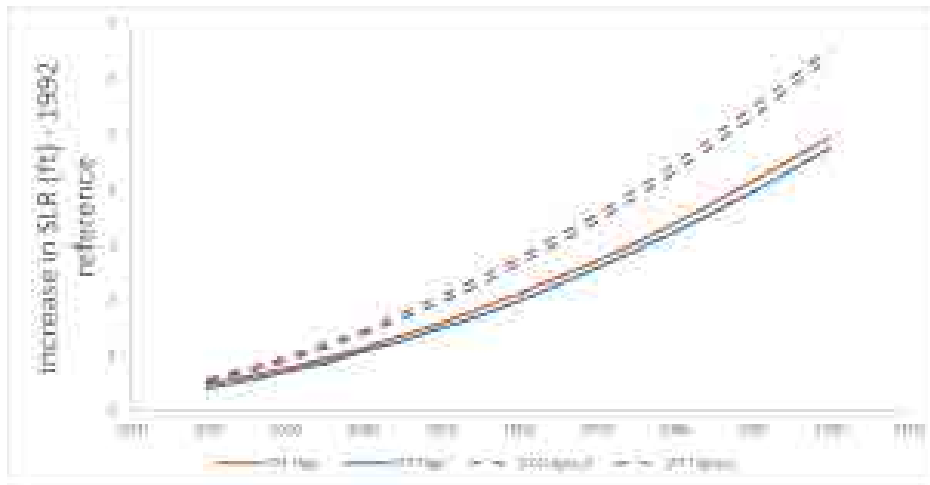


Figure 7: Sea level rise projections for St. Thomas (STT) and St. Croix (STX), based on USACE (2014) projections (“High”) and Hall et. al (2016) projection (“Highest”).

traditions and potentially creating health hazards. These changes might also impact other sectors that rely on natural ecosystems, such as tourism.^{21 22 23}

Sea level rise and flooding

The continued rise of sea levels around the USVI will cause inundation and coastal erosion on all three primary islands. This might have consequences for tourism at popular places like Megans Bay or Smith Bay on St. Thomas, or Sandy Point on St. Croix, and Maho Bay on St. John. The built environment will also suffer consequences, as Charlotte Amalie, Red Hook, Bovoni, Coral Bay, Christiansted, Saltriver area and Limetree Bay area will experience significant flooding. In particular, if—as predicted by USACE²⁴—sea levels rise by approximately one foot on both St. Thomas and St. Croix by 2050, nearly 16 critical facilities (four on St. Thomas, three on St. Croix, and nine on St. John)—such as government buildings, schools, police and fire stations, airport, power plants, wastewater treatment facilities—and 12 out of 147 miles of underground electric lines, will experience flooding due to rising seas. In addition to critical facilities, 106 structures

Temperatures and rainfall

Although the USVI has not experienced heat waves, increases in temperatures will lead to warmer days and warmer nights, and increase air quality problems. These effects will exacerbate health problems in vulnerable populations.²⁰

An overall drier climate means that drought might be more severe or last longer. This in turn might increase the risk for wildfires, especially on St. Croix. Changes in rainfall patterns will also impact water supplies for people, as well as different

sectors that depend on it, such as agriculture.

Ecosystems benefits

Climate change will greatly affect the health, conditions, and footprint of ecosystems, and the benefits they provide: mangroves and wetland footprints might shrink, reducing their ability to reduce storm surge or store storm water; coral reefs will continue to degrade and might not be able to recover from disturbances, thus reducing their ability to protect against wave action and serve as habitat for fish; the composition of forests and their species might change, leading to a changed landscape, altering cultural

²⁰ Diarmid Campbell-Lendrum, Carlos Corvalán, and Maria Neira. “Global Climate Change: Implications for International Public Health Policy,” *Bulletin of the World Health Organization* 85 (2007).

²¹ Greg Guannel, Katie Arkema, Peter Ruggiero, Gregory Verutes, S. Temmersman, P. Meire, and TJ Bouma. “The Power of Three: Coral Reefs, Seagrasses and Mangroves Protect Coastal Regions and Increase Their Resilience.” Edited by Carlo Nike Bianchi. *Plos One* 11, no. 7 (2016). <https://doi.org/10.1371/journal.pone.0158094>.

²² Erik J. Nelson, Peter Kareiva, Mary Ruckelshaus, Katie Arkema, Gary Geller, Evan Girvetz, Dave Goodrich, Virginia Matzek, Malin Pinsky, Walt Reid, Martin Saunders, Darius Semmens, Heather Tallis, and Evan Girvetz, “Climate Change’s Impact on Key Ecosystem Services and the Human Well-being They Support in the US,” *Frontiers in Ecology and the Environment* 11, no. 9 (2013): 483-493. <https://doi.org/10.1890/120312>.

²³ Katie Arkema, Greg Guannel, Gregory Verutes, Spencer A. Wood, Anne Guerry, Mary Ruckelshaus, Peter Kareiva, Martin Lacayo, and Jessica M. Silver, “Coastal Habitats Shield People and Property from Sea Level Rise and Storms,” *Nature Climate Change* 3, no. 7 (2013): 1

²⁴ U.S. Army Corps of Engineers (USACE), “Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation”, Technical Letter No. 1100-2-1 (2014).

(public and private buildings and houses) will experience flooding (56 on St. Thomas, 29 on St. Croix, and 21 on St. John). Fortunately, few coastal roads will experience flooding, and most of them are isolated. By 2100, a predicted four feet increase will threaten 54 critical facilities (23 on St. Thomas, 14 on St. Croix, and 15 on St. John), 23 miles of underground electric lines, and 748 structures (375 on St. Thomas, 238 on St. Croix, and 135 on St. John). In addition, four percent of the roads throughout the territory (most of them on St. John) will be impacted; most of the impacted roads are in urban centers on all islands, and near popular tourist destinations.

If the rate of increase accelerates, and extreme predictions come to pass, two feet of sea level rise in 2050 will cause 23 critical facilities, 13 miles of underground electric lines, and 199 structures; 92 on St. Thomas, 67 on St. Croix, and 40 on St. John) to experience flooding in the Territory. Fortunately, few roads will be impacted. However, a six feet increase by the end of the century will impact 67 facilities (37 on St. Thomas, 14 on St. Croix, and 16 on St. John), 31 miles of underground electric lines and 1,395 structures (555 on St. Thomas, 344 on St. Croix, and 190 on St. John), and more than eight percent of the Territory's roads; most of the impacted roads run through urban centers or lead to airports, and St. John's roads would be especially impacted. The most impacted facilities will be government buildings, wastewater facilities, and seaports. Fire and police stations, heliports, communication facilities, post offices, historical building, schools, public housing facilities,

water and power facilities, and healthcare facilities will also be impacted.

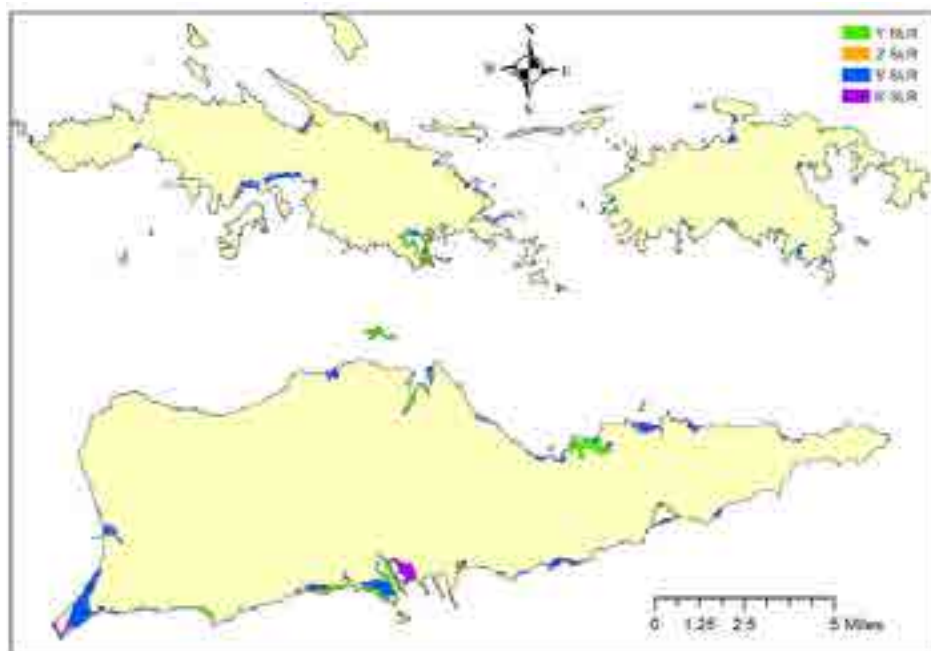
In addition to impacts to tourist attractions and the built environment, sea level rise might cause potential problems for drainage, as outfalls could become submerged. And as mentioned previously, the rise in sea level will also likely increase the inland extent of inundation of other coastal hazards, such as storm surge, swell-induced inundation, or even tsunami inundation.

Hurricanes and Rain Storms

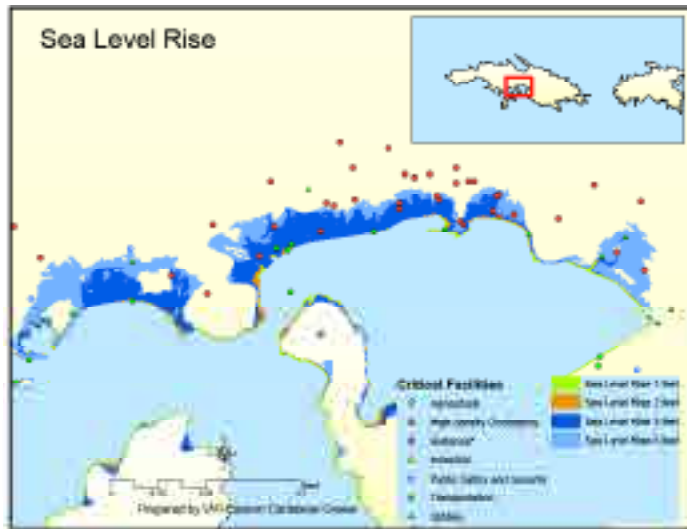
Even though the exact imprints of climate change are difficult to detect in the past hurricane season(s), NOAA predicts that hurricanes are likely to become more damaging by the end of the century: hurricane-related rainfall rates will increase, leading to more riverine flooding conditions; and it is likely that

hurricanes will become more intense albeit not necessarily more frequent. In other words, the USVI might not experience more frequent hurricanes, but those that do hit the territory are expected to be more destructive: winds will be stronger, storm surges will be higher, and rainfall rates will intensify and lead to more severe and longer-lasting flooding. If the strength of hurricanes and Atlantic storms is likely to intensify, it is likely that the power of swells will also increase, which will lead to more erosion and flooding.

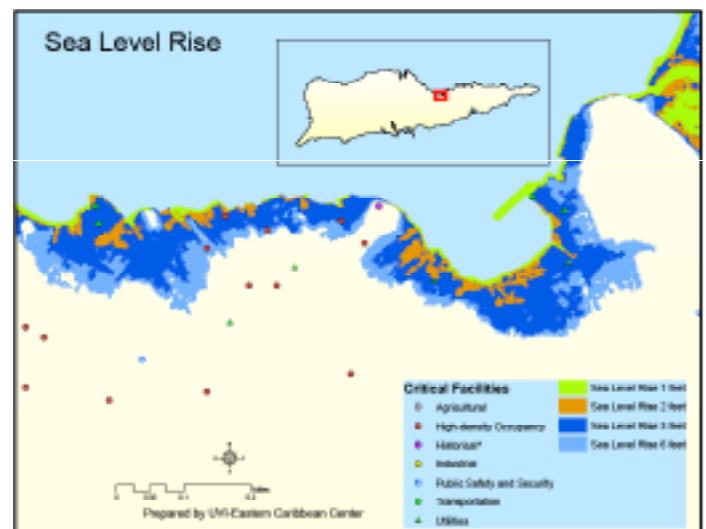
This potential increase in storm intensity, and accompanying flooding, will cause significant impacts on critical infrastructure and structures in the Territory. Under current conditions, 141 critical facilities, and 48 out of 147 miles of underground electric lines are located in flood zones. Aside from the docks and port facilities, the most impacted facilities are wastewater treatment plants and supporting infrastructure, government



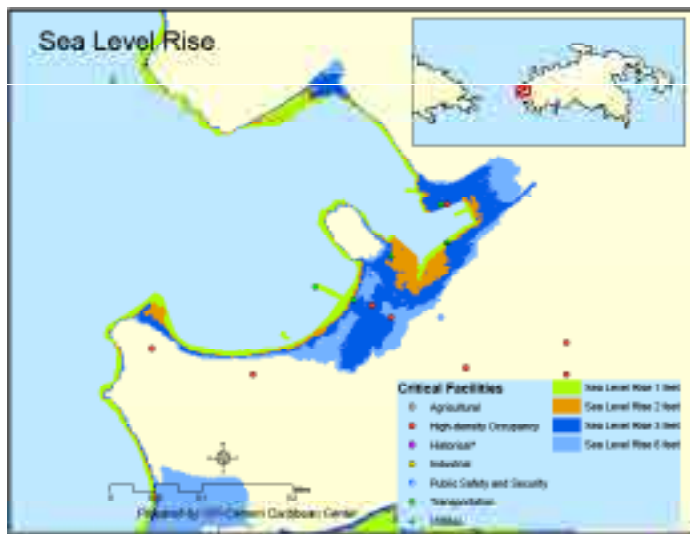
Sea level rise inundation in the USVI



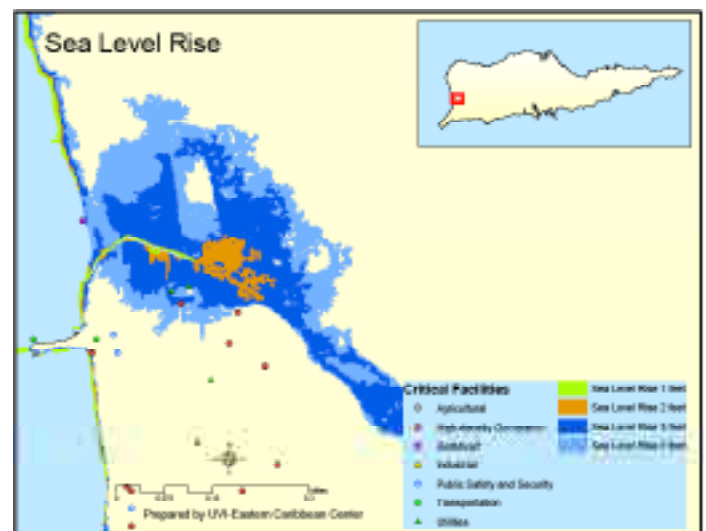
Sea level rise inundation in Charlotte Amalie



Sea level rise inundation in Christiansted

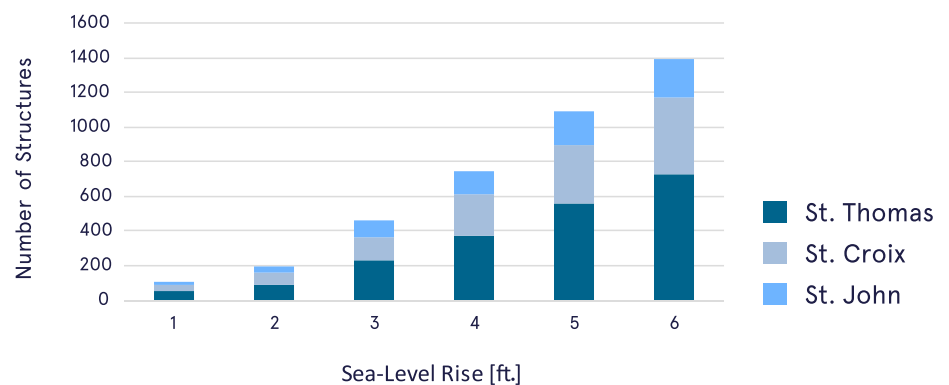


Sea level rise inundation in Cruz Bay



Sea level rise inundation in Frederiksted

buildings, and schools. Of the critical infrastructure impacted, 113 structures (64 on St. Thomas, 33 on St. Croix, and 16 on St. John) and 46 miles of underground electric lines are vulnerable to riverine flooding (caused by rain storms), and 98 structures (49 on St. Thomas, 33 on St. Croix, and 16 on St. John) and 33 miles of underground electric lines are vulnerable to coastal flooding (storm surge and swells). Similarly, 6,999 structures are located in flood zones (4,178 on St. Croix, 2,534 on St. Thomas, and 287 on St. John), 6,696 of which are vulnerable to riverine

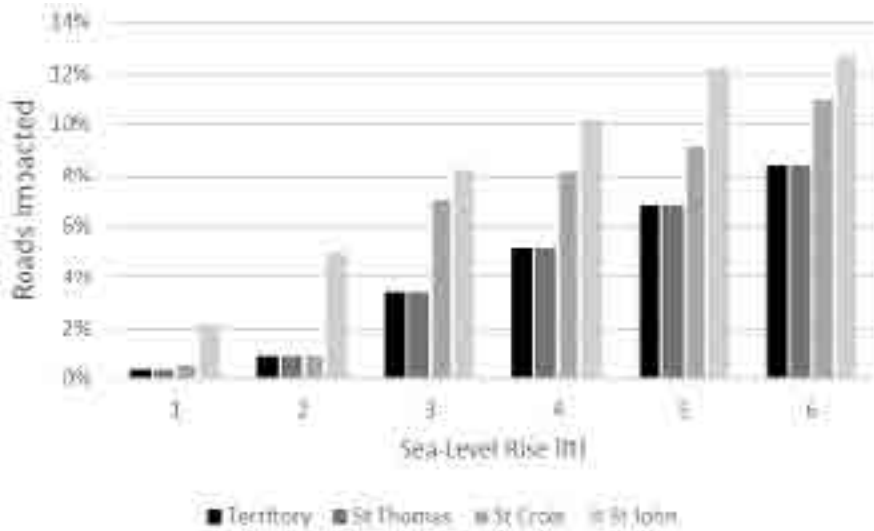


Land area lost to sea level rise inundation in the USVI

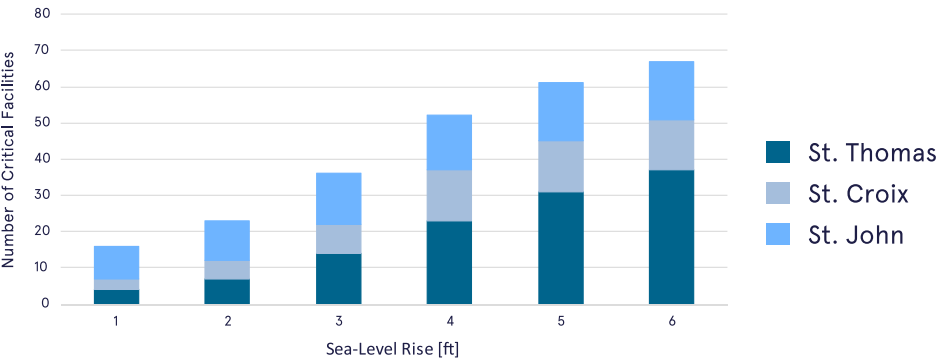
flooding (4,018 on St. Croix, 2,447 on St. Thomas, and 231 on St. John), and 2,188 are vulnerable to coastal flooding (1,142 on St. Croix, 800 on St. Thomas, and 246 on St. John). Finally, storms can inundate a significant amount of roads, complicating rescue operations and evacuations. Most of these roads are located in urban center and often lead to critical facilities, such as the landfills on St. Thomas and St. Croix. The majority of the vulnerable roads are on St. Croix, where nearly 40 percent are prone to riverine flooding, and 20 percent to coastal flooding. On St. Thomas and St. John, around 25 percent of the roads are vulnerable to riverine flooding, and less than 15 percent to coastal flooding. These numbers demonstrate the need for a robust drainage infrastructure in the Territory.

CONCLUSION AND NEXT STEPS

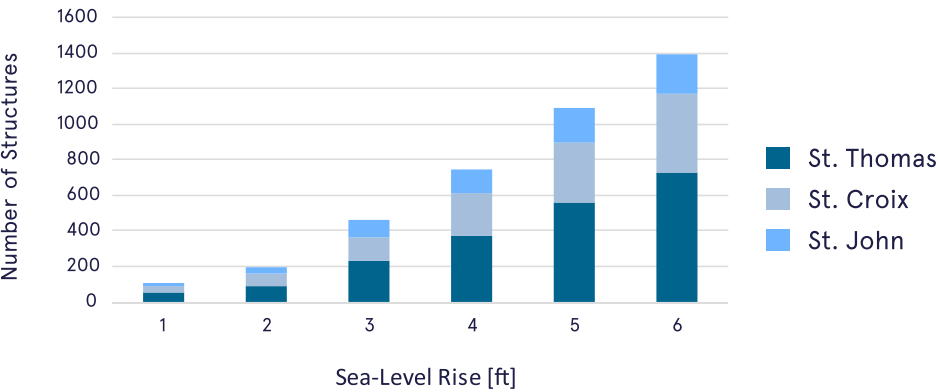
Even if the USVI’s emissions are relatively minor, the Territory is already suffering the impacts of climate change and will be for decades to come. Temperatures are rising, and will continue to rise leading to extremes not yet experienced in the Territory. In addition, rainfall patterns will become increasingly variable, so drought or near drought conditions will become more frequent as the climate grows drier. These changes will impact the health of various members



Percent of roads impacted by sea level rise

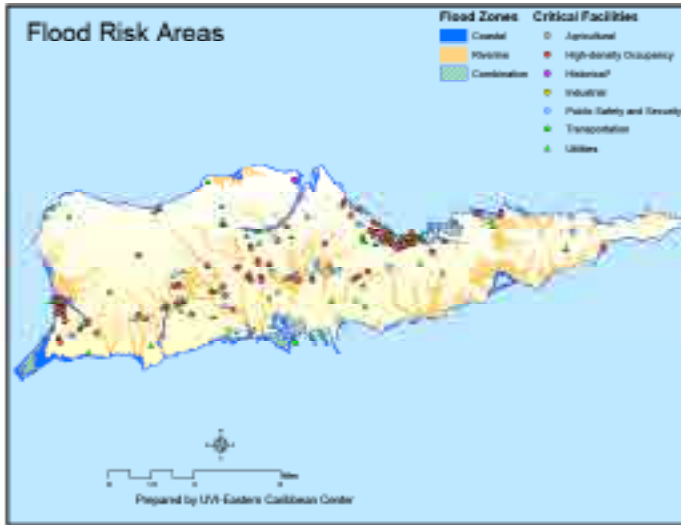


Critical facilities impacted by sea level rise

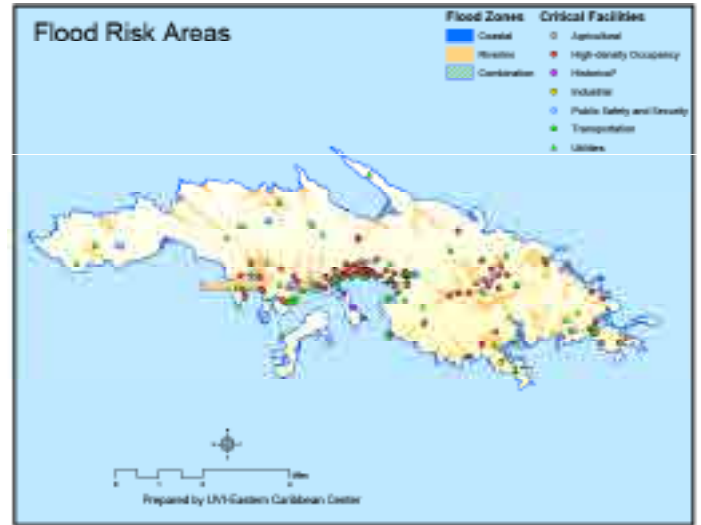


Structures impacted by sea level rise

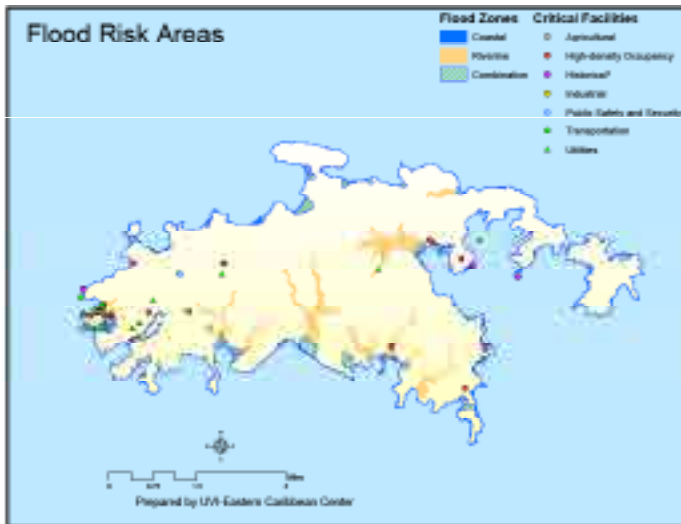
²⁵ “Global Warming and Hurricanes” National Oceanic and Atmospheric Administration, accessed June 2018, <https://www.gfdl.noaa.gov/global-warming-and-hurricanes/>.



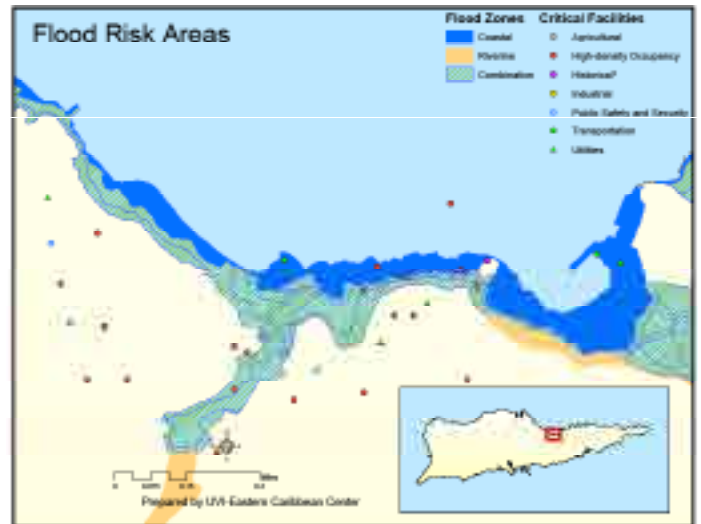
Coastal and riverine flood zones on St. Thomas



Coastal and riverine flood zones on St. Croix



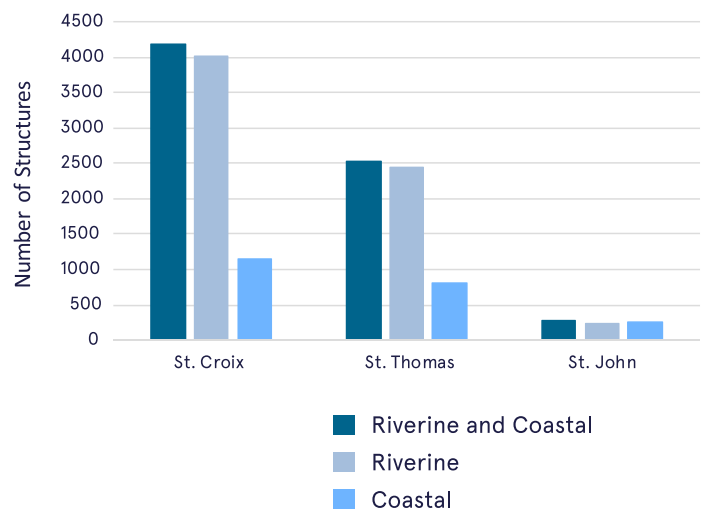
Coastal and riverine flood zones on St. John



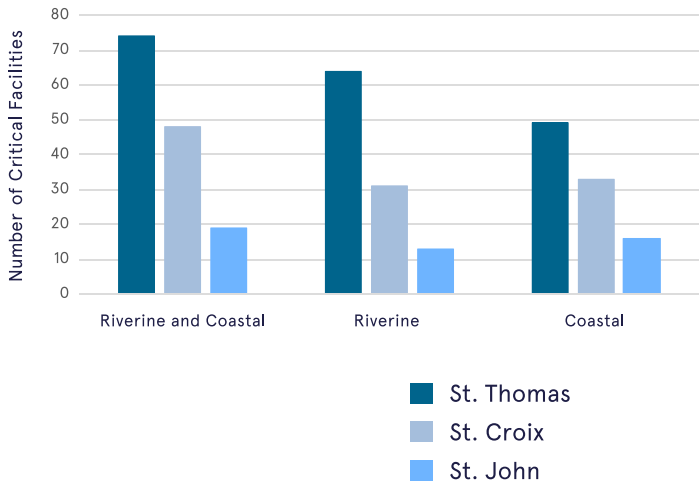
Coastal and riverine flood zones in Christiansted



Coastal and riverine flood zones in Bovoni



Structures impacted by different types of storm-induced flooding



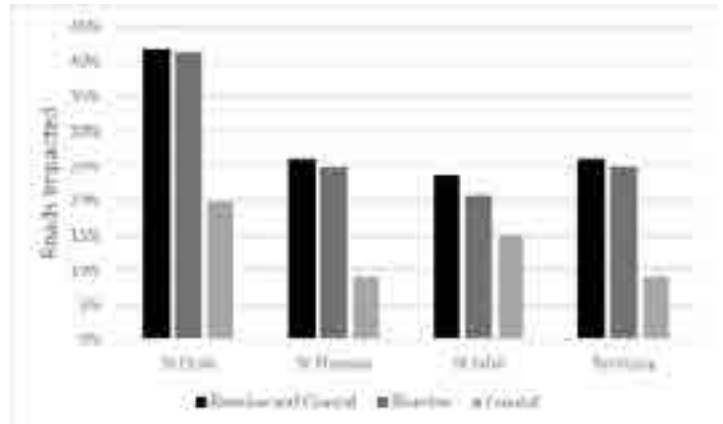
Critical facilities impacted by different types of storm-induced flooding

of the community—especially vulnerable populations. They will also impact natural systems, and the associated economic sectors that depend on them. Lastly, climate change will increase the impacts of climate-related hazards. Sea level rise will cause the loss of thousands of acres of land, especially on St. Croix. Sea level rise will also cause many structures—including critical facilities and buried electric lines—to flood, most of them on St. Thomas. At the same time, it is likely hurricanes will become wetter and stronger, causing widespread riverine and coastal flooding. This will put many critical facilities, including buried electric lines and structures at risk, since so many are already in flood zones.

Despite this bleak outlook on the future, the Governor’s Office is intent on preventing some, if not all, of the most negative impacts of climate change. First, in order to prevent the worst impacts of climate change, the Governor’s Office will work with its agencies and the University of the Virgin Islands (UVI) to help

educate the general population, agency staff, and members of the various economic sectors about the impacts of climate change and associated hazards on the territory, and on best practices to adopt in order to counter the impacts of climate change. Importantly, the Governor’s Office will work with UVI to continue, update, improve and/or augment the collection and curation of climate data in the Territory, starting with temperature, rainfall, and groundwater measurements. The Governor’s Office will also work with UVI to cater to its science, data gathering, and data management needs. Special attention will be paid to the regular update of climate projections, as more data and more sophisticated models will improve the quality of future predictions. These efforts will create better flood maps for variations in rainfall intensity—storms and sea level rise scenarios, especially in urban areas.

The Governor’s Office will also work with USVI agencies and UVI on the creation, continual



Percent of roads impacted by different types of storm-induced flooding

update and maintenance of asset management tools to better track the conditions, repairs and upgrades made or needed for critical infrastructure, including for building and drainage infrastructure. The Governor’s Office will also work with Territorial agencies and UVI to monitor the impact of climate change on ecosystems. This work will help scientists better understand how natural systems responds to various climate stressors and help predict the impacts on natural resources, and the consequent economic (fisheries, agriculture, etc.) and cultural (Agriculture Fair, Mango Melee, etc.) impacts on the people of the USVI.

NEED FOR BETTER FLOOD MAPS

The maps below demonstrate the need for better flood maps in the Territory. Coastal flood maps from FEMA under-predict flooding in parts of St. Thomas—especially in Charlotte Amalie, on

parts of St. Croix—near Limetree Bay, and on St. John. Similarly, as shown in Figures A4-A6, riverine flooding is under-predicted by NOAA, as many areas of repetitive flooding (identified after community group surveys) are not included in the FEMA flood map for riverine flooding. This discrepancy is likely due to a lack of data on drainage infrastructure.



Difference between FEMA flood zone in coastal areas and NOAA storm surge inundation for a Category 5 hurricane, on St. Thomas.



Difference between FEMA flood zone in coastal areas and NOAA storm surge inundation for a Category 5 hurricane, on St. John.



Difference between FEMA flood zone in coastal areas and NOAA storm surge inundation for a Category 5 hurricane, on St. Croix.



Difference between FEMA flood zone in coastal areas and NOAA storm surge inundation for a Category 5 hurricane, on St. Croix.



Difference between FEMA flood zone in coastal areas and NOAA storm surge inundation for a Category 5 hurricane, on St. John.



Difference between FEMA flood zone in coastal areas and NOAA storm surge inundation for a Category 5 hurricane, on St. Thomas.

ENERGY

The USVI energy sector provides electricity to 45,000 residential and 9,000 commercial customers across five islands. Delivering this power is a complex undertaking that relies on two fossil fuel power plants, three solar facilities, eight substations, undersea cables, and more than 1,000 miles of transmission and distribution cables, a large portion of which are aboveground. Most of the infrastructure is owned and run by USVI Water and Power Authority (WAPA), which is a public utility overseen by a board of directors and regulated by the USVI Public Service Commission.

The vast majority of the Territory's power comes from old and inefficient fossil fuel power plants. Partly as a result, WAPA's electricity rates are nearly three times higher than average rates throughout the U.S. and are among the highest in the Caribbean and the world. While

USVI residents use, on average, less than half the energy of an average American residential customer, they pay \$30 more a month in electricity bills. This disparity is even greater for commercial and industrial customers. This, compounded by a historically unreliable grid¹ and a dramatic decrease in solar and battery storage prices, is driving customers to install their own generation systems. WAPA's electricity sales dropped 15 percent between 2010 and 2016, the most recent period for which data is available.

This trend has exacerbated WAPA's existing state of financial distress. A recent report by the Congressional Research Service² found WAPA's revenues do not adequately cover its expenses, which is partially due to high non-payment rate across its customer base. At the end of Fiscal Year 2017, customers owed WAPA \$45 million, including: \$22 million from the Government of the

Virgin Islands (GVI), \$13 million from commercial and industrial customers and \$11 million from residential customers. In addition, WAPA has a large unfunded pension liability.³ These factors, combined with declining sales, led the rating agency Moody's to downgrade WAPA's credit rating in 2017 to below investment grade.⁴

While WAPA was already in a difficult position before the hurricanes, the unprecedented landfall of two Category 5 hurricanes within 10 days caused the kind of damage from which even a well-positioned utility would struggle to recover. More than 90 percent of WAPA's aboveground power lines were damaged, cutting power to all of WAPA's customers. Four of the utility's 18 fossil fuel generators and all of its solar fields—together representing over 20 percent of WAPA's generation capacity—were impaired as well. The island of St. John was hit particularly hard: utility power was not available on it

¹ WAPA has improved system stability over the past several years. Average interruptions per customer per year have declined from 6.5 in 2010 to 1.6 in 2016 and the average length of the interruptions has declined from over 500 minutes to 187 minutes. Both of these benchmarks, however, are above the U.S. average.

² Corrie Clark, et. al., "Potential Options for Electric Power Resiliency in the U.S. Virgin Islands" Congressional Research Service, Washington, DC, February 2018.

³ As of 2016, WAPA's share of the USVI government's net pension liability was \$258 million. WAPA also distributes other post-employment benefits to retired employees; WAPA's net obligation to that fund was \$48 million in 2016.

⁴ Moody's lowered WAPA's rating from a Baa2 and Baa3 in 2012 (moderate credit risk) to a Caa1 and Caa2 (speculative investment with very high credit risk) in 2017 with a negative outlook.



Crews working on power restoration
Source: FEMA

for 49 days, and customers on the eastern side of the island waited for more than 100 days for power to return. Across the broader Territory, power restoration took more than three months. WAPA met the Governor's goal and 90 percent of eligible customers were restored by Christmas, with the help of more than 800 off-island linemen.

In the future, high winds and storm surge from more intense hurricanes and rising sea levels will pose increasing risks to the USVI's energy system, with potentially similar consequences as the 2017 hurricanes. The influx of federal funding to recover from the hurricanes presents a once-in-a-generation opportunity to transform the USVI's energy system to better face these risks. Money alone, however, will not address the structural challenges facing WAPA that have pushed the utility to a near-crisis state. New investments must be paired with significant regulatory reforms and a push to catch up to industry best practices.

Increasing the resilience and reliability of the USVI energy system requires a focus on four separate goals. First, WAPA needs to transform its generation portfolio by replacing aging generators with more efficient units and increasing the use of renewable energy to achieve renewable generation capacity equal to 75 percent of the USVI's peak demand by 2025. This includes rebuilding St. John's energy network to provide close to 100 percent of peak demand with on-island renewable assets during the day and enabling the island to operate independently from St. Thomas in the event of an emergency—establishing St. John as a global model of resilience. Second, WAPA must modernize its grid—primarily its control and monitoring systems—to fully benefit from a more advanced, distributed, and diverse generation portfolio. Third, the utility must fortify its energy infrastructure against climate risks—particularly hurricanes. Fourth, the USVI must strengthen its energy planning and regulatory structures to make sure

that the territory can continually adapt to new technologies, industry best practices, and changes in the energy sector.

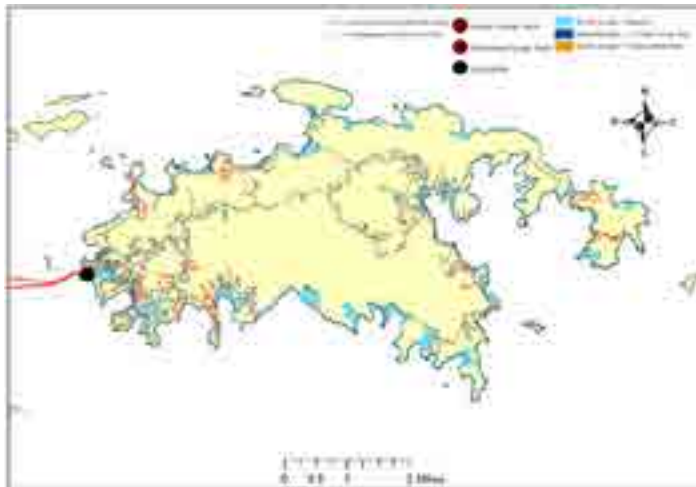
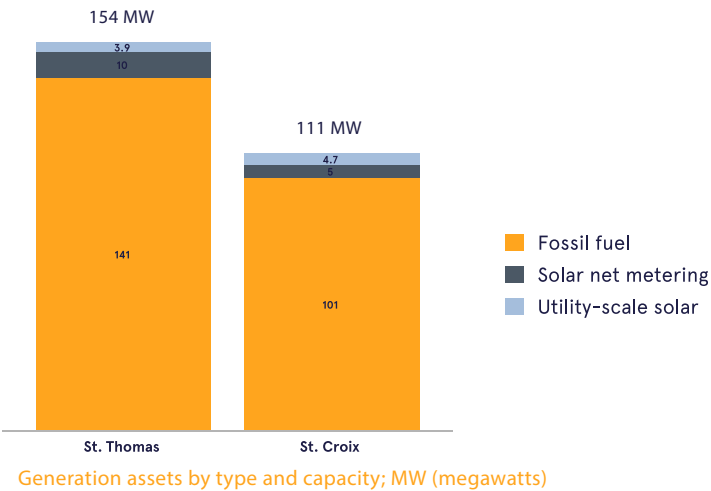
Achieving these goals will take time, effort, and funding. WAPA, with support of federal resources and the Governor's Office, has already made major strides in advancing these recommendations. Further work has the potential to truly transform the USVI energy system, lowering electricity rates, increasing system reliability, and significantly reducing grid defections. No grid can be fully hurricane-proof, but the strategies proposed in this report will enable the system to bounce back quicker from the next event and increase the overall resilience of the USVI.

HOW THE ENERGY SYSTEM WORKS

The USVI energy system consists of two separate energy networks that serve approximately 45,000 residential customers and approximately 9,000 commercial and industrial customers across five islands. The island of St. Croix is managed as one network; the islands of St. Thomas, St. John, Hassel and Water Islands are all served by a second network. Each network includes three primary components: generation assets that produce electricity, primarily from the fossil fuel power plants on St. Croix and St. Thomas; a transmission and distribution network that transports energy from generation assets to customers; and customers, who consume electricity.

Generation

The vast majority of USVI power generating capacity—242 MW—comes from two WAPA-owned fossil-fueled power plants on St. Croix and St. Thomas. The remainder—approximately 24 MW—is provided by solar panels throughout the territory, including three utility-scale fields and numerous small installations on individual rooftops⁵ (see chart: [Generation assets by type and capacity](#)).



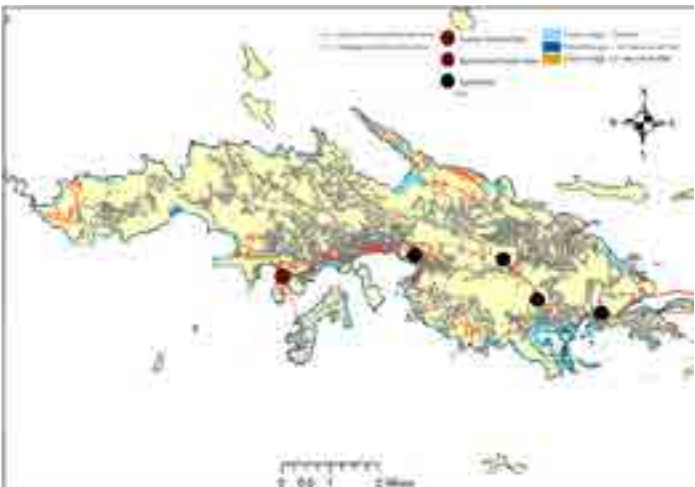
WAPA Assets on St. John



WAPA Assets on Coral Bay



WAPA Assets on Cruz Bay



WAPA Assets on St. Thomas

⁵ In determining how much power is needed to meet demand, utilities must account for differences between intermittent sources (e.g. wind and solar, which are only available when the wind is blowing or sun is shining) and dispatchable assets (such as biomass or fossil fuels, which can generate power at any time). Each energy source is assigned a capacity factor, which represents the average power generated by an asset divided by its peak power (or installed capacity). As wind and solar plants cannot generate peak power at all hours, they have a lower capacity factor than fossil fuel generators. In the US in 2017, according to US Energy Information and Administration (EIA) data, combined cycle gas turbine (CCGT) plants had a 55 percent capacity factor, while solar installations had a capacity factor of around 30 percent. That means that for the same amount of installed capacity, a solar installation would have generated, on average, slightly more than half the power than a CCGT facility would.



WAPA Assets in Charlotte Amalie



WAPA Assets on St. Croix



WAPA Assets in Red Hook



WAPA Assets in Frederiksted



WAPA Assets on Bovoni



WAPA Assets in Christiansted

The two fossil-fueled plants are Estate Richmond Power Plant on St. Croix and Randolph Harley Power Plant on St. Thomas. Each houses six operational fossil fuel generators that can produce 101 MW and 141 MW of electricity, respectively. Both plants used to run on fuel oil, but WAPA has been converting them to Liquefied Petroleum Gas (LPG) to lower costs (since LPG is historically cheaper than fuel oil). All but one unit on St. Croix have been converted to LPG; on St. Thomas, only one unit has been converted. The remaining units on both islands will follow.

The three utility-scale solar installations are the USVI Solar 1 field on St. Thomas, the Toshiba solar field on St. Croix, and a facility at Cyril E. King airport on St. Thomas. The first two installations are owned by private investors who have signed a power purchase agreement (PPA) with WAPA, which guarantees that the utility will purchase the power they produce for a defined period at a fixed price. Combined, these solar fields generate nine megawatts of power. The airport solar field was built by the Virgin Islands Port Authority (VIPA) with funding from the American Recovery and Reinvestment Act of 2009. It is relatively small, generating 0.5 MW of power. All of the facilities have come online in recent years, starting in 2014. Prior to that, WAPA depended almost exclusively on fossil fuels. This reliance was in line with the broader Caribbean region, which generated 95 percent of its electricity from fossil fuels in 2015. To lessen this reliance, WAPA has pursued more than a dozen renewable PPAs, but only the USVI 1 and Toshiba solar fields have been built. A number

of factors have prevented the remainder from moving forward, including challenges with the legislatively proscribed PPA process and WAPA's low credit rating.

Finally, another 15 MW of solar energy is generated through WAPA's Net Metering Program. Created in 2007, the program allows customers to install their own rooftop solar panels and feed excess power back to the grid in exchange for a credit on their bill equal to WAPA's retail electricity rate. The program's generation capacity was capped at 15 MW, a limit that was met in 2016. Additional solar power may be generated by privately owned assets that are not part of the net metering program, but the USVI does not track how much power is generated that way.

Transmission and distribution

Once electricity is generated, it is sent via high-voltage transmission lines to substations that step down the voltage and send it to lower-voltage distribution lines. This network includes eight substations (five on St. Thomas, two on St. Croix and one on St. John) and more than 1,000 miles of power lines, of which approximately 10 percent were buried underground prior to the hurricanes (57 miles on the St. Croix network and 18 miles on the St. Thomas/St. John network). The underground lines served approximately 75 percent of the territory's business districts.

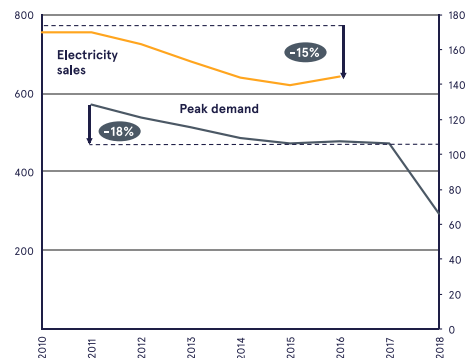
The St. Croix network is confined to the island. On the St. Thomas grid, the network carries power generated on St. Thomas to

customers on Water, Hassel, and St. John Islands. All three of those islands are connected to St. Thomas through submarine cables: one for Water and Hassel Islands and three for St. John. The St. John cables carry power from the East End Substation on St. Thomas to the St. John Substation. Customers on St. John's west end are then served by the substation directly. Customers on the east end in Coral Bay depend on an aboveground distribution line that carries power to them along the island's Centerline Drive.

Consumption

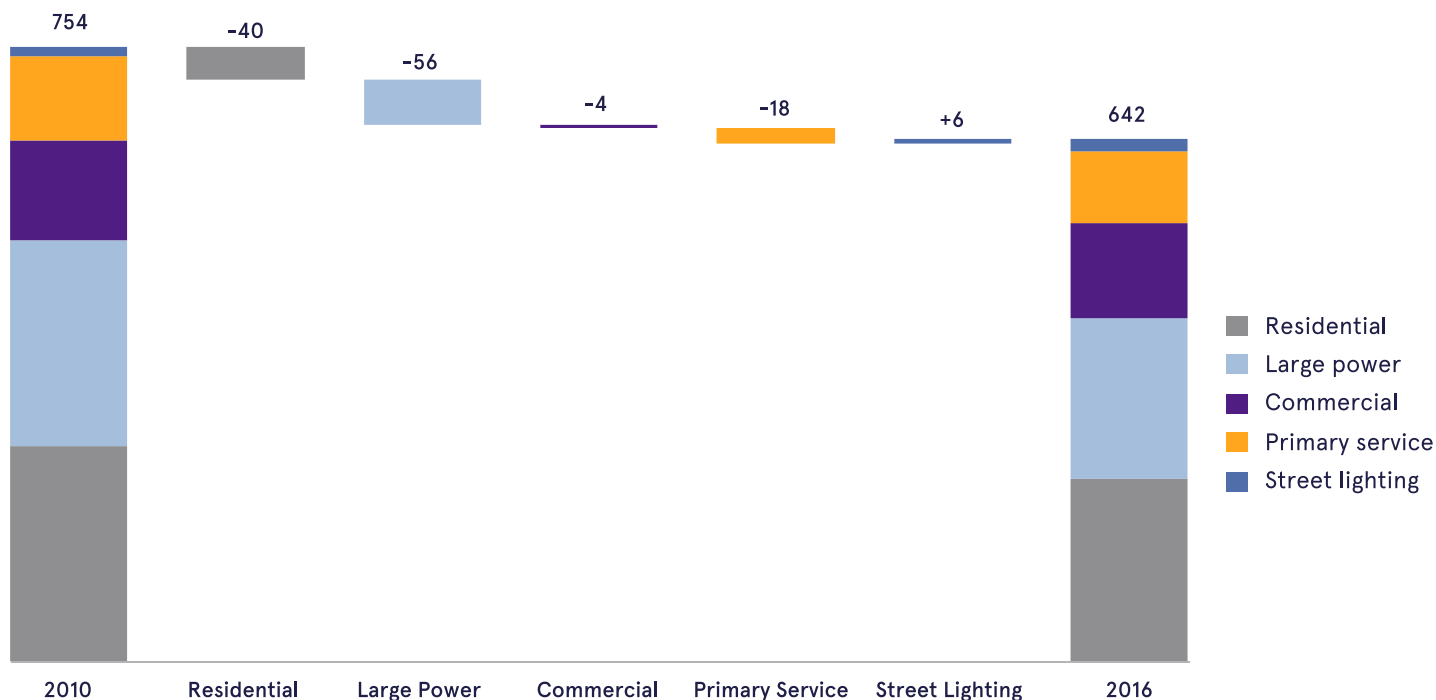
WAPA's peak demand—the maximum energy load consumed by customers at any point in a year—was approximately 107 MW before the storms. Peak demand has dramatically declined in recent years, driven by a variety of factors, including population decline and customers leaving the grid. Between 2011 and 2017, peak demand dropped 18 percent (see charts: [WAPA electricity sales and peak demand](#); [Change in WAPA sales by customer type between 2008 and 2016](#)).

Since the hurricanes, this has



Peak load as of May 2018 is ~66MW

WAPA electricity sales and peak demand
Thousands of MWh (left axis) and MW
(right axis)



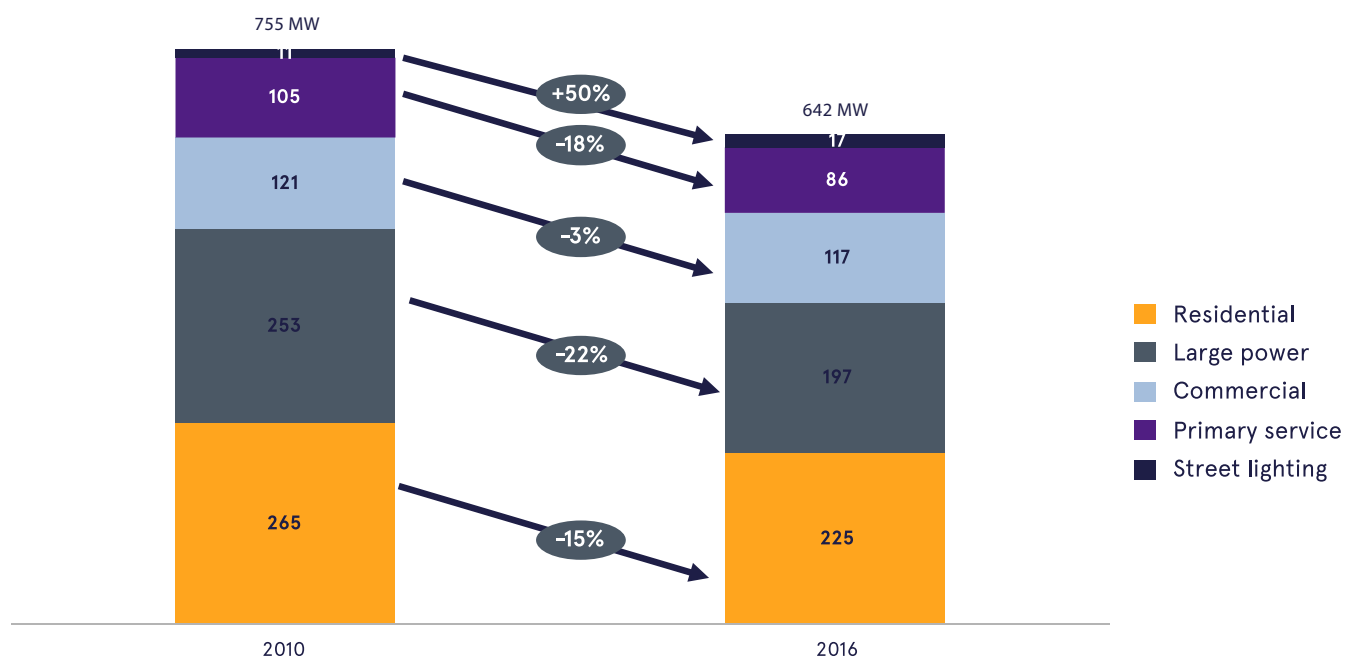
Change in WAPA sales by customer type between 2008 and 2016
Thousands of megawatt hours

declined an additional 20 percent, reaching 78 MW in April 2018. This will likely rebound to some degree as the Territory rebuilds and recovers; however, it is unclear how quickly or by how much. Overall sales have declined as well, especially for large power

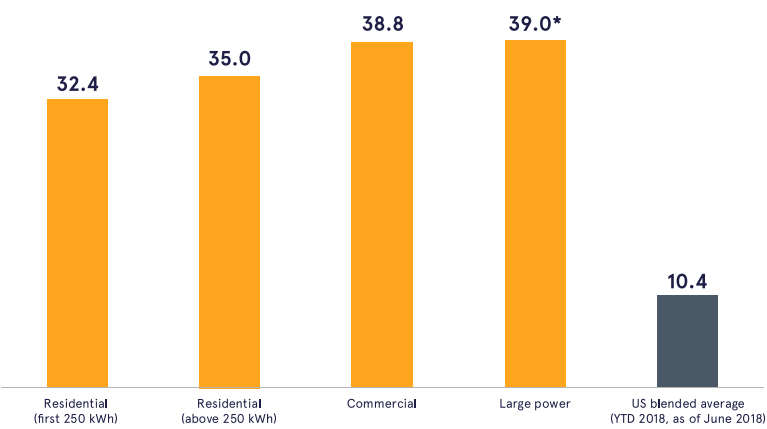
customers, which have fallen 22 percent since 2010 (See chart: [WAPA sales by customer between 2010 and 2016](#)).

WAPA is able to monitor its customers' energy usage through Advanced Metering Infrastructure

(AMI) installed in all of its customers' buildings over the past few years. AMI enables WAPA to read meters remotely and gain insight into how and when its customers use energy.



WAPA sales by customer type between 2010 and 2016
Thousands of megawatt hours



Power prices in the USVI
¢/kWh

* Note: WAPA uses a declining block pricing system for energy consumption for large power customers. As large power customers use more power, they pay a lower kWh fee for additional usage. The US blended average is the average rate paid by all customer types.

WAPA energy rates

Electricity rates in the USVI are among the highest in the world, varying between 32 and 39 cents per kilowatt hour (kWh)⁶ depending on customer type (compared to an average of 10 cents on the US mainland; see chart: [Power prices in the USVI](#)).

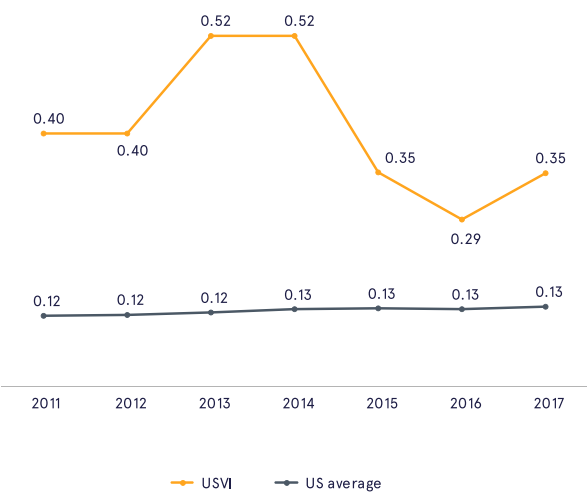
In the past, fuel costs have driven these rates as high as 50 cents per kWh (see chart: [WAPA residential energy rate vs. US average](#)).

WAPA's rates are made up of several different components. Approximately half of WAPA's electricity rates is the base rate, called the Energy Charge, which funds the cost of producing and delivering electricity, plus investment in the power plants, transmission systems and other facilities. The next largest component is the Leveled Energy Adjustment Clause (LEAC), which makes up about 40 percent of the rate. The LEAC almost exclusively funds the fuel needed to run

WAPA's generators. As a result, it is highly variable and more frequently updated by the PSC, which oversees rate-setting for the utility, than other elements of WAPA's rates. The next largest portion of the electricity rate (approximately eight percent of the total) is a maintenance charge, which funds ongoing repairs, maintenance, and upgrades to WAPA's system. The remaining two percent of the rate is made up of several small fees (see table: [Components of WAPA's residential rate for consumption above 250 kWh](#)).

Energy Charge	17.63 ¢/kWh
Fuel Charge (LEAC Rate)	14.36 ¢/kWh
Maintenance Surcharge	2.49 ¢/kWh
Line Loss Surcharge	0.22 ¢/kWh
Self-Insurance Surcharge	0.19 ¢/kWh
Pilot Surcharge	0.07 ¢/kWh

Components of WAPA's residential rate for consumption above 250 kWh, 2018



WAPA residential energy rate vs. US average
residential rate
\$/kWh

Regulation and planning

WAPA is an autonomous public utility holding the exclusive right to generate and distribute electricity throughout the Territory. A number of other entities also have jurisdiction and influence over the USVI energy sector. This includes the U.S. Virgin Islands Public Service Commission (PSC), the USVI Legislature, and the USVI Energy Office (VIEO). The federal government is also involved, mainly through supporting initiatives in renewable energy and providing ad hoc technical assistance.

⁶ A kilowatt-hour (kWh), as distinct from kilowatt (kW), is a unit of energy equivalent to one kilowatt (1 kW) of power sustained for one hour. kW is a measure of demand or generation at a moment in time. kWh is a measure of energy used over time. For this reason, utility bills are priced based on kWh.

The PSC sets customer rates for all regulated utilities in the USVI (including electricity, water, telephone, cable TV, and ferry operations). The main mechanism through which the PSC engages with WAPA is the rate case. In the rate case process, WAPA details proposed changes in rates along with the rationale for those changes. The PSC is tasked with regulating utility rates to ensure that residents receive high quality service in a safe and efficient manner. The PSC can also approve Qualified Facilities, who are vendors able to enter into contracts with WAPA to sell power.

The Legislature plays an oversight role and enacts policies related to the USVI energy sector. One of the most important acts that it has passed in this regard is the U.S. Virgin Islands Renewable and Alternative Energy Act of 2009 (Act 7075). Act 7075 set the goal of increasing renewable generation in the USVI to 30 percent of peak demand by 2025 and continuing to increase from there until it reaches 50 percent. Act 7075 also established the USVI's Net Metering Program and required the installation of solar water heating systems on all new construction and government buildings.

The U.S. Virgin Islands Energy Office (VIEO) primarily oversees several energy efficiency programs and serves as the point of contact for the Territory's engagement with federal energy entities. Unlike in many other jurisdictions, where offices like this would typically operate as the Governor's primary policy staff for energy-related issues, the policy-related role of the office is limited. The VIEO primary contribution to informing policy

issues is the Energy Roundtable, a forum that the office created for the major energy stakeholders (e.g. WAPA, PSC, federal agencies, and private sector energy companies) to discuss solutions to energy-related issues.

The federal government's involvement in the USVI has mostly focused on clean energy programs and technical assistance delivered by the U.S. Department of Energy (DOE) and the U.S. Department of the Interior (DOI). In 2010, the two federal agencies signed a memorandum of understanding with the USVI to reduce the territory's fossil fuel consumption by 60 percent by 2025. The USVI and DOE signed a second MOU in 2015, reaffirming the Territory's commitment to transitioning its energy system.

In 2016, WAPA developed a plan (known as its Integrated Resource Plan, or IRP) to guide investments to meet these goals. Through a relationship managed by the VIEO, WAPA has also worked closely with the DOE and the National Renewable Energy Laboratory (NREL) to develop a path to achieve the USVI's ambitious fossil fuel reduction and renewable energy goals. DOE and NREL have conducted several technical studies in an attempt to incorporate more renewables into the grid and regularly provide WAPA with technical assistance.

In 2013, the utility launched an initiative called VIenergize to provide customers with energy efficiency programs that can reduce their bills while helping WAPA avoid additional generation investments. To date, WAPA has not had the capacity to fully develop these programs, and customer uptake has been limited.

CHALLENGES

The USVI's energy system faces many challenges that existed before, and were exacerbated by, hurricanes Irma and Maria. These challenges have led to higher rates and a historically unreliable grid, which has pushed an increasing number of customers to move off the grid and supply their own power. While WAPA has worked to address several of these challenges, substantial financial and governance challenges have delayed progress on many of these issues.

GENERATION

Aging, inefficient, and oversized infrastructure

WAPA's fossil fuel generators are generally old. Only three of the utility's 18 generators were installed in the past 15 years; more than half are over 25 years old. These older units are inefficient and significantly less reliable than newer technology. This means WAPA must burn more fuel to create energy and has to regularly shut down units for repairs.

The generators are also larger than the utility needs: following standards set by the North American Electric Reliability Council (NERC),

WAPA maintains enough installed generation capacity to meet the USVI's peak load in the event that the utility's two largest non-renewable generation units are offline. This must be done for both the St. Croix and St. Thomas/St. John portions of the grid. Given the current sizing of WAPA's generation assets—which include some large generators (producing more than 30 MW of electricity)—WAPA must operate a significant amount of installed generation capacity well above each network's current peak load.

WAPA recently purchased three new seven MW Wartsila generators to replace some of its older generation assets and has plans to continue to modernize its generators with smaller, more efficient units.

Heavy reliance on fossil fuels

The current mix of generators on the islands means that WAPA relies heavily on imported fuel oil and LPG. These fuels have become expensive compared to renewables; fuel oil in particular is also vulnerable to unexpected price shocks. In 2016, over half of WAPA's operating costs went to fuel purchases.

By comparison, renewables have relatively low operating and maintenance costs.

Solar photovoltaic panels (PV) have an average operating and maintenance cost of 0.4-0.5 ¢/kWh, which is approximately three percent of the operating costs of diesel reciprocating engines. The Levelized Cost of Electricity (LCOE), which is the total capital and operating cost to generate a kWh of energy (including fuel costs), of recent renewable projects in the Caribbean are estimated at 7-20 ¢/kWh for wind and 9-15 ¢/kWh for solar.

It is anticipated that these prices will only continue to fall. In just the past year, Bloomberg New Energy Finance noted that global solar PV prices declined 20 percent. This comes on the tail of a decade of dramatic global price declines: 85 percent for solar and 79 percent for lithium ion batteries—but WAPA is yet to take advantage of these at a significant scale.

TRANSMISSION AND DISTRIBUTION

Fragile, isolated grid structure

WAPA faces a challenge common to many island nations: the need to operate a grid that is completely isolated from other utility structures. In the mainland US, many

utilities are interconnected and can rely on neighboring utilities to provide power when disruptions occur at their own power plants. In the USVI, WAPA must allocate resources across two relatively small power grids that function independently. Additionally, while undergrounding power lines can help reduce the risk of damage from hurricanes, the rocky soil and steep terrain on St. John and St. Thomas make it challenging and very expensive to implement underground power lines. Lastly, the nature of WAPA's network means there are multiple single points of failure, each of which can cause widespread outages if a piece of the transmission and distribution system fails or is damaged.

REGULATION AND PLANNING

Increased collaboration between the PSC and WAPA

Working together, the PSC and WAPA could make strides toward decreasing electricity rates for customers, while increasing the amount of sustainable energy in the Territory and increasing resilience.

⁷ Lazard Global Benchmark Utility-scale Renewable Project Costs, 2009-2016

⁸ Rocky Mountain Institute

For example, WAPA and the PSC both agree that WAPA and its customers would benefit if customers were able to install rooftop solar and sell their power back to WAPA at a lower rate than the current net metering program. Although there is alignment about the need for this solution, WAPA and the PSC have not reached an agreement on how to move forward. In addition, the USVI PSC's regulatory authority is restricted to approving rates, which is more limited than some other jurisdictions. Finally, PSC commissioners are part-time and receive a \$50 stipend per session, which also limits the PSC's ability to make informed decisions on complex rate challenges that WAPA faces.

Limited traction of energy efficiency programs

Given WAPA's high rates, energy efficiency programs are a critical opportunity for residents to lower bills. Offering energy efficiency programs is also advantageous for WAPA because lower energy use would allow the utility to reduce its costs through lower fuel use and avoided or deferred system upgrades. If efficiency were included in WAPA's rate structure—which is not currently included—the utility could recoup its investments and pass on a portion of the savings to customers.

The USVI has developed several small-scale programs to expand energy efficiency measures to help lower customer's bills: the VIEO has had success in several energy audits and energy efficiency projects at GVI-owned facilities, and WAPA launched VIEnergize to expand its focus on energy efficiency, but those programs have not gained substantial traction.

Financial challenges

WAPA's financial challenges put a further strain on the system. WAPA has reduced its costs by 30 percent since 2012 to keep pace with declining revenues, but this reduction is almost exclusively the result of declining fuel costs. The rest of WAPA's operational costs have increased by nearly 50 percent in the same time period. WAPA also faces a variety of broader financial issues that have led it to receive a below-investment grade credit rating. These include a 17 percent non-payment rate across its customer base (including approximately \$30 million from the Government of the Virgin Islands), a significant unfunded pension liability, and long-term debt commitments of \$265 million.

Customer defections

WAPA's high energy rates have led some customers—particularly larger commercial and industrial ones—to leave the grid. Several users, including major hotels, have installed stand-alone diesel generators to ensure access to more reliable power, even though these systems are often more costly than simply paying for WAPA power. Customers of all sizes have also explored installing rooftop solar panels outside of WAPA's net metering program. Under WAPA's current rules, customers who install PV outside of net metering need to disconnect from the grid. Before the hurricanes, this restriction held many customers back; after the hurricanes and the extended loss of power that they brought, customers are increasingly choosing to disconnect from the grid and rely on a mix of solar power, batteries, and diesel generators instead. This presents a critical challenge for the utility: moderate and high-income customers are likely to continue to turn to off-grid solutions, leaving low income customers to pay higher rates to cover the utility's fixed costs—and potentially accumulate further unpaid billing liability.



IMPACT OF THE HURRICANES

The USVI energy system was in a state of crisis before hurricanes Irma and Maria. The unprecedented landfall of two Category 5 hurricanes in the span of 10 days wrought catastrophic damage to WAPA's physical infrastructure, exacerbated many of the challenges facing the system and led to a \$2.3 billion need for federal support for both emergency and permanent repairs and resiliency measures. This included damage to 90 percent of the USVI's overhead transmission and distribution network and 20 percent of WAPA's power generation capacity, which meant that 100 percent of WAPA's customers were without power after the storms. While power restorations began within 72 hours, the breadth and scale of the damage caused large-scale restorations to take much longer. However, with the help of hundreds of off-island linemen, most customers that could receive power got it back by Christmas. This was far quicker than after previous hurricanes.

Generation

The storms damaged power generating units on both St. Thomas and St. Croix. On St. Thomas, coastal flooding damaged four units at the Randolph Harley Power Plant.⁹ This resulted in a loss of 20



Damaged USVI 1 solar field on St. Thomas; Source: Kelsey Nowakowski

percent of power generation capacity at the plant for almost one month. On St. Croix, the Richmond Power Plant suffered minor damages that did not have a substantial impact on service.¹⁰

Solar PV facilities experienced varying levels of damage. Some panels were not installed properly and were destroyed when the wind lifted them off their base; others that were installed well only suffered damage from flying debris. The USVI Solar 1 solar field on St. Thomas sustained catastrophic damage and most, if not all, of the facility will need to be rebuilt. The Toshiba solar field in Spanish Town fared much better: debris damaged only a few of the solar panels, and flooding caused minor damage to some equipment. The solar field adjacent to the airport on St. Thomas suffered substantial damage to inverters and electronics when the area around the array was flooded; the facility

will need to be rebuilt.

Many of the small-scale rooftop solar systems installed through WAPA's net metering program did not sustain substantial damage, nor did most privately owned diesel generators.

Transmission and distribution

The hurricanes decimated the islands' transmission and distribution (T&D) systems, damaging 90 percent of aboveground power lines and knocking down half of the USVI's utility poles. All told, the storms damaged more than 20,000 poles, 1,100 miles of transmission and distribution lines, and 5,300 distribution transformers. WAPA's underground T&D system was not damaged, enabling the utility to quickly repower certain areas of both islands served by these lines.

⁹ Units 9B, Unit 14, Unit 15, and Unit 18 were damaged, primarily due to water incursion into the plant. Emergency units, APR Units 25 and 26, were successfully brought online on September 10.

¹⁰ Units 10, 11, 17, and HRS 24 suffered minor damage; Units 11 and 17 were repaired by December 2017.

Winds and flooding also damaged several substations, including the East End, Tutu, and Donald Francois substations on St. Thomas, and the Richmond and Gregory Willocks substations on St. Croix.

The hurricanes also damaged WAPA's recently installed Advanced Metering Infrastructure (AMI). This limited the utility's ability to leverage real-time insight into the grid during the restoration process. Additionally, the damage prevented WAPA from automatically reading energy meters. As a result, WAPA had to revert to and hire contractors for manual meter reading, which delayed its ability to promptly and accurately bill residents after the storms.

Hurricane response

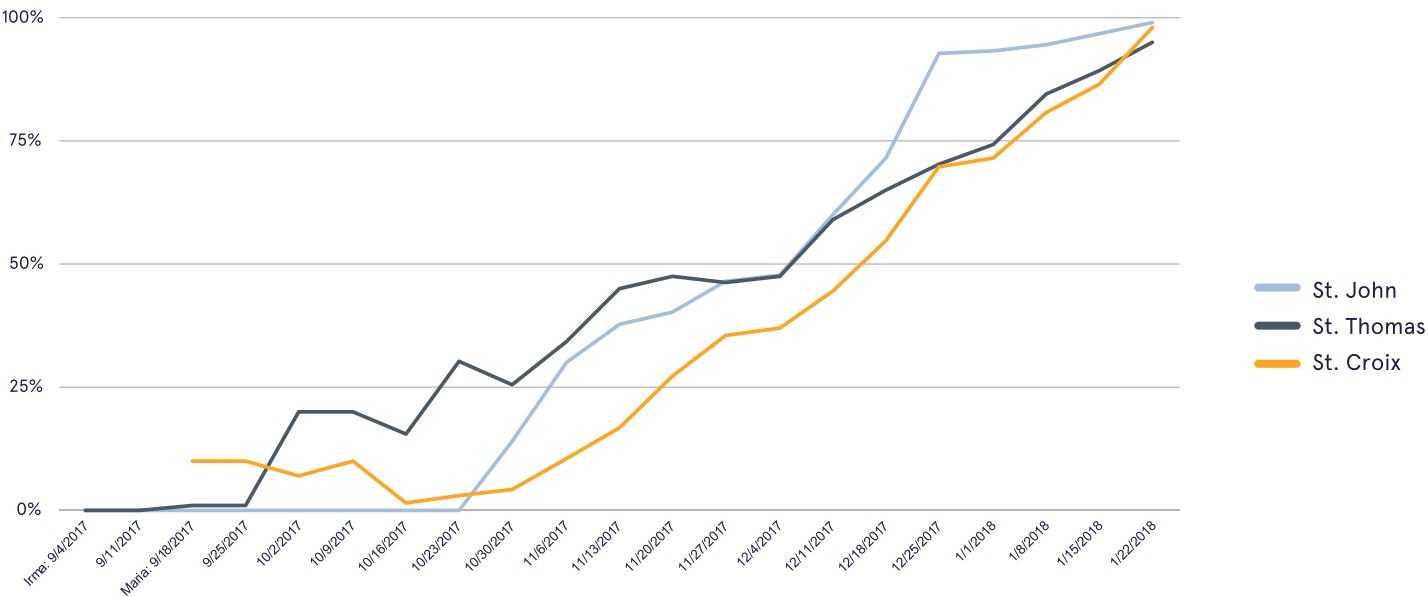
WAPA began repowering efforts immediately after the storms. While the Randolph Harley Power Plant was back online within four days, the transmission and distribution restoration effort was more complex. WAPA's efforts initially focused on neighborhoods with underground power lines and neighborhoods adjacent to those lines. On St. Croix, downtown Christiansted and surrounding neighborhoods were repowered before WAPA turned to the western portion of the island. On St. Thomas, WAPA first repowered Charlotte Amalie and surrounding neighborhoods, including Yacht Haven Grande and public housing communities such as Savan, Oswald Harris Court and Pearson Garden. The design of the T&D system on St. John has several single points of failure, which made restoring power there more difficult and time-consuming than on the other two major islands. Power supply to the Coral Bay

community on the eastern end of St. John depends on a single above-ground line connecting it to Cruz Bay on the western end; that line was destroyed. Cruz Bay's power, in turn, comes from St. Thomas via undersea cables; the aboveground lines connecting St. Thomas Randolph Harley Power Plant to the substation that feeds those undersea cables were damaged. As a result, Cruz Bay was without utility power for approximately 49 days until crews could rebuild the overhead supply network on St. Thomas. Coral Bay had to wait for almost 100 days until its link to Cruz Bay could be restored.

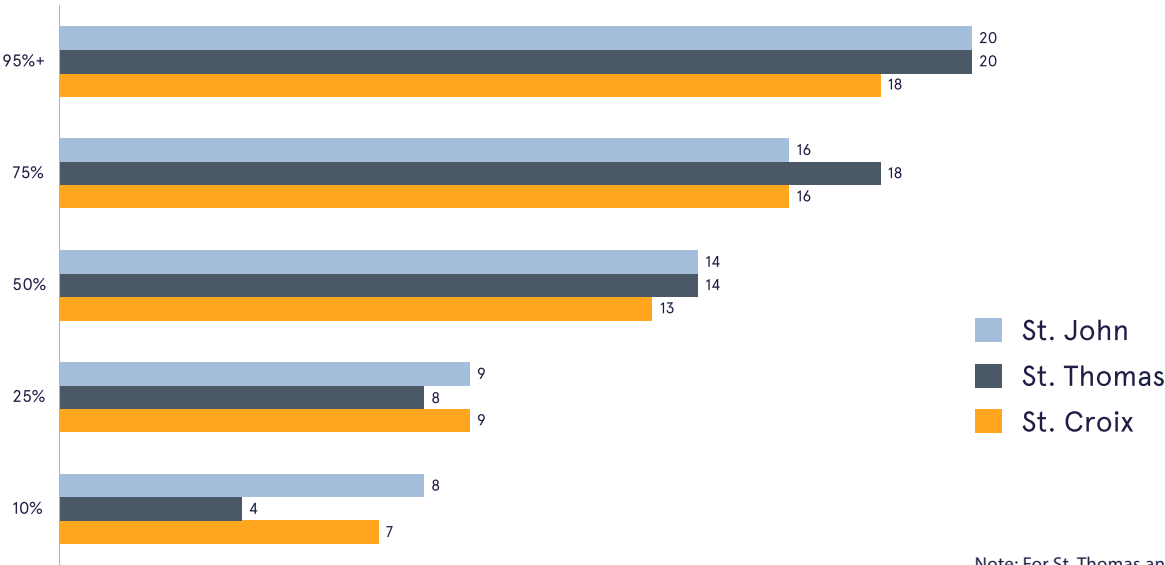
Despite the challenges of restoration, the USVI government's active engagement with WAPA, federal agencies, and external partners enabled the territory to restore its energy system faster than other islands impacted by Irma and Maria. While power restoration took as long as six months for previous hurricanes, Governor Mapp set a target of restoring power to 90 percent of customers who could receive electricity by Christmas 2017. WAPA worked with a number of partners to bring in more than 800 off-island linemen to meet this goal. By Christmas, approximately 90 percent of eligible customers across the three islands had power restored. Some homes had substantial damage to their electrical infrastructure from the storm and were not able to receive power safely until they repaired their electrical equipment; those homes were repowered later (see charts: [Customer restoration progress by island](#) and [Time post-storm to reach a given level of customer restoration, by island](#)).



Hurricane damage to power lines in St. Thomas, Source: Kenneth Wilsey/FEMA



WAPA customer restoration progress by island
% of total customers restored



Time post-storm to reach a given level of WAPA customer restoration, by island
% of eligible customers; number of weeks

Note: For St. Thomas and St. John, the bars represent the number of weeks after hurricane Irma. For St. Croix, the bars represent the number of weeks after hurricane Maria.

Until power was fully restored, backup generators provided some relief. Critical public sector facilities, including the airports and hospitals on both St. Thomas and St. Croix, received generator assistance from the Army Corps of Engineers (USACE) and the Virgin Islands Territory Emergency Management Agency (VITEMA). Privately owned

critical facilities (e.g., radio stations or private cell phone towers) were not eligible to receive USACE generators, which caused delays in getting some of those facilities back online. Among the residents, a small percentage was able to use their own generation assets installed before the storms to power their homes and businesses, while many more

purchased and installed generators following the storms. Some private generators were installed incorrectly, which resulted in energy being improperly pushed from the private generator back onto the grid, injuring at least one lineman and reinforcing the importance of comprehensive interconnection standards and appropriate enforcement.

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

The USVI has always had to deal with the impacts of hurricanes and tropical storms, which present a particular risk to the territory's energy infrastructure. In the past 30 years, the USVI has experienced five major hurricanes, each causing millions of dollars in damage. These risks are already real and significant, even without climate change, and they will only increase as the climate changes and the intensity of extreme events increases. The greatest risks will come from hurricane winds, rainfall, and storm surge, which can damage generation and T&D assets. Lower-impact risks will come from temperature increases,

which will lead to long-term reductions in the efficiency of equipment and change energy consumption patterns, from rising sea levels, which can threaten underground infrastructure and contribute to the effects of hurricane storm surge, and changing precipitation patterns, which will increase the risk of landslides as well as increase energy demand from reverse osmosis plants.

Hurricane winds, rainfall, and storm surge

High winds and flying debris are the main risk for energy infrastructure. On the generation side, both fossil and solar generation facilities are vulnerable. WAPA's power plants are designed to withstand approximately 200 mph winds associated with a Category 5 hurricane; stronger winds can put them at risk. Solar facilities in the

Caribbean are generally designed for Category 4 winds; stronger winds will put them at greater risk as well. Solar arrays are also vulnerable to flying debris. On the transmission and distribution side, high winds, downed trees and flying debris can knock down utility poles and wires just as they did in the latest hurricanes.

Storm surge poses a risk as well. The power plants are located on the coast of each island, and coastal flooding damaged St. Thomas's Randolph Harley power plant in the 2017 storms. The same risks apply to several substations. The Tutu, East End and Donoe substations on St. Thomas are in flood hazard zones and were damaged by the 2017 storms. The Donald Francois substation on St. Thomas is also within the Category 5 hurricane (Sea, Lake, and Overland Surges from Hurricanes) SLOSH zone.¹¹

Another risk involves hurricane damage to the territory's ports—at least as long as the Territory depends heavily on fossil fuels for its power generation. If a future storm causes extensive damage



WAPA Assets in Charlotte Amalie in and near current flood zones



WAPA Assets in St. Thomas in and near current flood zones

¹¹ The SLOSH zone is determined by the National Hurricane Center and is the area that they assess from models or from previous hurricanes to be vulnerable to "Sea, Lake and Overland Surges" due to hurricanes (see climate section of this report for more details).

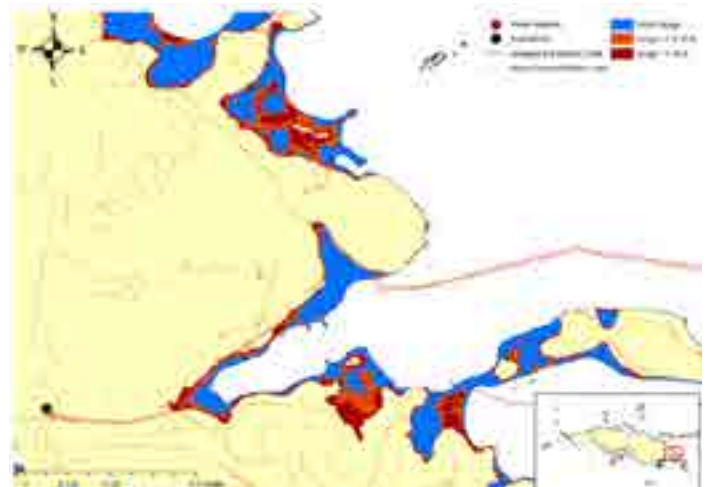
to the ports, fuel deliveries may be cut off. Existing storage facilities provide backup capacity of up to 20 days of propane storage on St. Croix and fuel oil storage of up to 65 days on St. Croix and 40 days on St. Thomas. While WAPA did not run out of fuel during hurricanes Irma and Maria, port damage does present a risk in the future.

Rising sea levels

Sea level rise will contribute to the effects of hurricane storm surge as described above. By itself, it poses limited risks to WAPA's assets given their current locations and elevations. Some underground transmission equipment is already inundated with salt water today. This will increase as sea levels rise. While WAPA has experienced minimal impact from salt-water intrusion to date, the utility should



Sea level rise risks to WAPA Assets



Storm surge for WAPA Assets in Red Hook, present, predicted 50 year, predicted 100 years



Storm surge for WAPA Assets in Cruz Bay, present, predicted 50 year, predicted 100 years



Sea level rise in Charlotte Amalie



Storm surge for WAPA assets in Charlotte Amalie, present, predicted 50 year, predicted 100 years

continue to monitor and mitigate this risk by insulating wires and performing regular maintenance. Increased use of undergrounding may also require additional training for WAPA personnel to be able to maintain and repair these assets.

Increases in Temperature

Higher temperatures may mildly affect aboveground distribution and transmission infrastructure. On hot days, overhead cables are likely to sag. When this occurs, lines can sway further than usual due to the wind and may impact other lines on the same pole. This risk is already being mitigated: during the restoration process after the 2017 hurricanes, linemen installed cross arm bars on power poles to be vertical instead of horizontal, so lines are less likely to collide.

Rising temperatures may also reduce the efficiency of generation and transmission assets. WAPA's generators and substations are built to operate at temperatures of up to 90 degrees fahrenheit and are not certified to operate at and above 105 degrees fahrenheit. During the hottest days when energy demand is likely to peak, the generators and substations could be at risk of overheating, causing brief outages or faster depreciation. The risks can be mitigated: on particularly hot days, WAPA already operates equipment at levels below its maximum thresholds. In addition, most generation equipment includes cooling mechanisms.

Finally, rising temperatures may lead to increased demand for mechanical cooling in residences

and businesses, which could lead to higher peak demand on very hot days.

Changes in Precipitation

Periods of more intense rainfall will increase the risk of landslides, threatening the T&D system, especially on St. Thomas and St. John, which are already vulnerable to landslides on some of the steeper parts of the islands. Landslide risks should be reviewed in collaboration with other government groups, including the Department of Public Works (DPW) and the Department of Planning and Natural Resources (DPNR).

Longer dry spells will increase demand for water from reverse osmosis plants, which will in turn increase energy demand. The increase is likely to be mild. Reverse osmosis plants, which supply 25 percent of USVI residents with drinking water, currently represent approximately two percent of WAPA's total electricity sales.

On particularly hot and dry days, the combination of increased demand for air conditioning and the increase in energy used at reverse osmosis facilities is likely to increase peak demand and cause stress to the USVI's energy system. The current generation capacity on the islands will very likely be able to manage moderate increases in peak load.

DAMAGE AND RECOVERY COSTS

The USVI summarized its funding needs for the energy sector in the Action Plan that was submitted to the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery (CDBG-DR) Program in May 2018. In the plan, WAPA identified \$2.3 billion in needs to repair the damage caused by the hurricanes and increase the resilience of the USVI's energy system in the face of future hazards. This included approximately \$600 million for emergency and temporary repairs and \$1.7 billion for permanent repairs and resilience enhancements. These funding needs include:

- Ongoing emergency response from mission assignments (e.g., portable generation, 800+ off-island linemen/support personnel)
- Repair and resilience actions needed to restore the power grid, including installing over 20,000 poles, rebuilding over 1,100 miles of transmission and distribution lines and replacing 5,300 distribution transformers
- Projects for which engineering estimates are not complete
- Engineering estimates for repairing four generating units to restore two plants to normal operations

INITIATIVES FOR INCREASING RESILIENCY IN THE ENERGY SECTOR

Hurricanes Irma and Maria devastated the USVI's energy infrastructure. Over 90 percent of the transmission and distribution system was destroyed, and more than 20 percent of generation capacity was damaged. At the same time, even before the hurricanes, high costs and unreliable service were already driving customers off the grid. Federal recovery funding provides a once-in-a-generation opportunity to transform the USVI's energy system to increase the reliability and resilience of the system, stabilize and ultimately reduce costs, stem the tide of grid defections, and attract customers back to WAPA's grid.

Achieving this transformation requires changes to all aspects of the energy system. The Territory must transform its energy generation portfolio, modernize its grid, fortify infrastructure against climate risks, and strengthen energy planning and governance structures. The changes will require large amounts of funding and coordination, as well as collaboration between all the different bodies that have oversight of the USVI's energy systems, including the legislature, PSC, WAPA, and the Governor's Office.

The measures will not fully protect the energy system from damage in future strong storms—the cost of fully hardening the system against Category 5 events would be prohibitive—but they will build resilience and redundancy into the system to reduce risks that can be avoided cost-effectively and enable the system to bounce back quickly following any future damage that does occur. These recommendations are built on much of the research, planning and implementation that WAPA, with support of federal and local resources, executed in the last decade to address the challenges facing the system. The utility is already in the planning and implementation stages for several key projects that advance these goals; the initiatives that follow highlight several of these projects that are already underway and several which are not yet under development.

TRANSFORM THE GENERATION PORTFOLIO

WAPA's generation assets are old, inefficient, and predominantly reliant on fossil fuels. All but three of its 12 operational generators are at least 15 years old, and approximately 90 percent of its generation capacity comes from fuel oil or LPG. This contributes to WAPA's high electricity rates, as more than half of WAPA's operational costs are for fossil fuel purchases. In addition, only four generators have a generation capacity under 20 MW. The relatively large capacity of WAPA's other generators makes it more difficult for the utility to use

renewables to lower costs, as it must run large fossil fuel units even when it may need only small amounts of additional power to balance system loads.

Replacing aging generation capacity with new, more efficient fossil fuel generators, adding substantial renewables, and capturing energy efficiency will increase the resilience of WAPA's network and can help stabilize and eventually lower electricity rates. To achieve this transformation, WAPA will use federal funding both to construct utility scale renewables that it will own and replace its fossil fuel generators with smaller, more efficient units. Simultaneously, the Governor's Office will work with the PSC and WAPA to enable the expansion of distributed renewable generation on private property, while the VIEO and WAPA's VIEnergize services unit will expand funding and programs for energy efficiency to save customers money and help offset the need for additional capacity in future years. Much work in particular will take place on the island of St. John, which provides an early opportunity to demonstrate that the strategies can be leveraged to dramatically increase the resilience of an island's energy systems. All of this work will enable WAPA to triple the amount of renewable generation capacity in the USVI by 2025, providing up to 75 percent of the territory's peak demand through renewable energy sources such as solar during periods of clear sunshine, and relying on fossil fuels and energy storage for the remainder.

Initiative 1

Increase utility scale renewables

As the costs of renewables and battery storage have dramatically decreased, renewable assets are less expensive in the USVI than fossil fuels assets on a per kWh basis (including capital costs). As a result, they offer a tremendous opportunity to reduce costs for WAPA and lower rates for customers—especially when coupled with battery storage, which can spread the benefits of renewable power to morning and evening peak times as well as help improve reliability.

WAPA will rely on several funding streams to add at least 50 MW of additional utility scale renewables with battery storage onto the grid by 2025, with near-term deployment targets of 20 MW. Renewable projects to be initiated in the next year include a 5-10 MW solar microgrid on the South Shore of St. Croix, a 10 MW wind project at the Bovoni Landfill on St. Thomas, and 1-4 MW of solar on St. John. To fund these and other projects, WAPA will explore using FEMA and HUD funding, as well as explore Rural Utility Service (RUS) financing if additional capital is needed.

Initiative 2

Reform power purchase process

Federal funding alone will not meet WAPA's capital needs for renewables—and the utility's ability to attract capital in capital markets is severely limited by its credit rating. In this situation, power purchase agreements (PPAs) can be a useful tool with which to attract private capital for utility scale renewable projects—but the USVI's current PPA process is inappropriately designed for the size and scope of the USVI's electricity market and has generally failed to add cost effective renewables to the grid.

Today, USVI law permits any project developer to advance a project by filling out a simple form with the PSC to become a Qualified Facility (QF).¹² Once a developer is designated as a QF, WAPA must begin negotiating the terms of a PPA and perform due diligence work. This takes significant time and effort from WAPA—but as long as the project developer claims that it can deliver power at or below WAPA's avoided cost, the utility must negotiate a PPA with that developer. Once the PPA is negotiated, the developer works to secure financing as well as all necessary environmental and planning permits.

The current QF process has resulted in the installation of few actual renewable energy projects to date. Some have attributed this outcome to WAPA's reluctance to

complete QF contracts. Others point to a lack of sufficient due diligence on vendors that receive QF status. Still others contend that project developers have failed to secure financing due to WAPA's credit rating and concerns about its ability to make timely payments agreed upon in a PPA.

The process has another disadvantage, too: it does not allow WAPA to effectively plan for future generation needs, as the utility cannot predict how many QF PPAs it will be required to enter and at what scale—especially because the current regulation allows projects up to 30 MW to qualify, an amount almost equal to 30 percent of the Territory's peak demand. Thus, even a modest number of unplanned projects could have a disruptive impact on WAPA's integrated resource planning and create stranded generation assets. Several states, including North Carolina and Michigan, are changing their QF process to address these kinds of issues; the USVI should follow suit.

The Governor's Office will work with the PSC and WAPA to establish a revised set of regulatory rules for the Qualified Facility (QF) PPA process. Working in collaboration with WAPA, the PSC should consider:

- Setting a limit for how many MWs of power can be approved through the QF process over a specified time horizon (e.g. a five year period)

¹² The Public Utility Regulatory Policies Act of 1978 (PURPA) was implemented to encourage, among other things, conservation and renewables. One of the ways PURPA set out to accomplish its goals was through the establishment of a new class of generating facilities, which would receive special rate and regulatory treatment. Generating facilities in this group are known as qualifying facilities (QFs), and fall into two categories: qualifying small power production facilities and qualifying cogeneration facilities.

- Permitting WAPA to issue one or more Request for Proposals (RFP) over that time horizon to meet the MW target to drive down costs through a competitive bidding process
- Requiring WAPA to share draft RFPs and model PPAs with the PSC and public stakeholders for review and comment before being issued to build market interest and public buy in. RFPs should include transparent scorecards for grading bids so that market participants understand how their applications will be judged

The process of reviewing and updating the QF process should take no more than six months, during which time the PSC should not approve any new qualifying facilities.

KAUAI ISLAND, HAWAII: A RENEWABLE ENERGY TRANSFORMATION

The USVI is not alone in its desire to transition to a greater use of renewables. Other islands are working to increase their use of renewables through new investments, financing mechanisms, and policy changes. Kauai, a part of the Hawaiian archipelago, is one of the most successful

examples in the U.S. On an average clear day, with its renewable projects performing as expected, the Kauai Island Utility Cooperative (KIUC), which provides power to the island, can turn off all but one of its diesel generators and rely on renewables to meet a typical daytime electrical demand of 55-65 MW and an evening peak load of 75 MW.

To achieve this outcome at the utility scale, KIUC primarily relied on PPAs to incorporate PV and battery storage into its generation mix. Storage plays an important role: its significant penetration allows KIUC to manage the intermittent power from solar sources and maintain constant power to the grid. All of the storage relies on lithium ion batteries for the moment, but the utility is also building a pumped hydro system, which will store energy by pumping water from a lower elevation to a higher elevation (when energy is needed, the water is released and turns several turbines as it falls to the lower elevation).

A large part of the transformation also happened on the customer side. Almost 10 percent of the utility's customers have installed PV systems, and customer-owned rooftop solar provides 26 percent of KIUC's total renewable assets. As customers primarily use these assets to supply their own power, power sold back to the grid from these systems makes up 4.5 percent of KIUC

sales. Unlocking the potential of and getting the economics right for distributed renewables required frequent updates to Kauai's rate and interconnection policies. KIUC is now focused on the next update to their tariff structure, which will incentivize distributed battery storage and enable the utility to purchase power from solar systems at times of peak demand in the evenings and early mornings, rather than during the midday when solar output is high but demand is low.

Grid management practices had to change, too: to operate the whole grid with a high penetration of renewables, including substantial distributed generation, KIUC implemented comprehensive control systems, installed smart meters, and updated its load schemes and interconnection requirements.

The transformation created a more resilient grid than before: KIUC has led the Hawaiian Islands in grid reliability over the past five years, attaining a 99.96 percent reliability rating. Costs improved as well: renewables, together with lower oil prices, internal cost controls, and customer-oriented energy efficiency, helped KIUC lower the average customer bill by 26 percent between 2013 and 2016 and keep rates flat, even as all other Hawaiian islands have seen rate increases.

Initiative 3

Replace aging fossil fuel generators with smaller, more efficient units

Currently, the majority of WAPA's fossil fuel assets are very large (more than 20 MW) and close to or beyond their stated lifespan. This makes it difficult for WAPA to efficiently operate these units and rapidly respond to changes in demand. WAPA's 2016 Integrated Resource Planning (IRP) called for the replacement of these generators with smaller, more efficient units.

WAPA will use federal funding to accelerate the transition described in the IRP and replace 57 MW of generation with new units in the next two years. On St. Thomas, WAPA is in the process of purchasing three new seven MW generators and is in negotiations for four additional nine MW units. On St. Croix, WAPA is leasing a 20 MW Aggreko power plant, which is made up of 18 separate approximately 1.1 MW units that will provide the utility with greater flexibility. Due to challenges with permitting at the Estate Richmond Power Plant, WAPA will likely not be able to add additional capacity to the St. Croix grid until 2021.

Beyond these immediate transactions, WAPA should hold off on any additional commitments until it can reevaluate demand and the pace at which renewables are brought onto the grid (see Initiative 7). If additional generation is needed on St. Thomas or St. Croix (and permitting challenges are addressed) during this interim period, WAPA should negotiate

contracts that provide it with the flexibility to downsize or cancel parts of an order as needed.

Initiative 4

Update WAPA's tariff structure to enable grid-tied distributed renewable generation

The amount of solar power that customers in the USVI can install on their properties while remaining connected to the grid is limited to 15 MW within the net metering program established in USVI Legislature's Act 7075 (10 MW for St. Thomas, St. John, and Water Island and five MW for St. Croix). This limit has been reached—and under current rules, any customers who want to install solar panels on their property would have to go off the grid. As batteries and solar become cheaper, an increasing number of residents will consider doing so—especially the more affluent, who can afford the initial investment more easily.

Such a situation is not sustainable. Without major changes in existing tariffs, customers will continue to leave the grid, and WAPA will be forced to raise rates on the remaining customers to cover its fixed costs. Identifying the appropriate rate structure to incentivize large customers is of particular concern: WAPA's 10 largest commercial customers made up nearly eight percent of overall electricity sales in Fiscal Year 2016, and at least one, Plaza East, has announced since the hurricanes that it is going off the grid.

Simply expanding net metering

is not a viable option: the policy pays those who participate in it full retail rates for electricity, which, considering the fixed costs of T&D, is not sustainable past a small initial amount of generation. Tariff reforms are required to ensure that new distributed generation can be added to the grid to benefit project developers, ratepayers, and WAPA in a way that is sustainable for the system overall. This includes the evaluation and creation of new tariff structures, including a Feed-in Tariff (FiT) and a Stand-By Tariff, as well as phasing out and replacing the existing net metering program. With the appropriate tariff structures in place, distributed renewable generation can lower energy costs and improve reliability for the grid and the individual customers who own these assets while providing WAPA with enough revenue to maintain the grid.

The Governor's Office will work with WAPA and the PSC to adopt new tariff structures before the end of 2018. The Governor's Office will also work with the USVI Legislature to enact legislation that replaces the current net metering policy in Act 7075 with one or more alternative tariffs that support the sustainable deployment of additional distributed generation. Specifically, the options could include:

- Stand-By Tariff—Targeted at systems over 500 kW, which are typically commercial or industrial customers. This is a special rate designed to collect only those costs imposed on the grid by a customer that self-supplies its own power but wants to rely on the grid for backup. WAPA included a Stand-By Tariff proposal in

its last general base rate case, which was not acted upon by the PSC. WAPA will develop a revised proposal and file it with the PSC for consideration. This should be coordinated with the self-generation tariff for smaller systems described below to ensure the two are aligned.

- **Feed-In Tariff (FiT)**—Targeted at systems between 10 and 500 kW, which are typically small commercial customers. A FiT is a policy that guarantees that customers who own an eligible renewable energy facility can receive a set price from the utility for all electricity they generate and deliver to the grid. In 2014, the Senate passed Act 7586 that authorized the establishment of a FiT for distributed generation systems between 10 kW and 500 kW. To date, the PSC has not acted on two separate proposals from WAPA to create such a charge. The PSC should complete the current open docket filed by WAPA in April 2017, ideally in parallel with an increase in the current cap on distributed renewable generation.
- **Self-Generation Tariff** – Targeted at small power users (systems under 10 kW), which are typically residential customers. As outlined above, the current net metering program has run its course. The Governor’s Office, in consultation with the VIEO Energy Roundtable and WAPA, will work with the Legislature to rewrite the net metering section of Act 7075. Revised legislation should enable the PSC to set a new MW cap for the program while altering the

pricing structure to better align incentives between customers and WAPA. Alternatives could include a “self-generation” tariff where customers are paid a rate lower than the retail electric rate for any excess solar generation that they produce and a “self-supply” tariff where customers are only permitted to sell solar power back to WAPA in prescribed situations. Moving forward, the PSC and WAPA should be engaged to jointly develop a new program cap, and the PSC should be authorized to revise this cap in the future without any legislative action. Much can be learned from the approach taken in Hawaii, where it took the Hawaii State Energy Office, the Hawaii Public Utilities Commission (PUC), and the Hawaiian Electric Company several attempts over the course of ten years to put in place an effective and sustainable tariff structure.

Beyond changing the tariff structure itself, it is also important to ensure that permitting, interconnection, and tracking policies and processes can manage the increase in renewable generation that will result. WAPA and DPNR will review these to ensure that they balance the need to be easy for customers with the need to protect the integrity of the grid. WAPA will also create clear guidelines for any customers who want to add renewable generation to their property outside of the net metering program.

Initiative 5

Establish St. John as a global model for energy sustainability and resilience

St. John’s power resilience needs are particularly urgent. The entire island was without utility power for 49 days after hurricane Irma, and customers in Coral Bay did not have power restored for 100 days. Given the challenges and opportunities on St. John, the island can serve as an accelerated test-bed for the territory’s broader energy vision, including utility-scale renewables, distributed rooftop solar PV, and hybrid microgrids.

To increase the resiliency of the St. John power grid in the event of generation, transmission, or distribution failures on St. Thomas, WAPA will build two

MICROGRIDS

Microgrids are subsections of larger energy grids that include distributed generation sources and transmission and distribution assets that can be disconnected and operate independently from the broader grid if parts of that grid fail (a practice known as “islanding”). Globally, more than 1,800 microgrid projects, totaling 19 gigawatt (GW) of capacity, are in operation or under development.¹³ Microgrids can be powered by a variety of energy sources.

¹³ Navigant Research, Microgrid Deployment Tracker, 4Q2017

Hybrid microgrids include a renewable generation source, battery storage, and fossil fuel generation. The combination of these three power sources takes advantage of the unique characteristics and timing of each source. Renewables provide power during peak supply times (the afternoon for sun and evenings for wind); batteries store and provide renewable energy during off peak times and help smooth supply; and fossil fuels provide power when renewables are not available and batteries are depleted.

Hybrid microgrids can help WAPA increase the reliability and resilience of the USVI's energy system. By distributing generation capacity throughout the territory and enabling individual communities to island themselves, WAPA can maintain power to large portions of a grid even after major hurricanes. Smaller scale microgrids can be particularly useful for providing continued power for critical facilities like hospitals or cell phone towers, even in the event of a system wide outage. Microgrids can also enable faster recovery from extreme events as portions of the grid can be brought online over time without requiring the full grid to be restored first.

hybrid microgrids in Cruz Bay and Coral Bay (see microgrid sidebar). These systems will include solar panels to provide power when the sun is shining, batteries to store energy and then provide it when the sun is not out, and diesel generators to provide emergency baseload power in the event that generation on St. Thomas is interrupted.

The microgrids will be able to meet St. John's peak demand, currently eight MW, and prevent the long-term outages experienced after Irma and Maria. Situating microgrids in Cruz Bay and Coral Bay will enable critical facilities on each side of the island to maintain power even if the power lines that connect the two communities along Centerline Road are damaged.

WAPA is in the process of scoping these microgrids to determine the land available for PV panels, the amount of solar energy that could be generated, and sizing of the batteries and diesel generators. This project will include between one and two MW of solar power. Pending approval of federal funding, the microgrids will be in operation in 2019.

In addition to the microgrids, WAPA will develop at least four to six MW of additional solar PV through utility scale projects and grid-tied distributed rooftop PV. This energy, combined with the solar energy from the hybrid microgrids, will create installed solar capacity equal to 100 percent of St. John's peak load.

To strengthen St. John's T&D network, the USVI has also applied for FEMA funding to

install 1,210 composite poles across Centerline Road and underground distribution lines in Cruz Bay up to the Myrah Keating Health Clinic. This will improve reliability for over 5,000 customers. WAPA will also move large overhead transformer banks from poles to pad-mounted banks.

These projects will enable the island to operate independently from St. Thomas in the event of an emergency and establish the island as a global model of sustainability and resilience.

Initiative 6

Expand energy efficiency programs

The cheapest power projects are those that prevent energy from being used in the first place. Estimates from around the Caribbean suggest that the cost of each kWh saved through energy efficiency programs ranges between 5-10 ¢/kWh. This is substantially below WAPA's current average cost to produce power of 16 ¢/kWh and is competitive with the cost of producing power through renewable resources. As a result, energy efficiency should be evaluated and included as the "first-in" resource in WAPA's Integrated Resource Plan (see Initiative 7).¹⁴ Research from NREL in 2011 suggests that energy efficiency strategies could help the typical USVI household reduce its energy consumption by at least 25 percent. Similarly, NREL's analysis suggested that USVI government and commercial

¹⁴ Massachusetts, California and many other U.S. states have energy policies that require that energy efficiency be considered the "first-in" resource in a utility's integrated resource planning because it is the cheapest resource available.

buildings could reduce energy use by 15-25 percent by addressing inefficient lighting and Heating, Ventilation and Air Conditioning (HVAC) systems.

The VIEO and WAPA's VIEnergize program both provide some mechanisms to help customers fund energy efficiency improvements. The USVI Energy Office runs the Sun Power Loan Fund, which provides loans to finance solar hot water heaters and has multiple rebate programs for Energy Star appliances. WAPA created VIEnergize to assist customers in energy efficiency; however, it has not yet been developed into a holistic program. The Energy Office and VIEnergize will develop a coordinated energy efficiency program that takes advantage of the resources and expertise of both offices and maximizes uptake and impact for customers.

In the long term, VIEnergize should administer most of the USVI's energy efficiency programs. This will allow the VIEO to focus on policy development and tracking the overall implementation of the Governor's energy agenda. In the mainland U.S., a third party administrator, or TPA, often manages these programs. These TPAs bring specialized expertise in energy efficiency programs and can help fill capacity gaps at smaller utilities. WAPA should evaluate its current capacity and consider hiring a TPA to design and/or administer its energy efficiency portfolio.

Initiative 7

Explore new funding mechanism for energy efficiency

Increasing the uptake of energy efficiency programs often requires significant financial resources. WAPA will work with the PSC to explore the adoption of funding mechanisms that enable it to invest in energy efficiency programs. Most U.S. utilities finance energy efficiency through a special "system benefit" charge. Under this model, utilities add a small charge to energy bills (typically between 0.2-0.4 ¢/kWh) that generates revenue that is redirected back to customers through energy efficiency programs. Even a charge as small as 0.2 ¢/kWh, which would cost the average USVI resident \$9 per year, would generate \$1.25 million annually for energy efficiency programs. Regulatory rules should require that the system benefits, including energy bill savings to customers, are greater than the costs of the program. Other jurisdictions include a range of services within a system benefit charge, including funding for distributed generation.

Other strategies for promoting energy efficiency include a Lost Revenue Adjustment Mechanism, where a utility can recover the revenue that it lost as a result of its energy efficiency programs, and decoupling, where the utility's approved rate of return is decoupled from energy sales. Both rate reforms eliminate the utility's financial disincentive from promoting a reduction in energy demand. This structure incentivizes utilities to invest in lowering customer demand without compromising their ability to recover their fixed costs.

Initiative 8

Strengthen building code compliance

The USVI has a history of adopting strong building codes that include requirements for high levels of energy efficiency. However, enforcement of these building codes is relatively weak. FEMA has launched a program to hire and train 10 new building inspectors across the Territory. DPNR will ensure that these inspectors are trained on the USVI electric code to ensure its enforcement.

At the same time, the GVI must lead by example. The reconstruction effort presents a great opportunity to do this. All public buildings should be built to comply with the latest USVI energy code and include high efficiency building systems, as cost effective. This cuts across a number of sectors, including education, healthcare, public housing, and any other government buildings.

MODERNIZE THE GRID

WAPA has made intermittent, but impactful, efforts to update the electric grid to keep pace with new technology. This includes the installation of Advanced Metering Infrastructure (AMI) to monitor customer energy usage and of Supervisory Control and Data Acquisition (SCADA) systems that enable different parts of the grid to communicate with each other.

This data provides a comprehensive platform to

improve supply-side and demand side energy efficiency. On the demand side, smart meters installed through the AMI system provide comprehensive data on customer power usage. This allows customers to take more informed steps to reduce their power consumption and WAPA to provide the customers with personalized energy efficiency programs. On the supply side, AMI and SCADA help increase the operational efficiency of the system and ensure that energy consumption is appropriately billed to customers. That is important because, of the total power that WAPA generates, it loses five percent on St. Thomas and nine percent on St. Croix in the process of delivering that power to customers.

While AMI and SCADA have been deployed by WAPA, they have not been fully installed and optimized to date.

Initiative 9

Accelerate the deployment of advanced control systems

WAPA will accelerate the deployment of advanced control systems to improve reliability and enhance energy efficiency and distributed generation. This work will primarily occur through the repair and expansion of WAPA's current SCADA and AMI systems.

On the demand side, WAPA will replace meters that were damaged by hurricanes Irma and Maria and finish installing meters in locations that did not have them before the storms. Building on the data provided by the AMI system,

WAPA will launch a customer portal that will allow residents to see details about their energy consumption (e.g., time and sources) in comparison to similar customers. The full restoration of smart meters and the expansion of the customer portal will allow WAPA to share personalized energy efficiency programs with customers to enable them to lower their bills while helping WAPA avoid additional capital investments.

In addition, WAPA will also explore expanding their program for load management devices. These devices allow customers to reduce energy consumption remotely (for example, by turning on the air conditioner five minutes before a resident arrives home rather than leaving it on all day). If customers are interested, they can also allow WAPA to connect to these devices so that WAPA can reduce their energy consumption during peak times to reduce stress on the grid.

On the supply side, WAPA will collaborate with Virgin Islands Next Generation Network (viNGN) and FEMA to expand the current fiber and mesh wireless information to improve WAPA's insight into the feeder system to reduce line losses. In addition, WAPA will rely on both AMI and SCADA capabilities to enable an e-mapping analysis to identify opportunities to reduce supply side losses. Due to dramatic changes in the grid infrastructure, the additions of new distributed renewable systems, and changes in population, WAPA should reassess the needs on each feeder.

The expansion of both the AMI and SCADA systems will enable WAPA operate the grid more effectively. These investments are

necessary to fully leverage new technologies and grid designs such as distributed generation and hybrid microgrids that WAPA is planning.

FORTIFY INFRASTRUCTURE AGAINST CLIMATE RISKS

The USVI energy system is particularly vulnerable to extreme weather events. The recovery effort provides a unique opportunity to harden the entire system against future storms as well as from chronic stressors related to climate change (e.g., sea level rise). Because it is not economically feasible to build a system that is completely resistant to damage from these risks, the USVI must focus on strategies that reduce risk, enable faster response, and increase the flexibility of the system. WAPA has incorporated many actions to reinforce its generation, transmission and distribution assets into the rebuilding process. It will continue to identify additional actions to harden the system as the recovery effort moves forward.

Initiative 10

Reinforce all generation, transmission and distribution assets

Hurricanes Irma and Maria exposed the extreme vulnerability of WAPA's system to hurricanes. High winds blew over numerous power lines, utility poles collapsed

under the weight of winds and falling tree branches, and substations and power plants experienced flooding. It is not financially feasible to harden all of the USVI's energy infrastructure to withstand the strongest possible storms, but it is certainly possible to identify projects that reduce risk at a cost that is acceptable.

To date, WAPA has submitted more than \$520 million in projects to FEMA as part of the agency's Hazard Mitigation program and is already executing many of these projects. Approximately \$400 million of this request is for undergrounding transmission and distribution lines in critical locations. WAPA has also submitted approximately \$100 million in funding requests to add composite poles in critical locations on St. Croix, St. John, St. Thomas, and Water Island. The remaining projects include improvements to substations (East End, Tutu and Donald Francois), replacing pole-mounted transformers with pad-mounted transformers, installing a submarine cable from Harley to the East End substation on St. Thomas to provide additional redundancy, and installing emergency generation on St. John. All the new poles that are being installed in the territory as part of these efforts will be installed deeper into the ground to provide extra strength.

Initiative 11

Update design and construction standards

Given the variety of challenges facing the utility in recent

years, WAPA has not had the capacity to update its design and construction standards to industry standards. WAPA will work with FEMA and industry associations to update its design and construction standards to better withstand extreme weather events. For renewable assets, WAPA will ensure that privately-owned utility scale renewables are built to the updated standards. DPNR will incorporate up-to-date standards for rooftop PV to reduce the potential damage caused by future storms. Some of these standards will be laid out by FEMA's Recovery Advisory Report on Rooftop Solar Panel Attachment: Design, Installation and Maintenance. WAPA can use these materials as a starting point for its efforts. In addition, WAPA will either incorporate sea level rise projections into its planning and design processes to ensure new facilities are built out of flood zones or incorporate features that reduce future flood risks.

STRENGTHEN ENERGY PLANNING AND GOVERNANCE STRUCTURES

Infrastructure investments can improve the reliability and resilience of the USVI energy system and help lower rates; however, there are a number of significant financial and regulatory issues that must be addressed to maximize these impacts. These changes cut across all aspects of the system, including operations, governance, and workforce capacity. Specifically, WAPA must review its overall operations and financial planning to reduce its costs and

more efficiently operate its assets. The overall energy governance structure must be realigned to increase accountability and better reflect industry best practices in other markets. Finally, workforce development must be enhanced to ensure that there is a local workforce capable of executing the vision outlined in this report, and that USVI residents benefit from the influx of investment coming to the territory.

Initiative 12

Update WAPA's Integrated Resource Plan

WAPA's Integrated Resource Planning (IRP) process guides its capital plans for the next several years. Since the publication of the Territory's first IRP in 2016, technology has rapidly evolved, especially with respect to battery storage. The current IRP does not appropriately incorporate these advances; nor does it include a strong focus on energy efficiency and demand response as strategies for avoiding future capital investments. Additionally, peak demand estimates in the IRP need to be updated to reflect the impacts of the hurricanes, increased deployment of distributed renewables, and rising grid defections.

WAPA will launch an accelerated update to its IRP to develop a new demand forecast, an updated plan for capital investments, and an assessment of the technical, economic, and achievable potential of energy efficiency and demand response as resources. The utility will also execute a grid stability analysis to understand

which feeders can operate with additional distributed renewable generation capacity (and how much of it) and which, if any, feeders need to be updated to handle additional renewable capacity. This analysis will be completed by the end of the year.

In the future, WAPA should be required to update its IRP at least every four years, with clear guidelines as to what information should be included in the study.

Initiative 13

Update and strengthen maintenance policies and procedures

Maintenance standards are critical to ensure that utility infrastructure operates at maximum efficiency for the full lifetime of technology and is resilient to damage from climate risks. These standards need to be updated to reflect the damage caused by the storms: in just one example, some of the damage to power lines could have been avoided by better trimming nearby trees.

WAPA will review and update its maintenance policies and procedures and allocate enough staff to carry them out. The utility already plans to cross-train line crews to enable them to manage vegetation in addition to addressing electrical issues. Proactive maintenance can greatly enhance the resilience of WAPA's system and help lower ongoing operating costs.

Initiative 14

Revise WAPA's emergency plan

Not all damage can be anticipated or prevented. A comprehensive emergency plan is critical to enabling a rapid, coordinated, and successful recovery effort. WAPA will update its emergency plan and operating procedures to incorporate lessons learned from the 2017 hurricanes. This should include a prioritized list of critical facilities to be repowered in any future outages and their distributed or backup generation capacity.

Initiative 15

Restructure financial commitments as needed to improve WAPA's fiscal solvency

As previously mentioned, WAPA is facing a substantial decline in revenues, substantial unpaid receivables, a large outstanding debt burden, and a low credit rating. This multi-faceted challenge jeopardizes the utility's financial health. In the short term, WAPA will focus on deploying federal funding to provide much-needed new generation capacity and reduce ongoing operation costs. Once WAPA has spent the available federal funding and taken advantage of federal low cost financing, the utility will review its debt burden and identify any opportunities to restructure or reduce its long-term commitments to improve its fiscal health.

Initiative 16

Realign energy governance structure

The USVI's energy sector has a unique governing structure that inhibits innovation. Typically, public utilities like WAPA are either wholly governed by an independent board or are directly managed by a government agency. Investor owned utilities are regulated by Public Service Commissions, which oversee all utility investments that will be recovered in customer rates. There also are a few exceptions (Indiana, Maine, Maryland, Rhode Island, Vermont and Wisconsin), where PSCs regulate utility rates for public utilities instead.

WAPA is caught between these two structures, as it has both an independent board and a PSC. The Board of Directors is appointed by the Governor; it has fiduciary responsibility for the utility but lacks ratemaking authority. The PSC's seven voting members are appointed by the Governor as well (with two additional non-voting members appointed by the Legislature); it has the authority to approve or reject changes to WAPA's rates and to grant QF status to project developers but no other oversight over the utility. Both the PSC and the WAPA governing board lack the authority and capacity to fully and ably execute their respective oversight roles over WAPA. The result has been a fraught relationship where disagreements are brought to court rather than resolved through the regulatory process, and where a lack of agreement on roles and responsibilities prevents the actions needed to drive down rates, increase resilience, and

improve the financial health of the utility.

To allow WAPA to function as well as it can, both the Board and the PSC must have clear and distinct roles and responsibilities that are mutually respected. The Governor's VIEO could play a role, too: in many U.S. states, such offices play a prominent role overseeing and managing energy policy for the state. In New York, for example, the Governor's Chairman of Energy and Finance is responsible for overseeing multiple government departments and bodies to ensure they are all advancing the Governor's priorities. While its work on energy efficiency and running the Energy Roundtable are important, the VIEO is not empowered to hold other government departments accountable.

The Governor's Office will work with WAPA, the PSC, and the Legislature to enact governance reforms to improve the oversight and health of WAPA. These reforms may include a variety of changes in the structure and oversight of the WAPA Board and of the PSC, but must give one or both of these groups the clear authority and capacity to oversee WAPA.

To elevate the regulatory role of the PSC, its powers should be expanded so that it can provide stronger oversight over the utility, in parallel with changes to professionalize the body and ensure any contracts that the PSC signs with consultants are competitively procured. To empower the WAPA Board, its capacity and composition should also be reformed to ensure appropriate utility expertise and provide it with funding to access technical experts as needed.

In the near term, the Governor should assign a working group of WAPA and PSC staff members to develop specific recommendations for reform by the end of 2018. This working group should engage third party technical support, such as the National Association of Regulated Utility Commissioners (NARUC), the American Public Power Association (APPA) and/or the Regulatory Assistance Project (RAP), to bring appropriate industry expertise to bear on utility governance and regulatory oversight.

The Governor's Office will also explore ways to reconstitute, empower and appropriately staff the USVI Energy Office. The VIEO should lead implementation of a subset of the recommendations outlined in this report, track and publically report on the USVI's progress towards its overall energy strategy and act as the Governor's primary advisor on energy issues.

Initiative 17

Support workforce development

Transforming the USVI's energy sector will require new jobs, knowledge, and skills. The short-term influx of capital and technical expertise will help launch this transition, but without a robust workforce development program the USVI risks having 21st century infrastructure without a 21st century workforce to maintain it. Critical needs in the Territory include energy auditors to evaluate energy use in buildings, contractors to execute energy efficiency projects, solar installers to meet the increasing

demand for solar panels, construction workers to build wind farms, and utility workers to manage and maintain an increasingly complex grid.

Some of these needs can be met with the existing workforce. WAPA will expand its internal training capacity to ensure that its workers are able to operate and maintain new infrastructure, including expanded underground facilities, new composite poles, new high efficiency generators and renewable assets. FEMA, in turn, has provided a variety of resources through the Recovery Advisory Reports to inform architects, engineers, and contractors about building more resilient and energy efficient homes up to the current building code and appropriately installing rooftop equipment, including solar panels.

Other needs will require the training of new workers. To prepare the next energy leaders for the territory, the University of the Virgin Islands (UVI) will expand current programs on renewable energy and energy efficiency in collaboration with WAPA. Currently, UVI is developing a net-zero energy home (a home which generates as much energy as it consumes) to use as a hands-on example of energy efficiency and renewable energy strategies. Beyond that, UVI is considering developing a certificate or elective courses on energy efficiency and renewable energy to expand knowledge on island. In addition, WAPA will explore the feasibility of creating an apprenticeship program with the USVI high schools to build skills for key roles and attract young talent to WAPA.

The overall potential for job creation as a result of the energy transformation is substantial: while slightly outdated, a 2012 report estimated that meeting the USVI's goal of a 60 percent reduction in fossil fuels by 2025 would create 800 jobs in that timeframe, equivalent to 2,000 "job-years"¹⁵ (for context, total formal civilian employment in all of the USVI stands at around 40,000). Nationally, a study by the National Association of State Energy Officials and the Energy Futures Initiative noted that jobs in energy efficiency alone represented half the total growth of jobs in the energy sector in 2017. In addition, within energy production, the solar industry employs more American workers than coal, nuclear, and wind industries combined and employs slightly fewer than the natural gas industry, where the jobs are primarily in fuel production.

¹⁵ A job year is one full-time job for the period of one year. For example, 10 job years can represent 10 jobs that last for one year, five jobs that last for two years, or two jobs that last for five years etc.

COMMUNICATIONS: PRIVATE SECTOR

Private telecommunications services in the Territory include landline telephone, cellular (mobile) phone, Internet, and broadcast systems and services. They are a crucial part of daily life everywhere in the world but even more so on an island territory like the USVI where physical distance from other locations make communications all the more important.

The infrastructure that makes these services possible is highly complex. It includes cables, fiber optics, and radios that transmit information. It includes computer switching systems that direct that information where it needs to go, often relying on off-island interconnections back to the mainland. It includes towers and poles to carry antennas and air conditioning systems to keep equipment cool. It also includes high quality power supplies and emergency backup power to keep the systems running during power outages.



The hurricane winds damaged or destroyed large parts of this infrastructure, especially the portions of the communications networks that were above ground, including exposed aerial cables mounted to wooden poles, and antenna systems attached to communications towers and the towers themselves. Buried cables did not suffer significant damage, but restoration work sometimes caused damage afterwards when cables were accidentally cut. The commercial power outages caused by the storm damage were a problem as well. While many communications sites had on-site emergency generators, the wide impact area and loss of commercial power over the course of 3+ months led to the failure of many generators as a result of long-term overuse. When generators failed, the sites that they supported went with them.

Once systems began to fail, the people of the USVI had no backup options. As a result, they could not access essential services like 9-1-1, contact loved ones, or check on and report conditions during and after the hurricanes. Commerce throughout the Territory was severely diminished, as consumers were unable to make credit and debit card transactions or ATM withdrawals to purchase necessary food, water, and supplies. Some islands were affected more than others; the island of St. John was hit particularly hard and had little connectivity in the weeks immediately after the storm.

Response activities to the destruction varied widely by company. Locally based companies were able to begin immediate assessment of damages, as were some companies

based off-island that had pre-staged personnel and equipment to facilitate a quick response. Other companies were slow to deliver personnel and resources to assess or begin repair activities. The companies that were better prepared were generally able to achieve initial restoration within a few days or weeks of beginning work, but even the best-prepared companies suffered delayed repair activities as a result of the remoteness of the islands, as well as customs and territorial taxation laws, which have no provisions for emergency waivers for recovery efforts.

As the Territory looks to prepare for the next storm and upgrade the existing telecommunication infrastructure, the strategies that will help make the communication system more resilient include hardening the system infrastructure, better preparing facilities for extended power outages, and making legislative and regulatory changes that support and encourage telecommunications resilience, including using existing regulatory authority of the USVI Public Service Commission (PSC) to ensure that private carriers are taking the necessary measures to prevent a repeat of the kinds of outages that the USVI experienced after Irma and Maria. No system will ever be completely failure-proof in the face of major natural disasters, but with these measures implemented, the USVI telecommunications system will suffer less damage and recover more quickly from future events.

HOW THE COMMUNICATIONS SYSTEM WORKS

The private sector communications system is broken into six sections: landline telephone services, wireless (cellular) network, cable television, broadcast radio and television, Internet service providers (ISPs), and off-shore international cable landing stations. All of these sections depend on power to operate.

Landline telephone services

Viya is the sole company to provide landline telephone services in the USVI as the incumbent local exchange carrier (ILEC). The Viya network of “wired” facilities is comprised of copper, coaxial cable, fiber

optic cables (Hybrid-Fiber-Coax or HFC), computer switching systems, and basic physical infrastructure (poles, generators, batteries, HVAC, etc.). These facilities provide traditional plain old telephone services (POTS), as well as Internet data connections. Most of these HFC facilities are buried; most of the copper cables—at least before the hurricanes—were aerial and attached to wooden Virgin Islands Water and Power Authority (WAPA) poles.

Wireless (cellular) network

There are five wireless carriers that offer service in the USVI: AT&T, PR Wireless (formerly Sprint), Viya, Verizon, and T-Mobile. Three carriers—AT&T, PR Wireless, and Viya—have physical assets in the territory. Two carriers—Verizon and T-Mobile—do not have physical assets on island and therefore lease service from companies that do have physical assets, including the three companies above.



Aerial cables attached to WAPA poles

The infrastructure on which the networks depend the most are communication towers. There are 51 total tower locations across the USVI (not including wooden poles or equipment installed atop buildings): 20 on St. Thomas, six on St. John, and 25 on St. Croix. Some of these locations host multiple towers. The towers are mainly of two types: free standing (or self-supporting) lattice towers and monopole towers. Free standing towers have either three or four sides; monopole towers consist of a single tube with antennas mounted to the exterior. Both tower types can perform well during hurricanes, but monopole designs tend to be more resilient. Most of the communications towers on the islands are free standing. The companies that offer wireless service own very few of these towers; they are mostly owned, maintained, and operated by specialist companies. These companies (two major operators are SBA Towers and Crown Castle) earn revenue by leasing space on their towers and, for some customers, providing services like power and generators. The tower



Free standing tower; Source: Dick Price

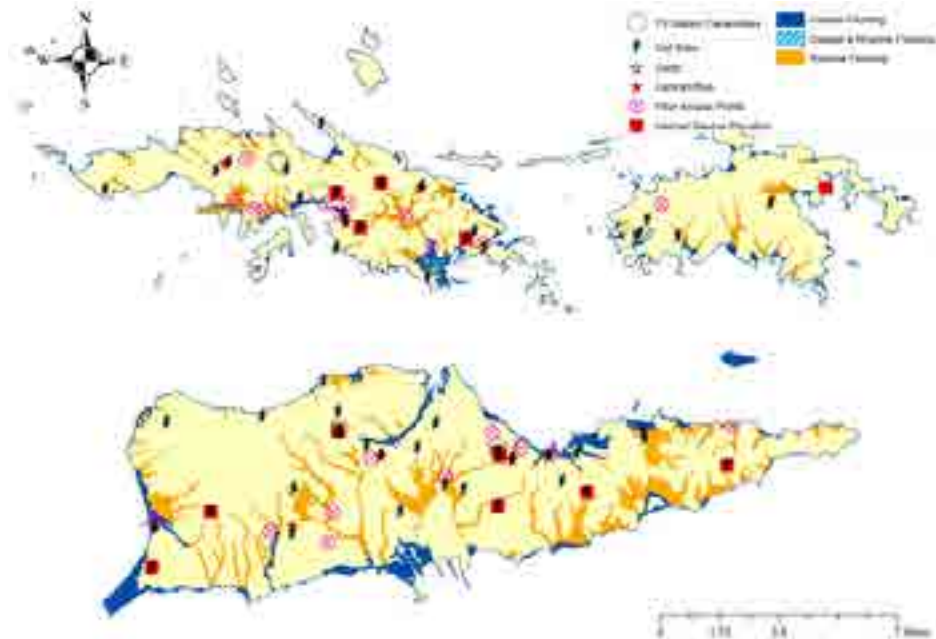


Monopole tower; Source: Dick Price

companies do not operate their own radios, antennas, or other broadcasting equipment.

Other infrastructure on which the wireless network depends includes antennas mounted to towers, microwave radio or fiber backhaul, and switching centers, all working together to

transmit information. Antennas communicate with users, then the signal is sent from the towers to a switching center (either on or off-island) to process the calls through what is called the backhaul, which is either a microwave radio or a fiber optic connection that can carry large amounts of data. Fiber connections can carry more data than microwave radios and are therefore preferred; those are owned either by the landline provider, Viya, or the middle mile fiber provider, viNGN (see Public Telecommunications chapter for details on viNGN; see graphic: [The workings of a wireless network](#)).



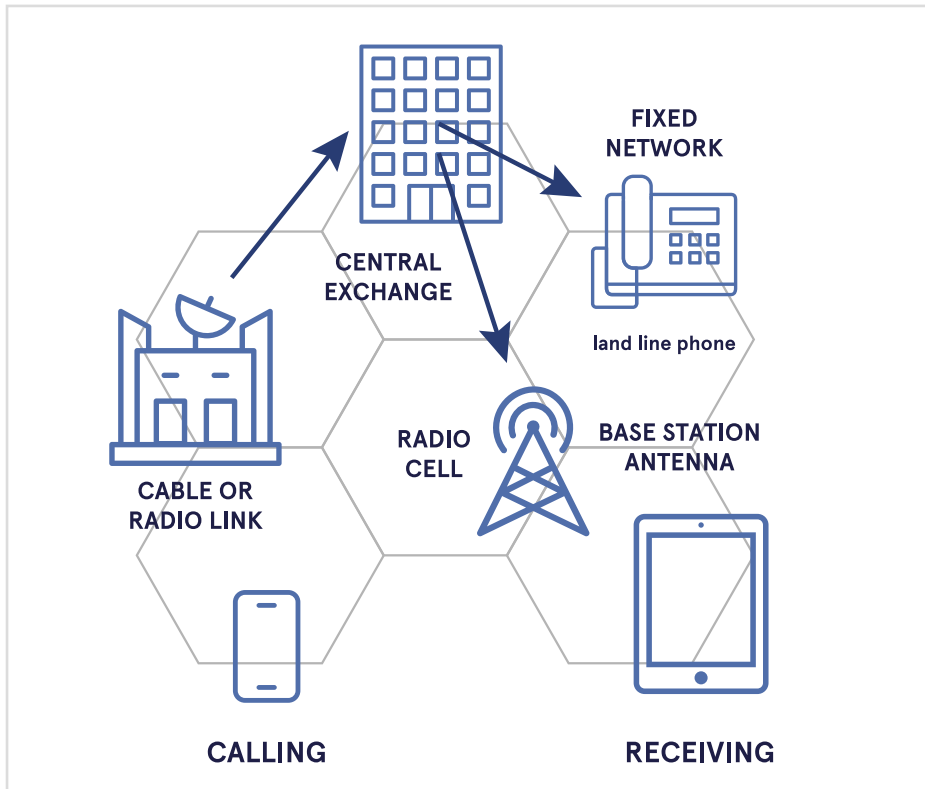
Map of USVI Telecommunication Assets



Internet Service Providers (ISPs)

Multiple ISPs offer their services to customers in the Territory. These services depend on three types of connections: backbone, which is the high-capacity fiber

(or trunk line) that carries massive amounts of data for local or regional exchange, middle mile, which connect the backbone to the ISPs' or telecommunications providers' core network or telecommunications exchange, and last mile, which delivers the data connection to customers' homes and businesses. Last mile connections rely either on HFC facilities (provided by Viya) or fiber (provided by viNGN), or on short distance unlicensed radios.



The workings of a wireless network

Cable television

Viya is the sole cable television provider in the USVI. Video content is delivered to the islands via satellite receivers/antennas (mounted on broadcast towers) as well as undersea fiber cables.

The last mile HFC cable facilities deliver content to users; before the hurricanes, those cables were attached to WAPA poles. Broadcast towers are structured differently and are larger than wireless communications towers, as they must be able to support the significant weight of mounted radio and satellite radio equipment.

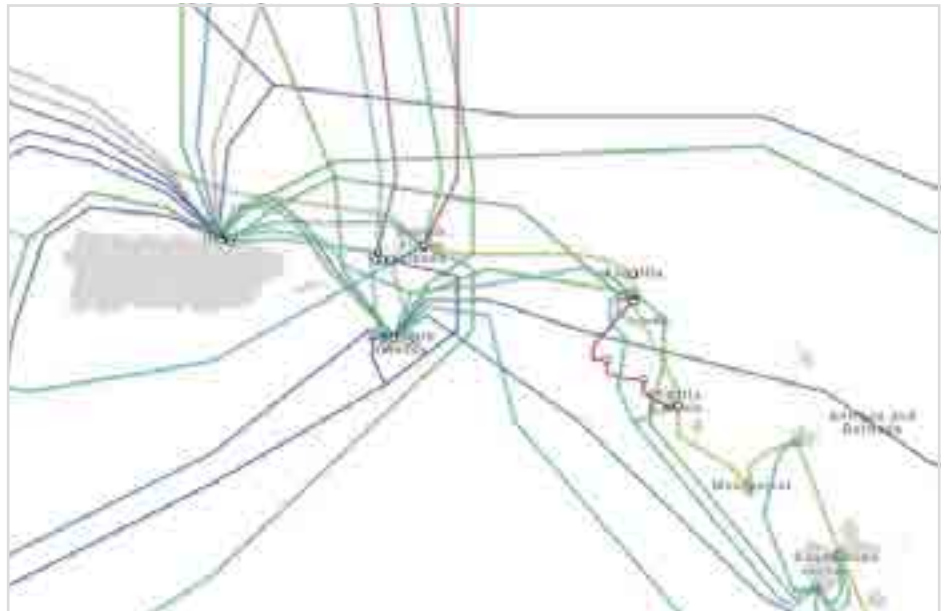
Broadcast: radio and television

The U.S. Virgin Islands are home to several privately owned broadcast radio stations on both AM and FM bands. The radio and TV stations

receive content either via the Internet or satellite receivers in their studios and then use copper or fiber wired facilities to send that content to transmitters on towers that are either leased or owned. The transmitters send the signal to listeners and viewers.

Off-Shore (Submarine) International Cable Landing Stations

The USVI depends on international submarine cables



Submarine cable connections in the vicinity of the USVI
Source: www.submarinecablemap.com

Company	Landline Telephone	Wireless/ Cellular Network	Cable Television	Broadcast TV & Radio	Internet Service Providers	Cable Landing Stations
AT&T		X				X
PR Wireless		X				
Verizon		Contracted				
Viya	X	X	X		X	
CenturyLink						X
T-Mobile		Contracted				
SmartNet					X	
BBVI					X	

Areas of activity of selected telecommunication companies operating in the USVI

for sending data off-island. These cables come into several cable landing stations on St. Croix and on St. Thomas. Satellite connections are also available, but because submarine cables have far greater capacity, they carry roughly 99 percent of all data traffic, including Internet, phone calls, and text messages, from the USVI to the rest of the world (see map: [Submarine cable connections in the vicinity of the USVI](#)).

Power supplies

All of the equipment that supports telecommunications networks in the USVI relies on commercial power provided by WAPA. Most facilities, including towers and on-island switching centers, are equipped with backup power sources (batteries, generators, or a combination of both), however, these backups are typically only intended to provide power for up to 96-120 hours.

Funding sources

All private telecommunications companies generate revenue from user-paid services. Privately owned broadcast companies generate revenue from advertising sales. Off-shore international cable landing stations companies receive some funding from joint ownership of cables by the communications companies and generate revenue from user subscription fees for their services.

Regulation

Communications companies, when they are regulated, are regulated either at the federal level by the Federal Communications Commission (FCC) or the Federal Aviation Administration (FAA, towers only), or at the territorial level by the Virgin Islands Public Service Commission (PSC).

The FCC regulates all cellular companies, ISPs, international cable landing stations, and broadcast radio and TV stations.

The FAA regulates tower companies with towers over 200 feet above the ground (by requiring them to be registered in the Antenna Structure Registration (ASR) database; tower companies are not otherwise regulated except for the requirements to meet local permitting, including building codes). The PSC regulates Quality of Service for landline telephone and cable companies and also provides local rate regulation for the landline company, Viya. The PSC has not historically regulated the operations of wireless carriers or ISPs.

At the federal level, the extent of the regulation does not include the ability to require certain levels of availability or performance; nor does it include any sanctions for, for instance, failing to restore service in a reasonable time after an adverse event (as would generally be the case in more heavily regulated industries like electric utilities). The logic of the current regulatory framework (or absence thereof) is that the risk of user defection to competitors (made easier, in the case of

wireless services, by number portability regulations) will force companies to pay attention to the quality of their service without explicit legal requirements to do so.

For a territory like the USVI, such a regulatory structure can create problems: for the national players present the market in the Territory is small compared to their markets elsewhere in the U.S., and the incentive to pay attention to this market's problems may be small as well. That said, the Legislature of the Virgin Islands does have the ability to approve or deny business presence in the islands under Title 30 §45a of U.S. Virgin Islands Code, which establishes the customer service criteria for "eligible telecommunications carriers" and gives the PSC limited oversight jurisdiction over all communications companies operating in the Territory. A relevant key criterion for gaining eligible carrier status in the USVI is a demonstrated ability to remain functional in emergencies (see sidebar: [Public Service Commission's regulatory authority](#)).

IMPACT OF THE HURRICANES

The 2017 hurricanes damaged all parts of privately owned communications networks, including landline telephones, cable television, Internet, cellular networks, and undersea cable landing stations. The storms also significantly impaired broadcast radio and TV networks, although the extent of the damage to

these networks is not yet fully understood.

Common Challenges

The far-ranging outages affecting private sector systems included collapse of transmission towers, destruction of antennas/radios on towers, failure of backup power systems, physical damage to communications shelters, and loss of equipment as a result of water damage and power failure. Extensive island-wide power outages lasted over three months, leading to the failure of emergency backup generators. These backups included both permanently installed and mobile generators, many of which failed because they are not designed to meet the demand of running continuously for extended periods. The challenge of obtaining sufficient fuel for generators over the extended time period also resulted in failure of site communications.

Companies varied widely in their response to the hurricane damage. Personal losses of local personnel employed by smaller companies slowed company response time. The logistical difficulties of transporting replacement equipment and accommodating temporary staff from the mainland meant companies reliant on off-island support were also slower to respond. Larger companies that employ primarily local personnel and house significant equipment on the islands were able to start the assessment and recovery efforts as soon as it was safe to begin.

Response was better and service impact was less in

those companies that followed proper pre-landfall procedures such as filling generator fuel tanks, staging spare equipment, accounting for personnel resources, and placing backup crews on standby. After the storms hit, restoration challenges included obtaining equipment and supply shipments (including by obtaining a high priority level for these shipments compared to other sectors), as well as securing transportation and housing for off-island support personnel.

Landline Telephone Network

The landline copper network suffered major damage because its cables were attached to utility poles above ground. That damage, however, caused minimal customer impact, as few customers still relied on the older infrastructure. The newer fiber network suffered less damage: a large percentage of it that provided main trunk line switchboard services (as well as transferring cable and Internet data) was buried and therefore better protected. However, last mile fiber service to residential and business communities was delivered largely via aerial fiber assets, which were damaged the same as copper cables were. Some fiber equipment was also damaged by falling trees and flooding. Main trunk lines could be restored rather easily once power was reestablished, but the copper cables will be abandoned and salvaged for scrap and replaced with buried fiber cables where possible.

Power outages did not pose a significant issue for the POTS central switching office locations,

as these were engineered with high capacity batteries and redundant generation facilities. Commercial power outages did cause major issues for remote locations, as their site generators are not designed to run for long periods. However, in some cases, a user could continue receiving service if the switching location that normally serves them was down but a central site was still on-line, powered, and functional, and their part of the network was designed in such a way as to make a connection to another location available.

The result of damage was either the degradation of, or total loss of traditional landline phone service. Unless the impacted customers had cellular phones with service or a working Internet connection with VoIP calling capabilities, their ability to make emergency 9-1-1 calls was at best severely hampered and at worst nonexistent.

Viya's response to the post-storm impacts was relatively quick, as the company had preplanned and staged personnel and equipment for quick post-storm assessments and initial restoration work. However, there were delays related to the fact that aerial cable restoration could only begin once WAPA replaced damaged utility poles—which meant that this work did not start until December 2017.

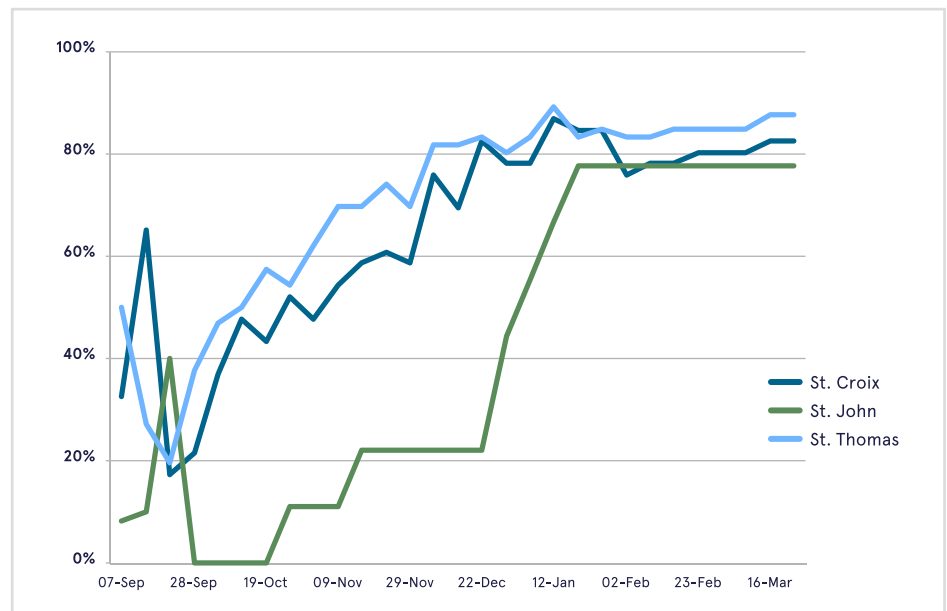
Wireless (Cellular) Network

All wireless carriers suffered damage, although the degree of impact varied by company depending on the locations of towers that carried their radios/antennas. The impact included either partial or total collapse of radio towers, misaligned antennas, and backup generator failure. Among the two different tower structure types (monopole vs. freestanding), the monopole design towers emerged as the least prone to suffer failure of the supporting structure. Like the freestanding ones, even those towers experienced damage to mounted radios and antennas. The freestanding towers generally fared well, but several did collapse entirely. None of the existing towers were supported by guy wires (tensioned cables to provide support); if they had been, their ability to resist high winds might have been greater. The damage to both tower types caused around 80 percent of cell sites on St. Thomas and St. Croix and 100

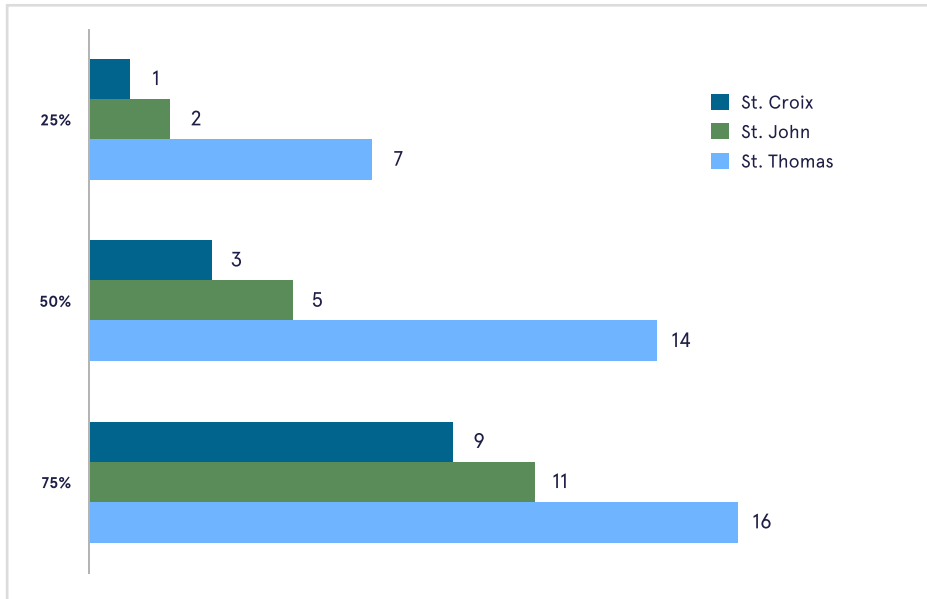
percent of cell sites on St. John to lose service immediately after the hurricanes. It was only by mid-October that the two bigger islands approached 50 percent recovery and St. John got its first cell site working again (see chart: [Cell site status by island](#)).

As a result of the physical damage, customers lost data communications (file and picture transfer, web searches, downloads of data and files), had their calls dropped, or could not place, send, or receive calls and text messages. During and immediately after the storms, people could not call 9-1-1 unless they had a secondary working method for making calls, such as landline or Internet calling. In the weeks following the storms, the poor state of communications limited people's access to FEMA and other recovery and relief aid information.

The restoration of service took several months. St. John in particular suffered a complete system outage and took the longest to recover, only reaching



Cell site status by island; September 2017 - March 2018
Source: FCC



Time (in weeks) from the moment of lowest service availability to reach a given level of active cell sites, by island; in weeks; Source: FCC

75 percent cell site restoration by mid-January and was 16 weeks after the point of lowest service availability, and well behind the other two islands (see chart: [Time to reach a given level of service restoration, by island](#)).

Where towers failed, repairs ranged from adjustments to antennas blown off alignment to the deployment of temporary tower trailers in order to provide interim services until failed towers could be either rebuilt or replaced. Where towers survived the winds, microwave radio and fiber backhaul communication links often did not; those had to be restored, usually relatively quickly, using small satellite earth station links or point-to-point radio links to make connections until the microwave/ fiber lines could be reinstalled. On St. John, philanthropy-funded groups organized temporary communications sites that allowed restoration of some Internet

and voice services until the commercial carriers could resume normal operations.

At all tower locations, power was an issue that set restoration efforts back even many weeks after the storm. Loss of power was not initially a problem as all sites had existing backup generators that turned on automatically to keep the sites running. However, those generators were not designed to operate for the extended period of the commercial power outages and often failed after a lengthy run time. Repair work was complicated by the need to bring repair personnel from off island—even the companies that have physical assets on the islands only maintain a small number of on-island personnel in non-emergency times. The time that it took companies to bring off-island staff ranged from days to weeks, in part due to limited airline service. Cellular companies without physical assets on the islands were

generally at the mercy of their on-island, contracted partners for service restoration, with varying results.

As of March 19, 2018, the FCC reported that 86 percent of cell sites were operational in the USVI; however, many of the networks were still operating with limited data capabilities because of the lack of fiber connectivity to their cell towers (which means they had to rely on lower throughput microwave links).¹

Cable Television

The hurricanes damaged both the receiving equipment and the distribution network. On the receiving side, the satellite antennas used to receive content were damaged. On the distribution side, Viya's cable infrastructure suffered extensive damage, as its cable network relied on aerial WAPA pole attachments. Near complete loss of the cable system meant cable TV services were unavailable. In rare cases, customers may have been able to receive a distorted or low-quality signal. While some services have been restored on the existing cable network, Viya is moving its cable services onto HFC cables and will either abandon or salvage its old coaxial cables. As with the restoration of landline services, work related to aerial cables could not start until December 2017, by which point WAPA had restored most of its poles.

Broadcast Radio

¹ One carrier, Viya, used the hurricane damage to their existing network to accelerate the rollout of a new, faster cellular communications network, which had previously been slated for installation in mid-2018. The existing networks were severely damaged, so rather than commit time and resources to repairing the old networks, the company instead focused on bringing the new network on-line, launching it in St. Thomas and St. Croix by the end of December 2017 and in St. John by mid-January 2018.

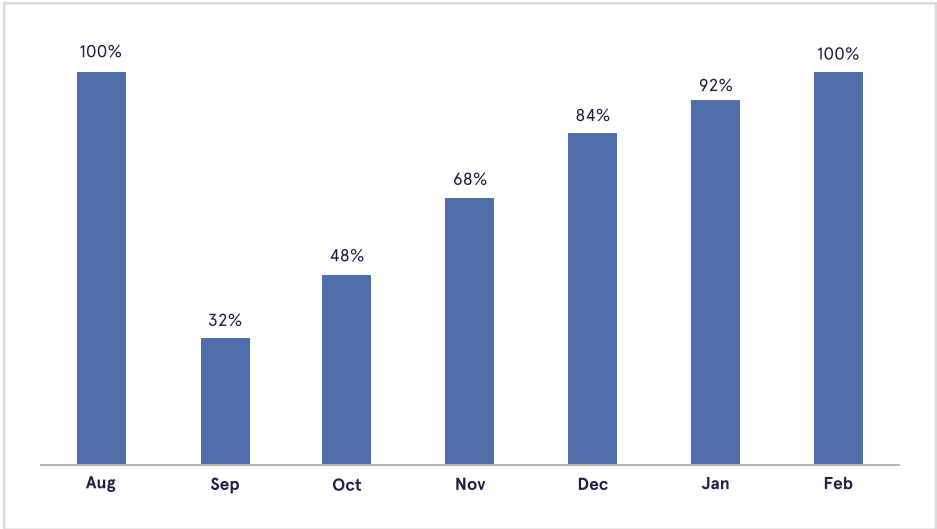
Many radio stations remained off-air for extended periods of time as a result of the loss of commercial power, loss of station equipment, and damage to structures and equipment. Many stations had backup generators, but the length of the commercial power outages eventually caused generators to fail from overuse or lack of fuel.

The loss of radio stations left the public unable to receive any programming. In particular, stations designated as the official emergency broadcast stations were unable to send important government advisories and messages, leaving citizens without accurate, current information on the status of the disaster and safety instructions from officials.

Internet Service Providers (ISPs)

Internet services suffered major outages, although the Territory was never completely disconnected.

A number of factors contributed to the outages: equipment failure

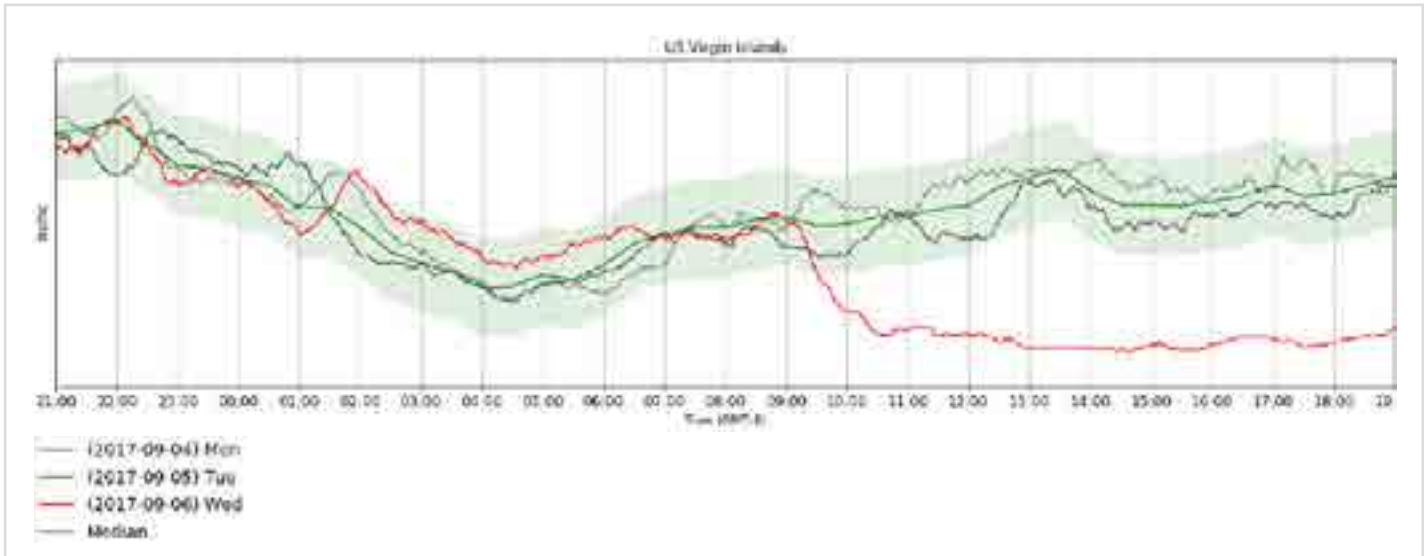


Internet traffic volumes in the viNGN network; August 2017 - February 2018; indexed to August 2017; Source: viNGN

as a result of physical damage, including crushing and water damage; loss of the connecting facilities provided by Viya or the viNGN middle mile provider; damage to “last mile” (local equipment) cables using aerial attachments; loss of power at the customers’ locations; and, in some instances, damage to ISP-provided equipment (such as modems and switches) in customers’ residences. The available data demonstrates a 60-70 percent traffic drop-off corresponding to when the

hurricane made landfall. Traffic volumes did not return to normal until February 2018 (see charts: [Volumes of USVI data traffic around the time of Hurricane Irma](#); [Internet traffic volumes in the viNGN network](#)).

The lack of Internet access hindered the public’s ability to access crucial information, including weather updates, locations and extent of damage, and instructions from emergency officials about sheltering or how to



Volumes of USVI data traffic around the time of Hurricane Irma; Partial data as measured by the IT company Cloudflare
Source: Cloudflare

obtain other protective measures (which was made worse by the fact that radio stations were damaged as well). The outage also isolated people who could not contact friends and family during and after the storms. Significantly, the Internet outages also limited public officials' and journalists'

means of sharing mainland accurate news and updates on what was happening in the islands with the US mainland, as well as individuals' ability to share updates and announcements on social media. Many people also rely on their Internet connection to place phone calls, and unless their landline or cellular services were functional, this meant many citizens could not place calls to request emergency 9-1-1 services.

ISP response level and timeline varied, resulting in a lengthy restoration process ranging from weeks to more than three months for many providers. The staff of many smaller ISPs primarily local personnel suffered personal losses during the storms, which in turn slowed the companies' response time. In some cases, ISPs were able to deliver a connection to a customer, but the customer did not have power (either commercial or generator), in which case the service could not be restored. The battery backup that some ISPs provide as a standard part of the customer's on-premises equipment is only designed to sustain the connection for limited times (less than 24 hours) and was of little help given the circumstances.

International cable landing stations

Submarine cable stations incurred some loss of service—although most of it was not related to the storm themselves. Cables originating offshore were mostly untouched by the storms, and the cables exiting the cable stations on land are buried, so they were largely protected from damage. The robust design of these facilities, supported by resilient backup and redundant power sources, including multiple generators and large battery storage banks, ensured that loss of commercial power was not an issue. What was, an issue was the restoration work in the hurricanes' aftermath: on several occasions during the restoration process, the placement of new power and telephone poles damaged some of the buried land-based cable facilities, not least because the Territory has not yet implemented a "call-before-you-dig" system. This damage and resulting lack of access to the cable landing stations severely limited the ISPs' and cellular companies' ability to process information and data requests, as well as to process calls, as most of this switching occurs off-island. Localized calling could still be available in limited cases if the rest of the on-island cellular services were also working.

Federal assistance and costs

The federal government provided some telecommunications-related assistance to the Government of the Virgin Islands (GVI) in the earliest days of the recovery efforts. The Federal Emergency

Management Agency (FEMA) provided and managed fueling assistance for backup generators, as well as transportation of some equipment. Federal fueling support for Territory government sector facilities continued only until regular fuel resources became available once again. The private sector also requested support, mainly for temporary spare generators, but could not by receive any since, FEMA may not to assist private sector companies except in the most extreme cases (e.g. no fuel from commercial suppliers).

Information on specific private company damages and associated costs, as well as the costs associated with their recovery efforts, is not available due to the competitive nature of the telecom industry.

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

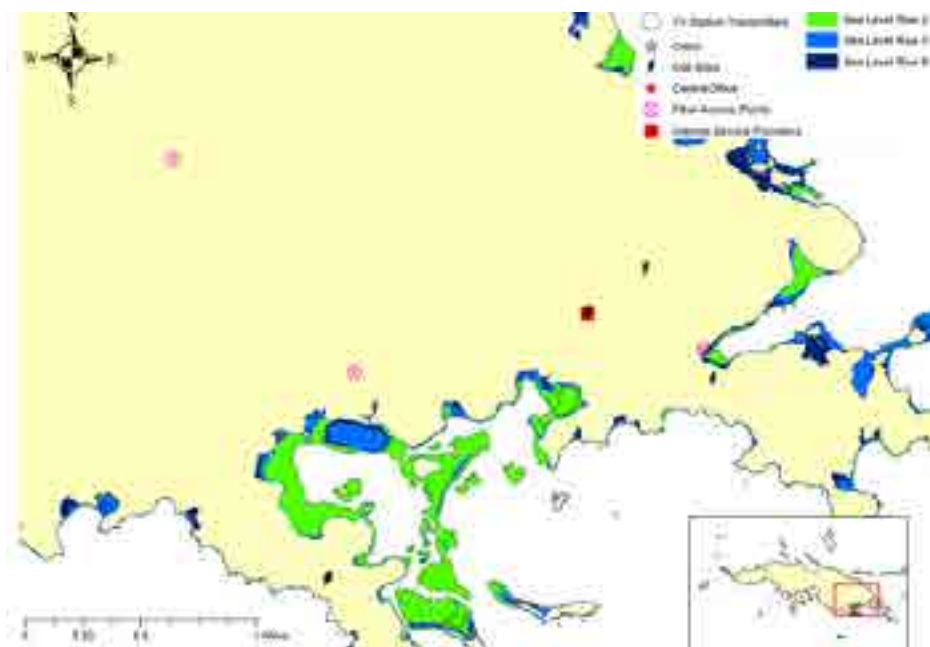
Of all the climate hazards, hurricanes represent the single greatest risk to the U.S. Virgin Islands' communications facilities, as storms bring high winds, increased rainfall over short time periods, and high storm surge levels. Rising temperatures represent a moderate risk, and increases in sea level and precipitation levels pose risks that are mild.

and poles supporting aerial cables will be at risk of toppling, leaving the equipment hosted on towers subject to water and crushing damage. Fallen or unstable towers will pose threats to nearby buildings and people and can also block access to roads (poles with both communications and power attachments are particularly dangerous if downed while still running live current because of the high voltage they convey). Satellite and radio equipment mounted to towers designed to withstand increased wind

speeds can be knocked offline if it is blown out of alignment, even if realigning equipment is significantly less expensive and time consuming than replacing entire towers. Finally, storm surge caused by hurricanes may pose risks to individual tower and landing site locations based on their relative height above sea level and proximity to the ocean.



Telecommunication Assets in Current Flood Zones in Christiansted



Telecommunication Assets in East End, St. Thomas at Potential Risk from Sea Level Rise

Rising sea levels

The USVI could see an increase in sea level of up to 1.5-2 feet by the 2050s. This amount of increase would lead to greater daily tidal flooding in low-lying areas, as well as increased coastal erosion. There are 10 private communications sites currently located at 25 feet or less above sea level, leaving them at risk for flooding or erosion damage as sea levels rise.

Increases in Temperature

Both the ambient temperature and the number of hot days may increase in the future, leading to warmer nights and more days with highs of 90°F or higher. Although all facilities housing communications equipment and electronics are air-conditioned, an increase in temperature will place additional strain on the on-site air conditioning units. Likewise, warmer temperatures will lead businesses and households throughout the Territory to rely more on-air conditioning, resulting in a greater overall demand on WAPA's commercial power production. While higher demand will not impact communications infrastructure directly, more strain on existing WAPA equipment may result in more frequent commercial power outages or a higher likelihood for commercial power failure during and after a hurricane.

Changes in Precipitation

The Territory could experience greater variability in rainfall levels from year to year; however, projections predict both the dry and wet seasons will be drier overall. A drier climate may result in soil shifting and cracking, creating the potential both for buried cables to be exposed and for settling in the foundations of equipment shelters.

FUNDING

Some of the proposed initiatives require coordination between different entities and do not carry an immediate cost. Others require infrastructure investments; where that is the case, the greatest part of the cost of these investments will be borne by infrastructure operators and will be passed along to either their customers in the form of higher prices or their shareholders in the form of lower returns. Some federal funding will be available: on March 6, 2018, the FCC proposed a \$204 million Connect USVI fund as part of the \$954 million fund to restore and repair networks in Puerto Rico and the USVI, focusing on short-term service restoration and long-term improvements to broadband access. The Governor's Office will work with its federal partners to get these funds disbursed as soon as possible.

INITIATIVES FOR INCREASING RESELIENCE IN PRIVATE SECTOR COMMUNICATIONS

Strategies for building and ensuring a more robust communications system in the USVI include infrastructure reinforcement, better preparedness for long-term commercial power outages, and reviewing and updating legislative and regulatory frameworks to encourage resilience. Of particular note will be the ability of the USVI Legislature to use its powers to approve or deny business presence in the islands under 30 V.I.C. § 45a based on the extent to which lightly regulated private telecom providers are ensuring the resilience of their networks.

HARDEN PHYSICAL INFRASTRUCTURE

Considering that most of the disruption to telecommunications services came from physical damage to facilities, some degree of infrastructure hardening is absolutely necessary. The measures will include upgrading tower design standards to withstand higher winds, strengthening or burying power cables serving communications infrastructure, designing micro grids for critical communications

locations, and burying aerial copper cables and converting them to fiber whenever possible and burying aerial fiber cables.

Initiative 1

Work with tower operators to upgrade tower design standards

While all towers have a failure point, many towers supporting the various communications services on the islands could be more resilient. The tower on Bordeaux Mountain on St. John was designed to withstand winds of 200 mph. It failed. The new tower has been built to withstand even greater wind speeds; however, it is estimated that it was winds in excess of 225 mph that brought down the original tower. Although the new tower is stronger than the one it replaced, tornadic winds such as those experienced during recent storms in that location could still prove to be too much for it. Towers in other locations were designed to withstand substantially less than Category 5 hurricane winds. Replacement towers in these locations should be more robust or of a new design in (monopole if applicable) order to ensure better survivability in future storms.

The Governor's Office, as well as the PSC, will work with private tower operators to ensure that they implement best practices and use robust equipment across the infrastructure that they manage.

Initiative 2

Work with WAPA to strengthen or bury power cables serving communications infrastructure

Poorly installed power poles and the lack of buried power lines caused commercial power outages that affected telecommunications facilities. WAPA is working to address these issues by making sure that the newly installed replacement poles meet proper specifications and by using more durable composite poles in places where the risk of high winds is higher. WAPA is also developing a plan to bury power cables in numerous at-risk locations (see Energy sector chapter for further details).

The Governor's Office will work with WAPA to bury cables serving the high cell tower locations and the locations providing public safety communications.

Initiative 3

Work with WAPA and telecom operators to evaluate potential for micro grids for most critical infrastructure

As currently designed, the USVI power grid as currently designed has several single points of failure; meaning, if one section of cable or one substation is damaged, the customers that depend on them will lose power. Those customers include telecommunications facilities. One way of preventing this from

happening is to create additional redundancies in the system (discussed in the Energy chapter); another way is to create so-called microgrids, which are subsets of the larger grid that have their own generation infrastructure (usually a combination of renewables, battery storage, and fossil fuel backup) and the ability to isolate themselves from the rest of the grid and continue operating if part of the grid goes down.

The Governor's Office will work with WAPA and telecommunications companies that own assets in the Territory (AT&T, Sprint, and Viya) to examine the possibility of creating microgrids that will include several critical communications locations that could provide at least some level of wireless service to the majority of the Territory in the event of a long-term power outage.

Initiative 4

Work with aerial cable owners to bury cables where possible

Of all the elements of the telecommunications system, aerial cables proved to be some of the most vulnerable to high winds. For future storms, the solution is to move all aerial fiber cables (main trunk and as many additional connector aerial facilities as possible) to buried fiber facilities, with the exception of areas prone to widespread flooding or erosion. In all other locations, routine maintenance, both of cables and equipment facilities, should include inspections to identify and immediately report any signs of soil shifting or cracking in

order to prevent further damage, especially as the climate becomes drier. Sections of cable that need to remain above ground for access and construction purposes should be reinstalled on more durable composite poles (rather than the current wooden poles).

The Governor's Office will work with aerial cable owners to encourage burying of cables and conversion to underground fiber, ideally in parallel with burying WAPA power lines, road restoration and resurfacing. The process will require coordination and additional immediate expense compared to simply restringing aerial cables, but it is the best solution for long-term service quality improvement.

IMPROVE PREPAREDNESS FOR POWER OUTAGES

Most telecom facilities are prepared to survive a short-term outage, but not a longer term one. To better survive a future extended commercial power outage, private companies must equip all communications sites with adequate, regularly maintained power backup solutions.

Initiative 5

Schedule and ensure proper generator maintenance

Most telecommunications facilities had on-site emergency generators installed, as they

were supposed to. However, a number had not been properly maintained, leading to premature breakdowns and loss of service at affected sites.

The Governor's Office, together with the PSC, will work with operators to ensure that they perform regularly scheduled routine generator maintenance, especially before major storms. To that end, all operators need to have in-house or contracted generator maintenance personnel prepared to deploy and respond to issues resulting from storm damage.

Initiative 6

Stockpile spare parts for essential equipment and resolve servicing issues

As generators run, they begin to require spare parts; but all supplies are necessarily sourced from off-island suppliers, which can take time especially in an emergency situation when transportation options are limited. Even when parts are available, some vendors may require their equipment to be serviced only by their technicians, which can lead to further delays.

The Governor's Office will work with both government and private sector entities to stockpile sufficient quantities of spare parts in order to allow for delayed shipment of replacements. The GVI will also work with private companies and generator vendors to develop agreements allowing on-island staff and technicians to service another company's

equipment during emergencies.

Initiative 7

Increase on-island generator inventory

All companies should be responsible for their own generators and backups to those generators; however, sometimes even the backups to the backups fail. In those cases, it helps to have a generator sparing plan in place to make sure that companies that need additional generators can borrow them from a central cache maintained by the government. A company participating in the plan would, for example, commit to having one generator for every active communications site and backup generators in some ratio to the main ones (say, one to every three). If both its main and backup generators failed it could borrow a generator from the cache on a first come, first served basis.

The Governor's Office and the Virgin Islands Territorial Emergency Response Agency (VITEMA) will work with private telecommunications companies as well as public critical infrastructure providers to discuss and develop a generator sparing plan for future emergencies.

Initiative 8

Set standards for pre-emergency communications site preparation

Before a major storm, all sites need to be pre-inspected to ensure that fuel levels are topped off, oil and filter changes are current,

batteries are sufficient to support the expected loads, transfer switches are tested in order to prepare for power loss, and hookups for portable generators are working and will support the connector of the portable unit, and access roads are free from dead vegetation.

The U.S. Virgin Islands Bureau of Information Technology (BIT) will develop a checklist of such measures to be shared with all operators and will establish a contract with each private sector company desiring to participate to outline the details of the program.

Initiative 9

Prepare and stage sufficient fuel

Even without major damage to fueling facilities, fuel availability for generators was an issue during the storms. To prevent this problem from recurring, all operators need to have ample backup fuel supplies or contracts with fuel suppliers.

The Governor's Office will work with private companies to broach this problem with individual suppliers.

UPDATE LEGISLATIVE AND REGULATORY FRAMEWORK TO SUPPORT RESILIENCE

The legislative and regulatory framework that is already in place supports resilience to some extent;

however, there is more that can be done. Possible measures include studying the possibility of federal assistance to private companies in long-term power emergencies, reviewing USVI and enforcing existing territorial authority over communications companies, reviewing customs exceptions, providing curfew passes in advance, and funding and implementing Call-Before-You-Dig laws.

Initiative 10

Work with federal government to advocate the possibility of providing emergency assistance to private telecom carriers

The Stafford Act, which is the main law governing federal emergency response, does not generally allow for the possibility of providing federal assistance to private companies, telecommunications operators included. During the hurricanes, commercial carriers frequently needed and requested emergency support to replace failed generators when their own backups either were not available or not working. Because of the legal constraints written into the Stafford Act, neither the U.S. Army Corps of Engineers (USACE) nor FEMA supplied urgently needed backup generators from their ample supplies staged on each island, leaving communications sites to fail. Within the current legal framework, the federal government can only assist private sector companies in

order to remedy a problem that the government itself caused; for example, if the Department of Homeland Security (DHS) invokes a fuel emergency, FEMA or USACE may assist private companies with fueling until the emergency is lifted.

The Governor's Office will work with its partners in the federal government to examine the possibility of relaxing some of the private sector assistance rules when it comes to generators for telecommunications facilities in major emergencies. The discussions will need to be mindful of the need to balance public interest in making sure that telecommunications services remain available with the need to avoid directing public resources to covering deficiencies in private company resource planning.

Initiative 11

Work with PSC to review and enforce part of USVI Code giving it authority over telecommunications services

To the extent that the private communications companies that provide service in the USVI are regulated, they are regulated primarily by the FCC at the national level—but that regulation does not generally concern resilience. This leaves the GVI with little input into the companies' business practices as far as resilience is concerned. However, the Legislature of the Virgin Islands does have the ability to approve or deny

business presence in the islands under 30 V.I.C. § 45a. After the 2017 hurricanes, the PSC acted on this clause to get all communications companies to join a regularly scheduled status call to help assess the progress made on repairing the communications networks.

The Governor's Office will work with the Legislature to review, enforce, and use this control mechanism as necessary to encourage private telecommunications companies to implement the recommended improvement measures.

Initiative 12

Develop mechanism for deferring customs and excise tax in emergencies

The U.S. Virgin Islands Code does not currently include any provisions for waiving customs and excise tax fees during emergencies (except for nonprofit organizations, which are always exempt). The Bureau of Internal Revenue (BIR) is legally required to process customs and excise tax fees for all shipments, but this slows the processing of shipments and subsequent access to essential and emergency supplies. Waiving these fees entirely during an emergency would not be ideal, both because of the revenue that would be lost and because of the near impossibility of ensuring that shipments actually contained emergency supplies; however, one solution is to defer payment of some of these fees in order to expedite receipt and distribution of emergency shipments. After the 2017 hurricanes, the BIR did

issue some deferments, but only to a limited extent (as a result of connectivity problems) and late in the response process.

The Governor's Office will work with BIR to develop a list of importers who could get automatic deferrals of fee payments in a declared emergency situation and will include some telecommunication service providers on that list.

Initiative 13

Issue curfew passes for movement of essential personnel

In an emergency, the curfew system ensures that the public does not move about after dark when it is not safe to do so. VITEMA issues curfew passes to workers who need to move around after the curfew so they can perform their duties, however, the passes were issued only after the hurricanes, which often led to delays and made it more difficult than it should have been for emergency workers to move around.

The Governor's Office will develop and implement a system that will distribute curfew passes to emergency personnel to include the private sector communications companies in advance.

Initiative 14

Fund and implement "Call Before You Dig"

Underground communications and power cables generally survived the hurricanes intact but were often damaged in the aftermath when restoration crews were doing clean up work, including at least four documented instances of buried fiber line cuts. This occurred because the crews did not have access to maps of underground utility infrastructure.

The Territory passed the "Underground Facility Damage Prevention and Safety Act" (Bill no. 31-0004) in 2015 to support a "Call Before You Dig" program, but the program was never funded.

The Governor's Office will work with the Legislature to fund and implement the program.



COMMUNICATIONS: PUBLIC SECTOR

In the USVI, public communications networks provide services to the government and first responders, middle-mile fiber services to Internet service providers, and public broadcasting services to the general public. All of these networks sustained significant damage in hurricanes Irma and Maria, which, in many cases, resulted in systems being out of service for several months.

Damage ranged from minor water and physical damage to equipment and offices to destruction of transmission towers, studios, and buildings, as well as Information Technology (IT) storage resources. Internet access ranged from completely to partially inaccessible, while government voice communications capabilities were either entirely out of service or severely limited. Public safety radio network was only partly functional. Public radio out for several weeks and television were out for several weeks or months.

Repair technicians' response to these disruptions was hampered by limited access to site locations (communications facilities are often on mountains or hills) as a result of inaccessible roads. Lengthy commercial power outages required constant refueling and servicing of backup generators not designed to run for long periods of time, which in turn resulted in loss of power until the generators could be restored to service. Limited staffing resources resulted in long hours for staff and lengthy delays in installing replacement equipment. The scarcity of spare equipment and burdensome procurement process to acquire essential parts also hindered the recovery efforts.

Future major storm events will damage the networks as currently designed. Of particular concern will be facilities near the coast, which include parts of the fiber infrastructure and some government IT facilities. Other climate risks like rising temperatures or changing

precipitation patterns will affect public telecom systems as well, but the impact will be mild to moderate.

To prepare the public communications networks for future climate risks, the responsible agencies will reinforce existing systems, change current system design and operations, and work to improve the sector's emergency preparedness and response. Measures will include burying aerial parts of system infrastructure, building a completely new public safety radio system, introducing cloud systems for data storage, upgrading the government's phone systems, and preparing for eventual outages through procuring satellite phones and deploying public WiFi hotspots.

HOW THE PUBLIC COMMUNICATIONS SYSTEMS WORK

OVERVIEW

The three primary components of the public communications systems in the U.S. Virgin Islands are the services and functions of the Bureau of Information Technology (BIT), the infrastructure and services of Virgin Islands Next Generation Network (viNGN), and public television and radio broadcasting (provided by WTJX).

BIT is a government agency that provides four main services to other parts of the government: it manages the vendors that run the government's telephone network, runs a microwave radio broadband Internet network that some parts of the government use for their communications, offers help desk support to those territory agencies that request it, and operates and maintains the public safety radio network that provides radio communications to all public safety agencies in the Territory via a land mobile radio (LMR) repeater network.

ViNGN is a semi-autonomous government agency and a wholly-owned subsidiary of the

Virgin Islands Public Finance Authority (VIPFA). The agency provides a territory-wide, fee-based broadband "middle mile" fiber network to private Internet Service Providers (ISPs), which enables the ISPs to provide broadband Internet connection services to their customers. Through the ISPs and BIT, viNGN network provides Internet to all of the Territory's government facilities, including schools and hospitals. The agency also runs several dozen public computer centers throughout the Territory.

WTJX is also a semiautonomous governmental agency that both receives content from the public broadcasting service (PBS) and National Public Radio (NPR), and produces their own content for distribution in both television and radio formats to the general public.

Government telephone network (BIT)

Several companies provide phone service for USVI governmental agencies under independent contracts that BIT manages. The companies' networks are either Plain Old Telephone Systems (POTS) or Voice over Internet Protocol (VoIP) lines that run on a combination of copper (coaxial), Hybrid Fiber Cable (HFC) or fiber optic cables. The government depends on these networks for its daily voice and fax communications and conducts much business that way.

Government enterprise network and data storage (BIT)

BIT runs a microwave radio based network that agencies can use for Internet access and data sharing—but not all agencies do. BIT also offers data storage capabilities on physical storage devices in its St. Croix offices; as with the microwave network, not all agencies use it. Those agencies that do not use BIT's services are responsible for their own Internet access and data storage.

Land Mobile Radio (LMR) public safety radio network (BIT)

BIT runs the USVI public land mobile radio (LMR) network that government agencies use for communications while in the field. Police agencies, for example, use the network to receive calls for service and to obtain information for field requests like wanted persons information or vehicle records checks. The Virgin Islands Fire Service (VIFS), the Department of Health's Office of Emergency Medical Services (VIEMS), and volunteer non-government rescue groups on each island also use this network to dispatch emergency workers and to communicate with hospital emergency rooms.¹ The network relies on a series of radio repeaters and microwave links installed on each island, typically atop mountains or hills. Standby power generators back up both the repeaters and the links.

¹ Two dispatching centers, one on St. Thomas and one on St. Croix, dispatch all emergency response calls for Territory agencies and double as the Territory's 9-1-1 Public Safety Answer Points (PSAPs). Each center has the ability to back up the other center if needed. VITEMA (Virgin Islands Territorial Emergency Management Agency) oversees and manages these centers (discussed in the Government Response chapter of this report).

Middle mile fiber optic network (viNGN)

The viNGN fiber network provides bandwidth to local Internet service providers (ISPs) and to BIT. The viNGN backbone infrastructure consists of 220 miles of undersea and terrestrial fiber optic cables throughout the USVI and fiber access points (FAPs) that make it possible to connect to the system. 60 percent of the terrestrial network is underground. To connect to the U.S. mainland, the agency uses undersea fiber connections; it also owns the interisland undersea connections between St. Croix and St. Thomas. Through local private ISPs and BIT, the agency's infrastructure supports over 200 of what are known as Community Anchor Institutions (CAIs),² including all three of the Territory's hospitals, all public and private schools, and all of the government bureaus connected to broadband Internet.

Public Computer Centers and Wi-Fi hotspots (viNGN)

The territory has 33 Public Computer Centers (PCC), which viNGN runs with the help of volunteer managers. PCCs provide computers with broadband Internet access, along with printers and scanners, for public use across the territory. viNGN also provides a network of free

public WiFi hotspots at several locations throughout the three islands.

Public broadcasting: WTJX TV and radio

WTJX provides public television (TV) and radio broadcasting through programs that range from children's programming and craft shows to public affairs programming and, in emergencies, official government instructions to the public. Local staff produces TV and radio shows in the WTJX production studio; the stations also broadcast off-island content received via the Internet or satellite receivers. To distribute programming, WTJX owns two broadcast towers on St. Thomas and leases space on a privately owned tower on St. Croix for its translator. It operates its own transmitters on St. Thomas and a translator on St. Croix; the translator sends the communications signal out to listeners on a different frequency, which allows the programming to be received better on St. Croix, despite using the signal generated on St. Thomas.



St. Andrews Public Communication Center
Source: viNGN

FUNDING

The USVI government provides financing for BIT and its various networks, including LMR. ViNGN earns revenue from the sale of its broadband service (and was initially funded by grants awarded by the U.S. Department of Commerce to VIPFA in 2010). The public broadcast network is financed by USVI government grants, the Corporation for Public Broadcasting (CPB), and private donations.

Regulation and governance

The Federal Communications Commission (FCC) regulates the individual private communications companies that provide telephony services, as does the USVI Public Service Commission (PSC), which oversees customer service quality and service standards in the Territory (see Private Telecom chapter for details). The FCC also regulates the microwave radio network, the land mobile public radio (LMR) system, and the public broadcasting service for both radio and television. The viNGN network is not regulated, as viNGN is solely a middle mile provider.

² As defined in Broadband Data Improvement Act, 47 U.S.C. § 1305(b)(3)(A-B), Community Anchor Institutions include "schools, libraries, medical and healthcare providers, community colleges and other institutions of higher education, and other community support organizations and entities to facilitate greater use of broadband service by or through these organizations; organizations and agencies that provide outreach, access, equipment, and support services to facilitate greater use of broadband service by low-income, unemployed, aged, and otherwise vulnerable populations."



viNGN installing infrastructure in 2015; Source: viNGN

IMPACT OF THE HURRICANES

The hurricanes severely damaged public telecom systems: the government telephone system was offline for weeks to several months, some government data stored at BIT was lost, the LMR public safety radio system was only partly operational, viNGN aerial cables were destroyed and service to customers interrupted, and WTJX programming was off the air for months.

Government telephone system (BIT)

The Government of the Virgin Islands (GVI) phone system suffered damage both to the interconnecting lines owned by either viNGN or Viya and to the equipment provider infrastructure (phones and



equipment). The interconnecting lines were installed on wooden poles (WAPA infrastructure), which suffered extensive damage in the form of downed poles and lines. As a result, end user telephone and fax services were offline for periods ranging from weeks to several months. Some of the equipment inside of government buildings was also damaged when the structures themselves suffered storm damage.

GOVERNMENT MICROWAVE NETWORK (BIT)

The microwave network is installed on the same towers that support the public safety radio network. In some cases, storm damaged or destroyed

the antennas for this network so they had to be replaced. The antennas were also blown out of alignment in some locations, so they required realignment. The network went down as a result, and service was not restored as of May 2018. The government agencies that used the network switched to using regular Internet service when it was available.

Government data storage (BIT)

BIT's data storage system suffered physical damage causing some data either to be temporarily or permanently inaccessible. It also experienced issues with power outages. The damage was due to pre-storm preparation processes: in order to prepare the hardware before potential power spikes, the equipment was taken offline, but data files were corrupted when staff performed the functions to restore services. Power issues occurred because many of the emergency standby generators that support the system failed after being run for much longer than their designed run-times (over three months instead of hours to a few days); when that happened, agencies could not access the uncompromised data.

With the regular system partly down, BIT used a cloud storage solution to restore some critical applications. The damaged storage drives were shipped for restoration in February 2018, but the vendor was unable to recover any data; BIT has identified a second vendor to attempt additional recovery, but had not resented the drives as of May 2018.

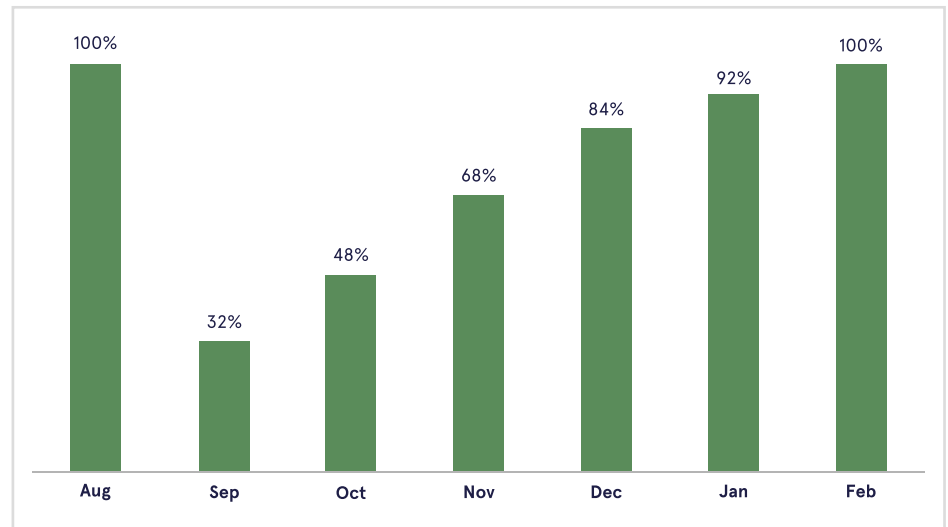
LMR public safety system (BIT)

Eight of the 11 LMR radio towers suffered damage, including two BIT-owned ones; three privately owned towers were destroyed completely. Numerous antennas and microwave dishes were heavily damaged or destroyed, and other interconnecting equipment was also compromised. The radio system was offline at various times during and after the storms, which meant police officers on patrol could not receive radio calls or had to move to different locations to receive signals; Virgin Islands Fire Service (VIFS), Virgin Island Emergency Medical Service (VIEMS) and rescue personnel were similarly affected. At times, public safety personnel had to use personal cell phones, but cellular service also suffered major service outages. Lack of reliable communications caused delayed response to calls.

As of May 2018, the LMR network was operational and all tower locations were running on commercial power, however, there were still some coverage issues resulting from lost towers that had not been restored to pre-storm conditions. Damage to the system was estimated at above \$800,000.



Repairing
Source: viNGN



Internet traffic volumes in the viNGN network
August 2017 - February 2018; indexed to August 2017

ViNGN middle mile fiber network

The two hurricanes did not affect viNGN's underground backbone infrastructure, but they did destroy or render unusable 90 percent of the agency's aerial cable infrastructure. Because the aerial cables deliver 90 percent of viNGN's connections to end users, the damage resulted in a significant outage. Elsewhere, two fiber access points (FAPs) that housed the network's most vital electronic equipment sustained significant structural and water damage, and several of the PCCs suffered equipment damages due to the destruction of the buildings in which they were located. In the weeks after the storms, 18 of viNGN's 24 generators suffered significant damage from operating well beyond their designed runtime (24/7) and backup battery banks were constantly depleted and recharged, drastically reducing their life span.



ViNGN was able to restore service to sites served by underground connections as soon as the users' buildings had power. Aerial connections had to wait until the Territory's electric utility, Virgin Islands Water and Power Authority (WAPA), was able to restore its poles; as customers waited for service restoration, viNGN set up 15 free public WIFI hotspots in key locations on St. Croix (seven), St. John (one), and St. Thomas (seven). The disruptions to the viNGN system and to end user infrastructure resulted in a nearly 70 percent drop in the volume of traffic in the viNGN network; the traffic volumes returned to normal in February 2018 (see chart: Internet traffic volumes in the viNGN network). As of May 2018, all viNGN systems were back in operation, although many of the aerial and last mile connections were running on temporary facilities. PCCs fared less well: of the 33 PCCs territory-wide, only 12 in undamaged buildings have been restored as of May 2018.

Public broadcasting: WTJX radio and television

The public broadcasting network sustained varying degrees of damage. On St. Croix, the damage was relatively minimal: a translator suffered water damage and wind damaged two antennas. On St. Thomas, the damage was significant: Irma destroyed the main WTJX office and studio, and both the structure and the production equipment inside the building sustained massive damage. Winds toppled the WTJX-owned, 100-foot auxiliary transmission tower and caused significant damage to the roof of the building that houses the radios at the base of the antennas. Antennas and satellite receiving equipment were damaged and the generator was not able to maintain service, which in turn caused the Heating, Ventilation and Air Conditioning (HVAC) equipment to fail, increasing the risks for sensitive electronics that require climate controlled temperatures. The loss of this equipment and the studio meant that programming was very limited for a lengthy period,

especially for television: the FM radio station (WTJX-FM) went back on the air on September 27, 2017, and the television station (WTJX-TV) went back on the air the first week of January 2018. Internet at its critical transmitter site was down since Irma and minimal service was not restored until February 2018.

FUTURE CHALLENGES TO THE PUBLIC COMMUNICATIONS SYSTEMS RESULTING FROM CLIMATE CHANGE

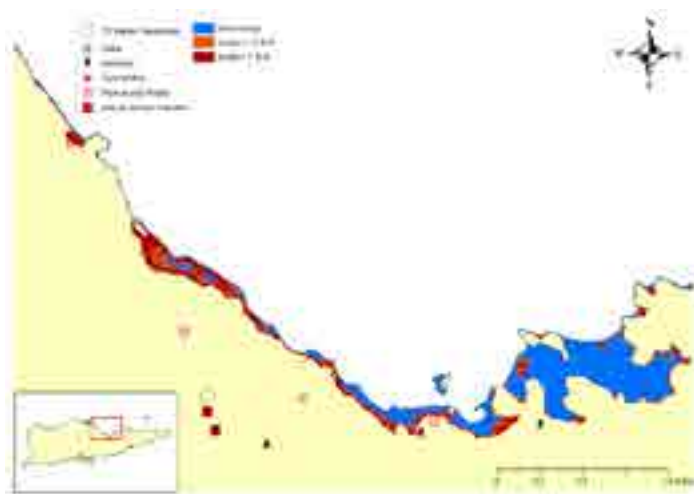
In the future, potential increases in the intensity of hurricanes present the biggest climate-related threat to the public communications sector.

HURRICANE WINDS, RAINFALL, AND STORM SURGE

Stronger (although not necessarily more frequent) hurricanes will continue to threaten public telecommunications infrastructure: buildings, towers, and aerial cables may be damaged or destroyed, and storm surge may impact coastal facilities. Of particular concern are BIT's new St. Thomas location (100 feet from the waterfront), viNGN's remaining aerial infrastructure, and some of viNGN's FAPs located near the coast (see map: [Public telecom assets in flood hazard areas](#)).

Rising sea levels

As sea levels rise, some telecommunication and power manholes will be flooded constantly, which may lead to equipment degradation. Rising seas may also threaten optical fiber, which degrades when exposed to water for extended periods of time unless properly sealed. BIT's St. Thomas facility



Storm Surge for Telecommunication Assets in Christiansted, Present, Predicted 50 year, Predicted 100 years



Storm Surge for Telecommunication Assets in Charlotte Amalie: Present, Predicted 50 year, Predicted 100 years

may also be at risk of flooding and soil erosion.

Increases in temperature

Communications equipment is cooled by mandatory HVAC equipment. As temperatures rise, this equipment may experience greater stress and occasional outages. Higher temperatures will also increase the potential for heat exhaustion and heat stroke for staff working outdoors.

Changes in precipitation

Possible periods of increased rainfall will adversely affect wireless Internet service. Higher bandwidth frequency will experience worse attenuation: for example, 5G will be more disrupted by rain than 3G.

INITIATIVES FOR INCREASING RESILIENCE IN PUBLIC COMMUNICATIONS

The initiatives to increase the resilience of public communications include reinforcing existing systems, changing current system design and operations, and working to

improve the sector's emergency preparedness and response.

REINFORCE EXISTING SYSTEMS

As with all sectors, the public telecom sector has to strengthen its existing infrastructure to protect it against future storms and storm surge. These measures will include burying viNGN's aerial cables, burying WAPA cables that provide power to FAPs, protecting fiber infrastructure from rising sea levels and storm surge, and hardening public radio and television infrastructure.

Initiative 1

Bury viNGN's aerial cables

Although 40 percent of viNGN's entire network is buried, 60 percent (a total of 115 miles)—and 90 percent of customer connections—relies on aerial cables. The buried fiber survived the storms, but the aerial cables were mostly destroyed and will be destroyed again if rebuilt as before. Burying the system's aerial cables will improve viNGN's ability to service customers, although it will not guarantee all customers will remain online since last mile service depends on private ISPs as well as power at customer locations.

ViNGN will bury the existing vulnerable portion of the network fiber optic cable in PVC conduit in order to replace the fiber attached to the WAPA telephone poles. Where cable is not buried, for example, where there is rock just below the surface or where only

a very small number of customers would be served, the agency will use stainless steel straps to hold all aerial slack loops in place instead, per the USDA (U.S. Department of Agriculture) Rural Utility Service code.

Initiative 2

Work with WAPA to bury the power cables that feed viNGN fiber access points (FAPs)

ViNGN's FAPs are the facilities that make it possible to connect to the fiber network. They depend on having commercial power, and although they are equipped with backup generators, those generators are not designed to run for extended periods of time. The power lines that fed the FAPs before the storms were mostly aerial and were largely destroyed. Although many of those lines will be rebuilt on stronger composite poles, burying them where possible would be ideal.

ViNGN will work with WAPA to ensure all power coming into the FAPs is run underground.

Initiative 3

Protect public telecom infrastructure against rising seas and storm surge

Coastal infrastructure of both BIT and viNGN face risks from rising sea levels and storm surge. Specifically, offices, FAPs, and cable enclosures could be affected, which could lead to degradation or loss of

service to some customers.

viNGN will floodproof FAPs in flood zones, ensure all splice enclosures are properly sealed with silicon, and will install any new facilities as far inland as possible in the future. BIT will review the flood protection standards in the USVI Building Code and determine whether its facilities need additional freeboard (number of feet above flood level) or more stringent flood protection standards.

Initiative 4

Improve network and facility resiliency for WTJX public broadcasting

The WTJX network plays a vital role in supporting the entire territory for distribution of video and audio content in emergency and non-emergency times. The loss of the transmission tower and studio took away one critical communications capability the Territory's government could have used to distribute instructions and information to the public after the storms. This distribution method helps to calm and direct citizen activities, including identifying where vital services such as food and water distribution points are located, explaining how to receive emergency assistance, and even helping locate lost loved ones post-storm.

WTJX will rebuild its St. Thomas studio as a hardened facility. This will allow for continuous broadcasting throughout a storm and will even provide a backup communications source to the St. Thomas VITEMA Emergency

Operations Center (EOC) and public safety with its datacasting capabilities. WTJX will also rebuild the transmission facilities to include an additional backup transmission tower and radios.

CHANGE SYSTEM DESIGN AND OPERATIONS

In some cases, rebuilding systems and returning to old protocols makes sense; in others, it makes more sense to replace old systems with newer ones while also improving the way the systems are run. Measures in this category include building a completely new public safety radio system, introducing cloud-based systems for data storage, switching the government's phone systems to VoIP on buried fiber, and consolidating the government's IT operations.

Initiative 5

Design and build a new public safety radio system

The hardware of the existing public safety radio network is obsolete. Much of the equipment has reached the end of its useful life and replacement parts are no longer manufactured. Towers at several locations are in need of an upgrade. Before the hurricanes, there were already numerous locations where the signal was too weak to allow effective connectivity between the dispatchers and the mobile units—and storm damage only made this worse. Nor does the network provide for any

interoperability with off-island resources nor include temporary tower trailers that could replace towers that failed in the storm—

FirstNet and public safety networks

The implementation and installation of a new nationwide (U.S.) First Responder Network called "FirstNet" (currently in progress) will provide an additional communications method to back-up many applications of the public safety radio network. The 2012 Middle Class Tax Relief and Job Creation Act created the First Responder Network Authority (FirstNet) as an independent authority of the National Telecommunications and Information Administration (NTIA), which is a branch of the U.S. Department of Commerce (USDOC). FirstNet will provide for a high-speed state-of-the-art communications network dedicated to first responders and engineered and operated by AT&T using mostly its existing infrastructure. This network will initially carry only data and voice communications (much like existing cellular networks do today) and will eventually link to the LMR/public safety networks around the country. Funding for FirstNet will be the responsibility of the US Department of Commerce and AT&T.

both of which became an issue after the hurricanes. System management and processes could be improved: for instance, there is no system in place to track which radios are in use at any given time, who is using radios, or whether users are authorized to use the equipment.

A radio vendor assessed the existing system, presented its findings in February 2018, and proposed a total replacement of the network. The network replacement plan will add new towers, reposition a tower for better signal, and add the latest technology for a digital radio system that fully complies with P-25, which is the standard for U.S. public safety networks to allow agencies from multiple jurisdictions to use their own radios to communicate with other systems.

BIT will work with FEMA to hire a consultant to evaluate the existing system more thoroughly, engineer a new network to meet existing industry standards and create an request for proposals (RFP) to facilitate the competitive selection of a vendor to build the new system. The new system will replace all existing radios and establish a new BIT-owned process for ensuring tracking and validation of authorized, trained users. BIT will coordinate with private tower owners to evaluate all existing towers for structural integrity before new equipment is installed. BIT has also requested FEMA funding for five BIT-owned temporary tower trailers to be deployed throughout the territory in order to facilitate quicker recovery of failed towers. BIT will work with VITEMA to engage all network user stakeholders in discussion of the existing radio procedures and to create an

operating standard for all users on the network. This process will contain language to clarify the role and responsibility both of the dispatcher and dispatch center in managing the use of the network by all users. VITEMA will coordinate and implement training sessions to ensure understanding and compliance by all users; these trainings will occur even before the new network is put in place.

Initiative 6

Introduce cloud-based systems for data storage

Many government agencies currently host critical applications on a server-based system maintained at BIT facilities on St. Croix. However, some of the data and applications were lost after hurricanes Irma and Maria. A hybrid system built on a mixture of local and remote infrastructure would have avoided some of these problems. Such a system was not fully implemented at the time of the hurricanes; BIT had moved some data to the cloud, but far more data remained on the physical backup servers.

BIT will work with other government agencies to fully implement a hybrid system for data storage and unified IT services for all governmental agencies. The system will use the cloud for primary data storage and hardware devices for backup. This dual approach guarantees at least two methods of data recovery should one method fail.

Initiative 7

Switch the government's phone systems to VoIP on buried fiber

The government's current phone systems rely on multiple private providers, many of which use aerial cables that were destroyed in the 2017 storms and will be destroyed again in future ones. Since the government relies on voice communications for conducting much of its daily business, it needs a more resilient phone system.

BIT will create a single telephone network for the government based on Voice over Internet Protocol (VoIP). All services would be built on the viNGN network—and therefore on buried fiber, which is significantly more resilient than aerial cables—using existing government-owned resources (although some commercial contract considerations will be needed to complete the installation and scaling). A VoIP network would have benefits beyond resilience as well, including total cost control, state of the art equipment, a unified help desk function for troubleshooting, and a universal dialing pattern for four or five digit internal network extension to make it easier to communicate.

Initiative 8

Consolidate GVI's IT operations

The GVI does not have a centralized enterprise network: departments run their different systems, which means the risk

of service interruptions is high during the best of times and BIT's ability to respond and provide support is limited. The 2003 Technology Enterprise Act passed by the V.I. Legislature (Act No. 6634) called for consolidating the IT resources and staff currently dispersed across numerous government agencies under a BIT-led structure, but the act was never fully implemented.

BIT will work with the Governor's Office to implement the act and to consolidate IT services across the GVI. BIT will do an agency-by-agency assessment, propose a plan for networking and staffing, and identify any resources best left within an agency based on unique needs. Consolidation will improve service and user support, reduce costs, and make the overall network more resilient.

IMPROVE EMERGENCY PREPAREDNESS AND RESPONSE

No amount of hardening and system reconfiguration can protect public telecom systems entirely from all outages. Measures to plan for eventual outages include procuring satellite phones, deploying additional public WiFi hot spots, and preparing for long-term commercial power interruptions.

Initiative 9

Procure satellite phones for all government agencies

Satellite phones were the only reliable form of communication for a while after the hurricanes. However, no government agencies except for VITEMA had these available. Furthermore, no agencies had any form of Very Small Aperture Terminal (VSAT) satellite equipment. VSAT units create a satellite-driven broadband network for voice and data communications as a substitute for damaged broadband and cellular networks; the units' small size and ease of setup and use make them ideal for emergency communications.

VITEMA will work to ensure each government organization except BIT has a cache of satellite phones and VSAT terminals as part of their disaster equipment inventories, including the variety of system hardware devices such as portable to vehicle and permanent mount units. VSAT units will be deployed on each island, with enough units to ensure key personnel have access. BIT will have its own satellite phones as well as VSAT terminals to support the government's IT network. Rhode Island donated five VSATs to BIT for permanent use in March 2018; the agency distributed the units to all three islands.

Initiative 10

Work with viNGN to deploy additional public WiFi hotspots

viNGN's public WiFi hotspots provided wireless access at no charge to the general public when all other sources of broadband access were not available. There was no definitive plan for the

placement of additional hotspots deployed after the hurricanes' landfall, but key locations like government facilities (libraries, police/fire stations) and major business locations (grocery stores, banks etc.) proved to be ideal as long as they were close to a working network element, easily accessible by the public, and powered to allow for the equipment to work.

ViNGN is coordinating a plan for activating hotspots in key locations after a disaster, including identifying ideal locations and emergency generator power sources. Hotspots can be pre-deployed long before a disaster and simply activated when needed. viNGN has requested FEMA funding via the 404 and 406 funding mechanism for this effort.

Initiative 11

Ensure power generators can operate for long periods of time

Most public telecom facilities have backup power generators installed, but the facilities' current models are not designed to operate for longer than a few days at a time, which meant many failed from overuse in the post-storm outages.

BIT, viNGN, and WTJX will procure continuous duty generators to power their most critical facilities. The generators will be regularly maintained and topped up with fuel before storms.

TRANSPORT- ATION

The U.S. Virgin Islands is separated from the mainland United States by 1,200 miles, and its geographic location makes a robust and high-functioning transportation network essential. Sea and air transportation make possible the supply of nearly all of the Territory's materials and daily necessities; road transportation supports activity within each of the Territory's islands. Air and sea links also serve as crucial escape routes before major hurricanes for those residents of the USVI able to evacuate: here, unlike in continental US, driving over to another state is not an option.

Despite this crucial role, much of the transportation infrastructure is aging and fragile due to lack of funds, deferred maintenance, and challenging environmental conditions. On top of these issues, many roads, maritime facilities, and airport structures underpinning the transportation sector were not built to withstand category 4 or 5 hurricanes to begin with.



Damaged road on St. Thomas; Source: Piotr Gajewski

Hurricanes Irma and Maria put the Territory's transportation system to a severe test. On land, their winds downed trees and utility poles, blew out houses, and deposited over 850,000 cubic yards (y³) (660,000 tons) of debris onto roads and other surfaces, making roadways temporarily impassable. 10-20 inches of combined rainfall created mud

and mudslides, rockslides, potholes, sinkholes, and washouts that further damaged the Territory's roads. Runoff exceeded the stormwater system's capacity. Entire roads collapsed. The storms obliterated signage and blew streetlights and traffic lights away.

Along the coasts, silt, runoff, debris, and more than 400 sunken vessels blocked some



Damage from Hurricane Irma at the Cyril E. King Airport on St. Thomas; Source: FEMA/K.C. Wilsey



Damaged caused by Hurricane Maria at the Henry E. Rohlsen Airport on St. Croix airport. Source: Jocelyn Augustino/FEMA

seaports and channels around St. Thomas, St. John, and Water Island, leaving them unnavigable and unable to accommodate relief ships. Ferries and barges were damaged, preventing travel between the islands. On the shore, cargo equipment and facilities on St. Thomas were broken and destroyed, hindering the receipt of massive volumes of relief cargo. U.S. Customs offices on all three islands were destroyed as well.

Air transportation was damaged, too: commercial traffic was halted for nearly a month. The airport tower on St. Croix was damaged and the tower on St. Thomas was destroyed. Terminals at both airports suffered severe damage.

During the response effort, government crews and residents alike cleared debris from roads. Federal responders set up temporary air traffic control infrastructure. Crews from the U.S. Coast Guard checked the safety of the ports, and dock masters worked to clear berths and ensure safe dockage for incoming relief ships. The U.S. Coast Guard, in cooperation with the Virgin Island Port Authority (VIPA), removed sunken vessels in phases until February 2018.

The Territory now has the unique opportunity to improve its transportation future as it recovers from the storms of 2017 and faces more frequent possible disasters in the future. Building a more resilient transportation sector will include hardening and repairing the existing system (including bringing roads up to current federal standards), improving the Territory's capacity to rebuild (including increasing the availability of building materials and contractors),

adopting more resilient road and street designs to encourage modes of transportation other than private cars and that depend less on signaling and electricity (including promoting walking, cycling, and using roundabouts instead of signalized intersections), expanding and improving ports to accommodate greater cargo and passenger volumes (including expanding the container port on St. Thomas and creating a small cruise ship terminal on St. Croix),



Workers clear debris from roadside drains during a rain storm to alleviate flooding on St. Thomas. Source: FEMA/K.C. Wilsey

improving transportation system management processes (including by speeding up customs processing), and better preparing for future storms (including preparing a debris management plan).

HOW THE SYSTEM WORKS

The USVI's transportation system includes a network of roads, extremely limited walking and cycling infrastructure, limited public transport, two major airports, and several ports. Road infrastructure provides transport within each island. Sea and air transportation are the only means for traveling between islands and for bringing goods and passengers into the territory.

Roads

The USVI road network includes 1,230 miles of roads: 340 miles that are classified as federal routes, 410 that are local, and 480 that are private.

Most federal routes and local public roads are two-lane roadways paved with asphalt or concrete, mostly without shoulders. Signage provides traffic control along roads and at intersections, as well as location identification, although few street signs exist. "Guts," culverts, inlets, and swales provide drainage. Retaining walls on steep slopes help prevent road collapse and landslides. Traffic signals regulate 57 public intersections. Many public roads suffer from deferred maintenance, which leads to

cracks, potholes, deterioration of roadway striping, and disrepair of crosswalks.

Private, multi-household roads and driveways are how most residents access their homes. Those roads are often completely unpaved or semi-paved and poorly built. They can also be poorly maintained, potentially making it difficult for emergency services or equipment to use them.

Federal routes are supported by federal grants, local public roads are funded through the budget of the Department of Public Works (DPW), and private roads are paid for and maintained by the residents who use them to access their homes. Public road maintenance for both federal and local roads is the responsibility of the local government. On those roads, deferred maintenance is primarily a result of inadequate planning, lack of resources, and a difficult procurement process.

Cycling and walking

Cycling is not common, and there are currently no designated bike lanes or bike marking or signage in the territory. A 15-mile bike

lane has been proposed and approved for St. Croix through a public-private partnership with nonprofit Crucian Bikeways Inc. DPW would provide oversight for the design process and fund the construction, while the non-profit would pay for the design and ongoing maintenance of the lanes. Although some permitting and design work has been completed, the project has stalled because funding has not been fully secured.

Pedestrian access is also very limited or dangerous. In the historic Charlotte Amalie district on St. Thomas, pedestrians can use 47 historical "step streets" to quickly travel the steep hills between the streets on which the town sits – but for the most part, pedestrians must walk along the edges of roads because so few roads have sidewalks.

Public transportation

Public transportation in the USVI includes a public bus system, shared-ride multi-passenger taxis, open-air safari taxis, and unique open-air safari "dollar rides," as well as private taxis.



Safari bus; Source: Theknot.com

Bus service is provided on St. Thomas, St. John and St. Croix by the Virgin Islands Transit System (VITRAN), a department of DPW, for a basic fare of \$1. St. Thomas is the system's busiest location: ridership there is about four times higher than on other islands.

"Dollar Rides" aboard older open-air safaris generally run the same route as the public bus and pull in at or close to bus stops, and can sometimes also be hailed on major roads. These are unique to the Territory and do not have a schedule. Frequency can depend on the time of day, whether they are servicing cruise ship passenger excursions, and how many drivers choose to run the route.

Private and shared-ride taxis (usually 8-12 person enclosed passenger vans traveling between major points) operate on St. Thomas, St. John, and St. Croix. These multi-destination shared vans are the only public transportation from the airport.

The USVI Taxicab Commission regulates taxis and fares, which are fixed based on the destination. Unfortunately, this oversight is little known to passengers and difficult to enforce. Taxis will refuse to pick up locals in favor of more lucrative cruise ship passengers and tourists, and it is common for taxi drivers to overcharge passengers or refuse to take them if their destination is too far or not far enough.

Seaports

On St. Thomas, the Edward Wilmoth Blyden IV Marine Terminal is the ferry dock on Charlotte Amalie's waterfront that supports passenger vessels

traveling between St. Thomas, St. John and Tortola. The St. Thomas/St. Croix ferry boards and disembarks passengers at this facility, and the facility also houses the U.S. Customs clearance point on St. Thomas for vessels entering U.S. waters. Separately, the St. Thomas waterfront in Charlotte Amalie offers berthing for public and private vessels. On the East End of St. Thomas, the Urman Victor Fredericks Marine Terminal in Red Hook supports passengers between St. Thomas and St. John, as well as the British Virgin Islands.

Cruise ships arrive at one of two docks on St. Thomas: the VIPA operated Austin "Babe" Monsanto Marine Facility or the West Indian Company Ltd. (WICO) dock across the harbor in Havensight. WICO is a public corporation owned by the VI Public Finance Authority (VIPFA), and the WICO dock is the only public dock not operated by VIPA. This historic dock accommodates cruise ships and sees the greatest cruise ship traffic in the Territory. Less frequently, it also accepts crane-equipped cargo vessels (WICO does not have a crane for offloading).

On St. Croix, Gallows Bay dock accommodates mini-cruise vessels, small inter-island sloops, ferries, private yachts, cargo vessels and USCG vessels. Ann E. Abramson is the cruise ship dock in Frederiksted. St. Croix's hub for commercial and industrial marine traffic is the Wilfred "Bomba" Allick Port. The Gordon A. Finch Molasses Pier multi-purpose facility is used primarily to import molasses for the Virgin Islands Rum Industries Limited distillery. This pier is also used for importing all liquid asphalt, bulk cargo such as gravel, cement

blocks and other construction materials critical to St. Croix's construction industry.

On St. John, the Loredon L. Boynes Sr. Dock is the main passenger port of entry to St. John located in Cruz Bay. The Theovald Eric Moorehead Dock and Terminal at Enighed Pond is the main cargo and car barge facility serving the island. The Victor William Sewer Marine Facility is the Customs dock for St. John used for the berthing of commercial passenger ferries and privately owned vessels departing for the British Virgin Islands (BVI), as well as U.S.-registered privately-owned vessels clearing customs on their return to U.S. waters.

Customs is a common and essential part of inter-island travel in the Caribbean. Travel within the USVI requires no passport, but traveling to the BVI does regardless of whether it's on a private boat/plane or publicly owned ferry. Private boats are required to clear Customs on arriving in the BVI and upon return to the USVI. A "Local Boater Option" (LBO) permits US citizens to register in advance with Customs, obtain a registered boater ID number, and call in or use an online Customs portal upon their return to US waters, instead of physically going to the Customs facility.

Ferries and car barges

Private ferries and car barges offer passenger services between St. Thomas, St. Croix, St. John and Water Island, as well as to Puerto Rico, the BVI and other Caribbean islands. Two private



Passenger ferry from St. Thomas to St. John; Source: vinow.com

franchises, Varlack Ventures and Transportation Services of St. John, operate the most common passenger ferry route between Red Hook on St. Thomas and Cruz Bay on St. John with an operations and maintenance subsidy from the DPW. Car barges are operated privately by two franchises out of two VIPA car barge terminals on St. Thomas and St. John.

Cargo

Most incoming cargo arrives at the Crown Bay dock on St. Thomas, which includes facilities for U.S. Customs to process imported goods into the Territory, or at the Wilfred “Bomba” Allick Port on St. Croix. Importing cargo into the Territory is a complex, paper-driven, costly, and time-consuming process that involves the Virgin Islands Bureau of Internal Revenue (BIR) and the U.S. Customs Service. On St. Thomas, where most of the Territory’s incoming cargo lands, a cargo recipient must make four stops before receiving the cargo, none of which are within close

walking distance of the others. On a typical day, this process can be completed in about three hours. There are no excise tax or customs fees for items barged between the islands of the Territory.

Air transportation

Two major airports, Cyril E. King on St. Thomas and Henry E. Rohlsen on St. Croix, connect the Territory to the rest of the US and the world. The airports are owned by the Virgin Islands Port Authority (VIPA); air traffic control towers are owned and operated by the Federal Aviation Administration (FAA) on St. Thomas and owned by VIPA but operated by the FAA on St. Croix.

Seaplane service provides connections to nearby islands and within the Territory. The Territory has two terminals: the St. Thomas Seaplane Terminal on Charlotte Amalie’s waterfront next to the Edward Wilmoth Blyden IV Marine Terminal and the St. Croix Svend Aage Ovesen Seaplane Terminal in Christiansted.

GOVERNANCE AND REGULATION

Two territorial government agencies have primary oversight for transportation: the Department of Public Works (DPW) and the Virgin Islands Port Authority (VIPA or Port Authority). Several federal agencies provide additional oversight.

DPW administers land transportation, including all roads and public buses. Public roads, highways and storm drainage systems, public transportation systems, public parking facilities, public buildings, and public cemeteries are the responsibility of DPW. The department’s duties include planning, engineering, project management, construction, and maintenance of these public assets. While DPW interacts with all government agencies, laws enacted by the Virgin Islands Legislature regulate DPW’s scope. The legislature also approves the department’s budget and provides appropriations for projects.

VIPA owns and operates all airport and maritime facilities in the Territory with the exception of one fuel port operated by Limetree Bay and one cruise ship dock operated by the West Indian Company Ltd. (WICO). The authority also maintains the shipping channels into the Territory and dredges them when it is necessary to increase channel breadth or depth. A public corporation, VIPA is an autonomous governmental agency administered by a board of governors.

Federal agencies that oversee and regulate transportation include the Department of Transportation (DOT) and its subsidiary agencies, namely the Federal Highway Administration (FHWA), and the Federal Transit Administration (FTA), which funds 100 percent of public works and public transportation. The Federal Aviation Agency (FAA) regulates airports and all aspects of civic aviation. Federal border security and law enforcement is carried out by the Department of Homeland Security (DHS) and the U.S. Customs and Border Protection (CBP); maritime law enforcement is carried out by the U.S. Coast Guard (USCG), which has jurisdiction in both domestic and international waters. At the local level, the Department of Planning and Natural Resources (DPNR) regulates permitting, construction and environmental standards as the local arm of the Environmental Protection Agency (EPA). The Virgin Islands Bureau of Internal Revenue (BIR) collects cargo excise taxes, and the Virgin Islands Police Department (VIPD) is responsible for local law enforcement and public safety.

FUNDING

DPW is funded primarily by the local and federal government. It receives annual funding approximating \$40M (FY2018 projected) from the following sources:

- \$18.7 million: U.S. Virgin Islands General Fund
- \$16.8 million: Federal Highway Administration

(FHWA) funding for support of Federal Routes, Moving Ahead for Progress in the 21st Century Act (MAP-21), and Territorial Highway Program Implementation and Stewardship Agreement

- \$1.7 million: Federal Transit Administration (FTA)
- \$2 million: miscellaneous appropriated funds
- \$800,000: revenue (public transportation, barge fees, parking, cemeteries).

VIPA operates on fees collected for the use of its facilities, including: rent, seaports, and airports. The authority receives no funding from the General Fund of the Government of the Virgin Islands (GVI).

IMPACT OF THE HURRICANES

The storms damaged road, marine, and air transportation to different extents. Roads received large amounts of debris, but debris removal made major roads passable within several days. Seaports received some damage but were also operational within a few days. Airports suffered the worst and were unable to support commercial traffic for nearly a month after the storms.

Roads

After the two hurricanes passed, over 850,000 cubic yards (y³) of vegetation, mud, rocks, boulders, downed utilities, construction materials, and other debris blocked the Territory's roadways. Erosion and clogged drainage contributed to public and private



Damaged road on St. Thomas; Source: K. Nowakowski

road surface damage. Some modern retaining walls failed due to heavy rains; many older walls, and those not built to current standards, failed as well. Wind damaged or destroyed traffic lights at all 57 intersections equipped with them; it also damaged signage and streetlights.

Driving after the storms was dangerous without traffic and streetlights. Occasionally, when debris blocked passage completely or when whole road sections were washed away, driving was impossible. People were stranded, effectively cut off, and often had no option but to hike. Military personnel and local police controlled traffic at key intersections and enforced the mandatory curfew (which was as restrictive as 6 p.m. to 12 p.m. the week of Hurricane Irma, but was gradually relaxed, reaching 11 p.m. to 5 a.m. the week of October 22 and lifted completely throughout the USVI on October 30). Limited hours between curfews concentrated traffic, generating “rush-hour”

on the limited but passable roads. Accomplishing errands was complicated and sometimes impossible.

Repairs to the road system started immediately after the storm. Government responders and residents worked with neighbors to clear private and community roads, where retaining walls failed, DPW installed temporary barricades and closed lanes for extensive failures. The department also performed limited repairs to a few intersections immediately after the storm, but the commercial power outage limited the repair of traffic signals. Debris removal on St. Thomas and St. John was soon taken over by the U.S. Army Corps of Engineers (USACE), which awarded a contract to Ceres Environmental (Ceres), a private response corporation, which then subcontracted work to local firms. On St. Croix, DPW awarded debris removal contracts to local firms, and on Water Island, one local contractor collected debris under a DPW award. DPW handed

off debris and waste removal for the territory to VIWMA in March 2018.

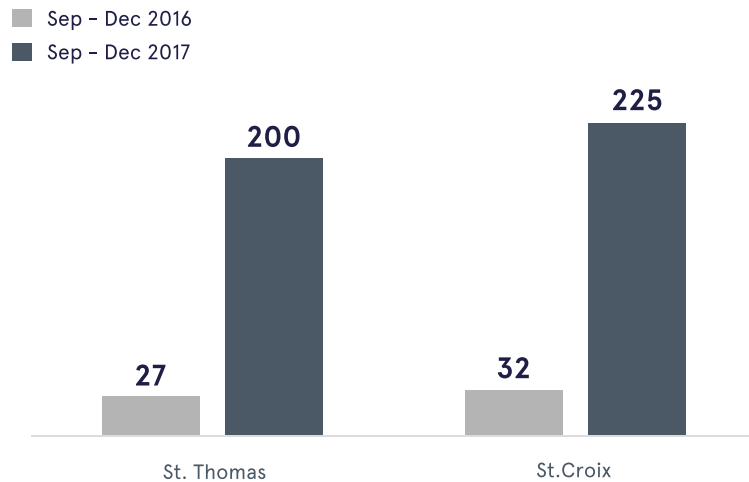
DPW, with FHWA and FEMA, continues to secure funding and to award contracts for permanent repairs. Repairs under these contracts commenced in spring 2018 and will be ongoing for several years. Costs to repair the hurricane-damaged roadway infrastructure exceed \$100 million. FHWA-funded roadway restoration and FEMA-funded repairs to local routes require more than \$50 million for road surface and retaining wall repair. Debris removal requires another \$30 million. FHWA will fund another \$20 million to repair traffic signal and signage.

HURRICANES AND TRAFFIC CRASHES

The Territory saw a seven-fold increase in vehicular crashes reported at intersections on St. Thomas and St. Croix in the months immediately following the storms. For the post-storm period of September to December 2017, the Territory measured 425 vehicular crashes at intersections compared to 59 during the same period the previous year. Given that there was enforcement of no civilian nighttime vehicular traffic from in September and October due to the curfew, this sharp increase is even more salient (see chart: [Intersection crashes in the USVI](#)).



Downed trees, snapped utility poles and debris are evidence of the powerful winds from Hurricane Irma. Source: FEMA/K.C. Wilsey



Intersection crashes in the USVI

Marine facilities

Marine facilities in the USVI experienced varying levels of damage. U.S. Customs' seaport dockside facilities were destroyed on St. Thomas, St. John and St. Croix. The most significant impact of this was the loss of the building at Crown Bay, where customs agents cleared the bulk of cargo into the Territory. The WICO dock also experienced damage, with silt and sand from storm surge and runoff rendered WICO's berths too shallow for most large vessels. Only the outer portion of the WICO pier, in the deepest water, could accommodate the first relief ships to arrive in the Territory. At the Austin "Babe" Monsanto Marine Facility, one of two berths was obstructed by a floating dock washed up by the storm. Shortly after the storm, a FEMA relief ship occupied the other berth. After the floating dock was removed, a second FEMA ship tied up to the dock. These ships remained for a number of weeks, bringing relief to the Territory, but making the dock unable to

accommodate revenue ships. The St. Croix docks—like those on St. Thomas—stood up to the storms with little damage, and only the Ann E. Abramson pier sustained significant damage to its catwalk mooring extension. The buildings and facilities fared poorly: the storms destroyed VIPA's main St. Croix office, which housed administration and operational offices.

After hurricane Irma, USCG, VIPA and WICO assessed St. Thomas' harbor for underwater hazards before reopening the port there and on St. John on September 8 for ferry traffic only—which meant that the already isolated St. John residents were effectively stranded for three days. For Hurricane Maria, USCG again closed ports September 19-26, with ferry service reopening on September 24, leaving St. John residents stranded for five days this time.

Even with the ports reopened, damage to marine transportation infrastructure caused delays in processing cargo when the Territory desperately needed

supplies. At the cargo dock on St. Thomas, only two of three cranes were able to offload shipments for the first 30 days after the storms. The sheer volume of incoming relief and rebuilding cargo overwhelmed the importing process, and inadequate service facilities worsened port conditions.

At the WICO port, 1,100 cubic yards of silt were removed at the dock less than a month after Hurricane Maria. This cleanup allowed the first post-storm, revenue-producing cruise ship to dock on November 3, 2017.

Customs and imports

With the U.S. Customs office at the cargo port destroyed, CBP relocated their cargo services to a temporary office at the Blyden Terminal. This location was inadequate for regular volumes of cargo, much less the high volume of relief cargo arriving after the hurricanes. Without adequate parking, or enough stations for Customs agents, this led to long lines and slowed processing. The facility had no Internet access in the first days after the storm, but then acquired a satellite receiver to supply Internet. They also extended their operating hours and remained open on weekends to clear the large volume of cargo. Trucks picking up containers of relief supplies or commercial cargo and individuals picking up palletized cargo caused daily congestion at port entrances. Vehicles accessing a temporary debris disposal site located on the same narrow road leading to the dock further encumbered traffic.

Well-intentioned private individuals and groups from the

mainland sent relief supplies to the Territory without realizing the cargo would incur importation fees in the form of excise tax (there is no legislation permitting waiving or deferment of federal customs fees or territorial excise taxes in the USVI; only registered non-profit organizations are exempt from these fees; however, they still have to go through a similar process). Many USVI recipients were also unfamiliar with this complicated process, leading to confusion and increased stress after the hurricanes. The BIR Excise Tax office at Nisky Center on St. Thomas processed tax documents on paper by hand. Lacking Internet, this office was unable to charge credit cards for six weeks following the storms. Importers were forced to pay by check or make the hour-long drive over damaged roads to reach the BIR offices in Red Hook on the East End of St. Thomas to use credit cards, as the Nisky Center office does not accept cash. Despite efforts to quickly offload cargo, shipping warehouses became crowded with landed cargo and warehouses rapidly ran out of storage space for incoming shipments due to the backup of unreleased cargo. Tropical Shipping, a private company, lent their office space with backup power and Internet connectivity to the Excise Tax office in an attempt to aid the situation.

Airports

Both STT and STX closed to commercial air traffic on September 5 in advance of Hurricane Irma and did not reopen for nearly a month.

On St. Thomas, Hurricane Irma

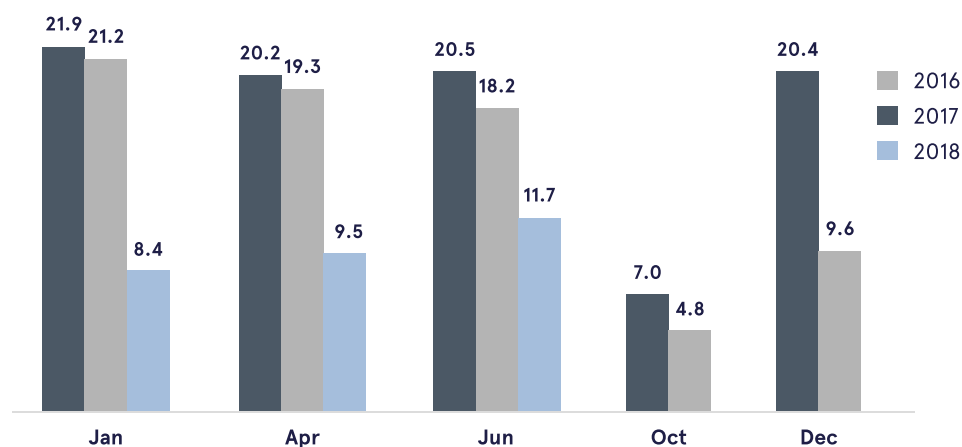
destroyed STT's air traffic control tower. Controllers operated from a tent on the airfield until the FAA could supply a mobile tower the following week. A C-130 cargo plane delivered the FAA's mobile tower on September 13, and, in less than three and a half hours, the temporary tower began assisting relief flights from the U.S. government, as well as private and small commercial aircrafts. Following the tower's delivery, the airport reopened on September 15 with very limited service. The airport had effectively lost the second floor of its building; the first floor passenger lounges were closed off where damaged, and gates were reduced from 11 to three. The U.S. Customs and Transportation Security Administration (TSA) screening facilities were flooded and terminal ceilings collapsed. VIPA reopened the airport to limited commercial traffic on September 28, 2017, nine days after Hurricane Maria.

At Henry E. Rohlsen Airport (STX) on St. Croix, both storms caused damage to air traffic control systems and the terminal's roof. Challenges with the Henry E. Rohlsen air traffic control

tower, which is owned by VIPA, but operated by FAA, kept the airport closed to commercial traffic until October 5, 2017.

Upon reopening, airline passengers at both airports endured exhaustingly long lines at security checkpoints, despite arriving hours in advance of their flights, as TSA agents screened luggage manually and used hand-wand screening for passengers. With limited to no telecommunications, passengers could not be alerted about delayed or cancelled flights before arriving at the airports, compounding airport congestion and passenger frustration. VIPA and airline officials worked to stagger departures, reducing the numbers of passengers in the facility at one time.

As of July 2018, remediation was still ongoing in departure lounges and at TSA and CBP checkpoints. VIPA anticipates STT's roof will be repaired by November 2018. Interior repairs will follow (see the initiatives section of this chapter for more details). Flight volumes returned to 57 percent of what they were in June 2017 (see chart: [Major carrier flight seats by month](#)).



Major carrier flight seats by month; Thousands
Source: BER

CLIMATE RISKS

In the future, as the climate changes, more intense (though not necessarily more frequent) storms may result in damage similar to that experienced with Hurricanes Irma and Maria, while sea level rise will contribute to flooding and erosion in coastal areas. Changes in precipitation may result in moderate impact on the storm water system depending on the intensity of rainfall. The impact of temperature increase will be relatively minor as it can be mitigated by considering heat loads in choosing road materials while remodeling or building new facilities.

Hurricane winds, rainfall, and storm surge

In the future, hurricanes are likely to become more intense, though not necessarily more frequent. More intense hurricane winds will result in proportionally more debris, roadway deterioration, building facility damage at ports and airports, and traffic signal and signage damage. Stronger rainfall could overwhelm the existing drainage system, resulting in more surface flooding. Storm surge will result in moderate to high impact on seaports. Airport facilities at STT are moderately vulnerable: major storm surge would have an impact (runway is approximately 10 feet above sea level at its lowest elevation). Impact at STX would be low because the facility is located at a higher elevation (runway is approximately 23 feet above sea level at its lowest elevation).

Rising sea levels

Flooding and erosion of low-lying coastal roads and storm water outfalls in coastal areas due to sea level rise are areas of particular concern, as the USVI could see up to 1.5-2 feet of sea level rise by 2050. This risk will lead to greater daily tidal flooding in low-lying areas and increased coastal erosion, and could impact low-lying coastal roads. Although most roads in the USVI are elevated enough not to be substantially affected by sea level rise, several roads—some critical to the transportation network—lie within areas at risk to flooding at high tide or erosion in the case of a two-foot sea level rise. Roads of particular concern are VI-37 at Hull Bay Beach on St. Thomas, North Shore Rd VI-20 and VI-107 in Coral Bay on St. John, and on St. Croix, VI-71 south of Frederiksted, VI-63 (Hans Bluff Rd), and North Shore Rd, VI-80. Since the most vulnerable roads are located in areas with low population and little or no commercial activity, this climate risk may have a larger impact on recreation, tourism, and environment than on the USVI population's ability to conduct daily business.

Risks are low to nonexistent for sea and airports, and sea level rise will have low to moderate impact on the transportation infrastructure overall. Critical airport infrastructure is sufficiently elevated at both STT and STX, and it would take very high levels of sea level rise before operations are impacted. However, in the case of a tsunami, STT would be affected.

Increases in temperature

Temperatures in the USVI will increase slightly, with the number of hot days—especially days with maximum temperatures above 90°F—and the number of warmer nights increasing slightly. This will have a negligible impact on physical transportation infrastructure, because higher temperatures are incorporated into system design. Roads are designed to withstand an increase in temperature, and the risk to seaports and airports are low. Lifestyle and human behavior may be impacted, however, producing demand for transportation requiring less physical activity or a reluctance to rely on multiple modes of transportation to reach one's destination.

Changes in precipitation

It is anticipated that the USVI will experience greater variability in rainfall from year to year and the Territory will become drier on average during both the wet and dry seasons. This greater variability in rainfall may have a moderate impact on storm water systems if greater than average or more intense rainfall is experienced, as increased rainfall intensity could overwhelm existing drainage systems and result in more surface flooding. Otherwise, change in precipitation and an overall drier climate will have low or no impact on other elements of this sector.

INITIATIVES FOR INCREASING RESILIENCE IN TRANSPORTA- TION

The USVI economy depends heavily on shipping and tourism, and every individual and business in the Territory benefits when the transportation system operates reliably. Building a more resilient transportation sector will include hardening and repairing the existing system, improving the Territory's capacity to rebuild through increasing the availability of building materials and contractors; adopting more resilient road and street designs that encourage modes of transportation other than private cars and that depend less on signaling and electricity; expanding and improving ports to accommodate greater cargo and passenger volumes; improving transportation system management processes; and better preparing for future storms.

HARDEN AND REPAIR THE EXISTING SYSTEM

These initiatives will strengthen roads to federal standards, rebuild ports and airports, and support several shovel-ready projects.

Initiative 1

Complete latent system repairs and improve road system to meet federal standards

Lagging repairs present a significant vulnerability in the Territory's transportation network that can be readily reduced by making repairs and hardening transportation system assets. DPW will work with FHWA, FTA, and the GVI to complete system repairs that are outstanding and bring the Territory's roads up to current FHWA standards in the next 3-5 years (including repairing all storm-damaged roads). Federal roads will be repaired using FHWA Emergency Relief funding and local roads using FEMA Public Assistance. All remaining roads that currently do not meet standards will be improved using FEMA Hazard Mitigation Grant Program, CDBG-DR, existing Grant Anticipation Revenue Vehicle (GARVEE) bond proceeds, U.S. Department of the Interior (DOI) funds, and FHWA federal-aid funds.

Initiative 2

Utilize concrete as the most suitable building material for roads

St. Thomas' steep topography and load requirements often mandate concrete instead of asphalt. Although concrete roads can be more expensive to build, they provide greater strength and longer lifespan, and require less

maintenance than asphalt. DPW will rebuild as many roads with concrete as funds permit, focusing especially on roads that have suffered repeated damage due to heavy loading and inadequate drainage.

Initiative 3

Repair storm damage at ports and airports

VIPA, working with airlines, TSA, FAA, and CBP where necessary, will conduct outstanding repairs of existing airports and seaports to bring them up to new buildings codes. At both ports and airports, this will include replacing or upgrading generators, upgrading and hardening security measures such as lighting and fencing to withstand higher wind loading, and hardening communication capabilities (e.g. satellite phones).

Initiative 4

Repair and harden Henry E. Rohlsen Airport (STX) and Cyril E. King Airport (STT)

Both airports sustained significant damage in the storms, which caused them to be out of service for several weeks. VIPA will carry out repairs to damaged terminals, replace runway lighting and signage, and conduct other storm-related repairs. Resiliency will be a concern throughout the repair process: airport roofs at STT and STX are both being replaced to a higher standard, all sloped roofs are being replaced with structural metal panels, and flat

roofs (formerly singly ply) are being replaced with two-ply TPO roofing system. Additionally, new standards call for increased wind loading (from 125 miles per hour to 165), stronger windows and walls, and roofs to withstand higher winds.

Initiative 5

Expand and modernize Cyril E. King Airport

The Cyril E. King Airport STT on St. Thomas is already one of eastern Caribbean's busiest hubs—and passenger numbers have grown in recent years. To address future needs, VIPA will expand the airport's capacity and modernize it in the process. The expansion and modernization will proceed in four phases:

- Phase 1: Build out second level, create 10 air bridges, increase retail space, improve passenger flow, involve community in design process
- Phase 2: Build new transportation center, short and long term parking, rental cars area, and multi-level parking structure connected by bridge
- Phase 3: Build new commuter wing to accommodate interisland flights
- Phase 4: Tie marine passenger routes to the STT waterfront and STJ; connect airport terminal to water transportation.

The first phase is to be completed in approximately three years at an estimated cost of \$230 million.

Initiative 6

Project	Description	Estimated Cost
St. Thomas		
Veterans Drive - Waterfront	Roadway widening & improvements. 1 st Phase currently in construction. GARVEE funded project.	\$120 M
Raphune Hill	Roadway widening & improvements. 1 st Phase completed. Remaining 2 phases in final design.	\$ 40 M
Scott Free Road	Roadway widening & improvements. 1 st Phase currently in construction.	\$ 10 M
St. Croix		
Melvin Evans	Roadway rehabilitation. 1 st Phase currently in construction. GARVEE funded project.	\$ 15 M
Clifton Hill Phase 2	Roadway improvements including roundabout at La Reine intersection.	\$ 10 M
Spring Gut Road	Roadway widening & improvements including 2 mile multiuse path. Currently in final design. GARVEE funded project.	\$ 20 M
Mahogany Road	Roadway rehabilitation. Currently in design. GARVEE funded project.	\$ 8 M
Hams Bluff Road	Roadway rehabilitation. Currently in design. GARVEE funded project.	\$ 7 M
Rattan Road	Roadway rehabilitation. Currently in design. GARVEE funded project.	\$ 3 M
Frederiksted Roads (Routes: 702, 7029, 7027, 7025 & 7023)	Roadway rehabilitation. Currently in design. GARVEE funded project.	\$ 3 M
Christiansted Roads (Routes 754, 75E & 75W)	Roadway rehabilitation. Currently in design. GARVEE funded project.	\$ 3 M
St. Croix Bike Path	14 mile multiuse pathway along the South Shore. Funding through nonprofit Crucian Bikeways Inc.	\$ 14 M

"Shovel Ready" Road Projects

Facilitate completion of existing capital improvement projects and "shovel-ready" projects

Planning for multiple capital projects has advanced to "shovel-ready" phase, but the implementation has been delayed for lack of funds. These include improving public transportation stops for land and water networks, replacing the damaged crane at the St. Croix Container Port, reconstructing the St. Thomas waterfront—in the largest single road project in the USVI history, and several small-scale projects

in various stages of design. DPW will deliver these projects subject to available funding (see table: "Shovel Ready" Road Projects).

IMPROVE CAPACITY TO REBUILD

The Territory's recovery will require large amounts of materials and labor—and those may not always be available. These initiatives will improve the availability of both.

Initiative 7

Study measures to expedite building materials imported into the Territory

To perform the amount of work required for recovery, the Territory will need considerably more construction materials than under non-recovery circumstances, but those materials can often be difficult to secure. With the exception of some quarried materials like stone, most materials are imported into the Territory, including ready-mixed concrete, construction aggregates, sand, soil cement, bagged cement and masonry block. Other building materials such as lumber, steel, and hardware are also imported by ship. Post-hurricane, the volume of goods coming into the ports will include both new materials for reconstruction, as well as replacements of storm-damaged inventories—and those volumes will have to go through existing facilities and processes.

DPW will work with VIPA and CSB officials to determine what measures can be taken at ports and import facilities in order to expedite building materials acquisition, starting by conducting a study to determine the impact on ports of importing a large volume of post-storm building materials. Some of the materials availability issues may also be addressed in the future by the expansion of the container port at the location of the destroyed Cancryn Middle School on St. Thomas (see Initiative 13).

Initiative 8

Study measures to expand local availability of materials

Expanding and/or speeding up the import of materials into the Territory does not have to be the only way of meeting the Territory's materials shortage. Another way is to expand what is available locally, either by expanding government operations to aid the supply chain or working with existing supplies. For the former, the Governor's Office, together with the DPW, will determine the possible options. For the latter, the Governor's Office, together with the DPW, will work with both new and existing suppliers and vendors of asphalt, concrete, and aggregate to identify possible options, including by addressing possible land challenges with the use of government land (especially on St. Thomas) and by considering tax and other incentives.

Initiative 9

Grow contractor and workforce capacity

Post-hurricane recovery work will require large amounts of skilled and semi-skilled labor. This labor pool may now not be sufficient in the Territory. The Governor's Office will coordinate with the Departments of Labor and Education, and private contractors to offer workforce development and trade education, especially to create and train a disaster responder workforce specializing in transportation-related hurricane damage restoration.

To make sure that enough skilled labor can be attracted, the Governor's Office will ensure that wages are competitive and will work with the VI Department of Labor (VIDOL) to raise the prevailing wage of federal aid projects.

ALTER ROAD AND STREET DESIGN TO SUPPORT RESILIENCE

A resilient transportation system does not just mean a hardened one—it also means one in which users have more options for moving around and the system depends less on other systems like power. These initiatives will use roundabouts, expand walkability, and improve routes to schools.

Initiative 10

Utilize roundabouts instead of street lights at intersections

Roundabouts (traffic circles) are simple and resilient traffic flow solutions currently underutilized in the Territory's roads infrastructure. Roundabouts increase the level of service and capacity, improve pedestrian mobility, and eliminate the need for electricity to traffic signals—all of which also contribute to resilience. This type of measure is supported by the FHWA, and the Territory is looking to build several roundabouts, starting with the USVI's most dangerous intersections. DPW will construct a modern two-lane roundabout that is currently in design for

the LeRaine intersection on St. Croix. The next candidate will be Clifton Hill, where detailed engineering studies have shown that the roundabout has better capacity and performance versus a conventional signalized intersection. Beyond these two project, DPW will consider the use of roundabouts when making major intersection improvements anywhere in the Territory.

Initiative 11

Implement Safe Routes to Schools

Safe Routes to Schools is a planning approach; where feasible, communities should try to encourage active transportation to schools like crossing guards and monitors, reducing reliance on vehicles and encouraging healthy activities for higher quality of life and safer, more cohesive communities. For example, on St. Thomas, school pickup and drop-off creates and inordinate amount of congestion in school zones and roadway traffic, and poses both an inconvenience and a safety risk. Safe Routes to Schools would help alleviate this, as well as encourage community building and more active transportation options for students and families. DPW will work with the Territory's non-profit groups to implement the approach.

Initiative 12

Deploy walkability recommendations

Improving walkability enhances resiliency by reducing dependence on cars where feasible, as well as decreasing roadway congestion and pollution. It also benefits all residents by providing more green space, shade, and a more enjoyable environment; reducing obesity, depression, hypertension, diabetes, and other health issues; and stimulating tourism, increasing land values, and contributing to overall economic activity.

Right now, the USVI ranks very low in walkability standards and high in chronic health issues indexes—but there is no reason why it should remain that way. The VI Department of Health (VIDOH) and the Centers for Disease Control (CDC) have created a program to encourage walking, biking, accessibility, and mass transit in the Territory, promoting a healthier society by using infrastructure to change behavior. The nonprofit USVI Walkability Institute also developed a "Complete Streets Policy" to improve walkability and accessibility in the Territory. The Governor's Office will work with VIDOH, DPW, and the Walkability Institute to implement walkability recommendations throughout the Territory.

EXPAND AND IMPROVE PORTS AND CUSTOMS PROCESSING

These initiatives will expand the Territory's ability to receive cargo and passengers and will also speed up customs clearance.

Initiative 13

Expand container port on St. Thomas

Current container port capacity on St. Thomas—which serves as the hub for the rest of the Territory—is insufficient to accommodate the Territory's needs in the hurricane recovery period. VIPA will work to expand port capacity, including possibly using the space where Cancryn Middle School—destroyed in the storms—was once located. Discussions between VIPA and the VI Department of Education (VIDOE) about a potential land trade are ongoing.

Initiative 14

Conduct dredging and expansion in Gallows Bay Port

Gallows Bay Port on St. Croix is a facility that can currently only accommodate smaller vessels, but not cruise ships of any kind. VIPA is planning to conduct dredging and terminal expansion in the Gallows Bay Port to accommodate small cruise ships, which are typically luxury vessels with high passenger purchasing power. Plans for the terminal are complete,



however, they are stalled due to both permitting and financing issues. VIPA is working with the U.S. Army Corps of Engineers (USACE) to approve permits for dredging of Schooner Bay, upon which the remaining funding of this expansion project is reliant on. Separately, in order to create the environment for high-end cruise ships and luxury vessels, the port's current cargo operation must be moved to the Gordon A. Finch Molasses Pier on St. Croix. This portion of the project is already underway; however, difficulties with contractors and skilled labor shortages have encumbered the timeline. VIPA will continue to work with USACE, and federal and private partners in order to bring this project to fruition.

Initiative 15

Modernize and expand customs clearance in Red Hook

Plans to expand U.S. Customs and Border Protection (CBP) clearance point in Red Hook (on the East End of St. Thomas) have been underway for years. Currently, there are temporary facilities in place to process paperwork, however, plans for a permanent CBP structure are currently under review by the USACE. VIPA will work with CBP, USACE, and other federal partners to complete the project. Construction costs are estimated at \$6 million.

Initiative 16

Deploy Automatic Customs Environment system to improve customs processing

The Territory depends on its ports for the import of nearly everything essential for its survival, however, because the USVI is outside the US customs zone, the imports take more time and effort than they would elsewhere in the U.S., slowing down the recovery after the storms. Automatic Customs Environment (ACE), a Customs and Border Protection proprietary system for automatically connecting importers to various responsible agencies and expediting approvals and tariff collection, could facilitate a faster recovery by: 1) Accelerating the import of critically needed recovery materials; 2) Accelerating the transmittal of collected tariffs back to the Territory; 3) Improving the long-term economic prospects and health of the Territory, and; 4) Alleviating reporting and storage burden on both the Virgin Islands Office of Licensing and Consumer Affairs (DLCA) and CBP.

FEMA has included the acquisition of ACE in its Hazard Mitigation Strategy for the Territory and has been in active discussions with Customs and Border Protection on how to best deploy the system. Doing so involves some work: due to the USVI's unique status outside of the customs zone and associated tariffs, the software package would need considerable development before it can be ported to the USVI. The Governor's Office and VIPA will continue to work

with FEMA, CBP, Department of Homeland Security Infrastructure Protection, and the U.S. Army Corps of Engineers to bring the system to the USVI. The total cost for the acquisition, development and deployment of this technology system are still being evaluated, but are currently estimated to be above \$7 million.

IMPROVE ROAD SYSTEM PLANNING AND ASSET MANAGEMENT

These initiatives will improve the way the system is run and the way that planning for it is done through focusing on drainage and asset and resource management.

Initiative 17

Conduct a comprehensive drainage study of the territory's transportation network and apply results by improving the road drainage system

Proper road drainage is critical in the event of a hurricane or flooding, as poor drainage makes roads more vulnerable to damage. The Territory, however, suffers from inadequate drainage both because of the way it is built and because of the way it is maintained (DPW only does drainage maintenance when there is a clog, because a map or database of drainage facilities

does not currently exist). This could destabilize transportation infrastructure in the event of another natural disaster—and all the more so as precipitation patterns change in the future.

DPW, in collaboration with the University of the Virgin Islands (UVI) and the Department of Planning and Natural Resources (DPNR), will conduct a comprehensive drainage study. The study will map all of the Territory's drainage features, integrate them into the resource management system, identify problem areas, and aid in the planning of future drainage improvements. The study will also take into consideration the effects of sea level rise and changes in rainfall amounts and intensity. Once complete, DPW will apply results of this study by developing a list of the physical improvements (e.g., culverts, concrete roads, guts, green infrastructure) needed and begin planning efforts for the identified improvements. Funding for the study is already available through FHWA's Every Day Counts program.

Initiative 18

Develop and implement asset and resource management system for all territorial roadways

No centralized on-island inventory of all roadway assets and building/repair resources in the Territory currently exists. Creating one will help ensure that maintenance projects are

scheduled on time and correctly prioritized, and that materials and labor are deployed more effectively and efficiently. DPW will create and maintain a GIS database for all roadways by developing an Asset and Resource Management System. This system will include the inventory of all roadway elements along with their condition, support the planning and performance of daily maintenance, and will also aid long-term resiliency by helping with planning and management of infrastructure improvement projects. As the system's specific components, DPW will utilize VIRAMS (Road Asset Management System) to monitor the condition of the Territory's roadways and perform and prioritize maintenance. Additionally, DPW will implement a resource management system (VUEworks) to track resources (manpower and costs) associated with all facilities, including roadways.

IMPROVE PREPAREDNESS AND POST-STORM RESTORATION

Some of the challenges that future storms will bring are predictable. These initiatives will help make sure that the Territory is better prepared for any damage and that it can recover more quickly if and when damage does occur.



Initiative 19

Update response plan for ports and airports to support restoration of critical baseline services after storms

Both ports and airports, when damaged in a storm, can restore their services only gradually, and it is important the restoration process prioritizes restoring critical baseline services as quickly as possible. The Governor's Office will work with VITEMA and VIPA to update response plans to support such prioritization.

Initiative 20

Institute a debris removal plan

After the 2017 storms deposited more than 850,000 cubic yards of debris on the Territory's roads, complete clearance took many months. Contributing to the length of the process was not just the volume of work, but also the need to sign contracts and to find staging locations for the debris that was collected. To expedite debris removal after future storms, DPW will work with the Department of Property and Procurement (DPP) to have debris removal contracts in place prior to the hurricane season. DPW, working with the Waste Management Authority (the agency responsible for disposing of debris disposal by mulching it, burning it, or shipping it off-island), will also identify debris staging locations and have necessary equipment on standby

(or equipment already identified and accessible on the mainland) so that future debris clearing operations can start and move as quickly as possible.

Initiative 21

Provide power backup source for signalized intersections

After the 2017 storms, traffic signals—even if they survived the storms intact or could be repaired quickly—were out of service for many weeks as power supply was being restored. DPW has considered the feasibility of using back-up battery power for signalized intersections to increase system resiliency. As such, DPW will standardize battery backup on all signalized intersections and install backups on all new intersections.

Initiative 22

Conduct temporary patching and emergency system repairs

After a major storm, certain types of road system repairs will likely need to be conducted. To accelerate such repairs, it helps to have a plan in place to perform temporary patching of infrastructure while more permanent solutions are being developed. DPW will work with the DPP to put emergency contracts in place prior to the hurricane season to ensure that emergency road repairs can be

performed more quickly than they otherwise would be.

Initiative 23

Update VIPA emergency plans to stockpile repair materials

VIPA's emergency repair process was at times hindered by lack of available materials. Securely stockpiling materials for emergency repairs would help prevent lead times and delays in making emergency repairs after another storm event. VIPA will update its emergency planning process to account for materials availability.

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WATER

When it comes to water supply, most of the USVI relies on rainwater collected in cisterns for household needs and on bottled water for drinking. Some hotels and communities run small systems for turning seawater into freshwater. About 25 percent of the territory's residents living on St. Croix, St. John, and St. Thomas are connected to the central water supply system that is run by the Water and Power Authority (WAPA). The system is fed by reverse osmosis plants on St. Croix and St. Thomas; it also includes tanks for storing the water and pumping stations for delivering it to customers through a network of pipes. The system's desalination plants are less than a decade old, but much of the distribution system is far older—with some pipes dating back to the 1940s—and therefore prone to leaks and easily damaged, including during hurricanes.

Hurricanes Irma and Maria affected all parts of the water supply system to different extents. The reverse osmosis plants lost power and were not working for two days on St. Croix

and ten days on St. Thomas. Storage tanks and pumping stations were damaged or even—in the case of one pumping station—completely destroyed. Distribution pipes throughout the territory were damaged by uprooted trees and utility poles. While the system never fully shut down, many customers experienced unpredictable supply interruptions, and it took WAPA a month to restore the system on all three islands to its normal functioning.

In the future, stronger (though not necessarily more frequent) storms will threaten all of the system's components, including RO facilities, storage tanks, pump stations, and distribution pipes. Higher average temperatures and possible longer dry spells may also drive up water demand.

Facing future climate risks will require hardening all components of the existing system (including rehabilitating old distribution pipes), expanding the system to serve isolated communities and to strengthen service on the western end of St. Croix, and better preparing for future

hurricanes through installing backup generators at major facilities, educating the public, and developing a water rationing plan.

HOW THE WATER SYSTEM WORKS

The U.S. Virgin Islands have little naturally occurring water. The majority of the islands' population uses cisterns to collect rainwater for general use and purchases bottled water for drinking. About a quarter of the population also has access to the water supply system that is run by WAPA. This system produces freshwater at reverse osmosis plants on St. Croix and St. Thomas through desalinating seawater and then distributes it through a network of storage tanks, pump stations, and pipelines. Some residents are also served by third-party water hauler trucks (see map: [WAPA's water system](#)).

WAPA water production

WAPA produces potable water for the territory at a rate of around 6 million gallons per day (MGD), supplying around 13,000 customers on St. John, St. Thomas, and St. Croix.

Water is first produced at reverse osmosis (RO) plants on St. Croix and St. Thomas that make potable water out of seawater.¹ On St. Croix, the two plants at the Richmond Power Plant can produce 3.6 MGD. On St. Thomas, the plant at Randolph Harley Power Plant can produce 2.3 MGD, with a maximum capacity of 3 MGD (see table: [Water infrastructure in the USVI](#)). All of the plants are owned and operated by Seven Seas Water, a private for-profit company established in the USVI in 1996.

From the tanks, pump stations move water into the mains that deliver the water to customers. The mains are old and fragile: many of the pipes are old ductile iron types installed as far back as the 1940s. As a result, leaks are a major problem: on St. Croix, approximately 30 percent of water is lost in the distribution system, and on St. Thomas, approximately 10 percent. Customer coverage is limited, too: on St. Thomas, only 45 percent of the island has potable water service, and the system has not yet been expanded to provide service to the western and northern parts of the island. On St. Croix, the system primarily serves Frederiksted and Christiansted. On St. John, which receives its water from St. Thomas via a reinforced underwater distribution pipe, the water system only serves Cruz Bay.

Rainwater cisterns

Approximately 95 percent of the territory's residents collect rainwater and store it in cisterns attached to their homes or businesses. These cisterns function as manmade wells, are privately owned and operated, and vary widely in capacity. Cisterns are generally one of two types: concrete holding tanks lined in waterproof coating and placed underground or plastic tanks that are either aboveground or buried. Rainwater is generally collected from a rooftop drainage system, which routes the water down to the cistern, from which electric pumps send the water into plumbing systems. Cisterns commonly provide all running water for homes, including toilets, sinks, dishwashers, washing machines and showers, but are generally not used for drinking water. In the event of a drought (or leak in the cistern tank), residents purchase water from WAPA to refill cisterns. Private water haulers deliver WAPA water in large tanker trucks and pump it into customers' cisterns; typically, customers pay the third-party water haulers both for the water and delivery, and the water haulers purchase the water directly from WAPA.

Cisterns are subject to contamination because they are generally not sealed and thus exposed to the environment. Rooftop intake drains are usually covered with a mesh screen to keep out larger animals and debris, but mosquitoes and frogs are frequent uninvited cistern residents. It is common practice throughout the territory to treat cistern water with a cup or two

	St. Croix	St. Thomas / St. John
Storage tanks	7	7
Storage capacity	20 MG	35 MG
Water mains	190 miles	420 miles
Reverse osmosis plants	2	1
Reverse osmosis production	3.6 MGD	2.3-3 MGD

Water infrastructure in the USVI

Once Seven Seas produces the water, WAPA treats it again and then sends it to storage tanks, of which there are seven in each system, with a total capacity of 20 MG (five and a half days of maximum production) on St. Croix and 35 MG (10-15 days of maximum production) on St. Thomas.

¹ The RO plants replaced an older and much less energy efficient process called multi-effect distillation (MED), which used heat and vacuum to boil the water and leave the salt behind, requiring four times as much energy.

of chlorine bleach to kill any bacteria, insects or animals, and potential pathogens. This bleach treatment is in line with CDC guidelines for the safe treatment of collected rainwater. More advanced treatment systems can effectively treat cistern water to produce clean, potable water, but these are typically expensive and thus less common; these include UV treatment and a variety of filtration systems.

Bottled water

Most Virgin Islanders rely on bottled water purchased in stores for their drinking water. On St. Croix and St. Thomas, WAPA or well water is re-filtered and bottled, and certified by the Department of Health for use. The use of bottled water in small bottles and jugs contributes to the territory's plastic waste problem.

Privately owned "small systems"

Because WAPA does not provide potable water in all areas, between 50 and 80 percent of the hotels and condominiums in the USVI produce their own water, usually by using small reverse osmosis units.

Regulation

Three main bodies regulate water in the USVI: the Department of Planning and Natural Resources (DPNR), Public Service

Commission (PSC), and the Department of Health (DOH).

DPNR and PSC regulate WAPA—the former on water quality, the latter on rates. DPNR's regulation under the federal Safe Drinking Water Act, which DPNR enforces on behalf of the Environmental Protection Agency (EPA),² requires WAPA to collect daily water samples from all parts of its system and to send them to its EPA-certified lab to ensure that the levels of turbidity (cloudiness or haziness of the water), pH (acidity), E. coli and other contaminants fall within regulated ranges. PSC's regulation sets WAPA's rates. The PSC also represents WAPA's consumers in any issues related to rates and terms of service.

DOH regulates bottled water resellers. It issues their permits and has the right to inspect their premises and either issue fines or retract permits if it finds any violations.

Finally, DPNR also regulates cisterns, water haulers, and well providers. At present, there is no system in place for cistern testing and inspection.

Funding, planning, and budgeting

The majority of WAPA's water budget comes from federal grants: the EPA provides 95 percent of WAPA's system maintenance and rehabilitation funding based on a needs survey that the agency conducts every four years. WAPA does not rely on

residential service revenue to any meaningful extent, as service fees are insufficient to support, maintain, and operate the system—let alone expand it.

WAPA has both a capital plan and a 20-year strategy plan that is about 25 percent accomplished. Capital projects are roughly 25 years behind schedule primarily due to funding issues: among other constraints, WAPA has no capital market access for the last 10 years. WAPA's deteriorating cash position has been a problem, too: when the authority contracts with vendors that require upfront payment, payment issues lead to project delays.

IMPACT OF THE HURRICANES

Hurricanes Irma and Maria affected nearly all water facilities across the territory to some extent. Both the public infrastructure and private facilities suffered storm and flood damage, and the extended commercial power outages also impacted the production, delivery, and availability of potable water. The initial response focused on plugging pipeline and tank leaks, as well as getting the service stations for water haulers back up and running. Water quality sampling restarted three days after the storms, and WAPA put its emergency water-monitoring plan into effect at each island's lab. Roadways blocked by storm debris, downed power and

² According to the EPA, "The Safe Drinking Water Act (SDWA) is the federal law that protects public drinking water supplies throughout the nation. Under the SDWA, EPA sets standards for drinking water quality and with its partners implements various technical and financial programs to ensure drinking water safety."

communications lines delayed WAPA's response and damage assessments across the territory for the first couple of weeks after the storms. Full restoration of the system was accomplished within a month.

Water production

Reverse osmosis plants need electricity to operate, and because the hurricanes led to territory-wide power outages, potable water production was halted on both islands. On St. Thomas, poor water quality resulting from stormwater run-off into Crown Bay from which WAPA pumps water for desalination was another constraint. The water system ran on reserves in storage tanks until water production was restarted 48 hours after Hurricane Maria on St. Croix and 10 days after Hurricane Irma on St. Thomas.

Storage tanks

On St. Croix, there were problems with tank damage as well as with topping tanks off before the storms. WAPA's hurricane plan requires the topping off because full tanks are not only essential for post-storm recovery but also help the tanks weather storms better. However, pumping issues and necessary repairs to the 5 MG Mountain Tank that serves the western end of St. Croix's distribution meant that St. Croix tanks were at roughly 75 percent capacity when hurricane Irma hit and at 50 percent when Hurricane Maria hit. After Hurricane Maria, the 5 MG Mountain Tank, 5 MG Kingshill Tank, and 2 MG Mon Bijou Tank were emptied to make repairs. Post-hurricane

mechanical failures at two of the main pump stations made it impossible to fill these three tanks, leaving the St. Croix system operating at 50 percent capacity for months after the storms. Storm debris also hindered access to the tanks, and while most were cleared within the first few days after the hurricane passed, debris limited access to one tank for nearly four months.



Damaged gauges on Richmond Tank on St. Croix; Source: WAPA

On St. Thomas, all of the storage tanks suffered some damage during the hurricanes. One of the tanks serving the Altona community lost its roof, but was still in service for a month after the storm. Another suffered weatherhead (overhead power line connection point) damage, leaving it without utility power. Yet another (Tank 3) was damaged and taken out of service in October 2017 due to a water quality issue and remained offline as of June 2018. All St. Thomas tanks had been filled prior to Hurricane Irma's landfall.

Pump stations

On St. Croix, Hurricane Irma did not cause any major systems damage, but the Concordia pump station was impacted and down for six to eight days. Hurricane Maria, however, caused significant damage throughout the system—especially due to its impact on power supply. The Richmond pump station—the main one on St. Croix—was the only St. Croix station not to lose power because underground power lines serve it. None of the other pump stations had backup generators though; nor did WAPA have agreements in place with contractors to purchase generators to supply emergency power. Even with electricity at the system's center, the Richmond station could not distribute water through the system to the other stations, which need power to pump water from the tanks to their gravity feeds.

On St. Thomas, the main pump station at Sarah Hill went offline during hurricane Irma when its generator tripped. Storm conditions made it too dangerous to attempt to reset it during the

storm—and, unlike on St. Croix, the water stored in St. Thomas tanks is not chlorinated until it leaves the tanks, so once the generator trips, WAPA cannot maintain chlorination and must shut down the system after four hours. As a result, the Sarah Hill system was shut down from 11pm on September 6 until it could be restarted around 6am on September 7. Several WAPA staff weathered the storm at the Sarah Hill facilities, enabling a quick restart to the system once it was safe for personnel to move about. On the east end of the island, underground power lines serve Donoe Pump Station that feeds the Donoe Tank and the underwater pipeline to St. John—so power to that station was restored quickly. Elsewhere on the island, every other pump station suffered some form of physical damage, and the Sototown station was completely destroyed. The stations also suffered from power outages as they were not equipped with backup generators.

Distribution system

On all three of the islands that the water system serves, the hurricanes' strong winds and torrential rain ripped trees and utility poles out of the ground, damaging the underground pipelines and creating many leaks. Soil erosion and caved streets damaged pipelines as well. In some instances, lines were severed completely, so pipes were sending water back into the sea. The pipelines on the western end of St. Croix suffered a particularly high number of leaks related to the storm.



Water leak on St. Croix
Source: WAPA

Service impact

On St. Croix, facilities have chlorinated tanks, so the water in the tanks was usable immediately following the storms even with power outages, but intermittent water service and distribution issues led to a boil-water advisory for several months. Districts at the highest elevations were most likely to be without service, with the system struggling to support any pumps requiring above 80psi. While the number of people affected overall is difficult to calculate, service was disrupted to nine of St. Croix's 13 districts. Hanging power lines and impassable roads hindered water haulers and WAPA personnel alike for the first two weeks following the storms. In one instance, FEMA requested water, but water trucks could not safely reach FEMA personnel. The water needs of the large cruise ship housing response workers docked in St. Croix's Frederiksted posed a strain on the system, too: Frederiksted pier is at the lowest elevation point and is served by the 5 MG Mountain tank (which was empty for repairs)

under normal operations, and Mountain tank is fed in turn by Kingshill tank. Because of the low tank levels and empty Mountain tank, once the ship started taking water, there was no other water in the system. Pumping water to the ship hindered the effort to fill Kingshill, leaving the residents on the western side of St. Croix with intermittent low pressure or no service for approximately two weeks after hurricane Maria.

On St. Thomas, nearly all the pump stations faced a lack of power—but because the tanks had been topped off before the storms they were able to keep the system running until the pump stations were back online, at least for those customers that could be supplied with gravity feeds. Many customers also experienced interruptions that were related to service line leaks from uprooted trees and debris removal.

On St. John, the water facilities did not suffer much damage, and an emergency generator kept the systems online. The biggest issue for St. John was the lack of communication as a result of the island-wide communications and power outages. Because the commercial interisland ferry service was not yet operating in the days after Hurricane Irma, WAPA personnel had to rely on federal assets to access the island. Despite the significant damage to St. John overall, the island still had water service during the storms.

On all three islands, response to storm damage was hindered by the absence of staff members who dealt with the storms' effects on their personal lives and homes, as well as by debris blocking roadways. The full restoration of the system in both districts was

accomplished within a month of the storms.

Impact on rainwater cisterns, wells, and small RO systems

Storm damage to home and business roofs and gutters left many cisterns unable to collect rainwater and unprotected from contamination caused by debris and storm surge water. The commercial power outage also meant most cistern pumps did not have power, so residents could only access collected water by hand dipping with buckets. Where residents and businesses relied on wells, lack of electricity halted access unless backup generators were available. Where—as in some hotels—small reverse osmosis systems were installed, storm water runoff into the bays interrupted water production, and storm damage to facilities and power outages caused problems as well.

Impact on bottled water

Most residents rely on bottled water for drinking; subsequently, bottled water was in high demand following both hurricanes. Residents had difficulty accessing bottled water as a result of short curfew windows, lack of electricity (which meant no credit or debit card transactions), and lack of access to cash (because banks could not process transactions).

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

Future climate challenges to the U.S. Virgin Islands include stronger and more frequent hurricanes, as well as rising sea levels, higher temperatures and decreased rainfall. All of these pose some threat to the potable water infrastructure of the USVI: hurricane winds rainfall and storm surge, as well as rising sea levels, represent a significant threat to infrastructure and service continuity, while higher temperatures and decreased rainfall pose moderate threats to water production and storage.

Hurricane winds, rainfall, and storm surge

Winds can destroy waters infrastructure located anywhere in the territory: in the 2017 hurricanes, at least one pump station was destroyed completely. Rains—together with wind—can damage roads and uproot trees, damaging water mains. Finally, storm surge presents a risk to facilities located near the coast: flooding can damage reverse osmosis plants and compromise electrical infrastructure in storage tanks and pump stations. It can also contaminate non-chlorinated tank water.

Rising sea levels

Rising sea levels do not pose a major threat for the system by themselves, at least at the levels predicted by the 2050s—but they do have the potential to worsen the effects of storm surge and threaten low-lying infrastructure that would not have been threatened before.

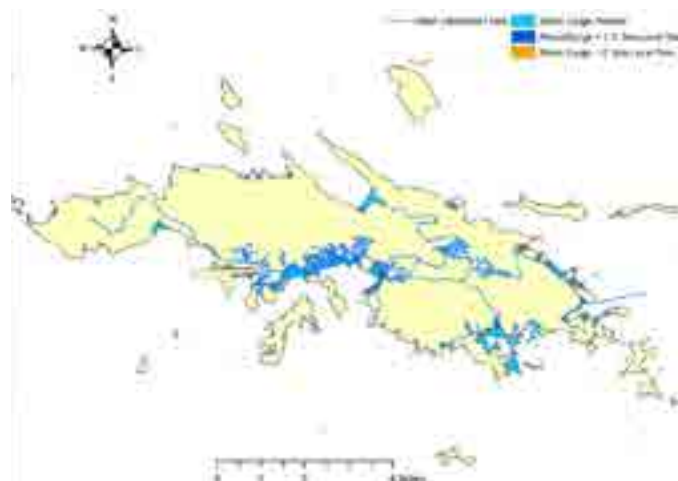
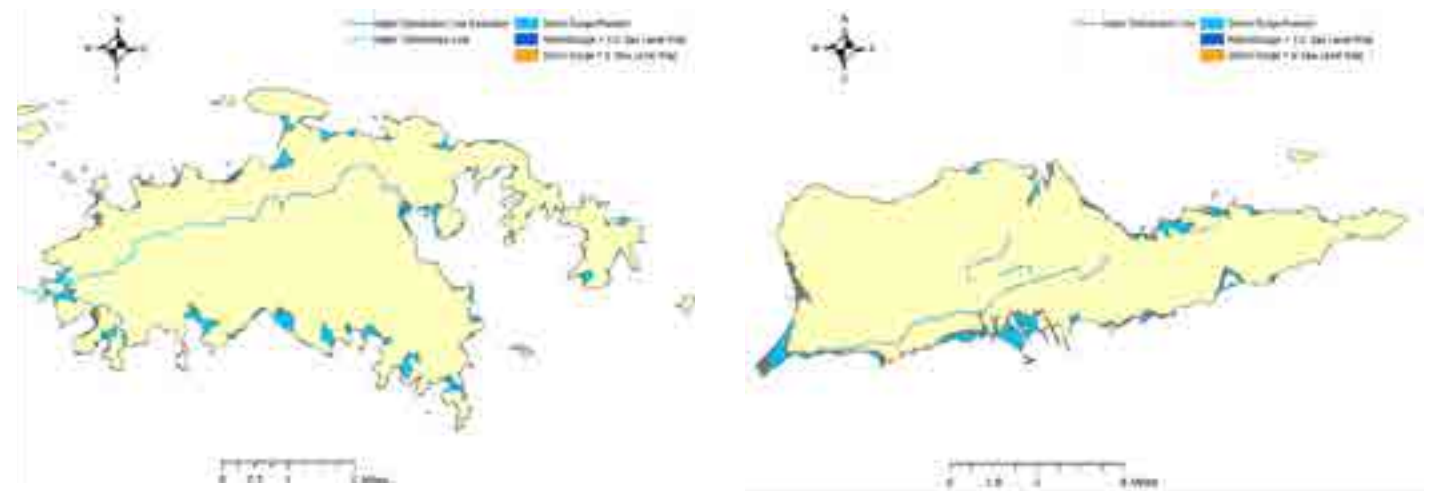


Figure 19 - Storm Surge for St. Thomas, Present, Predicted 50 year, Predicted 100 years



Storm surge for St. John, present, predicted 50 year, predicted 100 years

Storm surge for St. Croix, present, predicted 50 year, predicted 100 years

Temperature increase

Increases in average temperature will increase potable water demand across the territory. Additionally, higher average temperatures will increase the amount of stored water lost to evaporation both for WAPA and private residents.

Precipitation changes

Longer dry spells can create problems for residents relying on water cisterns and increase demand for water production at RO plants, as well as the services of water delivery trucks that will have to supply residents who run out of water.

INITIATIVES FOR INCREASING RESILIENCY IN WATER

Preparing for future climate risks to the territory's water supply will require hardening the existing system's infrastructure, expanding the system to better serve some of the existing communities and to include new ones, and better preparing for the inevitable disruption that future storms will bring.

HARDEN THE EXISTING SYSTEM

The first set of initiatives will harden the system that now exists, focusing on rehabilitating aging pipes in the distribution system, hardening all other water system components, and setting up a testing program for private cisterns in the territory.

Initiative 1

Harden and rehabilitate the existing distribution system

The majority of the water distribution system in the USVI is old ductile iron pipe installed as far back as the 1940s. These pipes have reached the end of their useful lives: the lines are fragile and, during and after the hurricanes, they were easily damaged by uprooted trees and water hammer effect when water pressure returned to empty pipelines.

WAPA will rehabilitate the existing problem areas using federal funds through a combination of pipe replacement and pipe inspection and repair to fix high rates of leakage. WAPA will also inspect and assess the distribution network to ensure that pipelines are minimally threatened by trees, roads and other infrastructure failure as well as work with the Department of Public Works to ensure that water mains running under and alongside roads are securely



installed. Finally, the utility will complete a Supervisory Control and Data Acquisition (SCADA) system to better control and monitor the distribution system.

Initiative 2

Harden and rehabilitate pump stations, storage tanks, and administrative buildings

During the 2017 hurricanes, pump stations, storage tanks, and administrative buildings proved vulnerable to physical damage and – in the case of one pump station on St. Thomas – complete destruction. To protect the pump stations and administrative buildings, WAPA, working with DPNR, will ensure that all pump stations and buildings are built or upgraded to highest hurricane codes. To protect the storage tanks, the utility will construct wind girders and seismic zone fittings to stiffen and strengthen

them. WAPA will also perform rehabilitation structural work on the Recovery Tank on St. Croix, which had not been rehabilitated in more than twenty years.

Initiative 3

Develop a cistern testing program

DPNR has the authority to test private water storage cisterns in the territory – but the department has so far not undertaken any large-scale testing. This makes it more likely that some cisterns will fail in future natural disasters, straining the WAPA system and increasing the demand for emergency water distribution. Considering the number of cisterns in the territory and DPNR's resources, conducting a test of all cisterns in the territory may not be feasible – but developing a program to test at least some cisterns is certainly possible, whether those would be cisterns in remote or low-income areas, cisterns above a certain size, cisterns of a particular type,

or some combination of these or other criteria. DPNR, working with the Governor's Office, will develop a cistern testing program that will strike a balance between the department's capacities and the need for cistern oversight.

EXPAND THE SYSTEM

Expanding the system will include better serving communities that the system serves now and adding new communities to it – as well as updating planning documents to better prepare for future demand.

Initiative 4

Expand the water system to serve isolated communities

After the hurricanes, water supply systems in some hotels and condominiums failed because of physical damage to water equipment, lack of power, or both. Water to those users had

Priority	Project	Cost, \$m
1	Nazareth Waterline Extension (St. Thomas)	\$4.7
2	Bolongo Waterline Extension (St. Thomas)	\$3.4
3	East End 16 inch Expansion (St. Croix)	\$1.7
4	Raphune Hill Bypass (St. Thomas)	\$4.6
5	Lovenland WL Extension (St. Thomas)	\$12.5
6	Fortuna (New Road Route) WL Extension (St. Thomas)	\$19.4
7	Pond Bay Line Extension (St. John)	\$3.1
8	Myra Keaton Clinic (St. John)	\$6.5
9	Coral Bay WL Extension (St. John)	\$26.4
10	Gallows Point WL Extension (St. John)	\$1.1
11	Northshore Extension (St. Croix)	\$3.2
12	Centerline Extension (St. Croix)	\$2.2
	Total	\$88.7

Proposed water distribution system expansion projects

to be hauled by truck, which was extremely difficult with roads blocked by debris. To address the issue, WAPA is considering several projects to extend the distribution system on all three islands that the water system serves. The total funding request to support these projects adds up to \$88.7m; which projects will ultimately get built will depend on the USVI Government's decisions about allocating FEMA's hazard mitigation funds that would fund these projects (see table: Proposed water distribution system expansion projects).

Initiative 5

Strengthen water infrastructure on the west end of St. Croix

On St. Croix, the west end of the island is supplied by the Kingshill Tank, which gravity feeds to Frederiksted. The tank went empty immediately after the storm, so it was difficult to fill the tank and maintain needed demand for customers in the west end of the island. WAPA will, subject to availability of funding, construct a main transmission line from Richmond Pump Station to Frederiksted in addition to connecting the north shore transmission to mid-island and western distribution. This would provide a duplicate means of getting water to the west end while creating loops in the system that would increase efficiencies. The authority will also add a 5 MG storage tank to feed Frederiksted in the event of a disaster.

Initiative 6

Develop a new distribution master plan

WAPA's distribution master plan is a long term planning document that outlines projects that need to be completed to address the system's future growth. The current plan is 31 years old and does not adequately address the system's needs. WAPA will develop a new distribution master plan.

PREPARE FOR HURRICANES

Regardless of the degree of preparation and hardening, future strong storms will cause at least some disruption – including to the territory's power system. The purpose of these initiatives is to reduce the impact of those disruptions.

Initiative 7

Install backup generators at all major pump stations

After the 2017 hurricanes, WAPA could not produce and distribute water at its full capacity because of the widespread power outages. Even when the main pump stations had power, many distribution pumps did not. WAPA will install, at all major pump stations, backup generators designed to withstand long runtimes and installed to automatically turn on during power outages. On St. Thomas/St. John the pump stations include: Donoe, Contant Knolls, Jail/

Tank 2, Bergrs Home, Altona, Savan, Vester Gade, Roberts Pump, Lindberge Bay, Estate Thomas, Havensight, Standpipe, and Sototown. On St. Croix, the stations include: Richmond, Contentment, Concordia, and Mt. Welcome.

Initiative 8

Develop a water safety public education program

After storms, residents might need to use water in ways that they are not normally used to – for example, by boiling water from WAPA's supply and by adding more bleach than usual to their cisterns. However, not all residents may know what exactly they are supposed to do and when. WAPA will work with DPNR to develop a public education program to explain to USVI residents what they need to do before and after storms to keep their water supply safe.

Initiative 9

Develop a water rationing plan

WAPA does not currently have a water rationing plan. After the 2017 hurricanes, when water supply was constrained, the absence of such a plan meant that for many communities having or not having water was a matter of chance. WAPA will work with VITEMA to develop a water rationing plan that will include the isolation of major valves to ensure communities are fed from assigned tanks at various times during the day in order

to conserve water. The plan will also include a communication component to make sure that, after a major storm, communities are aware of when they can expect water to flow.

Initiative 10

Develop a 72-hour pre-landfall playbook

Before a storm arrives, WAPA can take standard precautions to ensure maximum resilience afterwards. During the hurricane season, Water Distribution already operates with all tanks at 80 percent capacity with the ability to increase capacity to ensure all tanks are topped off 72 hours before a landfall. Additional measures can include ensuring that all backup generators are topped off and functioning as well as pre-landfall inspections of tanks and pump stations. WAPA, working with VITEMA, will develop a 72-hour pre-landfall playbook and integrate the steps in it into VITEMA's WebEOC platform. VITEMA will be responsible for making sure that the steps in the playbook are followed.

Initiative 11

Form water sharing partnerships with private facilities

Seven Seas' RO facilities are by far the largest in the territory, but they are not the only ones. In the event of future damage either to the facilities or to the distribution networks that they feed, it would be helpful to have additional water supply options – especially

in the more remote communities. WAPA will contact private facilities with reverse osmosis systems (hotels and resorts) to discuss forming voluntary partnerships to share water during emergencies, including potentially serving as distribution points for water haulers and residents.

SOLID WASTE AND WASTEWATER

Waste management infrastructure in the Territory consists of two systems: solid waste collection and disposal and wastewater collection, treatment, and disposal. Virgin Islands Waste Management Authority (VIWMA) manages both systems, but the two systems are distinct and separate: each requires a different labor pool, maintains unique equipment inventories, and supports its own networks of facilities. The infrastructure that supports both systems includes bin sites, transfer stations, and landfills for solid waste, and sewage pipes, pumping stations, and wastewater treatment facilities for wastewater.

Both systems operate under federal consent decrees as a result of past Environmental Protection Agency (EPA) and Federal Aviation Administration (FAA) violations and failure to meet requirements for federally-

mandated EPA programs, including the Clean Air Act, Clean Water Act, and Safe Drinking Water Act. VIWMA was created in response to consent decree stipulations in 2004¹ and is one of the territory's youngest agencies. Under these decrees, the agency is court-mandated to take steps to bring the systems into compliance, including by closing the Territory's two landfills by 2021 and by bringing wastewater systems' treatment and disposal to EPA standards.² The estimated cost for two new landfills exceeds \$21 million, while the estimated costs associated with the closure of both landfills based on unapproved designs is \$65 million.

Hurricanes Irma and Maria meant additional trouble for the already struggling systems. On the solid waste side, the storms created nearly 850,000 tons of debris that had to be collected and

processed and also damaged solid waste processing facilities. On the wastewater side, pump stations and sewer pipes were damaged, and wastewater treatment plants could not operate during the electricity outages, all of which led to raw sewage discharges into streets and water bodies.

In the future, stronger—though not necessarily more frequent—storms will pose risks to the system's physical infrastructure (especially wastewater pumping stations and treatment plants); storm surges—especially exacerbated by sea level rise—will threaten the system's low-lying facilities, and higher temperatures and changing precipitation patterns will make it more difficult to manage the Territory's landfills.

Preparing the system for future risks will include improve conducting detailed waste and wastewater system studies to

¹ U.S. Virgin Islands Public Finance Authority (PFA). \$94,000,000 VIRGIN ISLANDS PUBLIC FINANCE AUTHORITY Revenue Bonds (Virgin Islands Matching Fund Loan Note) Series 2004A (Senior Lien). December 1, 2004. DAC Bond Rating, U.S. Virgin Islands, St. Thomas. Accessed May 9, 2018. <http://www.usvipfa.com/PDF/OS/OS%20PFA%2004%20MF.pdf>

² U.S. Environmental Protection Agency (EPA). Office of Inspector General. Improving Environmental Programs: Conditions in the U.S. Virgin Islands Warrant EPA Withdrawing Approval and Taking Over Management of Some Environmental Programs and Improving Oversight of Others (Report No. 15-P-0137). By Bob Adachie, et al. April 17, 2015. Accessed June 13, 2018. <https://www.epa.gov/sites/production/files/2015-09/documents/20150417-15-p-0137.pdf>

better develop programs and allocate resources, hardening existing infrastructure of both systems (including strengthening buildings, access roads, perimeter fencing, and backup power and telecommunications systems), reconfiguring solid waste systems (including by closing the two existing landfills and adding new ones), reducing solid waste volumes (including by developing recycling and composting programs and by enforcing existing measures like the plastic bag ban), and modernizing and upgrading wastewater systems (including by eliminating some pump stations and providing backup pumps).

their solid waste to 20-cubic yard collection bins at roadside locations, to staffed convenience centers, or directly to landfills. 15 percent of the territory's homes have residential collection service, which is performed directly by VIWMA and contracted to permitted service providers. On St. Thomas, where narrow roads and steep terrain restrict vehicle maneuverability, home collection is limited to 3,500 customers. On St. Croix, with its flatter terrain, home collection serves three times as many homes. Businesses directly contract waste removal with permitted waste haulers, and business waste must conform to debris type, size and quantity restrictions.

VIWMA hauls waste from roadside bins and convenience centers daily to one of its two landfills—Anguilla Landfill on St. Croix and Bovoni Landfill on St. Thomas. Both landfills have violated federal laws and regulations for decades, both are major sources of local air quality pollution, and both are under consent decrees with the EPA

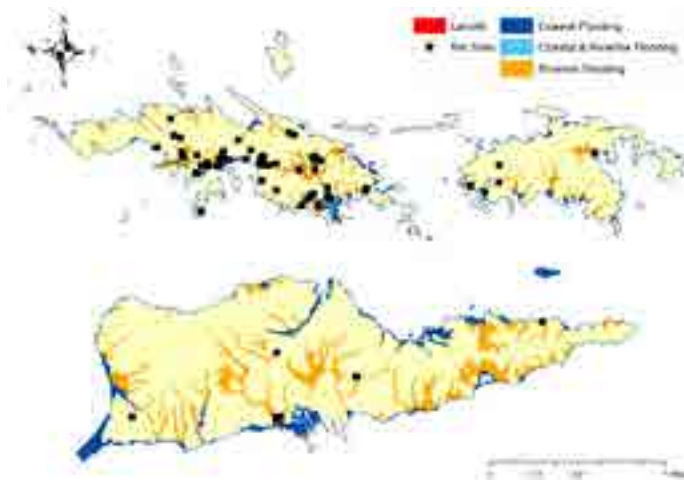
to close by 2021. The Anguilla Landfill is also under a second consent decree with the FAA because of its proximity to the Henry E. Rohlsen Airport and the resulting risk of bird strikes.³ As part of the closure procedures, waste going to that landfill is currently shredded, baled, and wrapped with plastic before being buried; this process will continue until an alternate disposal method is identified.

Adding to issues with the landfills is the fact that the territory has virtually no recycling and no composting. What little does get recycled has to be shipped off-island for processing, incurring transportation costs, as well as U.S. Customs and other agency inspections upon re-entry into the United States.⁴ The Territory is not permitted to burn wood and green waste, which adds to the total solid waste produced by the USVI and processed by VIWMA. The ban on burning green waste includes storm-generated vegetation waste.

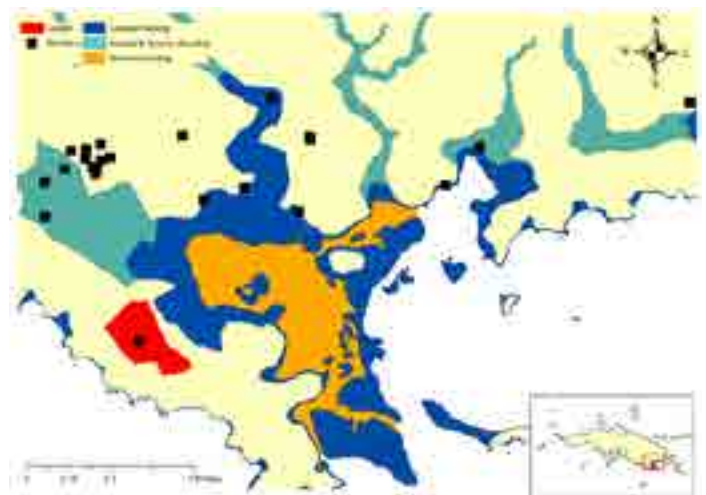
HOW THE SYSTEM WORKS

Solid waste

Most residents on St. John, St. Croix, and St. Thomas bring



VIWMA Solid Waste Assets



VIWMA Solid Waste Assets in Bovoni

³ U.S. EPA. Conditions in the U.S. Virgin Islands, 2015.

⁴ Jackson, Elizabeth. "Recycling Plastic in the US Virgin Islands: An Analysis and Proposal." Master's thesis, Duke University, Durham, NC, 2011. <https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/4944/MPPlasticUSVI.pdf>.



VIWMA Wastewater Assets



Mangrove Lagoon Wastewater Treatment Plant; Source: VIWMA

Wastewater

Wastewater, defined as “water that has been affected by human use,” requires transport, collection, treatment and disposal. More than 4.5 million gallons of wastewater is collected daily via more than 200 miles of public sewer lines (underground pipes) that deliver waste first to one of VIWMA’s 30 pumping stations and then to one of the authority’s eight sewage treatment plants (STPs) for processing and disposal. Of the eight plants, five are on St. Thomas, one on St. Croix, and two on St. John. VIWMA operates the wastewater system under a consent decree (originally filed in 1984 and amended in 1996) for Clean Water Act violations.⁵

Estimates of wastewater service coverage vary widely; VIWMA estimates the wastewater system serves between 30 and 60 percent of the Territory’s population. The population not served by the system uses private septic systems. These, when not properly constructed and maintained, can cause wastewater runoff, with



Bordeaux Wastewater Treatment Plant. Source: VIWMA

which the Territory has struggled for years because it contributes to surface water and groundwater pollution, threatens human health and environment, and can adversely affect tourism, the Territory’s leading industry.



Funding and regulation

VIWMA is funded primarily through the Government of the Virgin Islands General Fund and Special Fund. Some revenues are collected from end-user sewer connections, waste hauler permits, and special waste disposal permits, as well as from fines and penalties collected for compliance violations. Landfill

⁵ “Wastewater.” Virgin Islands Waste Management Authority (VIWMA). Accessed May 23, 2018. <http://www.viwm.org/index.php/post-formats/wastewater>.

closure costs, estimated at \$65 million, remain unfunded.

At the federal level, VIWMA falls under environmental regulations set forth by the EPA as well as the FAA, which regulates landfill height near airport facilities, particularly at the Anguilla Landfill near St. Croix's Henry E. Rohlsen Airport.

The authority provides service on four islands—St. Croix, St. Thomas, St. John and Water Island—pursuant to Act No. 6636, 29 V.I.C. § 494 et seq.⁶ VIWMA's statutory duties mandate that it dispose and manage all waste. The authority is subject to USVI code and federal laws, including the Clean Air Act, 42 U.S.C. § 7401 et seq., as well as U.S. environmental and federal codes.

IMPACT OF THE HURRICANES

Hurricanes Irma and Maria generated unprecedented levels of debris, which impacted both the solid waste and the wastewater systems. Damage and high waste volume overwhelmed the infrastructure of both systems, which were already susceptible to breakdowns as a result of inadequate funds for expansion and maintenance. Lack of electrical power also caused system failures for both systems and especially for wastewater.



Debris lines St. Thomas roadways after Hurricane Irma.
Source: Kelsey Nowakowski

Debris clearance

The hurricanes generated more than 825,000 cubic yards of debris.⁷ The authority increased collection by 1,200 percent to stay apace of bin-site disposal, but debris management was complicated by limited capacity at both the Anguilla and Bovoni Landfills and the Susannaberg Transfer Station on St. John, by delayed access for waste collection in residential communities that resulted in mixed debris at bin sites, by unauthorized, makeshift sites, and by the dumping of non-permissible items (e.g. appliances, furniture, and large batteries) at the authorized sites that were not monitored.

To support debris management operations, a Joint Debris Task Force consisting of local and

federal agencies was established in the immediate aftermath of the storm. The Task Force included federal partners such as FEMA, U.S. Army Corps of Engineers (USACE), and the EPA. USACE in particular oversaw the hurricane emergency sites for collected hurricane debris such as galvanized roofing material and green waste. Most of these materials will ultimately be shipped off-island, while some green waste will be made available to farmers and the general public for farming purposes. In addition to the agencies that assisted with land-based debris, U.S. Coast Guard's ESF-10 Unified Command worked with the USVI Department of Planning and Natural Resources (DPNR) to clear or recover 479 sunken vessels and mitigate associated pollutants from USVI waters at a cost of \$39.7 million, funded by FEMA.⁸

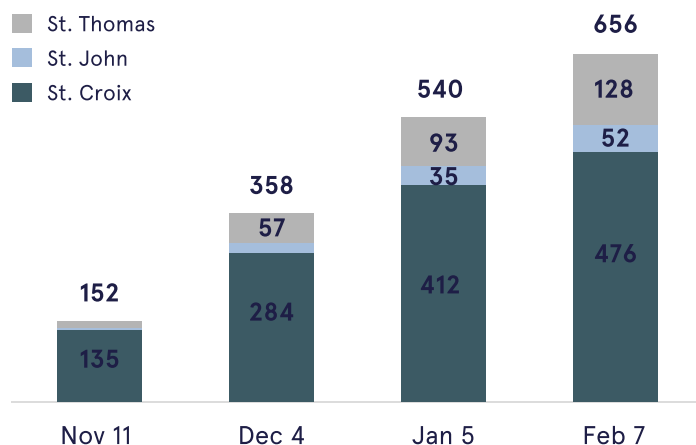
By February 2018, debris management operations had recovered nearly 700,000 cubic yards of debris, with most of it coming from St. Croix (see chart: [Volumes of debris collected by island](#))



⁶ U.S. Virgin Islands Code, Chapter 29 Virgin Islands Waste Management Authority-494-500 (2018 Office of the Code Revisor, Legislature of the Virgin Islands 2004). <https://advance.lexis.com/api/document/collection/statutes-legislation/id/56WP-9S91-6G1M-9115-00008-00?cite=29 V.I.C. %C2%A7 494&context=1000516>

⁷ "Community Development Block Grant Disaster Recovery Action Plan," United States Virgin Islands Housing Finance Authority, May 25, 2018. <https://www.vihfa.gov/sites/default/files/reports/USVI%20Action%20Plan.pdf>

⁸ The Historic 2017 Hurricane Season: Impacts on the U.S. Virgin Islands, Committee on Oversight and Government Reform Subcommittee on Interior, Energy & Environment, U.S. House of Representatives Cong. (2018) (testimony of William Vogel, Federal Coordinating Officer, Federal Emergency Management Agency, U.S. Department of Homeland Security). <https://www.fema.gov/media-library-data/1520864620524-9693103dc666209f01995f2dba052e96/FINALFEMA.pdf>



Volumes of debris collected by island; Thousands of cubic yards;
Source: CERES



Damage to wastewater treatment plant, Mangrove Lagoon.
Source: Geoffrey Watson/VIWMA

Impact on solid waste infrastructure

Winds damaged St. Croix's Anguilla Transfer Station's rollup doors and floods damaged site pavement. On St. Thomas, Mandahl Convenience Center's rollup doors were wind damaged, exposing its compactor motor to flooding. Flooding also cracked the facility's cistern walls and caused a landslide behind the facility's office. VIWMA lost servers and other equipment to flooding and wind-blown rain and debris. Commercial power outages and damaged cell towers

made VIWMA's communication between islands and on each island virtually non-existent. Satellite phones were the only reliable communication method, while some radios with adequate relay tower coverage provided backup.

Wastewater facility and system impact

The storms affected all parts of the system infrastructure. Major pump stations were damaged, including Cancryn on St. Thomas, and Fig Tree and LBJ Pump Stations on St. Croix (the latter of which serves all of Christiansted). Treatment plants lost power, which resulted in untreated sewage discharge into guts and receiving waters. Flooding and storm debris blocked sewer lines and caused manholes to overflow, adversely affecting the pump stations and wastewater treatment plants that were still functioning. On St. Thomas, mudslides washed away sewer lines at Brookman Road, Foothills, and Anna's Retreat. Raw sewage was discharged into streets and water bodies, creating potential for contamination.

Following the storms, VIWMA undertook repairs and replaced and added equipment to reach a minimal level of service. As of May 2018, restoration at wastewater facilities was still ongoing. The Vessup Bay (Nazareth) STP was taken off-line due to structural inadequacies; as a result, sewage had to be hauled for treatment to the Mangrove STP. George Simmons STP on St. John was not providing a significant treatment level as the treatment module was aging and worn-out, with significant process and operational deficiencies. All the other facilities currently in use were online and functioning, even though further repairs would be required.

Costs and federal assistance

As of May 2018, damage to the territory's solid waste system totaled at least \$10.5-12.6 million, while damage to the wastewater system totaled \$3.5-11.9 million (see charts: [Damage to solid waste facilities](#); [Damage to wastewater system](#)). Some of the damage would be eligible for EPA funding through the Water Infrastructure



Storm debris and waste in a residential area, St. Thomas. Source: Beth DeFalco



Damaged sewer lines at Anna's Retreat, St. Thomas
Source: Geoffrey Watson/VIWMA

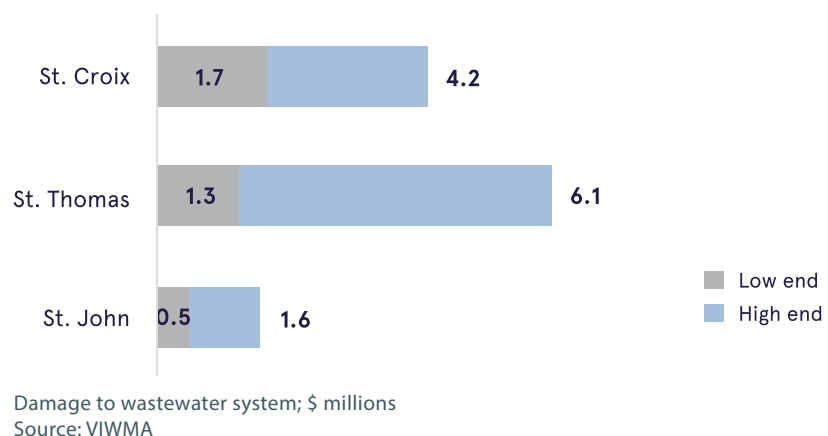
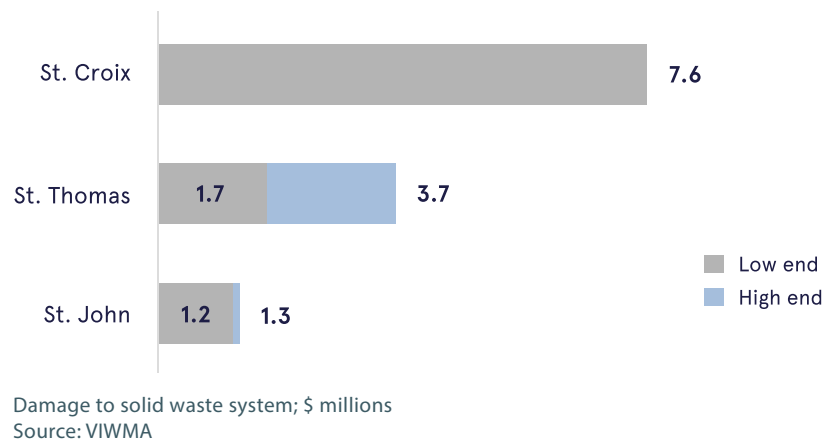


Crew repairing broken sewer line, St. Thomas.
Source: Geoffrey Watson/VIWMA

Finance and Innovation Act (WIFIA) program, which includes support for wastewater conveyance and treatment projects.⁹

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

In the future, stronger hurricanes will create large volumes of debris and potentially overwhelm the waste management system. They will also threaten all parts of solid waste and wastewater infrastructure. Rising sea levels will present a risk to low-lying facilities. Temperature increases and changes in precipitation may make it more difficult to manage landfills.



⁹ Environmental Protection Agency. Region 02. "EPA Announces New Funding for Water Infrastructure Projects in the U.S. Virgin Islands Funding Will Leverage Public and Private Investments to Keep Lead and Other Contaminants out of Drinking Water and Upgrade Aging Water Infrastructure." News release, April 5, 2018. U.S. Environmental Protection Agency. Accessed May 15, 2018. <https://www.epa.gov/newsreleases/epa-announces-new-funding-water-infrastructure-projects-us-virgin-islands>.

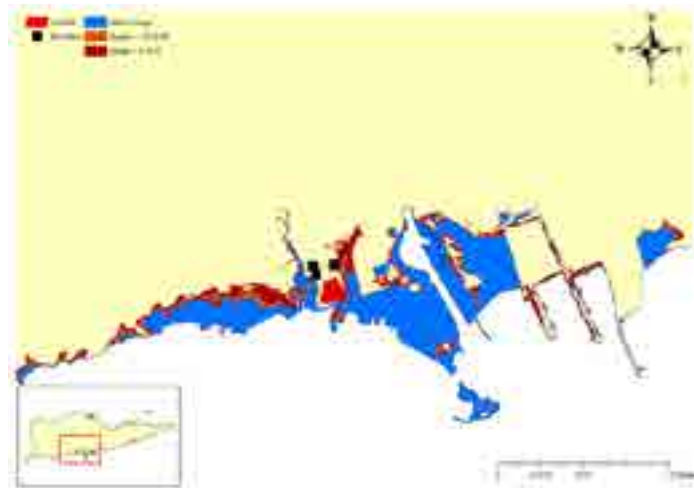
Hurricane winds, rainfall, and storm surge

Stronger or more frequent storms will generate more hurricane-related debris, which is the largest threat to the waste management side of VIWMA. The authority's structures in higher elevations and exposed areas may suffer destruction from direct impact of the wind or by flying debris such as utility poles, trees, and detached building parts (which can cause greater damage

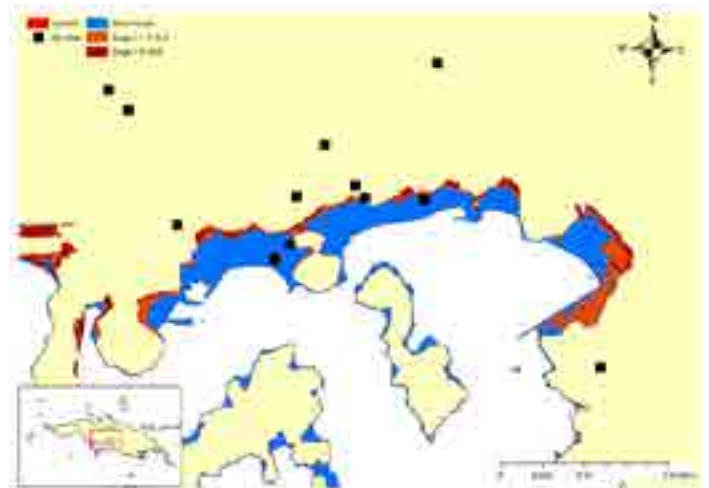
and injury than wind alone). Additionally, there is limited capacity left in the landfills, and both landfills are set to close between 2020 and 2021. In the system's current state, additional storms would cause a solid waste crisis. Currently, EPA Region two is working with the USVI on approvals necessary to construct new landfills.

On the wastewater side, all VIWMA pump stations and wastewater plants are vulnerable to wind and debris damage as well, especially since these

facilities were built decades ago to less stringent building codes and have not been well maintained. Another risk is that combined storm water and wastewater infiltration from heavy hurricane rainfall will overburden the sewer system—which, like all wastewater systems, is not built to process heavy rains.



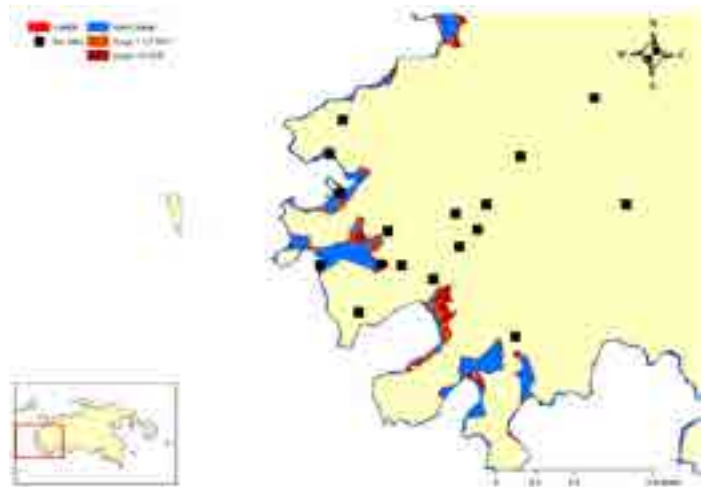
Storm Surge for Waste Assets on St. Croix, Present, Predicted 50 year, Predicted 100 years



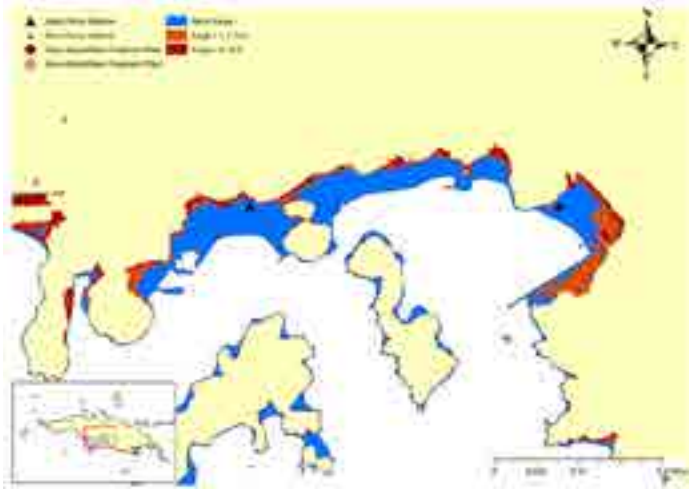
Storm Surge for Waste Assets on St. Croix, Present, Predicted 50 year, Predicted 100 years



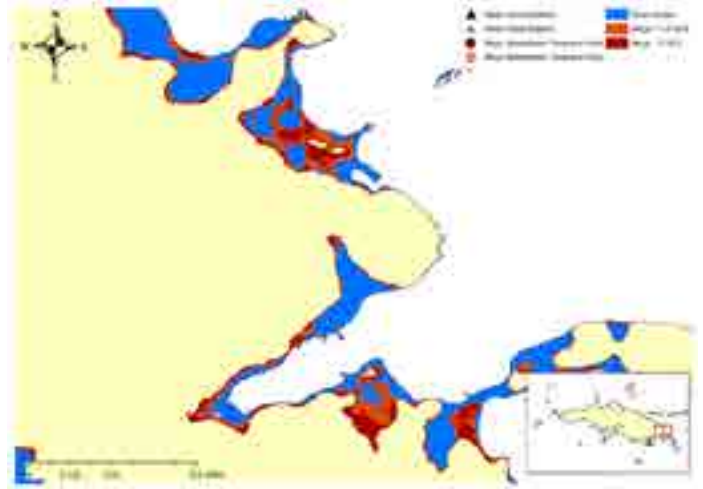
Storm Surge for Waste Assets on St. Croix, Present, Predicted 50 year, Predicted 100 years



Storm Surge for Waste Assets on St. Croix, Present, Predicted 50 year, Predicted 100 years



Storm Surge for Waste Assets on St. Croix, Present, Predicted 50 year, Predicted 100 years



Storm Surge for Waste Assets on St. Croix, Present, Predicted 50 year, Predicted 100 years

Rising sea levels

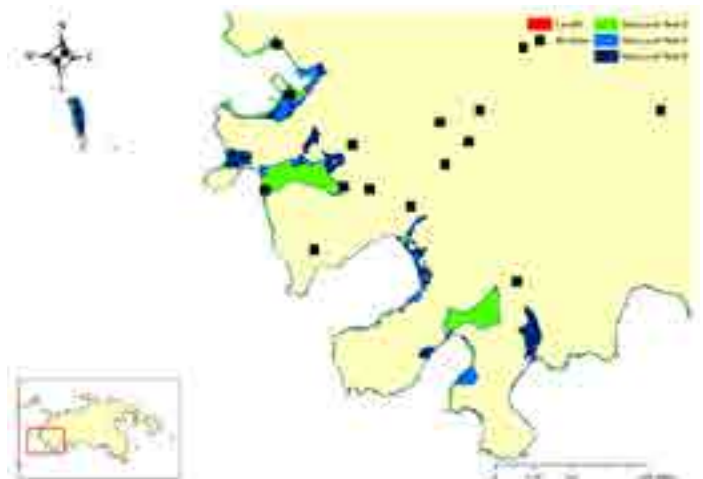
Rising sea levels will threaten low-lying facilities, which will be at

risk of more frequent flooding and equipment failures. Exposure of any electrical system to salt air or saltwater will result in shortened

life spans and system failures, thus requiring more frequent replacement.



VIWMA Wastewater Assets at Risk for Sea Level Rise



VIWMA Wastewater Assets at Risk for Sea Level Rise



FIGURE 33 - VIWMA Wastewater Assets at Risk for Sea Level Rise

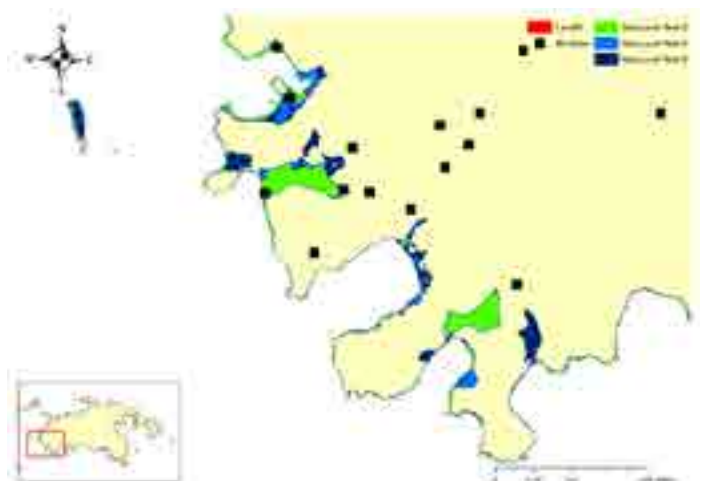


FIGURE 34 - VIWMA Wastewater Assets at Risk for Sea Level Rise

Temperature increase

Increased temperatures will leave motor control units and electrical components more susceptible to overheating and failure, so VIWMA facilities will need more robust cooling systems. Landfills will also be more prone to solid waste fires, resulting in air pollution and hazardous working conditions for VIWMA personnel (although removing current and eliminating future green waste in landfills will help lower the fire risk).

Precipitation changes

A reduction in precipitation will create drier conditions at the landfills, creating greater dust problems and increased potential for fires. Vegetative ground cover on the landfills will also require irrigation to thrive in a drier climate, be replaced with vegetation requiring little water, or mulched with processed green waste to reduce water evaporation and retain moisture.

INITIATIVES FOR INCREASING RESILIENCE IN SOLID WASTE AND WASTEWATER

VIWMA's plans for improving solid waste and wastewater systems include conducting detailed waste and wastewater

system studies, hardening existing infrastructure of both systems, reconfiguring solid waste systems by closing the two existing landfills and adding new ones, reducing solid waste volume by developing recycling and composting programs, and modernizing and upgrading wastewater systems.

CONDUCT WASTE AND WASTEWATER SYSTEM STUDIES

VIWMA can better learn from and assess the system impacts and negative outcomes of the catastrophic 2017 hurricane season by conducting comprehensive studies and system evaluations. These assessments will be used to develop new, more resilient standards and help inform better emergency operating procedures.

Initiative 1

Perform waste categorization study

VIWMA would benefit from a waste characterization study in order to determine the volume of potential waste reduction and recycling efforts. The authority will collaborate with the EPA and related agencies to facilitate such a study. The study would provide insight on increasing both systems' processing capacity, developing sustainable waste disposal practices in accordance with EPA standards and best practices for island nations, developing recycling and composting programs and creating more robust, updated

facility standards to manage waste in the territory. VIWMA will work with its engineers, the EPA, and partner with waste specialists as needed in order to complete the study.

Initiative 2

Conduct rigorous inspections of wastewater infrastructure

VIWMA will conduct an internal pipe inspection. The review of the system will identify all pipe failures, joint failures or pipe blockages, which will be repaired to reduce system infiltration and discharge. These efforts will reduce the amount of non-wastewater conveyed and treated by the wastewater system, which will in turn reduce damage to the pipes by controlling the peak flow. It will also reduce the volume of flow being handled by the pump stations and wastewater treatment plants.

Material needs for this repair include pipes, couplings, gaskets, bolts for force, and main and gravity lines. All manholes will be inspected for infiltration and sealed or repaired to eliminate further infiltration. Manhole access lids subject to surface flooding will be elevated, moved out of the surface flooding area, or sealed to prevent infiltration. These measures will reduce damage to the facilities, as well as operations and maintenance costs to the VIWMA. Costs to perform this task on all three islands are estimated at \$1,625,000.

Initiative 3

Execute telemetry study and develop remote monitoring capabilities

Conducting a telemetry study of the current state of the wastewater system will establish a baseline to developing the ability to remotely monitor the system for failures. Implementing remote control and monitoring capabilities will also reduce impacts of power loss, generator failure or pump failure at the pump stations. While staffing and technical capabilities will first need to be evaluated and updated in order to achieve this level of service, these measures will also enable immediate response to pump failure at one station and mitigate impact to upstream or downstream stations. Estimated costs for telemetry, controls, and monitoring—including three EOCs—total up to \$48.1 million.

Initiative 4

Develop a maintenance plan for wastewater systems and infrastructure; link it to financial planning

The results of the studies and inspections described above will help VIWMA develop an ongoing maintenance plan for its systems and infrastructure. This plan will be essential for VIWMA's financial planning moving forward, in order to ensure funding to maintain sufficient staff, materials, and related fees associated with

following the maintenance plan. The financial mechanism could include a system for collecting solid waste tipping fees and service fees for wastewater treatment. Financial planning and maintenance planning should occur concurrently in order to develop a more sustainable financial infrastructure for the wastewater treatment arm of VIWMA.

HARDEN EXISTING VIWMA FACILITIES AND INFRASTRUCTURE

VIWMA will harden existing facilities and protect both systems from flying debris with enclosures rated to 200 mph. Existing perimeter fencing will be upgraded—including burying enhanced strength poles deeper in addition to installing hurricane-resistant fencing.

Initiative 5

Update VIWMA facilities

VIWMA will upgrade its facilities to poured, in-place concrete or filled concrete block walls to reduce the repeat damage from multiple events and provide better protection to the equipment in the buildings. VIWMA will also assess flood risks to facilities in low-lying areas and work to elevate or relocate those facilities to higher ground. All windows and doors will be fitted with storm shutters and replaced with 200 MPH glass and frames; hardened facilities will also provide and serve as a

haven for VIWMA operators while on-site.

Initiative 6

Strengthen access roads to wastewater pumping stations

Many pumping stations are served by roads that are in poor condition, compromising access especially after storms. VIWMA will pave access roads and parking areas with all-weather, non-erodible materials for access during flooding and enhanced traction at a cost of approximately \$0.8 million.

Initiative 7

Upgrade perimeter fencing around wastewater facilities

Fencing around wastewater facilities protects them from flying debris – but much of it was damaged in the 2017 storms and much had not been built to withstand Category 5 winds. VIWMA will upgrade perimeter fencing to include enhanced strength poles and increased depth of bury—implanting the AFTEC hurricane-resistant concrete fence or one similar. The total cost of the measure will be approximately \$2 million.

Initiative 8

Procure and install backup generators at landfills, pumping stations, and wastewater treatment plants

On the waste management side, VIWMA will procure and install on-site, robust and appropriately scaled backup power generators as a failsafe for commercial power loss at the landfills. The estimated cost for the on-site generators for the landfills is \$83,200 each.

VIWMA will also place one trailer-mounted backup power generator on St. Thomas, St. Croix, and St. John (three total) to support critical systems at the largest pump stations and wastewater treatment plants in the event that both primary and secondary power systems fail. Sufficient backup power will reduce the damage to facilities and the environment by providing on-site power redundancy. Each unit will be adequate to power the landfill or transfer stations. These trailer units will be stored in a facility designed to protect and extend the life of the units. To prevent generators from running out of fuel during future outages, as these outages cause pump stations to stop functioning at intervals, all tanks will be filled to capacity prior to storms and re-fueling tanks will be established nearby. This mitigation effort will require \$150,000 per unit for purchase and assembly.

Initiative 9

Procure and install solar and battery backup power solutions

To ensure power redundancy and reduce demand on on-site generators and commercial power, VIWMA will equip each site with solar and battery backups for controls, lighting, and safety items at each facility. Estimated costs for solar and battery power backups are \$0.6 million for 30 installations.

Initiative 10

Improve and harden VIWMA communications and technology systems

To address the communications issues that arise during a storm, VIWMA will procure and equip personnel with communication devices designed to operate during and after disaster events in order to facilitate communication throughout the territory. VIWMA will procure: 10 satellite phones to serve upper-level staff, 23 single side band (SSB) radios to support field crew coordination, and one Antron 99/RG8X CB Base Station per island (three total). The anticipated costs for satellite phone and radio implementation, including installation of the three radio Base Stations, is \$22,050.

To protect its data, VIWMA will implement virtual file servers and cloud storage. VIWMA began the process in 2016, but the process was not completed before the 2017 hurricanes. Costs for an Azure

Backup system with a license for St. Thomas and St. Croix are \$21,150.

As a complement to new equipment purchasing for waste flow solutions addressed in a separate initiative below, VIWMA will seek to purchase a new technology system to track and monitor waste flow, and institute a computerized ticketing system for scales.

RECONFIGURE SOLID WASTE SYSTEMS FOR EPA COMPLIANCE AND RESILIENCY

The USVI's two existing landfills are at the end of their lifecycles, which provides the territory an opportunity to approach solid waste with a renewable and sustainable mentality. Programs to cut down on solid waste production, develop a recycling program for non-biodegradable plastics and metals, and create a composting mechanism will benefit VIWMA, local businesses, and residents alike. These programs should be developed as part of a cross-agency collaboration and include the unique challenges created by the Territory's limited land and massive tourist influxes; however, the infrastructure must be implemented before legislation and the programs are enacted in order to ensure the long-term success of a new, sustainable approach to solid waste. Likewise, public education and incentives for individuals and businesses alike will be essential for a sustainable waste program in the USVI. Some of these programs

also have distinctive revenue-generating potential for VIWMA, and this potential should be evaluated and included in the Authority's financial planning moving forward.

Initiative 11

Close existing Bovoni and Anguilla landfills

Both the St. Thomas Bovoni and St. Croix Anguilla landfills are over capacity and must be closed by 2021 in order to meet EPA mandates. As part of the process to close the landfills, organic materials should be removed from the landfills and utilized in organics diversion programs such as composting, as this effort will increase the lifespan of the landfill and decrease the sites' methane gas generation. Reducing the amount of methane produced by the landfills will also lessen the sites' risk of fire as ambient temperatures rise.

In 2017, a VIWMA engineering consultant estimated a combined total closure cost for the two landfills of approximately \$65 million, a figure subject to further review depending on technical reports currently underway, and which requires design approval by the U.S. Government (EPA/U.S. Department of Justice). This design has not yet been approved; however, the U.S. Government and the USVI are exploring other closure alternatives for the two landfills that could also efficiently address the Consent Decree landfill cap and gas collection system requirements with cost estimates of around \$38 million.

Initiative 12

Plan and build additional landfills

The solid waste system's biggest challenge is creating a comprehensive plan for disposal and funding the plan once landfills are closed. According to the Community Development Block Grant Disaster (CDBG) Recovery Program Action Plan, the cost to develop two new landfills is estimated to exceed \$21 million.

Prior to developing new landfills, VIWMA's solid waste program must be approved by the EPA, in addition to gaining approval of the sites for future landfills. VIWMA is working to identify property that meets all EPA requirements, as well as funding for landfill development. This will require purchasing 24 acres on St. Croix at \$350,000 per acre, or \$8.7 million total, and constructing ancillary facilities at \$644,000 for a total of \$9 million. On St. Thomas, this will require purchasing 25 acres at \$350,000 per acre, or \$8.7 million, and acquiring an existing 60 acres at \$50,000 per acre or \$3 million as well as constructing ancillary facilities at \$257,600, for a total of \$12 million. The transfer station on St. John also requires an upgrade for its ancillary facilities, which is estimated at \$644,000.

Initiative 13

Increase the number of vehicles in the waste collection and hauling fleet

VIWMA will increase the number of its fleet vehicles (trucks, backhoes, chippers, and mobile compactors) in order to increase waste hauling service capacity, including trucks that can collect source separated recyclable materials. Some of this is the same equipment necessary for a composting program. Balers and chippers/tub grinders are essential elements of a sustainable materials management program. Balers can be used to compact almost anything including metal, tires, plastic, cardboard, etc., thus reducing storage footprint, fire hazard, vector-borne disease transmission, and contamination from other materials, as well as facilitate ease of transport. Chippers and tub grinders also reduce the volume of vegetative debris and produce a valuable commodity that can be used for landscaping, compost, erosion control and, eventually, alternative daily cover. Optimizing and collocating this multi-use equipment would increase the benefits and value of the equipment while spreading the cost and simultaneously enhancing solid waste management, recycling, and composting programs.

The projected cost of additional vehicles and fleet assets is approximately \$3.5 million (see table: [VIWMA vehicle acquisition plans](#)).

Quantity	Vehicle type	Cost
5	Roll On/Roll Off Trucks	\$875,000
4	Grapple Truck with Dump Capability	\$520,00
4	Rear Loaders	\$800,000
20	Cubic Yard (CY) Dump Truck	\$225,000
1	Hopper and Compactor Assembly for Transfer Station	\$275,000
1	Scale Hhouse and Scale Assembly for Transfer Station	\$320,000
3	Skid Steers with Attachments	\$120,000
20	6 CY Dumpsters	\$8,000
30	20 CY Dumpsters	\$150,000
30	30 CY Dumpsters	\$240,000
20	40 CY Dumpsters	\$200,000
20	Compactors	\$240,000

VIWMA vehicle acquisition plans

Reduce solid waste volume

Reducing the amount of waste the territory produces is critical for future success. As noted previously, VIWMA should first conduct a waste characterization study in order to establish effective, efficient initiatives for the collection and use of solid waste such as organics. VIWMA proposes three types of centers to mitigate waste volume, as well as enforcement of current programs. Recycling and composting programs are part of this effort.

Initiative 14

Convert waste collection sites and improve collection facilities

First, VIWMA will convert unsupervised bin sites to enclosed, Staffed Bin Site facilities that will offer the benefit of sorted waste, which can then be routed to appropriate channels for recycling or baling. This will reduce both landfill and environmental impact, and possibly offset costs

for waste streams with some commercial value (e.g. scrap metal). Estimated costs for three sites on St. Croix, four sites on St. Thomas and three sites on St. John total \$14.6 million.

Second, current Staffed Bin Sites will be upgraded to Convenience Center concept facilities, which would also provide waste sorting to reduce impact on the landfills and environment, with the added features of compacting. Estimated cost for converting these centers is \$3.2 million each, for a total of \$33 million.

Third, each island will have a Recycling Convenience Center for recycling, compacting, baling, and wrapping each waste stream prepared for transport off-island, reuse centers or landfills. Estimated costs for Recycling Convenient Centers, including property, are \$14.3 million. This project would still require seven Convenience Centers at \$23 million, for a project grand total of \$37.3 million.



Initiative 15

Mandate a territory-wide recycling program

VIWMA will identify options for on-island recycling market development and implement scalable source separation recycling programs, robust enough to meet demands in disaster events. As part of this initiative, VIWMA will work with the Governor’s Office and V.I. Legislature to draft legislation mandating a territory-wide recycling program to be implemented either by VIWMA or a third-party vendor selected via a competitive request for proposal process. VIWMA will also work to increase community and public awareness of current recyclable materials and procedures, including partnering with relevant non-profit and non-government organizations (NGOs) as appropriate.

One part of an effective territory-wide recycling program would include a curbside recycling collection program. Public education efforts will also need to include clear guidelines on acceptable materials for disposal and identify banned and unacceptable materials; VIWMA should also consider a bottle deposit or recyclable metals purchase program to encourage public and local business involvement. Related efforts might include promoting the use of bulk water dispensers over individual plastic water bottles. In order to develop sufficient funding to manage and maintain a recycling program, VIWMA should also consider advance disposal fees.

Initiative 16

Designate recyclables monofills

Recyclables that are collected need to be processed—and for many recyclables that can be collected in the USVI, the necessary markets and/or facilities need to be either found or developed locally. Until then, monofills—landfills used for only one type of waste, in this case recyclables—may be necessary as they would allow the territory to begin a recyclables collection program sooner and then permit the authority to mine commodities either when markets are favorable or the territory has developed secondary uses for the materials. Use of monofills should be weighed against its potential impact on building recycling compliance, which becomes more difficult if recyclables are known to end up in a landfill—even if that landfill is a separate one and even if the landfilling is, ostensibly, only for some time.

Initiative 17

Develop organic waste processing program

The USVI does not currently have a local program for managing, disposing of, or utilizing green waste (organics), which comprises an estimated 30 percent of the territory's solid waste.¹⁰ VIWMA should coordinate with the Department of Agriculture at the

University of the Virgin Islands (UVI) to develop a composting and organics reuse program. The startup costs for composting green waste are lower than recycling; besides, composted materials can be processed and utilized in the USVI to improve the quality of topsoil, increase agricultural cultivation, and minimize erosion in at-risk areas. Additionally, eliminating the need to ship organics off-island would cut a significant cost for VIWMA—and even potentially turn into a revenue stream as composted materials could be resold in the territory.

Initiative 18

Mandate specific materials for reuse; develop alternate uses for scrap tires

VIWMA should also consider additional internal programs to eliminate problematic waste such as tires. In the Marianas, scrap tires were baled and coated with gunnite, then used as barriers surrounding landfills. Long-term recycling and reuse programs for tires could also include chipping to create rubber mulch for playground and landscaping use, coordinating with the Virgin Islands Housing Authority (VIHA) to develop urban food gardens, or working with multiple agencies and private organizations to deploy concrete-filled tires as part of storm surge or flood protection measures.

Initiative 19

Enforce existing Plastic Bag Ban

The Plastic Bag Ban (Act No.7938) was passed by the V.I. Legislature on September 20, 2016 and was supposed to take effect on January 1, 2017, but the ban has not been enforced.¹¹ Penalties for violating the statute were scheduled to begin on April 1, 2017; fines for noncompliance would also provide additional revenue for VIWMA, as the Act dictates 75 percent of fines collected go to the Authority, while the remaining 25 percent will go into the GVI General Fund. VIWMA will work to raise public awareness and actively enforce this statute to cut down on non-biodegradable plastic waste in the USVI.¹²

MODERNIZE WASTEWATER INFRASTRUCTURE AND DRAINAGE SYSTEMS

VIWMA will rebuild a more resilient wastewater system through initiatives aimed at increasing the health and efficiency of its wastewater processing capacities. Modernization will aid resiliency by creating a more reliable system in the face of future natural disasters.

¹⁰ According to the EPA, Region 2.

¹¹ "Plastic Bag Ban." Virgin Islands Waste Management Authority. Accessed June 14, 2018. www.viwmawm.org/index.php/businessinfo/plasticbagban.

¹² Act No. 7938, Bill No. 31-0379, U.S. Virgin Islands Legislature. (2016).

Initiative 20

Separate wastewater from storm water systems

Illicit storm drain connections and infiltration of groundwater into the lines, manholes, wet wells, and dry wells are major concerns for the wastewater system. Storm drain connections do not all currently have an alternative pipe system or capacity in the guts or roadways, so not all of these connections cannot be eliminated; however, VIWMA will work to reduce or eliminate the infiltration of groundwater in order to reduce the volume of wastewater pumped and treated by the system.

Initiative 21

Educate the public on greywater system implementation

VIWMA will need to undertake a public wastewater education program, including the advantages of implementing “greywater” systems. Greywater includes all water produced by businesses or households that is not contaminated by fecal matter, such as from sinks, showers, washing machines and dishwashers. Greywater systems recycle this used, but minimally contaminated, water for toilet flushing, landscaping, and other non-potable water use and reduce demands on the wastewater system.

Initiative 22

Eliminate some existing pump stations

Eliminating some existing pump stations will reduce the future damage at these sites while also cutting VIWMA’s operational and maintenance costs for the stations. All three facilities have been impacted by multiple events and sustained control systems damage.

Both Upper and Lower Tutu Pump Stations have been identified for elimination and conversion to gravity discharge (design is complete). Costs for demolition and the gravity conveyance system are approximated at \$646,000.

NaNa Gut Pump Station has been likewise been identified for elimination and conversion to gravity discharge. Estimates for this demolition and gravity conveyance system are approximated at \$755,000.

VIWMA will also relocate the Barren Spot Pump Station to the Home Depot site and eliminate the Ricardo Richards Pump Station. This project provides for conveyance of wastewater from Ricardo Richards Pump Station site to the Home Depot site, while eliminating the existing Barren Spot Pump Station. Estimates for this demolition and gravity conveyance system are approximated at \$1,680,000.

Initiative 23

Floodproof components of wastewater system

VIWMA’s top priority for pumping stations to develop a stronger, more resilient wastewater system is to elevate critical components above the 100-year storm elevation. This measure will allow access to facilities despite flooding and reduce repeat damage from multiple storm events to controls and pump components.

The access lids and control panels will also be raised above the 100-year storm elevation at those facilities that typically flood, but may not be shown in a floodway or floodplain. The at-risk facilities and their associated costs to remedy include: Pond Mouth PS at \$64,400 and George Simmonds PS on St. John at \$51,500; Long Bay PS at \$83,700 and AMCO-Bournefield PS at \$64,400.

Initiative 24

Strengthen underground elements of wastewater system

The most immediate mitigation priority is to seal the wet and dry wells to prevent infiltration from surrounding soil and reduce damage caused by infiltration. Mitigation efforts may include re-grading or the use of compost blankets to minimize debris and particulate infiltration. VIWMA will also inspect the force mains for illicit connections, as well as pipe failures and joint failures, and ensure no pipe blockages remain in the system.



Initiative 25

Provide backup pumps for wastewater pumping stations

In light of the limited inventory and maintenance capacity for pumps on the islands, VIWMA will stock one backup pump that can be installed quickly upon failure of one of the normal pumps in the inventory for each pump station. Where necessary, VIWMA will install a backup high capacity diesel pump. In addition, trailer mounted backup diesel pumps will be maintained and ready for deployment: three for St. Croix, four for St. Thomas and two for St. John, at an estimated cost of \$100,000 each.

HOUSING AND BUILDINGS

Residential buildings in the U.S. Virgin Islands include owner stock (privately owned homes and apartments), rental housing stock, and public housing and publicly administered communities. The Government of the Virgin Islands (GVI) and private owners (companies and individuals) also own and serve as operators of residential properties. Operator in this sector refers to a business, organization, agency, or person who operates a residential property, but does not occupy it.

Structures of all types were damaged as a result of the same causes (including poor enforcement of building code, or lack of retrofitting to meet updated building code), so it is impossible to discuss damage to one type of building without considering its impact on the others. The lines have blurred between public housing, private homes, commercial property, government buildings, or community buildings in the aftermath of the hurricanes—particularly in their uses during recovery. Buildings providing temporary housing are both



Damaged homes in the Crown Mountain Area of St. Thomas.
Source: Kelsey Nowakowski

publicly and privately owned, and individuals whose private homes were not catastrophically damaged similarly opened their doors to friends and families who did not have safe housing after the storms. Damage to commercial buildings caused businesses to delay reopening, making it difficult for people to obtain essential items needed for recovery and everyday life. Likewise, damage to government

buildings impacted GVI's ability to operate and to support its communities' recovery—just as personal home damage affected government personnel. Both the Virgin Islands Housing Authority (VIHA) and Virgin Islands Housing Finance Authority's (VIHFA) offices were destroyed; as a result, both agencies' staffs worked outside in the parking lot for two months.

HOW THE SYSTEM WORKS

The Territory's housing stock is comprised of privately owned and rented housing, public housing (government-owned and operated), and publicly financed housing. The Territory was home to approximately 58,330 total housing units prior to the 2017 hurricane season: 26,362 units on St. Croix, 31,968 on St. Thomas and St. John.¹

Private housing

Private single-family homes, multi-family dwellings, apartments, and condominiums make up roughly 85 percent of housing stock in the USVI.

Public housing

Public housing accounts for about 15 percent of all Virgin Islands homes and is managed by the Virgin Islands Housing Authority (VIHA), the territory's public housing authority.

VIHFA

VIHFA serves as the institutional delivery system for low and moderate-income (LMI) housing and provides home ownership opportunities for LMI families, as well as counseling services for

homeowners at risk of foreclosure or delinquency. VIFHA funds affordable and sustainable housing development through federal grants and subsidies, and ensures all Virgin Islanders can obtain safe, sanitary, decent and affordable housing.

VIHA

VIHA is the territory's public housing corporation, and manages planning, constructing, operating and maintaining public housing properties for low and moderate income and disadvantaged populations. VIHA oversees 26 public housing communities totaling 3,014 units. These units are shared between St. Thomas (9 communities, 48 percent of units) and St. Croix (17 communities, 52 percent of units).²

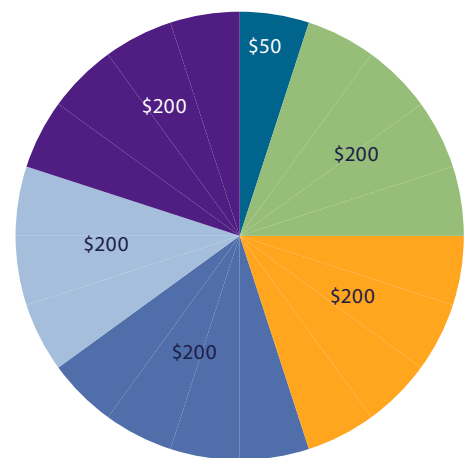
VIHA plans, finances, builds, maintains and manages public housing developments on St. Croix and St. Thomas. VIHA is an autonomous public housing corporation and operates under the provisions of the U.S. Housing Act of 1937, the Quality Housing and Work Responsibility Act of 1998, and Virgin Islands Code.

Under VIHA, the public housing sector includes private homes, rentals, private communities, and private tax-credit rentals. Based on the 2015 Housing Demand Study, the authority projected that 4,857 homes are needed to meet the Territory's housing needs. The housing shortage has been exacerbated by the 2017 storms, as damage to public, private and

rental homes—as well as hotels—left residents of all types in need of affordable and/or temporary housing. The VIHA estimates it can meet 82 percent of demand. The cost for 4,000 affordable housing units equals \$1.4 billion or \$140 million each year for 10 years. This cost estimate is predicated upon per unit cost of approximately \$350,000.

Possible funding sources for the 10-year plan include:

Funding Sources for 10 Year Plan



LIHTC

Federal Housing Trust Funds

Local Housing Trust Funds

Energy and Housing Preservation Tax Credits

Gap Financing (CDBG, HOME, Stamp Tax)

Bond Proceeds

*Funding in Millions of USD

¹ "2013 United States Virgin Islands Community Survey," Eastern Caribbean Center (ECC), University of the Virgin Islands, January 2016, www.uvi.edu/files/documents/Research_and_Public_Service/ECC/SRI/VICS%202013.pdf

² "Community Development Block Grant Disaster Recovery Action Plan," United States Virgin Islands Housing Finance Authority, May 25, 2018. <https://www.vihfa.gov/sites/default/files/reports/USVI%20Action%20Plan.pdf>

USVI RESILIENT AFFORDABLE HOUSING PLAN - 10 YEAR DEVELOPMENT PROJECTION (IN UNITS)								
2014 DATA	West STT	East STT	Total STT	West STX	East STX	Total STX	STJ	USVI
Total Occupied Households	14,925	7,110	22,035	10,376	8,686	19,062	1,900	42,997
Owner-Occupied Households	5,387	3,621	9,008	5,867	4,811	10,678	885	20,571
Renter-Occupied Households	9,538	3,489	13,027	4,509	3,875	8,384	1,015	22,426
Net Demand	2,320	957	3,277	748	554	1,302	278	4,857
Proposed Development	1,911	788	2,699	616	456	1,072	229	4,000

VIHA assists income-eligible families, the elderly and persons with disabilities with rent support vouchers under a number of federal programs, including the Section 8 Housing Voucher Program. The program provides affordable housing choices from private landlords in the USVI.

Public housing communities provide affordable rental homes, ranging from efficiencies to five-bedroom homes. VIHA manages nine properties on St. Thomas and 15 on St. Croix. VIHFA's four St. Croix communities are subsidized under the Housing Voucher Program and are managed by a contractor.

GOVERNANCE

Department of Planning and Natural Resources (DPNR), Division of Building Permits

Buildings in the Territory are subject to a number of regulations, including: Building code, Coastal Zone Management, and Historic Preservation Commission, while the U.S. Housing Act of 1937, the Quality Housing and Work Responsibility Act of 1998 and Virgin Islands Code regulate public housing. The USVI DPNR's Division of Building Permits (DBP) oversees building code development and permit issuance for new and modified buildings. Neither DPNR nor DBP performs compliance checks, and is instead reliant on outside engineers to submit their recommendations for approvals of designs and code issues.

Construction is subject to permitting and code enforcement

by the DPNR, the Coastal Zone Management Commission and Historic Preservation Commission, as well as other entities. DPNR also administers and maintains building codes designed to meet the needs of the environmental conditions of the U.S. Virgin Islands.

Insurance requirements

Public housing is protected by loss casualty insurance policies. This policy covers repairs to secure and provide safe and affordable housing. HUD requires adequate Fidelity Bond insurance coverage for VIHA's officers, directors and employees who handle cash or are authorized to sign checks.

Private rentals, tax credit rentals and communities are insured with casualty and property policies to protect buildings in the event of a disaster. Insurance for privately-owned real estate is not legally required; however, there are two notable exceptions for mortgaged properties and homeowners with construction loans. Lenders require insurance for mortgaged properties, and

forced-placed insurance is applied when homeowners do not insure a mortgaged property; all financed properties must also be assessed for flood insurance requirements. Homeowners with construction loans must purchase builders' risk insurance during construction.

Homeowners insurance premiums are expensive in the Territory, forcing many USVI homeowners with no mortgage to underinsure or forego homeowners insurance entirely. In an effort to ensure homeowners are educated on the risks of remaining uninsured, the USVI government issued an emergency order in February 2018 to insurance companies, mandating explanation of the consequences of under insurance to their policyholders.

FUNDING

Private housing sector funding

Private housing is funding either by mortgages or collected rent. Individuals are responsible for making payment on their mortgages, insurance (required and/or optional), and tax obligations. Private home owners may be eligible for tax credits related to green building and renewable energy—such as solar panels. Individuals or businesses who own renter-occupied housing collect rent and in turn pay mortgage, insurance, and tax obligations. Some rental owners also benefit from tax credits if

renting to families qualified under the Section 8 program.

VIHA

VIHA is funded both by Federal government grants and programs, and by the Virgin Islands Housing Finance Authority (VIHFA), which is in turn funded by the U.S. Department of Housing and Urban Development (HUD).

VIHA receives one tenth of one percent (0.10%) of HUD's annual budget. Thus, HUD provides approximately \$42 million annually to the USVI to provide housing assistance to over 4,000 households in the two housing programs. VIHA's current federal funding consists of two primary housing programs: the Public Housing Program and the Housing Choice Voucher Program. The Capital Fund Program supports the upkeep of the public housing inventory.³

VIHFA

VIHFA is financed through municipal bonds and HUD federal housing programs; in turn, VIHFA funds VIHA.

Private housing funding

Individuals seeking aid following a disaster can acquire assistance from sources such as: FEMA, the Small Business Administration (SBA), Community Development Block Grant Disaster Recovery Program (CDBG-DR), Home

Funds, Low-Income Housing Tax Credit (LIHTC), U.S. Department of Agriculture (USDA), Emergency Solutions Grants (ESG), and Section 8 housing funds. Those whose home is their primary residence can seek support from FEMA to receive funding for repairing or replacing personal property, home repairs, rental or housing assistance and vehicle repairs. Federal agencies share application information to prevent duplicating relief benefits.

IMPACT OF THE HURRICANES

Early on September 6, 2017, Virgin Islanders sought safe shelter from Hurricane Irma. The government closed its offices, issued a curfew and directed the Water and Power Authority (WAPA) to cut electrical service. Hurricane Irma made a direct hit on the U.S. Virgin Islands of St. Thomas, St. John and Water Island. Irma's sustained 185 miles per hour winds tore through seemingly strong buildings, and Islanders emerged twelve hours later to devastation: roofs partially or completely lifted from structures, windows blown out, and walls pushed over by the unrelenting pressure of the wind. St. Croix, 40 miles south, did not suffer a direct hit and was spared the worst of the damage from Irma. Hurricane José passed far to the north of the territory on September 9-10, but still created additional rainfall. When Hurricane Maria passed through the islands on September 20, it dumped between 5-10 inches

³ Virgin Islands Housing Authority: Independent Agency Budget Presentation, Fiscal Year 2017, USVI Cong. (2017) (testimony of Robert Graham, CPM, Executive Director of VIHA).

of rain on already-damaged St. Thomas, St. John and Water Island, and St. Croix suffered a direct hit of the storm’s winds and rain.

Immediately after each storm passed, residents emerged to look for neighbors who might have been injured or trapped in or under rubble in damaged homes. Power outages, downed phone lines, and minimal cellular network functionality made communication difficult both within the territory and with the mainland. Despite residents’ limited access to 9-1-1 and emergency services, first responders also made valiant efforts to reach trapped, injured, or at-risk residents across the islands. Residents spent the next days reinforcing what remained of homes, seeking new safe shelter, and—with nearly no communication—tried to prepare for two new forecasted hurricanes: José and Maria.

Maria’s deluge of rain further damaged vulnerable roofs, windows and walls. The sheer amount of precipitation over the storm’s short time period caused groundwater to seep up through foundations, as well as flash floods, and drainage system and cistern overflows. Without electricity to power air conditioning, the heat and humidity produced mold and mildew, contaminating buildings and leading to unhealthy living conditions. Standing water also provided breeding grounds for mosquitos, but without the ability to seal or air condition buildings, people could do little to control the potentially disease-carrying insects.



Destroyed home on St. Thomas after hurricanes. Source: Kelsey Nowakowski

	Actual	Normal	Departure	Record
High	87°	90°		N/A° (N/A)
Low	79°	78°		N/A° (N/A)
Average	83°	84°	-1°	
Precip	22.09 in	5.59 in	+16.51 in	
Since	0 in			



September 2017 Temperature and Precipitation for the U.S. Virgin Islands
Source: [Accuweather.com](#)



Destroyed home on St. John after hurricanes.
Source: Beth DeFalco

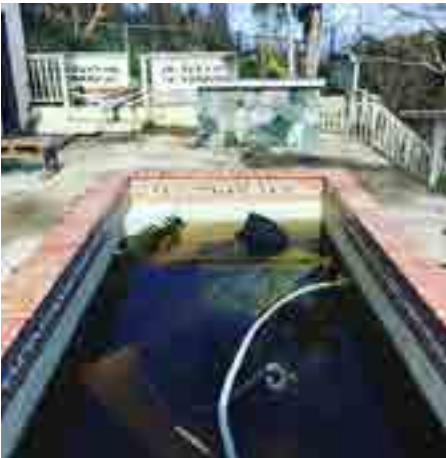


Damaged home on St. Croix after the hurricanes.
Source: Beth DeFalco

During and after the storms, residents sheltered neighbors whose homes were damaged or who could not return to their homes because of debris-choked roadways. During the storms, people who followed guidance to shelter in place were forced to choose between bunkering down in their storm-damaged homes or braving life-threatening wind speeds, flying debris and torrential rain to run to the safety of neighbors' homes.



Flooded roads in St. Thomas as a result of Hurricanes Irma and Maria.
Source: FEMA/Kenneth Wilsey



Standing water from the deluge of rain provided a breeding ground for mosquitos.
Source: Kelsey Nowkowski



Damaged trees block roadways on St. Croix. Source: Beth DeFalco



Residents faced dangerous road conditions on St. Thomas after the hurricanes. Source: FEMA/Kenneth Wilsey



Debris from the hurricanes block roads on St. Croix. Source: Beth DeFalco

Impact on residential housing

About 86 percent of all USVI homes were impacted by the two Category 5 hurricanes in just 14 days: 15 percent of public housing was damaged, and 52 percent of all private housing suffered damage. Thousands of single-family homes were destroyed, and tens of thousands of owner-occupied, rental and public housing units were damaged.

Hurricane force winds, record-breaking rainfall, and flying debris caused structural damage to walls, doors, windows, roofing, cisterns, and foundations, as well as to plumbing and electrical infrastructure.

In March 2018, the Virgin Islands Department of Health (VIDOH) conducted a CDC (Centers for Disease Control and Prevention) CASPER (Community Assessment for Public Health Emergency Response) survey to collect information about how residents were faring five months after the September 2017 hurricanes. The CASPER survey found less than

20 percent of homes had either been undamaged or completely repaired, and while about 50 percent of households had begun repairs, 31 percent had not undertaken any repairs at all. Of those surveyed, about 10 percent of respondents said they “still did not feel safe” in their homes.

Also concerning, more than 50 percent of respondents reported the presence of mold or mildew in their homes. Respondents largely indicated (42.4 percent) they were waiting for funding either from FEMA or insurance claims in order to complete home repairs.⁴

Impact on private housing

Storm damage statistics for private structures is complex to collect. A single comprehensive source for this data does not exist; statistics require contacting a number of governmental sources, and private sources such as insurance companies and banks. Even this information cannot be

assumed complete or accurate.

According to the VIHFA's Community Development Block Grant-Disaster Recovery (CDBG-DR) Program Action Plan released May 3, 2018: “Based on the FEMA IA data as of March 30, 2018, the USVI estimates approximately 22,527 households sustained some damage to their primary residences from one or both hurricanes, representing 52 percent of all housing stock on the islands. Of the 22,527 households impacted, 5,175 suffered Major or Severe damage; of these, approximately 2,362 are the owners' primary residences and 2,813 are renter-occupied homes.”



Residents in damaged public housing cleaning up the remains. Source: Beth DeFalco

⁴ Excerpt from “CASPER: U.S. Virgin Islands, March 2018,” Centers for Disease Control and Prevention (CDC). Accessed through VIDOH, June 2018.

Level of Damage	Owner-Occupied		Renter-Occupied		Total Households		
	No. of Households	% of Damaged Households	No. of Households	% of Damaged Households	No. of Damaged Households	% of Damaged Households	% of Total Households
Minor Damage	11,827	83%	5,525	66%	17,325	77%	40%
Major Damage	1,847	13%	2,688	32%	4,535	20%	11%
Severe Damage	515	4%	125	2%	640	3%	1%
TOTAL	14,189	100%	8,338	100%	22,527	100%	52%

Table: Housing Units Damaged by Severity and Occupant Type for FEMA Individual Assistance (IA) Applicants
Source: CDBG-DR Action Plan (FEMA Individual Assistance Data, Effective March 30, 2018; 2010 U.S. Census)

Private housing constructed after 1995 fared well in the most recent storms; however, 75 percent of the Territory's occupied houses (as well as other buildings) were built prior to new building codes. This data suggests that dwellings not built or retrofitted to meet this code were inadequate in the face of Category 5 storms.

The U.S. Virgin Islands was already struggling with a shortage of affordable rental units prior to the 2017 hurricanes. According to the CDBG-DR Plan, "The shortage of affordable rental units was exacerbated by the 2017 storms, as numerous rental units have been taken off-line during repairs while the influx of recovery contractors and volunteers coming to the Territory has increased upward pressure on rental housing stock prices, especially on account of hotel closures due to storm-caused damages.... Demand for rental stock is not isolated to renters: homeowners with damaged homes have themselves entered the housing market to find temporary rental housing until their homes can be adequately repaired. The market for purchasing homes also faces a supply shortage. VIHFA holds a waiting list of mortgage-ready families for their first-time home buyer programs. As of March

2018, 49 families on St. Croix and 92 families on St. Thomas were on the waitlist."

Impact on public housing

Following the destruction caused by Hurricane Marilyn in 1995, public housing was rebuilt to more resilient standards. Validating those standards, only 15 percent of existing public housing was damaged in Hurricanes Irma and Maria, compared to 36 percent of private housing. However, preliminary estimates still indicate 24 of 26 public housing communities were damaged, with at least four communities damaged beyond repair and scheduled for demolition.

Of the VIHA's inventory of 3,014 public housing units, only 15 percent sustained storm damage for a total of 589 units in need of repair: 156 on St. Thomas and 433 on St. Croix. The damage to housing facilities on St. Thomas was more severe, including the complete loss of 119 of the 304 Estate TuTu units and 85 units at the Lucinda Millin Home for senior citizens. HUD provided housing choice vouchers for private rentals to displaced

households, including to 248 households from TuTu.

Public housing officials assessed damages and helped relocate residents in damaged homes to government shelters. Some public housing residents were lodged at Bolongo Bay Beach Resort's hotel on St. Thomas until VIHA could make other arrangements.

Impact on facilities

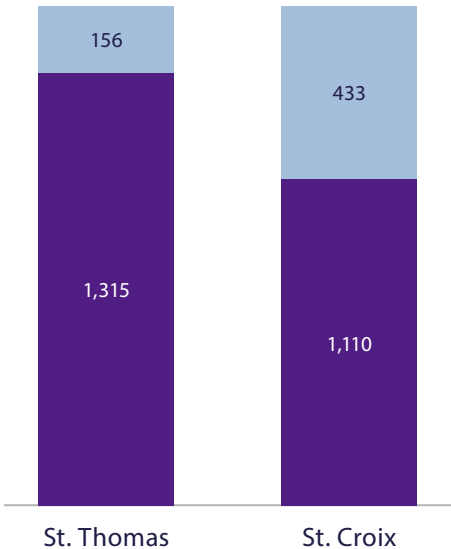
Without power or Internet, and with little cell phone service, residents sustained themselves on shared personal provisions and information for several days until help arrived. The damage to and destruction of many private rentals and communities increased rental demand from newly homeless households, while rental housing inventory shrank.

HUD determined all of TuTu High-Rise uninhabitable due to structural instability and approved demolition of the remaining 17 buildings. Hurricanes Irma and Maria destroyed about 25 percent of units. The 300 units designated for demolition will be replaced with smaller complexes spread around the island. TuTu High-Rise residents who wish to return to

the rebuilt complex will be first in line for the newly built units.

VIHA Public Housing Units

Occupied Units
Need Repairs



Impact on service

Territory-wide power outages, as well as downed electric poles, fallen wires and debris, made road travel difficult during daylight hours and treacherous at night. In the interest of public safety, the Governor issued restrictive curfews, which prevented more than a few hours of travel per day, leading to difficulties accessing aid and resources, which often meant waiting in queues for hours. Some areas were accessible only by hiking or climbing over debris and downed poles—some with live current. The travel limitations caused by the curfews led to tension, as the only way to check on friends and family without communication services was to go in person. Building and home owners and operators,

as well as officials, assessed damage, cleared debris, and made emergency repairs once they were able. Vulnerable individuals, including the elderly, children, and disabled persons, were at the greatest risk during this time as a result of limited communications, transportation, and access to supplies.

RECOVERY EFFORTS

The Governor announced a disaster declaration the day after Irma passed, but relief and recovery funding, support and supplies were delayed by transportation difficulties. Until the Territory began to receive help from FEMA, the Red Cross and other government and non-profit entities—as well as private donations, residents joined together and shared resources to overcome the lack of power, food and communication. Some residents lost everything: family members, home, jobs and vehicles. The March 2018 CASPER survey found a slight increase in the number of people living in each household—likely the result of insufficient housing. Nearly 50 percent of respondents said they knew someone who had left the Territory as a result of the hurricanes and indicated about 14 percent of those were household members.

Restoring electrical power was a slower process, but 90 percent of power was restored by December 25, 2017, and nearly all customers with adequate equipment had power as of January 1, 2018. Communications services such

as landline telephones, cable television, and cellular network took from weeks to months to restore.

Government response

After Hurricane Irma, government shelters opened to accommodate those without safe and habitable shelter in advance of pending hurricanes José and Maria. Curfews, blocked roads, and lack of communications services slowed the initial local government response, but once roadways were cleared, officials began damage assessments in their respective communities.

VIHA assessed public housing conditions to determine whether individuals needed temporary assistance or permanent placement in another home. During the initial devastation response, VIHA also provided water trucks for public housing residents who were without water and power. New applications for public housing units also increased after the storms, and VIHA recorded a 35 percent increase in households seeking public housing (as of January 31, 2018).

All public housing communities across St. Thomas, St. Croix and St. John have power as of May 2018. Already vacant public housing apartments on St. Thomas sustained significant damage, while similar apartments on St. Croix suffered less damage.

Federal government and FEMA response

Public and private, residential and commercial, government and community structures were all damaged in the 2017 hurricanes. The Government of the Virgin Islands (GVI) is working with FEMA to fund top priorities in order to meet USVI residents' needs. FEMA programs supporting recovery include: Temporary Sheltering, Direct Lease, Multi-Family Lease and Repair program for rental housing, and Permanent Housing Construction programs. GVI is also working with FEMA to prioritize public and residential housing for vulnerable populations. The USVI has also submitted applications for the Hazard Mitigation Grant Program (HMGP) to fund much-needed repairs to roofs, potential buy-outs in frequent flood zones, and to develop emergency shelters on each island.

COST ESTIMATES

The total impact on housing—including rental and public housing—is estimated at \$2.29 billion. As of June 6, 2018, \$1.25 billion in funding for housing had been disbursed by federal and other sources.

Private housing cost estimates

Private homeowners with homeowners insurance started the claims process and sought

materials and repair work for which they would eventually be reimbursed, while others without any or adequate insurance to make repairs struggled to find funds and materials to make repairs themselves. When travel, electricity, and Internet service permitted, private homeowners began applications for FEMA and SBA disaster recovery funding. 33 percent of the 14,189 damaged owner-occupied households accessed two or more months of rental assistance through FEMA.

As of March 1, 2018, FEMA had approved 11,235 individual assistance applications, and as of April 16, 2018, disbursed over \$78 million; however, the CBDG-DR Plan found a significant gap between FEMA's Individual Assistance (IA) estimates and its Public Assistance (PA)-funded Sheltering and Temporary Essential Power (STEP) program.

STEP funds emergency home repairs for owner-occupied homes with damage exceeding \$33,300 or which were not eligible to fund temporary repairs through FEMA IA. STEP is administered locally by the VIHFA as the Emergency Home Repairs VI program (EHRVI) and is intended to help people remain safely in their own homes, rather than relocating to shelters, rentals, or other paid temporary housing until their homes can be restored. While FEMA's Full Verified Loss (FVL) assessment includes the cost of "restoring homes to decent, safe and habitable standards," STEP's damage assessment is broader in terms of what it considers "habitable." As of June 2, 2018, STEP/EHRVI had received 9,967 applications, approved over 4,762 applications, conducted 5,146 site visits, and completed construction on 1,328 homes. Although EHRVI

is not fully deployed, it will serve an estimated 8,000 eligible households. Because STEP can be accessed in addition to FEMA IA, it can provide up to \$25,000 in additional repairs to homes. On May 24, 2018, FEMA announced a 100 percent cost share extension to fund STEP/EHRVI through September 11, 2018.

Public housing cost estimates

VIHA is working with FEMA to identify buildings eligible for repair through the FEMA PA program. As of May 25, 2018, approximately \$333,275 had been obligated for repairs for public, HUD-assisted housing, and other affordable housing through FEMA PA. VIHA is also working to identify projects that may qualify for HMGP in order to fortify public housing stock against future disasters—including completing repairs to storm-damaged public housing units.

As of June 2018, HUD had awarded a total of \$1,863,742,000 of CDBG-DR (Community Development Block Grant – Disaster Recovery) funds to the USVI: \$946,870,000 for unmet needs and \$774,188,000 for mitigation.⁵ These funds are intended to address: unmet housing, infrastructure and economic revitalization needs from the 2017 hurricanes, as well as mitigation to protect the Territory from future disasters.⁶

St. Thomas	
COMMUNITY NAME	Irma + Maria
Paul M. Pearson Garden	\$589,940
H. H. Bergs Homes	\$103,500
Oswald E. Harris Court	\$569,751
Michael J. Kirwan Terrace	\$1,098,740
Addition to Bergs Homes	\$0
Lucinda A. Millin Home	\$12,430
Estate Tutu Apartments	\$7,128,945
Willie George	\$3,225
Estate Bovoni Apartments	\$6,500
The Knolls at Contant	\$125,500
\$9,638,531	

St. Croix			
COMMUNITY NAME	Irma	Maria	Total
D. Hamilton Jackson Terrace	\$0	\$43,500	\$43,500
Ludvig E. Harrigan Court	\$161,200	\$243,800	\$405,000
Alphonso "Piggy" Gerard Complex	\$2,600	\$148,500	\$151,100
Marley Homes	\$1,700	\$166,464	\$168,164
John F. Kennedy Terrace	\$3,150	\$187,900	\$191,050
Addition to Marley Homes	\$24,250	\$105,580	\$129,830
Aureo Diaz Heights	\$1,400	\$8,700	\$10,100
Williams' Delight	\$48,984	\$159,200	\$208,184
Walter I. M. Hodge Pavilion	\$1,555	\$568,219	\$569,774
Whim Gardens for the Elderly	\$0	\$277,000	\$277,000
Mount Pleasant	\$400	\$58,600	\$59,000
Candido R. Guadalupe Terrace	\$200	\$5,500	\$5,700
Joseph E. James Terrace	\$700	\$59,880	\$60,580
	\$246,139	\$2,032,843	\$2,278,982
Total VIHA Preliminary Estimate		\$11,917,513	

⁵ U.S. Department of Housing and Urban Development. "HUD Awards Record \$28 Billion to Help Hard-Hit Areas in Nine States, Puerto Rico and U.S. Virgin Islands Recover from Major Disasters." News release, April 18, 2018. HUD. Accessed June 12, 2018. https://www.hud.gov/press/press_releases_media_advisories/hud_no_18_028.

⁶ Virgin Islands Housing Finance Authority, USVI Cong. (2018) (testimony of Daryl Griffith, Executive Director of VIHFA).

Impact on response

Rebuilding following the hurricanes was complicated by a number of factors, including: insufficient contractors in the Territory to rebuild all damaged structures; limited access and manufacture of building materials sourced on and off-island; bottlenecks at customs and during distribution.

Limited access to materials and building supplies

Storm damage and widespread power outages resulted in the halt of building material manufacturing in the Territory, and building materials stores were also closed due to damage and lack of materials. St. Thomas' single concrete facility had no power to operate, leaving the island without a source for poured concrete and blocks. St. Croix has multiple concrete providers and facilities, but faced similar challenges. St. John (and Water Island) relies on St. Thomas-produced concrete to be trucked and transported via ferry, limiting delivery and project capacity, and taking significantly longer to complete than deliveries on St. Thomas. Building materials intended to shore up homes before more storms arrived were delayed at the ports, leaving residents without access to new materials, so residents recycled debris from damaged structures into repair material as much as they could.

Import and distribution delays

Inbound relief and rebuilding supplies led to an increased strain on the ports and customs, both of which were hampered by lack of power, damaged equipment and facilities, and lack of communications services. Customs struggled to process imports without Internet access, and with limited authority to waive or defer excise and import taxes. Debris and road damage, the curfew, and limited access to fuel and transportation also slowed the distribution of materials once on-island.

Climate risks

Winds, precipitation and storm surge are equally dangerous risks to the territory. Tsunamis also threaten communities at low elevations near the coastline.

Hurricane winds, rainfall and storm surge

The sheer volume of rainwater brought by Hurricane Maria presents an example of what is likely to come with future storms. Town, neighborhood, and residential property drainage infrastructure is not built to support increased rainfall rates, leading to more mudslides, erosion and flooding—as well as increased runoff and pollution of the islands' bays and waterways.

Increases in storm frequency and wind intensity will mean greater damage to homes and housing properties. The aging 40+ year-old buildings in the territorial

public housing communities will continue to deteriorate and sustain more damage if the buildings are not improved and mitigated now. Worse storm damage, coupled with an increase in storms and flooding, will also lead to stricter requirements and higher property and homeowners insurance rates, potentially increasing the number of homeowners unable either to get or pay for insurance coverage.

Rising sea levels

Rising sea levels—resulting in higher storm surge—place both private and public waterfront properties at risk for coastal erosion, as well as greater risk of flooding. FEMA's 100-year floodplain will expand, putting more homes at risk of flooding during storms and requiring more homeowners to purchase flood insurance out of pocket. Higher sea levels also increase both the risk and potential danger of tsunamis, particularly to low-lying communities.

In addition to innumerable private homes, five public housing communities located within 250 feet of the coastline are at risk in the face of rising sea levels and tsunamis: St. Thomas properties include Lucinda Millin Home and Michael J. Kirwan Terrace; St. Croix sites include Marley Homes/ Additions, D. Hamilton Jackson Terrace and Alphonso Gerard.

Increases in temperature

Higher temperatures year-round will lead to an increase in residents purchasing air

conditioners, updating their current air conditioning systems, or operating their air conditioners more frequently, leading to greater electricity costs and increasing the load on WAPA's electricity grid. Running air conditioning units on backup generators during power outages will also increase demand for generator fuel.

Public Housing for the Territory's elderly—who are at higher risk from temperature extremes—will require more robust cooling systems in addition to ceiling and floor fans, thus increasing operating costs. Likewise, the need for better cooling systems will also drive up costs for family public housing, especially those with young children or elderly relatives in the unit.

Changes in precipitation

The Territory is projected to experience less precipitation both in the wet and dry seasons, presenting a number of potential problems in the housing sector. Homes in the Territory rely primarily on rainwater collected by water cisterns both for plumbing and potable water. Current codes for water cistern capacity are likely to be insufficient for longer dry spells, leading to increased reliance on water purchased from WAPA. Purchased water not only increases expenses for public and private housing alike, but it also places added pressure on WAPA's potable water capacity and infrastructure—including the ability to deliver water throughout the Territory.

In some parts of the islands where the construction is slab-on-grade foundation (such as the William's Delight community on St. Croix), soil already becomes so dry that buildings begin to shift, which causes interior structural issues. Without sufficient rainfall, housing sites in low-lying coastal areas will also lose crucial wild and landscaped grass, plants and shrubbery, leaving the ground vulnerable to erosion. Structures weakened by dried-out soil may also be more susceptible to earthquake damage.

INITIATIVES FOR INCREASING RESILIENCY IN HOUSING

Adequate and affordable housing solutions will continue to require comprehensive solutions, but established procedures for safe evacuation and shelter before and after disasters will be essential for the future. Identifying and building resilient temporary disaster housing is instrumental to a speedy recovery effort.

Initiative 1

Develop sector-hardening programs to reduce volume of vulnerable properties through buyouts or demolition

The VI Legislature should review and amend VI Code to permit the government to take action on properties abandoned as a result of slow repairs or lack of funding; setting criteria and an enforceable timeline for demolition or forced sale would help to reduce the number of abandoned properties.

Initiative 2

Create and implement accurate data collection methods on structure status

The VIHFA, through EHRVI, is conducting home visits and inspections. As of June 2, 2018, this program had reviewed 7,437 of the 9,967 submitted applications, completed 5,146 site visits, completed construction on 1,827 homes, and completed final inspections on 1,328 homes. VIHFA estimate the EHRVI program will include a total of 8,000 homes by its completion in September 2018.

VIHA will also work with DPNR and VITEMA (Virgin Islands Territorial Emergency Management Agency) to develop a property assessment tool and process in order to assess housing structures following disasters. This process will include

coordination efforts with local and federal agencies and authorities.

Initiative 3

Work with DPNR to improve construction standards and enforcement to Category 5 standard

More frequent and catastrophic storms will continue to severely damage and destroy homes not built to withstand increased wind speeds and rainfall. Faced with projections of greater storm frequency and strength, it is imperative to develop and implement strategies to minimize impact to housing and extend strategies to all building to harden the entire building sector. DPNR, with the support of FEMA, released recommendations for new housing codes, Construction Information Guide for Stronger Homes (4th edition), in April 2018. The changes reflect the 2017 hurricanes' "significant damage to the USVI and... continues to advance residential construction mitigation measures and resilience techniques." The document includes "higher ultimate wind speed criteria and considerations for seismic design" in its updated codes.⁷

Updated codes are only effective if enforced, but Territory authorities currently have neither the funds nor the staff to ensure compliance and enforcement. DPNR should be allocated funding to expand its staff and enforcement efforts. In order to bring existing buildings into compliance, voluntary

retrofits should be incentivized through financial assistance or property tax refunds, and certain building types should be specifically highlighted by DPNR for mandatory retrofits.

Initiative 4

Work with VITEMA to develop plans for evacuation and sheltering vulnerable properties

The Governor's Office will work with VITEMA and DPNR to identify characteristics of least stable public and private houses and require evacuation and—if possible—create a list of these properties with contact information. DPNR will own this list—in part to encourage owners to retrofit their properties. VITEMA should establish procedures for evacuation to shelter from these listed homes and work with DPNR to encourage construction of shelters in individual houses (e.g., safe rooms in stronger homes) and community facilities (e.g. gyms in schools). VITEMA will work with individual facilities and agencies to review existing emergency plans and make them more specific.

Initiative 5

Work with VIHA and VIHFA to build and/or designate a sufficient supply of temporary housing

VIHA and VIHFA will work with the Governor's Office and DPNR to build resilient emergency housing units. The Governor's Office should also coordinate with hotels to identify hotel and timeshare availability in the event of a disaster and update vacancies at regular intervals; similar coordination with cruise ships will provide additional temporary housing resources during a state of disaster. As part of this process, VIHA and VIHFA will work with the Governor's Office to assess sheltering needs for renters, homeowners and public housing tenants in advance. VIHA may also need additional support in order to enforce temporary housing time limits.

Initiative 6

Stabilize structures and make temporary repairs within specified timeframe

The Governor's Office will work with FEMA and local government agencies to acquire and distribute tarps for effective blue roofs immediately following an emergency. This blue roof program should include: purchasing and utilizing stronger tarps, maintaining accurate inventory, and advance staging

⁷ U.S. Virgin Islands Department of Planning and Natural Resources, "Construction Information for a Stronger Home, 4th ed." (DPNR: U.S. Virgin Islands, 2018).

at distribution sites (along with other commodities). VIHA and VIHFA will also work with DPNR, FEMA, and private contractors to expedite and ensure quality of temporary repairs, as well as to establish protocols for determining whether to make a quick temporary repair or wait for permanent repair. These protocols will recommend starting temporary repairs within 45 days of a storm event and address local materials procurement issues. DPNR will work with relevant agencies to provide training for emergency contractors to ensure quality repair, conduct pre-storm certification courses, establish a registry of certified providers, and enforce standards for emergency contractor training and work. VIHA will coordinate with DPNR to ensure construction efforts also adhere to protocols within the Emergency Housing Disaster Plan.

Initiative 8

Work with DPNR to protect housing in coastal and waterfront areas

VIHA will work with DPNR to identify and add new barricades along waterfront and coastal lying areas to protect from erosion (some retaining wall dimensions would need to change to reflect sea level rise). VIHA will also work with DPNR to identify and execute temporary measures, such as sandbagging, before storm events.

Initiative 7

Work with federal and local government agencies to expedite funding

The Governor's Office will work with the federal government to seek additional funding to encourage more resilient and efficient repairs and rebuilding. The Governor's Office will also need to clarify government agency funding and responsibility for repairs, as well as work with insurance companies to reduce claim delays, and banks to expedite emergency loans.

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HEALTH

The U.S. Virgin Islands healthcare system faces unique challenges specific to the Territory's geography and demographics. Category 5 hurricanes Irma and Maria further strained access to healthcare in an already fragile system.

There are no privately owned or funded acute care facilities in the USVI; rather, the Territory's two hospitals are government owned, overseen by a board of directors, and managed by CEOs who are responsible for daily operations. Alternate healthcare options include FQHCs, community health clinics and private providers. As a result of significant storm damage to both hospitals, more than 800 patients required medical evacuations to medical facilities in cities such as Miami, FL; Shreveport, LA; Atlanta, GA; Charleston, SC and Puerto Rico. The hurricanes caused significant property damage, but more importantly, forced individuals to leave the Territory in order

to access life-saving healthcare services; almost nine months later, some patients still have not been able to return to the USVI because of limited hemodialysis capabilities, limited specialty services and uncertainty about the safety and condition of their storm-damaged homes.

Hurricanes Irma and Maria damaged many healthcare physical structures. Those able to continue providing services faced the challenges of operating without electricity, increased costs associated with fueling and running a generator, limited access to fuel, reduced service delivery due to limited capacity, loss of pharmaceutical inventory and equipment, and staffing shortages. Patients in need of long-term medical care were forced to evacuate.

Inadequate funding, workforce shortages, limited educational programs, licensure processes and aging infrastructure all contributed to the pre-storm level

BY THE NUMBERS

Population¹: 104,116

Median Age: 39.7 years

Average Annual Income:
\$36,674

operational challenges and must be addressed while rebuilding healthcare infrastructure in the recovery. Looking ahead, the USVI must rebuild stronger facilities, improve emergency planning and response, engage in cemented private/public partnerships, and work diligently to enhance healthcare communication systems and technology that will permit the Territory to rebound quickly after natural disasters.

¹ 2013 Virgin Islands Community Survey. Eastern Caribbean Center (ECC), University of the Virgin Islands. January 2016.
https://www.uvi.edu/files/documents/Research_and_Public_Service/ECC/SRI/VICS_percent202013.pdf



Residents line up at a local pharmacy in Charlotte Amalie East while a 6:00 p.m. to 12:00 p.m. curfew is in effect. Source: FEMA/Kenneth Wilsey

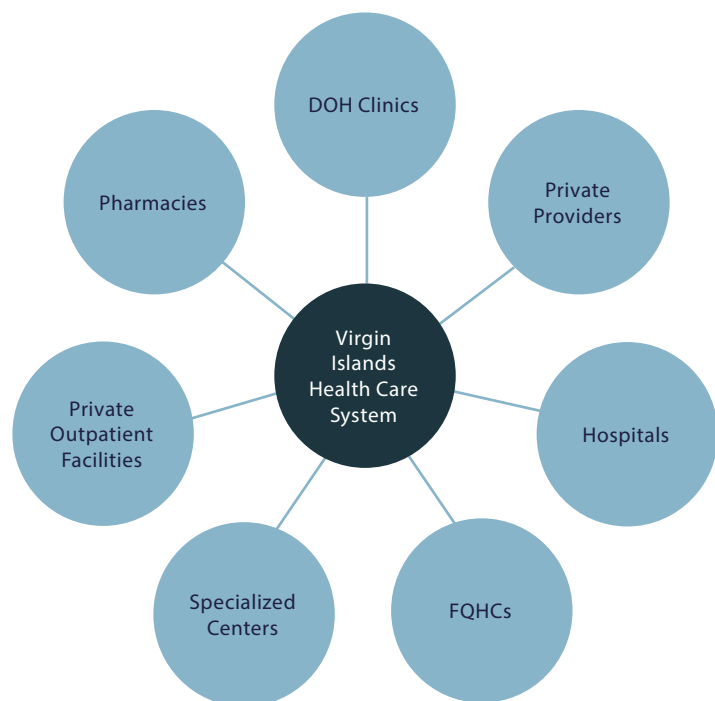
component of healthcare and can mean the difference between life and death.

The geography of the USVI also impacts healthcare, as patients are limited by their ability to access seaplane or ferry terminals, public transportation on each island, as well as the ability to pay for both. Approximately 82 percent of the USVI population is medically underserved and faces a number of health challenges, including limited access to overall healthcare services and specialized care such as cancer care. Some USVI residents refrain from seeking care altogether because of unaffordable costs and/or language barriers. The U.S. Health Resources and Services Administration (HRSA) has designated the U.S. Virgin Islands as a Geographic High Needs Health Professional Shortage Area (HPSA), indicating a shortage of health providers and services even prior to the impact of Hurricanes Irma and Maria.

HOW THE SYSTEM WORKS

According to the 2010 U.S. Census Data, approximately 23 percent of the Territory's population fell below the poverty line, compared to 12 percent on the mainland United States. Understanding the demographic and social determinants of health and poverty and the unique challenges these place on healthcare delivery is particularly important in the USVI. A practical, yet compassionate approach is critical to understanding current public health methods and fostering a more sustainable approach to healthcare in the Territory. Educational, cultural, religious and economic variables all impact how Virgin Islanders approach choosing a medical provider or seeking preventive healthcare services. A segment of the USVI community relies heavily on herbal and natural remedies, often forgoing traditionally western

medical intervention until later in their health crisis. The top leading causes of death in the USVI are Cancer and Cardiovascular Disease, followed closely by Diabetes complications such as kidney failure. Consequently, the availability of hemodialysis (kidney dialysis) services in the Territory is an essential



Components of Virgin Island Health Care system

	Juan F. Luis Hospital	Schneider Regional Medical Center
Certification	CMS-certified	CMS-certified
In-Patient Capacity*	188	159
Governance	Board of Directors, CEO	Board of Directors, CEO
Population Served	St. Croix: 50,000+	St. Thomas, St. John: 48,000+
Operating Rooms*	7	8
ER Visits (yearly)*	~20,000	~20,000

*Pre-storm

The Territory's healthcare infrastructure is comprised of two public hospitals, two federally qualified health centers (FQHCs), 1 department of health with offices/clinics across the Territory (St. Thomas, St. Croix and St. John), two specialized service centers, 23 pharmacies, numerous private providers and 382 VI licensed medical professionals (excluding nurses).

Public hospitals

Acute care provided by the Territory's two public hospitals—Juan F. Luis Hospital (JFLH) on St. Croix and Schneider Regional Medical Center (SRMC) on St. Thomas—is a critical element of the Territory's health system. Most patients are admitted to the hospitals as a result of a visit to the emergency room, a request for emergency services via ambulance, or by physician orders as a result of an outpatient visit with a private provider. A district board of directors oversees each hospital, and a CEO manages the day-to-day operations of each facility. These district boards are governed by the Virgin Islands Government Hospitals and Health Facilities Corporation Board of Directors, which



provides territorial oversight and is tasked to set "hospital policy and planning for health care delivery," and is responsible for coordinating ongoing discussion and ensuring efficient and consistent hospital policy and planning direction in the USVI.²

Juan F. Luis Hospital (JFLH) is the only acute care facility serving St. Croix's population and offered emergency services, elective procedures, hemodialysis services, radiology services, laboratory services, labor and delivery, as well as a myriad of other services, which included outpatient surgical procedures (before the hurricane).

Schneider Regional Medical Center (SRMC) on St. Thomas is the only acute care facility on St. Thomas and provides services including in-patient

behavioral health services, emergency services, hemodialysis services, surgical care, radiology, laboratory services, labor and delivery, and a span of other services. The SRMC emergency department serves approximately 20,000 persons per year and was equipped with eight operating rooms and 17 beds (before the hurricanes).

Federally Qualified Health Centers (FQHCs)

Federally Qualified Health Centers (FQHCs) are federally supported primary care outpatient facilities located in medically underserved areas or health professional shortage areas. There are 2 FQHCs in the Virgin

² VI CODE Title 19, Chapter 16 § 243 V.I. Government Hospitals and Health Facilities Corporation.



US Military medics prepare to load local residents with medical needs on a military plane out of the US Virgin Islands on September 29, 2017. Source: Jocelyn Augustino/FEMA

Islands: Frederiksted Health Care, Inc. (FHC) on St. Croix and East End Medical Center (EEMC) on St. Thomas. All FQHC locations are accessible by public transportation and focus on providing care to low-income persons who fall below the federal poverty level

and live in medically underserved communities. FQHCs also serve the general public by offering a sliding fee scale and accept patients covered through private insurance, Medicaid, Medicare and self-payment.

Both USVI FQHCs are approved National Health Services Corp (NHSC) sites and employ NHSC providers at both centers. FHC and EEMC are the only public dental health providers in the Territory, in addition to their primary care and mental health services. On St. Croix, FHC serves the special populations of the homeless, administers the federally-funded Health Resources & Services Administration's (HRSA) Ryan White HIV/AIDS Program, which serves persons with HIV/AIDS, facilitates a syringe exchange program, and operates the 340B discount pharmacy program.

On St. Thomas, EEMC offers limited mental health services but is not a recipient of Ryan White funding serving the HIV/AIDS population.

Federally Qualified Health Center (FQHC) overview by facility:

Frederiksted Health Care, Inc. (FHC)	East End Medical Center (EEMC)
4 locations: Christiansted, North Shore – Frederiksted School Base Clinic and Mid Island	1 location: East End Sub District (Tutu Mall)
Established 2000	Established 2000
HRSA Ryan White Program for HIV/AIDS	No Ryan White Funding
Syringe Exchange Program	--
Child & Adult Dental Services	Child & Adult Dental Services
Behavioral Health Care Services	Limited Behavioral Health Care Services
340B Discount Pharmacy Program	--
Primary Care Services	Primary Care Services
Nutrition & Immunization Services	Nutrition & Immunization Services
OBGYN (Obstetrics & Gynecology)	Pediatrics
Pediatrics	--
Optometry	--
Laboratory Services Internal Medicine	Laboratory Services
Approved NHSC Site	Approved NHSC Site

Virgin Islands Department of Health community clinics

The Virgin Islands Department of Health (VIDOH) serves the community as both a regulatory and clinical public health entity. It is the largest provider of public health in the Virgin Islands and operates clinics on St. Croix, St. Thomas and St. John. Clinic services under this umbrella include Mental Health, Family Planning, Communicable Disease, Maternal and Child Health, HIV/STD, and Community Health. The health department is also home to the Vital Statistics division, the Women Infant and Children Program (WIC), the Immunization Clinic, Public Health Preparedness, Environmental Health, Health Regulation and Licensing, Emergency Medical Services (EMS), Epidemiology Surveillance Services and Primary Care. Additionally, VIDOH operates the public health laboratory, which serves as the center for disease prevention, control and surveillance.

In accordance with USVI Code Titles 3 and 19, the VIDOH must provide medical services to the general public regardless of ability to pay. While the department accepts private insurance, a sliding scale fee is employed and offered to persons within the federal threshold of the poverty scale. Medicaid, Medicare and Self-Pay patients are also seen at the VIDOH operated clinics. The VIDOH clinics provide administrative, clinical, regulatory and mental health services at five physical locations: Charles Harwood Medical Center on St. Croix, Knud Hansen Complex, Community

Health Clinic (located at SMRC), Barbel Plaza on St. Thomas, and the Morris DeCastro Clinic on St. John. The Morris DeCastro Clinic offers limited clinical and regulatory services. Prior to the hurricanes, VIDOH employed and housed 343 clinical and regulatory full-time employees (FTEs) across these facilities.

Specialized outpatient facilities, community clinics, and private providers

The Myrah Keating Smith Community Health Center on St. John provides primary health care services to the island's 4,500 residents. The community center is operated and funded by SMRC. While the facility provides primary health care services Monday-Fridays, it is not an acute care facility and is limited in its capacity to provide a full range of medical care. Patients in need of advanced medical care must travel to St. Thomas via the VIDOH ambulance boat or ferry service.

The Virgin Islands Cardiac Center (VICC) on St. Croix was opened as a specialized cardiac care facility adjacent to JFLH in 2008. The expanded diagnostics and intervention services offered at VICC increased access to heart disease treatment and care, thereby reducing/eliminating the need for patients to travel outside of the USVI. Prior to the opening of VICC, services such as angioplasty, heart catheterization and implanting pacemakers were provided by cardiologists at JFLH. Unfortunately, due to the severe damage of the hospital, the VICC is being used as an inpatient facility for a variety of diagnoses.

The Charlotte Kimmelman Cancer Institute (CKCI) on St. Thomas was opened in 2005 as a state-of-the-art, comprehensive outpatient diagnostic, treatment, research and educational facility operated by and co-located with SMRC. As a specialized facility, CKCI's services benefited both the USVI and the entire Eastern Caribbean region and minimized the need for patients to seek cancer treatment on the mainland (at high cost). CKCI is also the only facility in the Territory to offer radiation oncology. Once again, severe damage from the hurricanes has closed this facility.

Community-Based Private Providers provide treatment for chronic disease, diagnostic services and medication management services. Private providers and allied health professionals operate in specialties such as internal medicine, pediatrics, family medicine, obstetrics, behavioral health, orthopedics and hemodialysis.

Mental health residential services

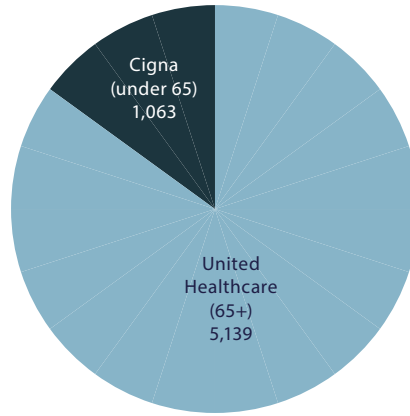
The Eldra Schulerbrant facility operated by VIDOH is the only residential facility in the U.S. Virgin Islands designed to treat patients diagnosed as chronically mentally ill. The facility also operates a day program for persons who are court-ordered to receive individual or group therapy, medication management services and independent living services. While there is greater need in the community for behavioral services, this facility has a maximum capacity of 32 persons. In-patient mental health services were available at SRMC,

but the hospital's capacity was capped at 15 beds. On September 23, 2016, citing a severe shortage of mental health professionals in the Territory, Governor Mapp declared a state of emergency in mental health. The state of emergency remains in effect, as there is still a deficit of mental health services, professionals, and care in the USVI.

Pharmacies

The USVI is served by 23 pharmacies, including one hospital pharmacy located in JFLH and one located in SRMC. There are nine retail pharmacies in the St. Croix district, and 12 in the St. Thomas/St. John district. The Virgin Islands Board of Pharmacy (part of VIDOH) is a member of the National Association of Boards of Pharmacy (NAPB) and is responsible for policy and oversight of the Territory's pharmacies, as well as issuing pharmacy licenses to qualified applicants. The USVI Department of Licensing and Consumer Affairs (DLCA) enforces licensing laws pertaining to pharmacies in addition to alerting the public to recalls of, or issues with prescription medications.

Because of the geographical location of the Virgin Islands, all pharmacies obtain medication through the same wholesaler and utilize a common shipping process. Certain medications are only distributed by pharmacies affiliated with larger national chains and are not otherwise available in the USVI since most pharmacies are small family-owned operations. Consequently, access to prescribed medication is a significant consideration in healthcare planning.



Retiree Insurance Coverage in the U.S. Virgin Islands

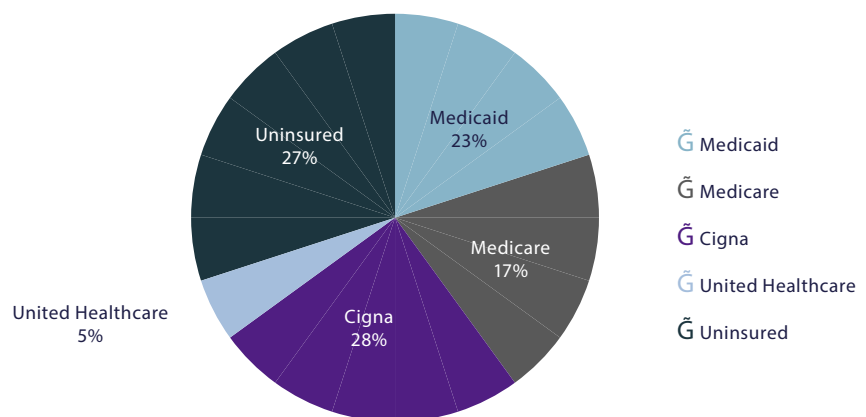
Funding healthcare in the USVI

The USVI has one of the lowest health insurance coverage rates of any state or territory with approximately 28.5 percent of the population uninsured. The impact of uncompensated healthcare and accessibility of care for patients who cannot pay must be considered when assessing healthcare costs for the whole system.

For example, a local study conducted pre-storm by Island Health & Wellness Center on St. John revealed that 72 percent of the island's residents do not have health insurance that covers

primary or preventive care, while 56 percent of St. Johnians are uninsured altogether. Of the 72 percent who have partial insurance coverage, 21 percent report they currently have healthcare-related debt, and 71 percent have delayed or avoided healthcare while living on St. John mainly due to high costs or lack of appropriate services. The Westin and Caneel Bay, two of the largest employee insurers on St. John, shuttered their operations following the 2017 hurricanes. The closure of these hotels meant employees lost their health insurance in addition to their employment. To a lesser extent, this situation in St. John is reflected Territory-wide. It is challenging for USVI residents to obtain insurance coverage if they are unable to access it through an employer; many small businesses in the Territory are not able to offer insurance. Small not-for-profit clinics do exist to offer affordable services to uninsured patients, but they are rare, and where they do exist, they struggle to maintain necessary funding.

Cigna is the largest health insurance provider in the Territory and holds the contract

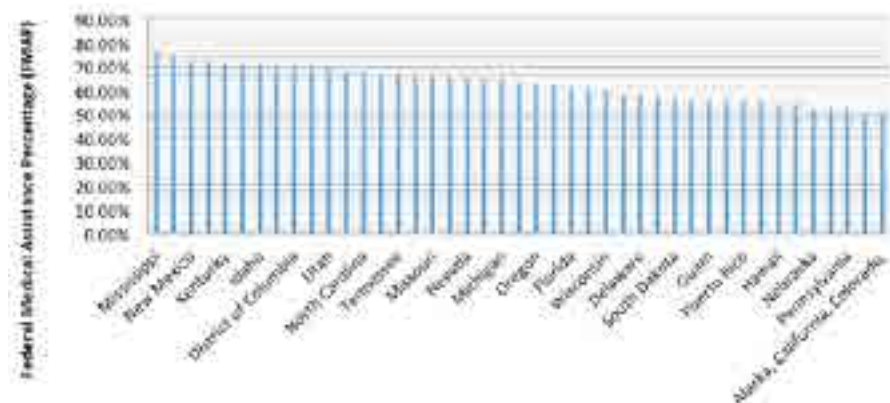


Insurance Coverage in the U.S. Virgin Islands

for the Government of the Virgin Islands (GVI), the single largest employer in the USVI. Cigna provides coverage for 30,000 individuals (to include active employees, their dependents, and retired GVI employees under the age of 65). Cigna also holds the contract for more than 10 Autonomous and Semi-Autonomous agencies, as well as the employees of 10 nonprofit organizations (approximately 150 people).

As of February 2018, Medicaid provided coverage to 25,854 individuals, while Medicare covered approximately 19,000 people. Other insurance companies operating in the Virgin Islands include United Healthcare, which provides coverage to government retirees age 65 and older, and Elan, which provides coverage to private sector company employees.

The USVI Medicaid program is exempt from the freedom of choice requirement, so Medicaid participants are required to first seek primary care from the local health department, one of the two FQHCs, or the local hospitals. Those who need specialty care must receive authorization from the Medical Assistance Program (MAP) in order to obtain a referral to private providers as medically needed. Providers at the FQHCs and VIDOH are not authorized to make off-island referrals for unavailable services in the Territory; rather, referrals for off-island treatment can only be obtained from the special services unit within the MAP program at the Department of Human



U.S States and Territories

Services. This may result in a delay in obtaining a referral to an off-island provider, disrupting continuity of care.

For the period of July 1, 2011 through September 30, 2019, section 2005 of the Affordable Care Act (ACA) provided an additional \$273.8 million in Medicaid funding to the USVI.³ The USVI was awarded \$24.9 million for its Medicaid program in lieu of establishing a health marketplace, but the Territory

must exhaust its ACA (section 2005) allotment prior to using these funds. The Territory receives a designated Federal Medical Assistance Percentage (FMAP) reimbursable rate of 55 percent for Medicaid; the lowest legal reimbursable rate of any state or territory is 50 percent, while the highest (Mississippi) is 76 percent.⁴ The local share equates to a 45 percent match. This formula is fixed and can only be changed through congressional action. Despite efforts, the



A member of the FEMA Disaster Medical Assistance Team speaks to a patient at the Gov. Juan F. Luis hospital center on September 30, 2017. Source: Jocelyn Augustino/FEMA

³ "United States Virgin Islands: Medicaid Overview." Medicaid.gov. Accessed June 28, 2018.

<https://www.medicaid.gov/state-overviews/usvi.html>.

⁴ "Federal Medical Assistance Percentage (FMAP) for Medicaid and Multiplier: Timeframe FY 2019," Kaiser Family Foundation, Henry J. Kaiser Family Foundation, <https://www.kff.org/medicaid/state-indicator/federal-matching-rate-and-multiplier/>

“...All health care providers who, in addition to their employment with the Government of the Virgin Islands, engage in a private practice and receive financial assistance toward the payment of their medical malpractice insurance premiums under this section, shall accept Medicare and Medicaid for payment of health care services from patients in their private practice, and in addition must provide medical services to veterans of the United States Military Services that are covered by an insurance carrier.”

-27 V.I.C. § 166

USVI had been unsuccessful in securing a higher reimbursement percentage. As a result, the U.S. Virgin Islands is at a disadvantage compared to the U.S. mainland as it pertains to healthcare funding. The USVI already faces a medical professional shortage, and the strain on the Territory's healthcare system is further exacerbated by the reluctance of private providers to accept MAP-insured patients due to the low reimbursement costs for services. Fortunately due to the hurricanes, the USVI has been given a 100 percent federal reimbursement rate for a two-year period. The Territory will continue advocacy for parity in reimbursement after the temporary increase ends.

Per 27 V.I.C. § 166, all healthcare providers participating in the Virgin Islands Malpractice Insurance program are required to provide services to patients insured through Medicaid and/

or Medicare. This has led to an ongoing concern that some private practice providers may avoid treating Medicaid/Medicare insured patients and choose not to participate because of the low reimbursement rate for these patients.

Currently, no insurance provider offers individual health coverage to residents of the USVI, as the Territory does not fall under the Affordable Care Act's mandate. The Lt. Governor's Office estimates between 30,000 and 35,000 (one-third of the population) individuals in the Territory are uninsured. Without individual healthcare plans, many people do not have employer-based coverage, but have incomes that exceed the threshold eligibility for MAP coverage, and thus cannot find health insurance. This uninsured population seeks medical services through self-pay with private providers (if they can afford to do so), the FQHCs, or VIDOH community clinics where they can utilize the sliding scale fee policy to receive affordable health services. While discouraged, there is also a segment of the community that utilizes the emergency room to meet their primary care needs. In an effort to ensure accessibility of healthcare services to all Virgin Islanders, the Virgin Islands Code Title 19, Part II, Chapter 17 states that “no resident of the Virgin Islands shall be denied medical care because of financial inability to pay the cost thereof.” As an unintended consequence, this law has resulted in an increase in uncompensated care in the Virgin Islands, thereby complicating and increasing healthcare costs.

Patients who need specialized services not available in the Territory must travel either to

Puerto Rico or the U.S. mainland. Three private companies (MASA, Horizon Air Ambulance, and AeroMD) provide air ambulance emergency evacuation, but these services can cost \$10,000 or more per incident if a patient is not enrolled with the company. Enrollment rates range from \$120 to over \$500 per year, depending on the company, destination and hospital location. Financially, this option is not feasible for most Virgin Islanders, even with private insurance options to limit the out-of-pocket costs for emergency air evacuation.

Health regulations and legislative policies

The VIDOH Office of Professional Licensure and Health Planning regulates all healthcare providers in the USVI, with two exceptions: the USVI Board of Psychology Examiners and Virgin Islands Board of Nurse Licensure (VIBNL). The boards oversee behavioral health providers and nursing professionals, respectively. VIDOH is responsible for licensing, malpractice certification and Certificate of Need applications requesting the operation of new and/or expanded medical services within the Territory.

VIDOH is also responsible for the inspection of kitchens operated within the hospitals, community clinics and residential facilities; however, staff shortages in the Environmental Health Division have prevented regular inspections; post-storm conditions have only exacerbated this irregularity.

Impact of hurricanes Irma and Maria

In anticipation of hurricane Irma's September 6 landfall, St. Thomas SMRC began discharging patients who could be sent home without compromising their health as a precautionary storm measure. SMRC transitioned hospital patients who required continued acute care services to St. Croix for triage and stabilization in an effort to ensure a safe transfer to hospitals and medical facilities in Puerto Rico. In partnership with the Department of Defense (DoD), SMRC began medical evacuations to Puerto Rico immediately following hurricane Irma.

While St. Croix functioned as a staging area for medical evacuations and supplies coming into the Territory, Puerto Rico served as a safety net for acute medical services only temporarily. Both USVI's and Puerto Rico's healthcare services were crippled when hurricane Maria struck only 10 days later. The lack of inter-island and national communication stymied the ability to connect to other islands immediately following the hurricanes and posed a significant problem for healthcare facilities, staff, and patients.

Damage to facilities

The hurricanes caused extensive structural damage to the Territory's healthcare facilities. Both hospitals suffered from significant flooding, roof and structural damage, as well as facing environmental challenges, resulting in the need to medically



Damage to Schneider Regional Medical Center from Hurricane Irma.
Source: Beth DeFalco

evacuate all acute care and dialysis patients. Without access to medical services in Puerto Rico, it was necessary to transition over 800 patients to medical facilities on the east coast mainland (from Florida to South Carolina) with the coordination of federal partners at the DoD and Health and Human Services (HHS). Compounding the initial hurricane damage, the hospitals also suffered generator malfunctions during the three month commercial power outage following the storms. Both the Myrah Keating Smith Community Health Clinic on St. John and CKCI on St. Thomas were rendered inoperable due to collapsed roofs, flooding and/or mold concerns. The healthcare system was and continues to be in severe crisis Territory-wide.

FQHCs also sustained flood and other structural damage resulting in lost medication and supply stores, but the damage did not prevent the centers from reopening. Like the hospitals,

the FQHCs also struggled with malfunctioning backup generators.

The storms also resulted in a backup of medical waste throughout the Territory; the U.S. Environmental Protection Agency (EPA) is working with USVI officials to dispose of 130,000 pounds of medical waste stockpiled at JFLH on St. Croix and SRMC on St. Thomas.⁵

The VIDOH clinics on St. Croix also suffered severe damage and resulted in service provision being conducted in an emergency tent and on a mobile van.

Impact on service

Both hospitals, SRMC and JFLH, decreased daily inpatient capacity by roughly 50 percent following the hurricanes. In addition to compromised infrastructure, decreased patient volume resulted in revenue losses totaling more than \$4 million monthly for both

⁵ "EPA Hurricane Maria Update for Thursday, October 12th." EPA. October 12, 2017. Accessed June 28, 2018.
<https://www.epa.gov/newsreleases/epa-hurricane-maria-update-thursday-october-12th>.

hospitals. The financial impact eventually resulted in a forced workforce reduction at both hospitals between September and December 2017 in an effort to decrease the financial losses of the organizations. According to Senate testimony on December 8, 2017, SRMC eliminated 12 positions and laid-off 46 non-medical staff; JFLH reduced non-medical staff by a total of 80 (including both eliminated positions and lay-offs). Both hospitals were understaffed prior to the storm, in part because of delayed funding from GVI and reduced levels of reimbursement.

The FQHCs were able to resume service more quickly, as they operate at lower costs and are not fully dependent on governmental allotments for operational costs. The centers resumed services without significant loss of personnel; however, the CEO of St. Croix's FHC confirmed the resignation of the FHC dental director—who was also an NHSC provider—following the hurricanes.

Storm damage also forced many private providers to close temporarily. Providers and community clinics able to resume service within the first seven days of the hurricanes were met with high demand for services due to the loss of primary care offices and the limited service offerings at the hospitals and community health clinics. The increased volume coupled with the mandated curfew hours created longer wait times, leaving patients to decide between spending time traveling to seek healthcare, violate the curfew, or seeking other essential supplies during the curfew's limited hours. Services such as surgical procedures and or outpatient treatment procedures

were reduced or eliminated altogether, as most healthcare facilities were operating on generator power, reduced hours of operation and under mandatory curfew.

Prior to the hurricanes, the USVI healthcare workforce was already identified as fragile and labeled under federal distinction as a geographical Health Professional Shortage Area (HPSA). SMRC reported the voluntary resignation of 58 staffers (including some resignations pending before the storms) immediately following the hurricanes, while JLH reported the loss of 80 personnel. Additionally, personnel across the healthcare system required extended personal leave and/or extended family medical leave to address their own emotional and physical impacts from the storms. Furthermore, a portion of healthcare personnel left the Territory as a result of overwhelming damage to their homes, lack of electricity, personal health needs or other challenges impacting their livelihoods. Consequently, the healthcare workforce experienced further deterioration as a result of the hurricanes.

Response

The coordination of healthcare services was non-existent in the initial period following the hurricanes, as the Territory lacks an electronic health record (EHR) system or another mechanism to track patients who present for care at a location other than their primary care provider. First responders and health providers initially experienced transportation challenges while

navigating the roads to and from work. Additionally, the ports were closed for several days, ferry services cancelled, and supply shipments halted or inaccessible. Telecommunications and Internet connectivity were out across the Territory, further crippling patients' and staff's ability to communicate with loved ones, medical peers, and pharmacies. Service delivery was restricted as a result of the three-month commercial power outage; facilities equipped with generators still faced the high cost and challenge of maintaining adequate fuel supplies to maintain operations, as well as the breakdown of generators not designed for continual use.

The catastrophic interruption of power, Internet and telecommunications complicated service delivery to patients who remained on island, as well as the continuity of care for medical evacuees and those who sought refuge on the mainland. The lack of Internet and fax service (via telephone lines) rendered information inaccessible for a period of time during and after the storms, both for providers who use an EHR system and those who rely on paper records.

Pharmacies were unable to verify patient medication needs and, in some instances, medication inventories were compromised or stolen. While most pharmacies prepared with an advanced 90-day supply of medication, the post-storm increase in their customer base quickly led to a depletion of their stores, forcing a seven-day supply limit per customer. Closed ports and damaged airports left pharmacies unable to restock quickly. Utilizing personal resources, pharmacists



EMS Task Force members from New Jersey help the local EMS personnel at Schneider Regional Medical Center transport a patient from St. John that arrives via a boat and needs medical attention. Source: Jocelyn Augustino/FEMA

went to extraordinary lengths to obtain essential supplies, including: chartering a plane to fly medication in to the Territory, traveling between St. John to St. Thomas via dinghy, and safeguarding their inventory by sleeping in their establishments. In other instances, medications available only at larger chains before the storms were no longer accessible to patients. Unfortunately, the national pharmacy chains also suffered damage, which forced closures and prolonged reopening timelines of those pharmacies.

To fill the gap of healthcare services, VIDOH deployed mobile health vans in the St. Croix and St. Thomas communities. The Department also requested support from the Emergency Management Assistance Compact (EMAC)—an agreement between U.S. states and territories to provide mutual aid and share resources during disasters; EMAC partners supplied and sent essential healthcare professionals, medical supplies and medication to the Territory. Private providers

and non-profit health clinics also maximized their resources to obtain supplies. Donors locally and across the nation reached out to offer resources, including small generators to operate health equipment, health supplies, in-kind donations and volunteer personnel. While the health system quickly shifted into response efforts following hurricanes Irma and Maria, the coordination of and access to resources were not optimally integrated into the medical response. St. John residents in particular had little access to healthcare following hurricane Irma, as the island had no community clinic, no hospital, and few private providers. St. John was further isolated by the lack of commercial ferry service, as well as by its compromised emergency response system and inability to reliably communicate off-island.

After the storms, many patients presented with unmet behavioral and mental health needs, while others remained at the emergency shelters far past the anticipated timeframe because of their

inability to care for themselves at home. These issues highlight the need for a long-term care facility, an inpatient behavioral health facility and an increase of recruitment/retention efforts in the Territory for medical providers.

To date, healthcare services in the USVI remain impacted. While VIDOH is pursuing the purchase of modular health units—scheduled for occupancy in August 2018—continuity of services remains at risk if the Territory were to experience another significant natural disaster within the next three to five years while these modular units are in use. Likewise, both hospitals and the community health clinic on St. John will operate from modular units and mobile operating rooms for the next three to five years. As of May 2018, initiation of permanent repairs, renovations, or replacement of the hospitals and community health clinics had not yet begun. Medical evacuees from Irma and Maria remain in off-island facilities: as of June 6, 2018, 71 dialysis patients and 20 additional medical evacuees had not been able to return to the Territory. Furthermore, hemodialysis services remain limited, an EHR system has not yet been introduced, and utility and communication systems have not yet reached standards of resiliency.



Cost

While a definitive dollar amount has not yet been assessed, the USVI health system has incurred massive financial consequences associated with infrastructure damage, staff overtime, and the loss of critical medical services. Medical evacuation costs, wages for temporary healthcare personnel, infrastructure repairs, and the installation of modular units were all covered by the Federal Emergency Management Agency (FEMA) public assistance program at 100 percent cost share; however, after May 14, 2018, the Virgin Islands is required to assume 10 percent of the costs associated with the continuation of healthcare assistance under this program.

As of May 2018, the U.S. Department of Health and Human Service's (HHS) Emergency Prescription Assistance Program (EPAP) had accepted more than 26,865 claims and expended more than \$1.8M to uninsured individuals to fund medication and durable medical equipment lost as a result of the hurricanes. The federal EPAP program was activated as a direct result of hurricanes Irma and Maria, and the program was extended with an end date of August 15, 2018. The cost of modular units to replace uninhabitable office structures at VIDOH exceeds \$10M. Additionally, in order to continue to provide care, both hospitals and community health clinics need mobile operating rooms and modular units. JFLH received two mobile operating rooms in April 2018, but have not yet been put into use. Modular units have been requested for: at Myrah Keating Clinic on St. John (received at the end of May), JFLH, SRMC, and for

VIDOH on both St. Thomas and St. Croix. As of early June 2018, only the Myrah Keating unit had arrived in the Territory.. FEMA currently funds these expenses, but without FEMA's assistance, the financial burden to the USVI would be overwhelming.

The VIDOH has requested \$800 million from Congress to rebuild the USVI healthcare system to be more resilient and to reduce barriers to care immediately following a natural disaster. If received, all physical and operational systems will be built with the capacity to meet the healthcare needs of the USVI population in a resilient and expedient manner. At a minimum, to meet this goal, hospitals and community health clinics will need to be rebuilt to more resilient building code standards, and pharmacies will also need to develop contingency plans to ensure medication availability.

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

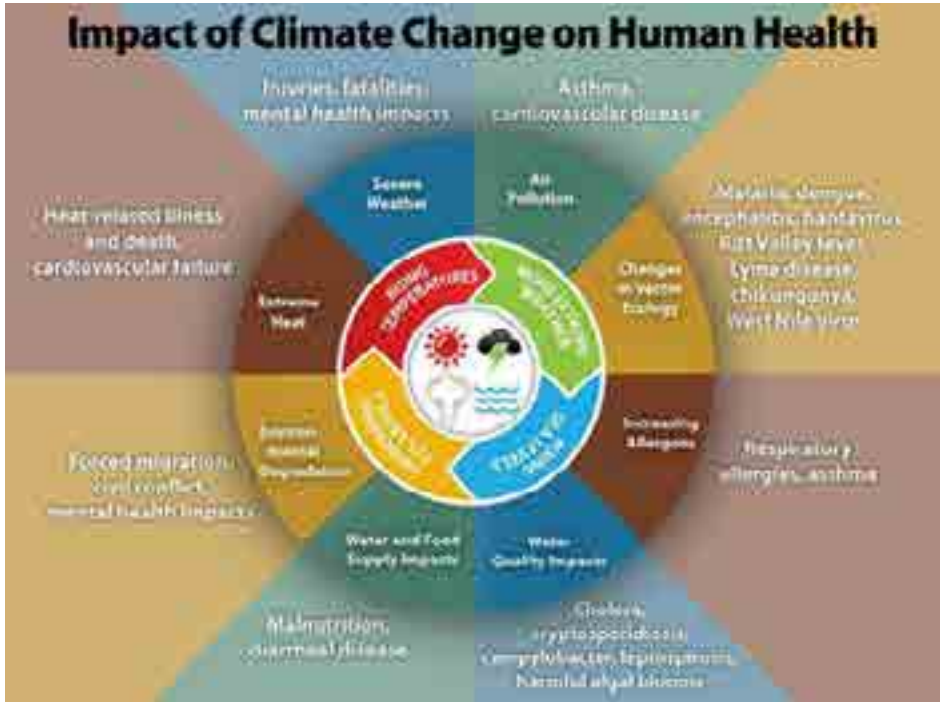
The health sector faces risks from all climate hazards, as each presents health risks such as the exacerbation of chronic disease, mental health deterioration, the manifestation of respiratory ailments due to increased mold, compromised water and food supply, environmental degradation, changes in vector

conditions and increases in mosquito borne diseases. The implications of climate change extend beyond the infrastructure and into the daily physical wellness of Virgin Islanders, as changes to the climate may result in new climate-related health threats. Consequently, climate change has the ability to change the healthcare service delivery dynamics through the frequency and severity of pre-existing health conditions, and secondly, by creating threats of previously unreported or unknown ailments.

The most serious risks to healthcare infrastructure and the VI community at large come from hurricane winds, rainfall, and storm surge. Other hazards carry smaller risks.

Hurricane winds, rainfall, and storm surge

Stronger future storms and higher wind speeds will potentially destroy facilities, inventory, medications, equipment, and patient records; the potential of hurricane winds to destroy healthcare facilities is of particular concern. Interruption of communication and technology services caused by hurricane damage will also lead to problems with insurance verification, prescribing and filling medications, and coordinating patient care. The increased potential for psychological and emotional trauma as a result of surviving catastrophic hurricanes is likely to lead to the manifestation and/or exacerbation of behavioral health symptoms. Storm debris, curfews, and limited access to



USVI also saw its first confirmed cases of Leptospirosis and Melioidosis after the hurricanes, both of which are caused by water-borne bacteria.

Adding to the threat of increased prevalence of infectious diseases, CDC Community Assessment for Public Health Response (CASPER) surveys conducted in November 2017 and again in March 2018, saw 39 percent of respondents reporting the existence of rats and mice in their households, and 40 percent of households reporting an increase in mosquito bites. CASPER is the CDC’s epidemiologic survey designed to provide “household based information about a community.”⁷ Additionally, the CASPER survey and other data sources have consistently indicated the increased presence of mold; mold is likely to be an ongoing challenge for structures within the Territory.⁸

transportation, fuel and vehicles will also severely hinder islanders’ access to healthcare following a storm.

Heavy rainfall alone will have minimal impact on service delivery and healthcare structures; however, the impact

will be contingent upon facilities’ drainage capacity and structural integrity. Hurricane rainfall and the resulting standing water will lead to increases in mosquito borne diseases such as the Zika, chikungunya and dengue viruses, which were a challenge in the Territory prior to the storms.⁶ The



Storm Surge for DOH Facilities and Pharmacies in Christiansted, Present, Predicted 50 year, Predicted 100 years

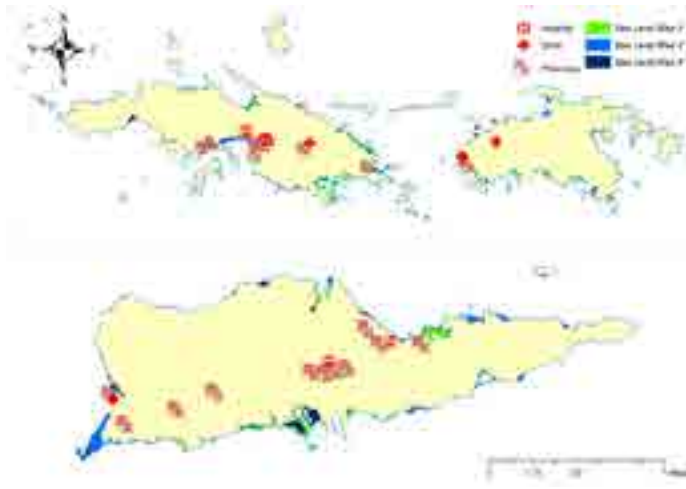


Storm Surge for DOH Facilities and Pharmacies in Charlotte Amalie, Present, Predicted 50 year, Predicted 100 years

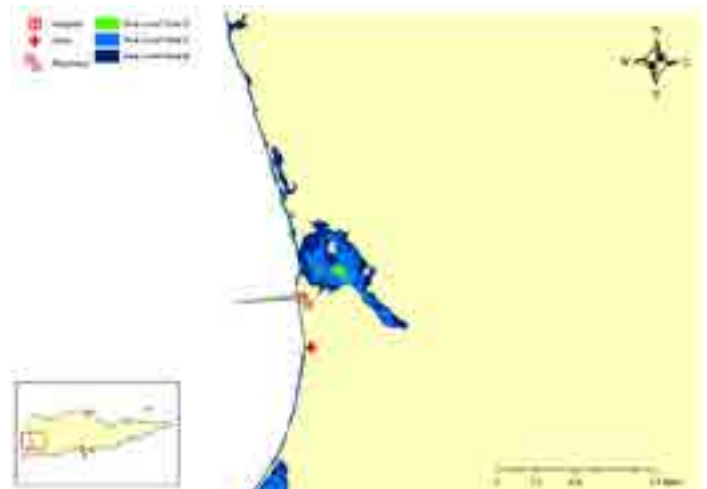
⁶ “Zika Weekly Surveillance Report,” U.S. Virgin Islands Department of Health, September 12, 2017 and April 24, 2018.

⁷ “Community Assessment for Public Health Response,” Centers for Disease Control and Prevention (CDC), June 14, 2016, <https://www.cdc.gov/nceh/hsb/disaster/casper/default.htm>.

⁸ “CASPER: U.S. Virgin Islands,” Centers for Disease Control and Prevention (CDC), January 25, 2018, <https://www.cdc.gov/nceh/hsb/disaster/casper/states/usv.htm>



DOH Health Facilities and Pharmacies at Risk of Sea Level Rise



DOH Health Facilities and Pharmacies at Risk of Sea Level Rise in Fredriksted

Rising sea levels

Static sea level rise will have minimal effect on the healthcare system, except for facilities in low-lying areas.

Increases in temperature

Increased temperatures in the Virgin Islands will likely have a moderate effect on the lifestyle of Virgin Islanders and the operations of the healthcare system. The elderly, medically fragile persons, pregnant women, and children are likely to experience health symptoms related to excessive heat—particularly those in homes without air conditioning. While air conditioning is commonly used in businesses and homes in the USVI, a large segment of the community cannot afford the costs of purchasing, installing, and operating AC units because of the high cost of power in the Territory. As a result, increased temperatures could lead to increased mortality in vulnerable populations.



DOH Health Facilities and Pharmacies at Risk of Sea Level Rise in Charlotte Amalie

Temperature management in healthcare facilities is required for disease control (hospitals), medicine storage (pharmacies/ community health clinics), and the comfort of patients and staff (particularly in the case of vulnerable patients). This requires daily use of air conditioning systems in order to adequately operate healthcare facilities, resulting in greater strain on cooling systems, higher energy costs, and increased probability of premature system failures.

Changes in precipitation

Longer dry spells will not likely affect healthcare structures, but may increase water costs associated with higher water usage. Drought or limited availability of fresh water for people who rely solely on household cisterns are more likely to be impacted by E. coli or other waterborne diseases.

INITIATIVES FOR INCREASING RESILIENCY IN HEALTH

Now is the time to rebuild a healthcare system that can stand firm in the face of future natural disasters. Hospitals, community health centers, FQHCs, pharmacies and specialized healthcare centers are the cornerstone of healthcare in the Virgin Islands. Given the Territory's susceptibility to intense weather patterns, much planning and preparation must go into the design of healthcare infrastructure, the sustainment of communication and technology operations and the effectiveness of an emergency healthcare response. The strategies and initiatives outlined below are recommended in order to create a more resilient healthcare system in the Virgin Islands:

IMPROVE PHYSICAL INFRASTRUCTURE

Physical infrastructure is an important element in preserving the health of Virgin Islanders, therefore health facilities must be hardened to the most current building standards in order to be able to meet the needs of the population during a disaster. Hardening of infrastructures will support a swift rebound and allow for the continuation of health services. The identified strategies are intended to decrease facility

damage, ensure the protection of medical equipment, expand utilities and air conditioning capacity, and ultimately eliminate the need for medical evacuations in times of disaster.

Initiative 1

Build new buildings to withstand climate risks and respond to local climate conditions

To ensure future resilience, VIDOH will work with DPNR to ensure new buildings are built to withstand climate risks and respond to local climate conditions. In addition to constructing new buildings to meet the updated building code standards, physical healthcare structures will ideally exceed code requirements in an effort to mitigate future risks. New construction will make accommodations for increased temperatures, flooding, high winds, and storm intensity.

Initiative 2

Retrofit old buildings to withstand climate risks, respond to local climate conditions, and become more energy efficient

Old buildings will be retrofitted to withstand climate risks, respond to local climate conditions and become more energy efficient. As with new hospitals, healthcare

facilities able to sustain the impact of Hurricanes Irma and Maria will be required to install backup generators, air conditioning units, chillers, lab equipment, telecommunications and any other equipment deemed necessary to protect critical services and prevent the need for medical evacuations. As appropriate, retrofitting work will include: energy audits, rewiring, renewable energy solutions, hurricane-resistant windows, upgraded lighting technology, full building renovation, and smart meters. DOH will work to complete a successful retrofit operation that will meet the standards for environmental performance required in a hurricane zone.

Initiative 3

Reduce reliance of facilities on central energy grid

DOH will equip each facility with a with backup generator systems to allow for continued equipment operation, inventory maintenance, and limited interruptions to service delivery, as well as eliminating the need for medical evacuations during disasters. Incorporating renewable energy in all current and new healthcare structures across the Territory will reduce reliance on the Water and Power Authority (WAPA) for commercial power, as well as reducing carbon footprint and electricity costs. DOH will assess it's ability to incorporate the use of solar power and/or other renewable energy solutions in order to enhance facilities' capacity to deliver healthcare services that would otherwise

be interrupted by a commercial power outage.

UPGRADE DATA AND TELECOMMUNICATION PROTOCOLS AND TECHNOLOGY

Community awareness and clearly outlined information for healthcare services is necessary to decrease confusion in a disaster situation; clearly established protocols and the strategic placement of health services enhances response time and improves access to care to persons experiencing medical emergencies during a disaster event. Securing medical supplies, formalizing partnerships, and added technologies such as electronic health records systems will improve the continuity of care and increase coordination of medical care efforts and enhance the overall resiliency of the system.

Initiative 4

Develop protocols and technical capacity for immediate post-disaster communications

VIDOH will work with federal partners and VITEMA to develop protocols for immediate post-disaster communications, and integrate this into its disaster communications plans. As part of this initiative, VIDOH will assess

its current technical capacity and telecommunications technology in order to identify gaps, and acquire enhanced technologies in order to bolster technical capacity for post-disaster communications. VIDOH will develop protocols to utilize satellite Internet connection, SAT phones and long range radios in the aftermath of a storm, as needed.

Initiative 5

Enhance data resiliency by establishing a health information exchange system

In partnership with HHS, representatives from VIDOH, FHC, SRMC, JFLH and EEMC are working to develop a health information exchange system in the USVI. Steps to achieve this goal include: participation in the Health Information Summit (2018) sponsored by National Health Information Technology (NHIT), stakeholder discussions and working groups, a survey of USVI medical providers, identification of financial resources (the 10 percent local match is yet to be secured), and technical assistance to complete and submit the Implementation Advanced Planning Document (IAPD) which will outline the goals, functionalities, and budgetary assignment.

Initiative 6

Transition to cloud storage of medical data

To establish best practices in medical health data management, VIDOH recommends transitioning medical data to a secure cloud storage provider or investing in an offsite data center to support virtual storage. All VIDOH healthcare facilities and providers should be integrated into a shared electronic health records system. As part of this initiative, VIDOH will also consider the maintenance of technologies like servers to mirror data and isolate total loss.

Initiative 7

Transition to electronic health records

Electronic health records (EHR) are not a universally established standard in the Territory. Some facilities still use only paper records, while others utilize a combination of paper and electronic records. Currently, some USVI healthcare facilities share patient information via fax. As medical providers depend heavily on medical records to track care and treat patients, the lack of a shared EHR system further compromises the quality of healthcare in the already demanding response phase.

An EHR system will eliminate the primary use of paper records, allow for cloud-based storage and ensure emergency care sites receive accurate patient information.

Initiative 8

Develop capacity to deliver medical care through Telemedicine

VIDOH facilities and providers will look to implement telemedicine technology as a practice in order to expand access to care to all residents in the Territory. VIDOH will pursue a United States Department of Agriculture (USDA) grant funding (up to \$500,000) to initiate telemedicine services. This option was introduced to the FQHCs, DOH, and Private Providers in the Territory; receipt of this funding will expand access to services to persons living in the Territory who are unable to obtain specialty healthcare locally due to the health professional workforce shortage.

IMPROVE MANAGEMENT OF EMERGENCY RESPONSE ASSETS

First responders and healthcare professionals are at the forefront of care coordination following a natural disaster. Relationships and partnerships with pharmacies and public/private healthcare providers will help ensure adequate medication, supplies, equipment and personnel are on-hand and ready to meet community needs in the aftermath of a natural disaster.

Initiative 9

Establish formal public/private partnerships for post-disaster medication storage

In order to enhance client-centered care prior to, during, and after a crisis event, VIDOH will work to establish and fund pre-storm formal public/private partnerships through memoranda of understanding (MOU) for post-disaster medication storage, emergency personnel and transportation.

Initiative 10

Preposition EMS assets in underserved locations in advance of storms

VIDOH will work with healthcare facilities and providers to preposition EMS assets and mobile health vans in underserved locations well in advance of storms. This will be carried out according to needs-based criteria and protocols developed before a disaster event.

Initiative 11

Ensure adequate supplies of pharmaceuticals

VIDOH will work with hospitals and clinics to forecast the supply of pharmaceuticals needed in advance of a disaster situation. VIDOH will establish protocols and put in place mechanisms

in order to ensure this quantity is delivered or accessible in advance of an emergency, and/or strategically and securely stockpile pharmaceuticals in a manner that ensures the integrity of the medical supplies is maintained (e.g. ensure proper cooling is maintained at all times so that medications do not spoil).

Initiative 12

Establish single point of accountability for management of donated relief supplies

VIDOH will work with government and non-government organizations to develop protocols and technical capacity for storing and disbursing donated medications and medical supplies immediately post-disaster; this will include establishing a single point of accountability for managing donated relief supplies.

Initiative 13

Assess morgue capacity, portable refrigerated trailers, and spaces capable of additional cooling

VIDOH will assess morgue capacity and invest funding in securing portable refrigerated trailers and spaces capable of additional cooling prior to a hurricane warning in order to increase emergency resources before they are needed in a disaster situation.

IMPROVE EMERGENCY PLANNING AND COMMUNICATION

Following a natural disaster, it is critical that patients have avenues to obtain health care through their private provider or another entity that is familiar with their health needs. In the aftermath of Irma and Maria, communications in the USVI presented a significant problem. Developing a best practice communications plan in the healthcare sector is critical for ensuring patients, providers, and pharmacies are connected pre and post storm. The health sector has participated in cross-organization conversations with communications stakeholders to identify best use strategies.

Initiative 14

Involve partners from within and outside the government in the emergency planning process

VIDOH will continue to work toward building robust cross-sector partnerships to include the entire healthcare system in order to develop an inclusive emergency planning process. Toward this end, VIDOH recommends the Territory's emergency planning and recovery processes include both government and private healthcare partners. VIDOH will also work with public and private stakeholders to develop and implement an emergency healthcare communications plan across the different types of healthcare providers on island.

Initiative 15

Develop an internal communications plan and the capacity to implement it

Following hurricanes Irma and Maria, lack of communication was a barrier in the response period as the whereabouts of providers were unknown, medical records were not available and the location where specialty medication could be obtained or refilled was not clearly established. Developing an enhanced communication plan between Community Health Centers, the Hospitals, and Private Providers will encourage the sharing of resources and allow primary care and behavioral health services to be accessible to VI residents without extended delays.

As a result of this learning, VIDOH will develop such a communications plan and establish the internal channels to implement it through establishing a communications center. The communications center will execute the pre-established disaster plan and utilize the enhanced telecommunications technology referenced in the preceding initiatives. Pre-disaster internal coordination is a path towards resiliency for the VIDOH and establishing a centralized communication center will additionally permit real-time information sharing with VIDOH healthcare facilities and personnel, as well as private providers, healthcare clinics and other health partners that may not be affiliated with the local hospital.

Initiative 16

Work with behavioral health community to inform and educate patients about storms

VIDOH will partner with local and off-island behavioral health professionals to analyze and forecast the behavioral impact on the community, for example, with Johns Hopkins Medicine. VIDOH will coordinate efforts to inform and educate patients and service providers about the impact of natural disasters on mental health, as well as the plan to meet patients' needs during a crisis.

Initiative 17

Educate the broader community on new and existing emergency plans

VIDOH will utilize its various pre-established communications channels and media to inform the public about new and existing emergency plans for healthcare. As part of this initiative, VIDOH will coordinate with VITEMA to educate the broader community on new and existing emergency plans outlining: who/what/when/where activities are during a natural disaster.

EFFECT POLICY CHANGES FOR EXPANDED HEALTHCARE COVERAGE

Initiative 18

Afford policy changes to negotiate better reimbursement rates for Medicaid

The Territory receives a designated Federal Medical Assistance Percentage (FMAP) reimbursable rate of 55 percent for Medicaid. As previously detailed, the USVI has been given a 100 percent federal reimbursement rate for a two-year period due to the catastrophic effects of the hurricanes. The Territory must continue its advocacy efforts to decrease the gap for Medicaid reimbursement after this temporary increase ends to reduce USVI's high local match rate of 45 percent to a range closer to 35-25 percent, in line with the mainland U.S. Such a reduction would have a profound effect to healthcare funding in the Territory. The Governor's Office and legislature must work closely and consistently with Congress to reduce this rate through legislative action.

The USVI's non-voting representative, Congresswoman Stacey Plaskett, introduced the Improving the Treatment of the

U.S. Territories Under Federal Health Programs Act of 2017 (H.R.2404) in May 2017. This Act calls for eliminating the Medicare funding cap and specific FMAP limitations, among other changes, for U.S. territories, including the USVI.⁹ The Act has not yet been passed, but the USVI will continue to work to push these changes through.

Initiative 19

Reduce number of uninsured patients by reconsidering the creation of a Territory Healthcare Exchange

The Territory struggles to maintain affordable healthcare services, and reforms such as the ACA intended to create healthy markets for consumers to choose high quality, yet affordable healthcare options do not apply to the USVI under the applicable definition of "state."¹⁰ Thus, the provisions of the ACA requiring individual or group health insurance issuers to offer guaranteed availability, a single risk pool, rate review, community rating, medical loss ratio, essential health benefits, etc., do not apply to providers in any US territories, and thus exempt insurance issuers in the USVI from most ACA market reforms (although some employer issued health plan recipients benefit from applicable ACA provisions). The lack of a mandated competitive marketplace for purchasing

individual insurance, known as an Exchange, means the marketplace reforms aimed at providing options for those completely uninsured do not apply to the USVI; residents of the Territory are issued an exemption from the insurance mandate penalty.

However, although the ACA does not require an Exchange to be formed the way it is mandated for states, it does permit the establishment of an exchange wherein individuals and small businesses may purchase private health insurance products.¹¹ Creating an Exchange would be a complex undertaking requiring the removal of several roadblocks in the healthcare system, including additional compliance. These complexities are part of the reason why the Governor's Office elected to forgo the creation of an exchange by the January 2014 deadline, and instead opted into receiving additional federal assistance in the form of Medicaid funding to serve the most vulnerable USVI residents. However, with the opportunities to the healthcare system afforded during this recovery effort, the benefits and cost-effectiveness of creating an Exchange and the positive impact an Exchange could have should be re-evaluated by the Governor's Office in close consultation with the HHS, as well as other federal and local partners.

⁹ H.R.2404, 115th Cong. (2017). Accessed June 28, 2018. <https://www.congress.gov/bill/115th-congress/house-bill/2404/text>

¹⁰ "Letter to the Commissioner," Department of Health & Human Services (HHS), July 16, 2014, <https://www.cms.gov/CCIIO/Resources/Letters/Downloads/letter-to-Francis.pdf>.

¹¹ "Impact of the ACA in the U.S. Territories," The Benefits Group, 2016, [http://www.benegroup.net/assets/files/Impact-of-the-ACA-in-U.S.-Territories-10-31-16-\(1\).pdf](http://www.benegroup.net/assets/files/Impact-of-the-ACA-in-U.S.-Territories-10-31-16-(1).pdf).

ENHANCE HEALTHCARE SYSTEM THROUGH WORKFORCE DEVELOPMENT AND CLEAR GOVERNANCE STRUCTURES

Healthcare sector workforce development and improved healthcare governance structures are potent improvements needed to meet the medical need of the Virgin Islands community. Following the hurricanes, the Virgin Islands depended heavily on nursing staff and allied health professionals in meeting immediate needs and ensuring qualified and licensed professionals are prepared for a natural disaster improves healthcare accessibility and response. Ensuring that healthcare infrastructure remains operational regardless of the challenges a disaster may present is the responsibility of healthcare leadership, and as such, proper and effective governance structures increase preparedness and help ensure longer term resiliency in the system.

Initiative 20

Assess current state of healthcare workforce in the Virgin Islands

The USVI's fragile healthcare workforce was further crippled by the loss of healthcare professionals in the aftermath of hurricanes Irma and

Maria. Insufficient healthcare professionals resulted in emergency requests for nurses, environmental health specialists, physicians, pharmacists, and behavioral health specialists. In the absence of subject matter experts and skilled technicians, the USVI relied on the Emergency Management Assistance Compact (EMAC) and the Disaster Medical Assistance Teams (DMAT) to supply and meet healthcare workforce needs following the storms.

Although these resources effectively filled the short-term need, the Territory needs a long-term approach to fill the gaps. VIDOH will conduct long and short-term surveys to assess health professional shortages in the Territory and develop a plan to address the workforce gaps identified.

Initiative 21

Support healthcare workforce development through public and private partnerships in education and employment

VIDOH will establish partnerships between the Virgin Islands Department of Education (VIDOE), the University of the Virgin Islands (UVI) and healthcare providers to outline emerging professional needs. VIDOH will coordinate with the Virgin Islands Department of Labor (VIDOL), VIDOE, the Career and Technical Education Board and UVI to take a holistic approach to implement

career paths and the create an educational and career pipeline to cultivate and prepare Virgin Islanders to fill health professional voids.

VIDOH will also engage the VIDOL and private employers in dialogue on how to prioritize the value and critical role of healthcare professionals and incentivize them by offering competitive wages and retention benefits. Funding new and ongoing training partnerships with local and external educational institutions to promote advanced learning, exposure to cutting-edge practices, and the continuation of skill development will also support the Territory's long-term healthcare staffing needs.

Initiative 22

Evaluate efficacy of healthcare governance structures and reform oversight mechanisms, beginning with hospitals' Board of Directors

Beginning with the Board of Directors (BoD) model, VIDOH will help evaluate the governance structures of both Juan F. Luis Hospital and Schneider Regional Medical Center in order to determine the effectiveness of the current board model and oversight mechanisms. The BoD typically takes a higher-level strategic and values-oriented role by ensuring the hospital's mission is abided by, approving strategic plans and making decisions, overseeing

the financial health of the hospital, allocating and managing hospital resources, credentialing, monitoring and evaluating the performance of the hospital CEO, and, ultimately, ensuring the hospital provides high-quality patient care for the community.

The role and the responsibilities of the BoD should be outlined clearly in writing, as should their oversight mechanisms, including checks and balances between the board and the operating CEO. It is common for the BoD to be independent and separate from those with daily operating responsibilities—namely the CEO. These performance metrics and evaluation systems should be clearly outlined for the hospital management, the CEO, and include requirements for the board itself. The BoD should act in accordance with each hospital's mission and charter, enforce policies, and operate with the utmost discretion when making a decision. Placing the hospital's and community's interest above the BoD member's interest is imperative for a well-functioning and dutiful board.

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Trainees in a youth support program helping to restore their community, Source: My Brother's Workshop

VULNERABLE CATEGORIES

The population of the USVI includes 65,000 people who are exceptionally dependent on government services: 56,500 are people with low incomes, and the rest are the elderly, young children, juvenile delinquents, and people with mental and physical disabilities. The Department of Human Services (DHS) serves all of these people through programs that provide financial, medical, and nutrition support to low income populations, help the elderly in their homes and in assisted living facilities, prepare young children for kindergarten, supervise and reintegrate juvenile delinquents, and support those with disabilities.

The hurricanes increased the need for all of these programs – occurring because people’s homes were damaged, their sources of employment were gone, or because of the physical and psychological distress that the storms caused. At the same time, the ability of DHS to support these populations was reduced: the storms damaged the department’s facilities and left them without power and communications and made it more difficult for staff to come into work. In the months that followed the storms, DHS largely



Trainees in a youth support program distributing food for hurricane survivors in their community; Source: My Brother’s Workshop

managed to continue delivering its services – but there were delays, and much staff effort went into improvising solutions on the spot.

In the future, stronger (though not necessarily more frequent) hurricanes will make it likely that similar challenges will repeat. Other climate risks like greater heat will further contribute to these climate challenges because of the aging population, causing the demand for DHS services to swell even more.

To ensure that DHS can continue to support the people who depend on its services, the department will, among other measures, rebuild and strengthen its senior homes and youth rehabilitation facilities, switch to underground fiber communications systems that proved highly resilient in the 2017 storms so that programs like SNAP (which require internet connections) can function, establish a new senior center on the West End of St. Croix, expand its emergency shelters, and revise its emergency plans to include

more nonprofits and improve communication with the public.

HOW THE SYSTEM WORKS

The territory's 65,000 vulnerable citizens – 56,500 low-income and 8,500 in other categories – are served by a network of Department of Human Services (DHS) and non-governmental facilities that include nursing homes, senior centers, and facilities for children. Funding for the low-income populations primarily comes from the federal government; funding for other groups is primarily local.

VULNERABLE POPULATIONS AND THE PROGRAMS THAT HELP THEM

The territory's vulnerable populations include several groups: the low-income, the elderly, children under the age of five, juvenile delinquents, and the physically and mentally disabled. Low-income populations require support with healthcare, nutrition, and job and training opportunities. The needs of the elderly range from getting assistance in the home with things like cooking, cleaning, and doing laundry to being taken care of in 24-hour nursing homes and being protected from abuse. Children, especially from lower income families, need help preparing for kindergarten; some need to be protected from child abuse as well. Juvenile delinquents need supervision and support. Finally, the physically and mentally disabled need help with

daily living as well as training and support to become more self-sufficient.

The programs in the Territory that support these groups are of two different types: financial programs that support the general low-income populations and client programs that work with the more specifically defined vulnerable categories.

Financial programs include:

- Medical Assistance Program (known as Medicaid in the rest of the United States), which allows people with low incomes to obtain medical care
- Supplemental Nutrition Assistance Program (SNAP, also known as Food Stamps), which provides food help to families and individuals below the poverty line
- Temporary Assistance for Needy Families (TANF), which provides on the job training and employment to single mothers

Client programs for the elderly include:

- Homes for the elderly, which provide 24-hour care
- Adult Protective Services (APS), which investigates possible abuse or neglect of adults by caregivers and provides support to families with adults with special needs
- Senior centers, which provide a communal setting for senior activities
- Meals on Wheels, which sends out hot meals to homebound seniors
- Homemakers, which has people assisting seniors with daily activities like cleaning, cooking, and laundry

Client programs for children include:

- Children and Family Services, which manages cases of child abuse and neglect and also oversees the Territory's foster care system
- Head Start, which works with



Trainees in a youth support program distributing food for hurricane survivors in their community Source: My Brother's Workshop

children ages two years nine months to five years old to prepare them for kindergarten

Finally, juvenile justice programs oversee all pre-delinquent and delinquent juveniles up to age 19, while Vocational Rehab provides assistance to individuals with physical and mental disabilities by offering them training and programming to increase self-sufficiency.

The total vulnerable population in all of these groups is approximately 65,000 people – 56,500 low-income people supported through financial programs (26,500 in MAP, 29,400 in SNAP, and 627 in TANF), 6,300 elderly, 1,100 children, several hundred juvenile delinquents, and 400 disabled persons.

PHYSICAL FACILITIES

DHS runs several physical facilities to deliver all of these programs. The department's client facilities include Herbert Grigg Home for the Elderly in St. Croix (a nursing home with a capacity of 40), Queen Louise Home for the Aged in St. Thomas (a nursing home with a capacity of 29), Youth Rehabilitation Center in St. Croix (a facility for youthful offenders and juveniles ordered by the court), three senior centers (one on each island), and 16 Head Start centers. Offices and support facilities include Mars Hill on St. Croix (running SNAP, MAP, and TANF programs), Commissioner's Office on St. Croix, and also the Office of Intake and Emergency Services on St. Croix (usually the first point of contact for the public). DHS facilities on St. Thomas all reside at the Knud

Hansen Complex.

NON-GOVERNMENTAL PROGRAMS AND ORGANIZATIONS

"Several non-governmental programs provide additional support to the territory's vulnerable populations. These programs are: Catholic Charities which operates two Bethlehem Shelters—one in Kingshill, St. Croix and the other in Hospital Ground, St. Thomas, the Village provides mental health and substance abuse treatment in Sion Hill, St. Croix, the Women's Coalition located on St. Croix and the Family Resource Center on St. Thomas which offers services to victims of domestic abuse, on St. Thomas Kidscope provides services to children who are victims of abuse, neglect, sexual molestation, anger management, and family disputes, on St. Croix the Men's Coalition works with male batterers through individual and group counseling, and the nonprofit 10,000 Helpers provides support for individuals struggling with mental health issues on St. Croix. There are several other nonprofit and faith-based organizations providing services to the community in both districts.

IMPACT OF THE HURRICANES

The impact of the hurricanes was twofold: they increased demand

for the services of DHS services and at the same time made it more difficult for the Department to deliver those services. The staff improvised solutions and was able to reorganize service delivery, but some programs experienced delays and outages of up to two months.

INCREASED DEMAND

In both St. Croix and St. Thomas/St. John districts, the need for services greatly increased in the aftermath of the storms. The storms made homes uninhabitable, left some families with no source of income, and forced them to rely on DHS services like SNAP, MAP and Meals on Wheels for basic needs—making it clear in the process that many members of the USVI community had already been teetering on the edge of financial instability before the storms hit.

FACILITY DAMAGE AND SERVICE IMPACT

The storms damaged the department's ability to deliver most of its services in the face of increased demand. In particular, the following were affected:

- The offices of financial assistance programs (MAP, SNAP, and TANF) were without power and connectivity and did not reopen until November 2017
- Senior centers on both St. Thomas and St. Croix were closed; the St. Croix center reopened in October, and the center on St. Thomas reopened on Thanksgiving week, both in

temporary locations

- Meals on Wheels and Homemakers programs had stoppages of two days on St. Croix and five days on St. Thomas because of vehicle damages, but the department was able to borrow vehicles from other departments and continued operating shortly after
- Homes for the elderly experienced physical damage, but continued operating
- Adult Protective Services, Children and Family Services, Office of Intake and Emergency Services, and Juvenile Justice were all displaced but continued to operate from other locations; offices in St. Thomas and St. John experienced issues with mold

RESPONSE AND RECOVERY

Before the storms, DHS had already been dealing with a staffing deficit; between the post-

FUNDING

DHS is sponsored through a combination of federal and local funds: the local funds tend to focus on supporting the client-based services, while federal funds mainly attend to the department's financial programs. Locally funded programs include Children and Family Services, Juvenile Justice, and Senior Citizen Affairs. Federally funded programs are made up of SNAP, TANF, MAP and HeadStart. Through grant opportunities like Sexual Assault Victims Grant, Criminal Victims Fund, and the Crisis Grant program, DHS also funds local nonprofit organizations that help meet the needs of the community. Nonprofits also do their own fundraising.

storm increase in demand and damage to facilities, delivering services became a significant challenge. Many staff members worked longer: either longer hours, especially at the 24-hour facilities like the Youth Rehabilitation Center and Herbert Grigg, or additional days, picking up shifts at the emergency shelters or the Emergency Operations Center (EOC). Service delivery began to return to normal by around January 2018.

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

In the future, DHS facilities and services will see severe risks from hurricanes and their effects and mild to moderate risks from rising sea levels, temperature increase, and changes in precipitation.

HURRICANE WINDS, RAINFALL, AND STORM SURGE

The greatest risk to DHS facilities comes from hurricanes and their effects. As with the 2017 storms, the effects will include direct damage to facilities, impacts of failure of other systems like power and telecommunications, and impact on staff that may be unable to come to work for long periods of time. Damage to 24-hour facilities that house youth and elderly populations is a particular high risk.



Trainees in a youth support program preparing food for hurricane survivors in their community (Source: My Brother's Workshop)

RIISING SEA LEVELS

Overall impacts on the system will be minimal, but sea level rise will increase the effects of hurricane storm surge. Two DHS sites located in coastal areas may be subject to flooding and impacts of erosion as a result of this: the Richmond Senior Center/Head Start and the Marley Head Start.

TEMPERATURE INCREASE

Higher temperatures mean that most DHS buildings will need to use air conditioning more frequently than before. Specifically, 24-hour facilities like YRC, Herbert Grigg Home for the Elderly, and Queen Louise Home for the Elderly will need to be better prepared with backup generators to operate the AC units in the event the power goes out. Demand for services may also increase as heat begins to affect vulnerable populations—especially the elderly.

PRECIPITATION CHANGES

Most DHS facilities depend on cisterns for water, and with longer dry spells, cisterns will run dry faster and more often. 24-hour facilities may see extreme shortages, as water is used for cooking, showering, and most aspects of daily living.

INITIATIVES FOR INCREASING RESILIENCE IN SERVING VULNERABLE CATEGORIES

Keeping future risks in mind, DHS will pursue four strategies in the coming years to be able to serve vulnerable categories: first, rebuild and strengthen existing buildings; second, better serve some of the existing vulnerable populations through expanding programs; third, better prepare for disasters by strengthening connectivity, power, and transportation infrastructure; and fourth, better prepare through emergency planning and preparedness.

REBUILD AND STRENGTHEN CLIENT SERVICE AND PROGRAM SUPPORT BUILDINGS

The 2017 hurricanes showed that the facilities used to provide DHS services could not withstand extreme climate events. The main buildings need to be strengthened in order to survive future storms; in the process, they can also be upgraded to improve their functioning.

Initiative 1

Rebuild, strengthen, and expand Herbert Grigg Home for the Elderly

Herbert Grigg Home for the Elderly was damaged in the storms but continued operating. In the future, damage will need to be repaired, and since the current capacity is 80, with only two wings designed for long-term care, capacity will need to be expanded as well to accommodate greater future needs.

DHS will add a new wing to this facility to increase capacity to 140. The new wing will hold 20 rehabilitation beds and 40 assisted living beds, and will also have the ability to increase capacity in order to house an emergency special needs shelter of 20 beds. Repairs will also be made to the current building: central air conditioning will be added, electrical wiring will be upgraded, and the roof will be fixed and stabilized. Funding for this expansion and renovation is expected to come from the Community Development Block Grant (CDBG); funding for hurricane-related damage will come from FEMA.

Initiative 2

Rebuild, strengthen, and expand Queen Louise Home for the Elderly

Queen Louise Home suffered small-scale damage in the storms but continued operating. However,

before the hurricanes, the home's second floor had been condemned due to mold issues and water leaks, which limited capacity to just 29 beds at this facility.

DHS will relocate the facility to another building, making it possible to increase capacity to 100 beds. The current home will be refurbished and repaired to house a much-needed senior center as well as an Emergency Special Needs shelter. Funding will be provided by CDBG.

Initiative 3

Rebuild and strengthen Youth Rehabilitation Center

YRC suffered some damage in the storms, and similar to Queen Louise, there were areas of the YRC facility that were in disrepair prior to the storms. That includes the intake unit, the kitchen, and the courtyard, all of which are currently unusable.

DHS will repair the damaged areas. In addition, new bathrooms, new kitchen equipment, as well as upgrades to the cameras and radios, will be considered for this facility. No funding source has been identified yet.

Initiative 4

Rebuild and strengthen Commissioner Office and office facilities at Mars Hill

The Homes for the Elderly and YRC house DHS clients directly, but central DHS office facilities make it possible to deliver services to clients – especially those who depend on financial programs. DHS's main office facilities, particularly the Commissioner Office and the Mars Hill facility, were damaged in the storms. These offices were not fully functional for many months after the storms, which made delivering services very difficult.

DHS will rebuild the damaged facilities and strengthen them to prevent the 2017 scenario from repeating. Particular attention will be paid to power and telecommunications capabilities.

EXPAND CAPACITY AND UPGRADE PROGRAM DELIVERY TO ASSIST UNDERSERVED SEGMENTS

As climate risks increase, so will the demand for DHS services in the aftermath of major events. The department will respond by expanding services for seniors and children in areas that are currently underserved.

Initiative 5

Create a new senior center on the West End of St. Croix

The West End of St. Croix does not currently have a senior center, however, DHS has an unused facility at Aldersville that could be turned into a new senior center. This conversion would allow DHS to have a hub in the West End in order to reach more rural areas where seniors can become homebound. A West End center in Aldersville would also provide an opportunity to increase capacity by working with homemakers to help support DHS staff in the area. It would also allow DHS to more easily make deliveries for Meals on Wheels and help expand other West End services.

DHS should create new senior center on the West End of St. Croix, subject to availability of funding.

Initiative 6

Expand child services capacity

Children's services provided crucial support in the aftermath of the storms – but some facilities were damaged, and subsequently there was unmet demand for several months.

DHS should increase service for pre-school aged children through more Head Start centers or expand program capacity through additional licensing for daycare and day camp facilities. The department should expand school centers that encourage and



FEMA Disaster Survivor Assistance team member helps a resident register for assistance at the Disability Rights Center of the Virgin Islands (Source: Kenneth Wilsey/FEMA)

support juveniles in the territory with structure and positive social interactions to serve as preventative care for at-risk adolescents.

upon which the functioning of its programs may come to depend in the case of another hazardous event.

to check eligibility and distribute benefits.

REBUILD AND STRENGTHEN CONNECTIVITY, POWER SUPPLY, AND TRANSPORTATION

In the face of future storms, stronger buildings alone are not sufficient – the department also needs the ability to use them. DHS will therefore work to strengthen the secondary systems

Initiative 7

Strengthen connectivity and power backup options in support facilities

DHS services mainly require the presence of staff, but some, especially the financial programs, depend heavily on power and telecommunications. For example, with programs like SNAP, electricity and a connection to the Internet are needed in order

The storm damage to electricity and communication networks made it impossible to administer such programs for up to two months after the storms, as the department did not have backup power and communications solutions. In some cases, even when temporary secondary sources for electricity and Internet became available, DHS may not have been able to use them due to the damage at the facilities that would have housed them. As facilities are strengthened in the future, it will be important to ensure that they can not only survive storms physically but can also support program delivery amidst communication and power

outages.

To address power issues, DHS will ensure that backup generators are available at critical facilities and that those generators are regularly inspected, fueled, and maintained. The department will also examine the feasibility of installing off-grid solutions like solar photovoltaics (solar PV) panels and battery storage.

To address communications issues, the department will switch to underground fiber communications by working with viNGN and Viya, as necessary. Buried fiber networks proved highly resilient in the 2017 storms and did not suffer major outages.

Initiative 8

Secure additional vehicles and create transportation redundancies

The storms damaged many of the department's vehicles. As a result, delivery of services like Meals on Wheels was disrupted for several days until the department could find alternative vehicles.

DHS will work on securing vehicles in a safe and unexposed location prior to the next event. In addition, the purchase of new vehicles to remove any older,

problematic vehicles from the fleet will be a priority for the division of operations, as will be ensuring that routine vehicle maintenance is performed regularly.

IMPROVE EMERGENCY PLANNING AND PREPAREDNESS

One can never do enough pre-disaster emergency planning or post-disaster public communication – and the different departments of DHS can improve on both counts. DHS will develop emergency plans for all of its different programs (including



Friends of Disabled Adults and Children (FODAC) deliver a new walker to a survivor at a Disaster Recovery Center in St. Croix
Source: Kenneth Wilsey/FEMA

by working with nonprofit partners) and will improve how it communicates with the public.

Initiative 9

Develop emergency plans for each program

The 2017 hurricane season severely disrupted DHS operations. This adjustment would have been simpler and speedier if there had been emergency plans in place to be followed. Each DHS program will develop an emergency plan. Specifically:

- Children and Family Services will plan for additional emergency short-term foster care placements as well as residential beds to be made available to displaced foster care children.
- The department will keep on hand emergency petty cash reserves for purchases until ERP (the online procurement system) is up and running.
- Juvenile Justice and YRC will plan for evacuation of residents as well as for relief for staff manning the facility during storms.
- Head Start will plan for redistribution of clients and work around double sessions and sharing spaces.
- Senior Citizen Affairs will plan for increased need in services like Meals on Wheels or beds at homes for the elderly. The

Department will also develop an evacuation plan for residents with functional or behavioral health needs.

- Departments like human resources, payroll, and fiscal programs will plan for having alternate spaces, reassigning personnel, and making emergency funds available.

Initiative 10

Expand special needs shelter capacity

Special needs shelters can currently operate from inside both homes for the elderly, but the need for this capacity was severely underestimated and many more residents were in need of those services than DHS could accommodate. In addition, before being managed by DHS, special needs shelters were under the management of the Department of Health; insufficient interagency communication and coordination caused delays and interruptions in service.

DHS will expand the capacity for special needs shelters at both Herbert Grigg and Queen Louise facilities and will determine the number of staff needed to service that population's needs.

Initiative 11

Magnify community communication through public relations

During the response effort, there were significant delays in relaying information to the

public regarding changes in DHS operations.

DHS will revise its emergency communications plans with a focus on keeping the community updated, including by making the Director of Community Affairs an integral part of the planning and response process.

Initiative 12

Include nonprofits in the emergency planning process

Some nonprofit agencies have deeper insight than DHS does into the individualized needs of distinct communities in the Territory and can deliver services that supplement what DHS can offer. That includes providing permanent, temporary and/or emergency sheltering and social services for homeless, abused, neglected, displaced and disabled persons of all ages; rehabilitation services for individuals with psychological needs, for the physically disabled, and for those facing social challenges; afterschool educational enrichment programs and adolescent to early adult career building engagement activities; and residential care and door-to-door transportation for the elderly and disabled.

DHS will include community-based nonprofits on each island in its emergency planning process to make sure that their individual abilities are best used in the next emergency.



EDUCATION

The USVI's educational system includes K-12 schools and the University of the Virgin Islands. The K-12 system includes 31 public schools run by the Virgin Islands Department of Education (VIDOE) and 28 parochial and private schools supported by some VIDOE funding, as well as a small number of homeschooled students. The University of the Virgin Islands (UVI) is the sole post-secondary institution in the Territory (excepting online programs). It offers undergraduate and graduate degrees, as well as online degrees, community programs, certificates, and continuing education.

Hurricanes Irma and Maria affected all elements of the education system, damaging or destroying school and university buildings and knocking out essential services like power and telecommunications. They also affected the lives of students and teachers, as some left the Territory and did not return for many months, if at all, leading to a 17 percent drop in public school enrollment, an eight percent drop in university enrollment, and a yet to be determined drop in private school enrollment.

In the hurricanes' aftermath, VIDOE, private schools, and UVI were left with the task of restoring instructional sessions as quickly as feasible, while simultaneously



Damage to Alexander Henderson Elementary School on St. Croix. Source: VIDE

rebuilding communities and restoring a sense of normalcy for students in the Territory. Parents, educators, school administrators, and the community at large faced an abundance of questions about the state of education after the devastation of Hurricanes Irma and Maria. Providing resources to staff and students, as well as finding safe temporary facilities, to continue educational instruction became the priorities for VIDOE in order to bring the 2017/2018 school year to a successful close. The University of the Virgin Islands was able to resume classes within one month after the first hurricane and, through an innovative reconfiguration of the curriculum, was able to successfully complete the Fall and Spring semesters.

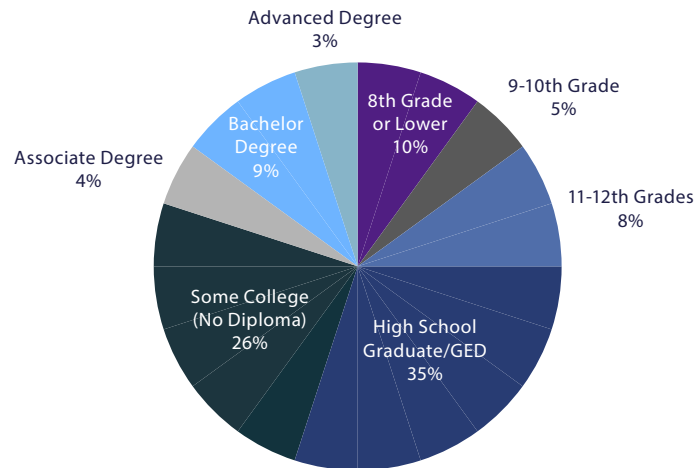
In the future, risks to the system will include hurricane winds, rainfall, and storm surge similar to those the 2017 hurricane season brought. Sea level rise will threaten low-lying facilities, high heat will increase the demand for air conditioning, and changes in precipitation may create water supply constraints for several schools that rely on cisterns in addition to WAPA water.

Better preparing for future storms (including by developing standard operating plans, training employees, diversifying power sources, and upgrading buildings to become emergency shelters), hardening and rebuilding facilities (including by using modular and sprung facilities while permanent ones are

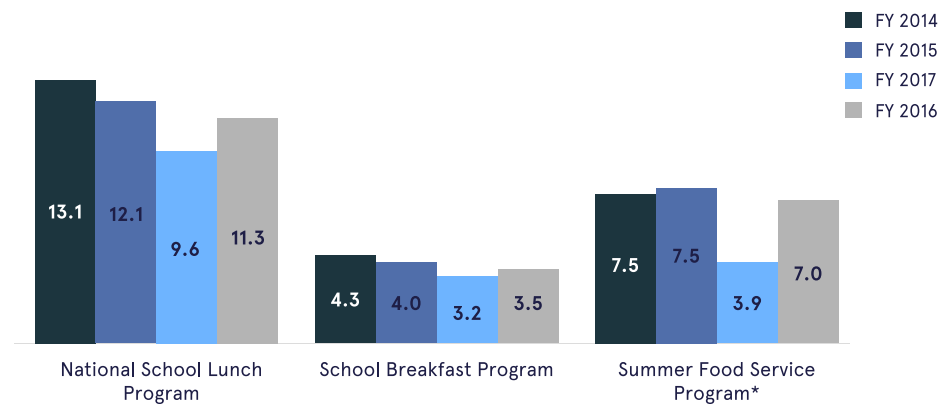
being constructed), and creating new opportunities for students (including by supporting farm to school initiatives and establishing an oceanic and atmospheric research center).

HOW THE SYSTEM WORKS

Education plays an important role anywhere, but it is particularly crucial in the USVI, which faces high levels of poverty, high costs of living, and a geographically restrictive job market. Among adults over the age of 25, roughly 23 percent do not have a high school diploma or GED, 35 percent have completed high school or a GED, and only 16 percent hold an Associate, Bachelor, or higher level college degree (see chart: [Education level of USVI residents above the age of 25](#)).¹ School student population is more vulnerable overall than most comparable stateside populations, and school students lag behind most states in test scores. All public schools in the USVI participate in federal free meal programs for students as a result of qualifying economic disadvantage and test scores across the Territory (see chart: [USVI K-12 students receiving school nutrition support](#)). It should also be noted that while the Territory has made vast strides in providing accessible, affordable Internet in the last five years, an estimated 14 percent of the population still does not have Internet access.²



Education level of USVI residents above the age of 25
Source: USVI Community Survey, 2013



*Average daily attendance

USVI K-12 students receiving school nutrition support; Thousands
Source: U.S. Department of Agriculture

K-12 EDUCATION

K-12 education in the USVI is provided through public and private schools (both parochial and independent). School enrollment is mandatory for all children from ages five through 18. Private and parochial schools accept children ages three to 18 through each school's unique application process.

Private and parochial schools

The Territory is home to many private and parochial schools across St. Thomas, St. John, and St. Croix, 28 of which receive some funding from Federal grants. Enrollment numbers at private schools in the Territory vary based on the schools' grades and facilities; some offer preschool or kindergarten

¹ "2013 United States Virgin Islands Community Survey." Eastern Caribbean Center, University of the Virgin Islands. January 2016. Accessed June 1, 2018. https://www.uvi.edu/files/documents/Research_and_Public_Service/ECC/SRI/VICS%202013.pdf.

² "Community Development Block Grant Disaster Recovery (CDBG-DR) Action Plan," United States Virgin Islands Housing Finance Authority, May 25, 2018. <https://www.vihfa.gov/sites/default/files/reports/USVI%20Action%20Plan.pdf>

through grade 12, while others offer only elementary and/or middle school grades. Schools range in size from a few dozen to 500 students. While many USVI private schools are parochial or affiliated with a particular church or denomination, several schools have no religious affiliation.

Private schools are funded by student tuition, grants, and private donations and endowments. While all private and parochial schools charge tuition fees, they also offer varied levels of financial aid and scholarships. The Territory's private and parochial schools also receive some funding from the U.S. Department of Education (DE) Consolidated Grant.

Virgin Islands Department of Education (VIDOE)

VIDOE is an executive branch of the Government of the Virgin Islands (GVI) responsible for all K-12 public education, special needs, and adult education through age 21, and support services such as student transportation, library services, and child nutrition. Through VIDOE, the public educational system in the USVI provides a free education to all children from kindergarten to age 21 (for special education). In the 2017 fiscal year, 13,194 students were enrolled in the USVI public school system—not including those served by VIDOE's adult education programs. This is a slight decrease (4.4 percent) from 2016, when

VIDOE served 13,805 registered students. At the beginning of the 2017/2018 school year, there were a total of 31 public schools in the Territory.

In addition to the public schools themselves, VIDOE oversees three Non-Instructional State Operational Education Facilities to provide support services for students. These sites housed many division offices critical to the delivery of educational instruction (all three are now shuttered as a result of storm damage). On St. Croix, these included the VIDOE headquarters and a Curriculum Center. The St. Croix District VIDOE Headquarters provided information on school related finances, policy, and procedures to parents, students, and the community. The facility housed the Offices of the Insular Superintendent, Business Office, and Payroll Office. The St. Croix Curriculum Center housed the district content coordinators and IT. It also provided information and resources related to instruction (teaching and learning). The St. Thomas/St. John District Curriculum Center housed the Insular Superintendent's Office, which provided students, parents, and the community registration services and support and resources on teaching and learning. The center also dealt with federal grants and procurement and housed school lunch freezer/refrigerator and a maintenance division.

Adequate funding to support the public education infrastructure in

the USVI is an ongoing problem.³ VIDOE receives approximately \$167 million a year from the Territory's General Fund budget (locally funded). The VIDOE also brings in about \$40 million in funding from other sources, including about \$33 million from the federal government. Additionally, VIDOE was allotted approximately \$15 million in funds to supplement teaching and learning processes through the U.S. Department of Education's Consolidated Grant to the Insular Areas (Consolidated Grant).⁴ In addition to supporting the 31 public schools, a percentage of this allotment supports 28 private schools in both districts. The Consolidated Grant is only available to U.S. territories and serves as a single application vehicle for funding disbursed under multiple programs.

Post-secondary education: University of the Virgin Islands

Founded in 1962, the University of the Virgin Islands (UVI) is the only institution of higher learning in the territory. A public, co-ed, land-grant Historically Black College/University (HBCU), UVI offers degree programs in 47 undergraduate and graduate disciplines to approximately 2,400 enrolled students. UVI has two primary campuses on St. Thomas and St. Croix, as well as an Academic Learning Center on St. John (destroyed by Hurricane Irma), and an extension campus on St. Martin/St. Maarten. In

³ "Virgin Islands Department of Education Shares FY 2018 Budget." Legislature of the Virgin Islands. August 18, 2017. Accessed June 15, 2018. <http://www.legvi.org/virgin-islands-department-of-education-shares-fy-2018-budget/>.

⁴ "Consolidated Grants to the Insular Areas." Programs. April 28, 2017. Accessed June 19, 2018. <https://www2.ed.gov/programs/insular-areas/index.html>.

UVI: BY THE NUMBERS

Acceptance Rate: 98%

Retention Rate: 67%*

Overall 6-year Graduation
Rate: 23%

Student-Teacher Ratio: 12-1

USVI Resident Tuition: \$4,631
(annual, undergraduate)

*First-time, full-time Bachelor
Degree seeking students

2017, the University received accreditation approval to offer online degrees. Starting in 2018, UVI began to offer 100 percent online courses and programs across 16 Associate, Bachelor, and Master levels specialties.⁵ UVI often accepts students early, and also participates in a dual-enrollment program, whereby high school students can earn transferable college credits.

In addition to student degrees and programs, UVI is home to a number of research centers and specialty institutions, hosts the annual Paradise Jam NCAA Division I basketball tournament at the St. Thomas campus' Sports

and Fitness Center, and offers a variety of concerts and shows at the Reichold Center for the Arts on St. Thomas.

UVI's student demographics reflect its predominantly USVI attendance. Students from out of Territory accounted for roughly five percent of incoming freshmen for the 2017/2018 academic year, while international students made up only one percent. While all enrolled students must pay tuition, the University offers 100 percent tuition, room and board scholarships to USVI valedictorians and salutatorians, in addition to a variety of other scholarships and grants for which some students may be eligible. As with most public colleges and universities in the U.S., tuition is higher for out-of-territory students than residents.

The average SAT scores for incoming freshman at UVI are 481 on the evidence-based reading and writing sections, and 441 on the math section. These fall below the nationwide averages of 488 on reading (494) and writing (482) and 508 on math. However, it must be noted that UVI has a 98 percent acceptance rate for applicants—far higher than many colleges and universities, which lowers the overall average test scores of applicants, but also translates to more opportunities for students to earn a college degree.

The University is accredited through the Middle States Commission for Higher

Education, the Accreditation Commission for Education in Nursing, Inc., the Accreditation Council for Business Schools and Programs, and the National Council for Accreditation of Teacher Education. UVI is also authorized to offer online programs and degrees in all 50 US states and the District of Columbia through its membership in the National Council for State Authorization Reciprocity Agreements. A 17-member Board of Trustees governs UVI. Under Title 17, Chapters 33 and 25 of the Virgin Islands Code, the Board is responsible both for general management and control of the University's affairs and its Fund.

UVI is funded by: a portion of the Territory's general fund; tuition and fees; public and private grants and contracts; investments; service contracts; and private gifts, donations, and endowments.⁸

IMPACT OF THE HURRICANES

Hurricanes Irma and Maria damaged or destroyed significant portions of the USVI's educational infrastructure and affected the mental well-being of students, educators, and parents alike. With significant damages to all schools and university facilities following the hurricanes—more than 50 percent of schools

⁵ "About UVI." University of the Virgin Islands. Accessed June 19, 2018. <https://uvi.edu/administration/about-uvi/default.aspx>.

⁶ "Fact Sheet: Academic Year 2017/2018." Institutional Research and Planning. Accessed June 22, 2018. <https://uvi.edu/research/institutional-research-and-planning/fact-sheets.aspx>.

⁷ "NCES Fast Facts: SAT Scores." NCES Fast Facts. Accessed June 22, 2018. <https://nces.ed.gov/fastfacts/display.asp?id=171>.

⁸ "Fiscal Year 2018 Proposed Operating Budget" and "Fiscal Year 2017 Proposed Operating Budget," Budget and Financial Reporting Analysis. University of the Virgin Islands. Accessed June 20, 2018. <https://uvi.edu/administration/administration-and-finance/budgets.aspx>.

reported damage—VIDOE and UVI leadership alike faced the challenge of operating minimally functional facilities. Specific hurdles included: lack of telephone service or reliable commercial electricity; added costs to run backup generators; reduced instructional support and service delivery due to capacity; loss of supplies, materials and equipment; and staffing shortages. Three schools in the Territory served as emergency shelters—two of which remained shelters far beyond the anticipated timeframe because residents could not return to their damaged homes or secure temporary housing.

In the aftermath of the storms, VIDOE worked to assess the immediate educational community, to determine how school families fared through these storms, and to get facilities up and running as quickly as possible in order to resume instruction for K-12 schools. Many VIDOE schools and most private schools were able to resume instruction in early October—only a month after the storms. By mid-November, instruction had resumed for all students in the Territory, although for over 9,000 students, this was accomplished only by implementing double and/or split sessions or in temporary structures.

Based on a faculty survey conducted by the American Red Cross, the mental health of students remains a challenge in the USVI public schools as a result of the storms. While respondents typically stated students were coping well with school closures, part-time schedules, and the

complete loss of after school programs, more than 80 percent of teachers across St. Thomas and St Croix reported difficulties engaging with students and problems with student morale.

Impact on students

In addition to emotional trauma, students in the USVI faced tangible struggles following the catastrophic September 2017 hurricanes. Nearly all students—public and private alike—lost belongings and clothing to storm or water damage. More significantly, a high number of students were displaced or living in storm-damaged homes. As a result of the storms, a number of families either emigrated out of the Territory entirely or sent their children to stay with family or friends to continue their education on the mainland US. Many families lost employment, vehicles, homes—essentially everything—in the hurricanes.

The high percentage of students from LMI families in the USVI were at particular risk following the storms. Families reliant on supplemental nutrition programs such as SNAP (Supplemental Nutrition Assistance Program) struggled to purchase food and supplies following the storm, as power and Internet outages made it nearly impossible to use pre-loaded EBT cards. Students who rely on free in-school breakfast and lunch were of particular concern while schools were closed. In October, the USDA's Food and Nutrition Service (FNS) approved flexibility to the School Lunch and Breakfast Programs

so VIDOE could serve students regardless of which session they attended at split-session school sites. The special permission also included an exception for meeting the regular requirements to prepare specific foods—a near impossibility given the storms' disruption to imports and distribution.⁹

Impact on K-12: VIDOE public schools

VIDOE utilizes more than 3 million square feet of property, much of which suffered irreparable damage during the 2017 hurricanes. While some damage was immediately obvious, some was less evident and will continue to impact facilities over time. Aside from structural and equipment storm damage, some VIDOE facilities were looted, which impacted the normal operations of instructional sessions and required additional effort to get the Territory's schools and facilities operational. The U.S. Army Corps of Engineers (USACE), Federal Emergency Management Agency (FEMA), U.S. Environmental Protection Agency (EPA) and VIDOE conducted Rapid Assessments and Site Evaluations for Category A & B emergency work estimated at close to \$1.2 billion, although VIDOE requested an initial estimate of \$750 million for emergency support from the federal government to help the USVI public education system recover.

In terms of impact on facilities, nearly every K-12 public school suffered damage. Of the school

⁹ "Food Assistance for Disaster Relief: U.S. Virgin Islands." Food and Nutrition Service. June 19, 2018. Accessed June 17, 2018. <https://www.fns.usda.gov/disaster/us-virgin-islands>.

buildings deemed reparable, at least 30 are in need of permanent work, estimated at approximately \$676 million including contingency and resilience efforts. More than half of the schools in the Territory reported that over 50 percent of their facilities are damaged, including leaks in roofs, flooding, structural damage, and broken windows.

At least five public schools are likely to meet the criteria for replacement and will need to be reconstructed. Of the five, Arthur A. Richards Junior High School on St. Croix and Addelita Cancryn Jr. High School on St. Thomas must be relocated and rebuilt outside their current flood zones. The estimated cost to complete these projects is more than \$100 million.

Until these schools can be rebuilt, VIDOE is deploying temporary facilities. These temporary structures are slated for completion before the start of the fall 2018 semester and include 143 modular buildings and 37 sprung structures.

After the hurricanes, VIDOE's administrative teams, VIDOE's Maintenance Division and

District	Campus
St. Croix	Pearl B. Larsen Elementary School
	Lew Muckle Elementary School
	Alfredo Andrews Elementary School
	Eulalie Rivera Elementary School
	Alexander Henderson Elementary School
	Elena Christian Jr. High School
	John Woodson Jr. High School
	Arthur Richards Jr. High School
St. Thomas-St. John	Guy Benjamin Community Center
	E. Benjamin Oliver Elementary School
	Addelita Cancryn Jr. High School
	Gladys Abraham Elementary School

Long-term school closures after the hurricanes

Engineering team, and USACE conducted several assessments on VIDOE's existing buildings and facilities. Cleaning contractors and landscapers have completed thorough cleanings of reopened campuses. Scopes of Work (SOW) and Project Worksheets (PWs) are being finalized by FEMA in conjunction with private consultants and VIDOE's engineering team. The most significant challenges VIDOE continues to face are the scarcity of materials and A & E contractors, and slowed progress while addressing roof damage, which results in on-

going moisture and mold issues in some school facilities and non-instructional buildings.

Impact on public education process

Facilities damage caused substantial disruption to instruction. Following the hurricanes, VIDOE shuttered 12 school campuses across the Territory, eight on St. Croix and six on St. Thomas and St. John (see table: [Long-term school closures after the hurricanes](#)). The department then moved to provide some form of instruction and restore school sessions for the school-aged population by relocating to temporary facilities and instituting a split calendar. The affected school populations continued on double or split sessions through the end of the 2017/2018 school year. The abbreviated schedules accommodated four hours of instruction instead of the regular 6.6 hours, and took place during two sessions: mornings 7:30 a.m. – 11:30 a.m. and afternoons 12:30 p.m. – 4:30 p.m. Additionally, the school year was extended to June 29. When possible, VIDOE kept

Percentage of school area damaged	Number of schools	Estimated cost of repair and reconstruction*
0-20%	2	\$1.5 million
20-40%	10	\$112 million
40-60%	0	N/A
60-80%	13	\$316 million
80-100%	4	\$245 million
Not categorized	1	\$1.3 million
Total	30	\$676 million

Damage to USVI public K-12 educational facilities

* Estimated cost includes resilience work.

Source: U.S. Virgin Islands Department of Education (accessed on March 21, 2018).

Island	School	2017/2018 Year Start	Reopening Date
St. Croix	AZ Academy	Wednesday, August 30	Monday, October 2
	Good Hope Country Day School	Monday, August 28	Friday, September 29
St. John	Giffit Hill School	Tuesday, September 5	Monday, September 25
St. Thomas	Virgin Islands Montessori School & Peter Gruber International Academy	Monday, August 21	Monday, September 25
	Antilles School	Monday, August 28	Monday, September 25
	All Saints Cathedral School	Monday, August 28	Wednesday, September 27
	Saints Peter & Paul Catholic School	Monday, August 21	Monday, October 2

Sampling of private school reopening dates after the 2017 hurricanes

students with the same teachers and placed them in locations near their original schools in an attempt to maintain some form of continuity.

In an effort to provide an environment to promote excellence in education for the 2018/2019 school year, all VIDOE schools must operate on a full session basis. As of June 2018, VIDOE was in the process of ordering modular classrooms and sprung shelters to meet this essential need.

Impact on K-12: Private and parochial schools

Private and parochial schools in both districts suffered structural damages, as well as damage to infrastructure as a result of wind and water during the hurricanes. The hurricanes also destroyed instructional materials, books, and equipment, as well as furniture. Fortunately, in the

days following the devastation, community and faith-based partners—including economic development companies (EDCs)—provided assistance in clearing debris from school grounds in an effort to ensure a safe environment for studies. Students, parents and staff also worked feverishly, assisting with repairing and cleaning buildings and classrooms for the anticipated start of school, despite the lack of power or phone service.

Nearly every school saw a drop in enrollment following the hurricanes, although some students are likely to return and the initial numbers may reflect the difficulty ensuring clear communication to parents or accessing transportation. The number of students each school lost varies widely: for example, Antilles School reported a drop in nearly 200 students between the first day of classes and its reopening after Maria,¹⁰ while All Saints Cathedral School lost 28 students.¹¹

Donations of funds and generators assisted with the reopening of private schools for students who remained in the Territory, including some students from public schools. Thanks in large part to these joint efforts, several private schools were able to reopen within a week of Hurricane Maria. Private schools able to reopen a week after Maria also had to contend with the ongoing Territory-wide curfew, and adjusted staff and student attendance hours accordingly.

Some schools have set up special hurricane relief funds or fundraisers to meet ongoing repair and construction needs, as well as to replace damaged materials and support increased need for financial aid. Schools will be working to repair, reinforce, and reconstruct damaged facilities over the course of summer 2018.

The storms' significant impact on the USVI economy also impacted families' ability to pay tuition during the 2017/2018 academic year. At least one private school,

⁹ Sacks, Brianna. "These Students Say They Want To Leave The US Virgin Islands For Safer Schools." BuzzFeed News, October 5, 2017. Accessed June 17, 2018. <https://www.buzzfeed.com/briannasacks/usvi-schools-after-maria?>

¹¹ "Recovery Efforts Still Ongoing in U.S. Virgin Islands." National Association of Episcopal Schools. February 6, 2018. Accessed June 22, 2018. <http://www.episcopalschools.org/news/news/news-archive/2018/02/06/all-saints-cathedral-school-calls-for-support>.

Gifft Hill School on St. John, took the additional step of waiving tuition for the 2017/2018 school year so as to ease the financial burden on as many families as possible following the September hurricanes.¹² Other schools, such as the Montessori School on St. Thomas, revised their financial aid policies to reflect financial hardship as the result of the hurricanes.¹³

University of the Virgin Islands

UVI suffered damages to its facilities, including the main campuses, the Research and Technology Park (RTPark) on St. Croix, and the Virgin Islands Environmental Research Station on St. John.

The St. Thomas campus was severely damaged by Hurricane Irma, while the St. Croix campus was hit hard by Hurricane Maria. All buildings incurred some level of water damage, broken ceilings, damage to internal and external lighting, security cameras, technology equipment, rooftop solar panels, roads and other infrastructure. As with the rest of the Territory, the campus greenery and trees were stripped or destroyed. Facilities that incurred the most damage included: Center for Marine and Environmental Studies (CMES); School of Business Building; Quarters B Administrative Building; West Hall Residence (largest dormitory housing 104 students); Reichhold Center for the Arts; Institute for Geocomputational Analysis and

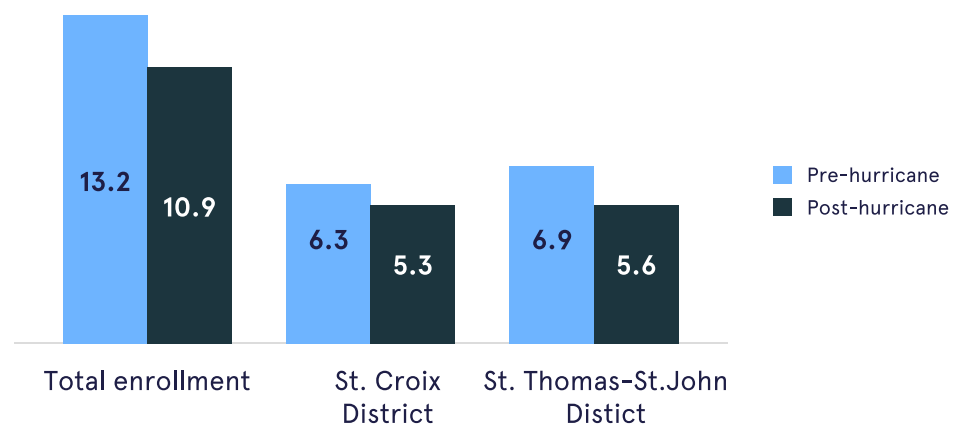
Statistics (GeoCAS) and Caribbean Green Technology Center (CGTC) Building; Faculty West Building; President's Guest House; St. Croix Residence Hall; and UVI Research and Technology Park Building (College of Science and Math).

Classes resumed on October 9, a few weeks following Hurricane Maria, albeit with a noticeable impact on enrollment—350 of nearly 2,400 enrolled students did not return after the storms. The faculty, staff and students of UVI demonstrated enormous resiliency as the course schedule was redesigned, the calendar extended, and some courses moved online or to the weekends. Various buildings were repurposed and some faculty and staff had to operate without offices for an extended period of time.

The damage to UVI will cost an estimated \$60 million to repair, including resiliency measures. It is estimated that \$23 million of the facility losses will be covered by insurance, and UVI is looking to the federal government and other funding sources to cover the remainder of the damages.

Impact on student enrollment and employee retention

Enrollment levels fell across all parts of the education system. VIDOE's student enrollment declined over 17.5 percent since Hurricanes Irma and Maria, from roughly 13,200 students before the storms to 10,900 students after (see chart: [Public school enrollment, 2017-2018 school year](#)). The department, however, expects these totals to increase for the 2018/2019 school year, bringing enrollment closer to pre-storm levels. Private and parochial schools experienced a noticeable decrease in enrollment as well, although the true extent of the changes will not be clear until the 2018/2019 school year begins. UVI lost 8.4 percent of its students, with enrollment going from 2,400 before the storms to 2,050 after. Of the 350 students who left, 210 withdrew immediately after the storms.



Public school enrollment, 2017-2018 school year; Thousands of students
Source: VIDOE

¹² "Hurricanes Irma and Maria." Gifft Hill School. Accessed June 22, 2018. www.giffthillsschool.org/hurricanes-irma-maria.

¹³ "Post Hurricane Tuition Impacts." Virgin Islands Montessori School & Peter Gruber International Academy. Accessed June 22, 2018. <http://www.vimsia.org/hardship-tuition-application/?rq=hurricane>.

In the public school system, the hurricanes exacerbated existing problems with student retention and academic performance. Home displacement and lack of basic necessities like clothing, reliable transportation, nutrition, and emotional support amplified problems while schools remained closed in the weeks after the storms. To address the situation, VIDOE created a truancy team to seek out students who were not returning to school. In partnership with school security, attendance counsellors on the truancy team looked for students on weekends. When found, students usually returned to school within a day or two. The department also worked with students' families. Schools worked with the VIDOE's alternative education program, the St. Croix Community Foundation, and other organizations to provide support.

Retaining employees has become more challenging as well, especially for VIDOE. Coupled with the longstanding gap between the cost of living and salaries, the hurricanes burdened VIDOE with an additional 60 separations on top of the

existing 77 vacancies across the territory. UVI and the private and parochial schools retained most of their staff. UVI instructors who relocated continued to provide educational services to students through the online program.

FUTURE CHALLENGES RESULTING FROM CLIMATE CHANGE

In the future, education facilities will face mild to moderate risks from sea level rise, temperature increase, and changes in precipitation, while hurricanes, winds, rainfalls, and storm surge present moderate to severe risks. Hurricane and storm surge risks are of particular concern, as they can force education facilities to close for long periods of time. Consequently, this can put the Territory at risk of losing families to relocation. VIDOE facilities at particularly high risk include

Addelita Cancryn Jr. High School on St. Thomas and Arthur A. Richards Jr. High School on St. Croix. Climate risk analysis was not conducted for UVI facilities.

HURRICANE WINDS, RAINFALL, AND STORM SURGE

Hurricanes and their related winds, rainfall, and storm surge present the biggest risk to education facilities. Category 2 or higher hurricanes will cause wind damage to facilities. At particular risk are facilities of a certain type of construction like high rib; these include facilities such as Eulalie Rivera Elementary School, where at least one building has high rib exterior walls. Storm surge caused by hurricanes or related tsunamis will impact coastal facilities. At particular risk are facilities below the 80 feet mark for tsunamis; these include: Charlotte Amalie and Ivanna E. Kean High Schools, Addelita Cancryn Jr. High School, Ulla Muller, Leonard Dober, and Gladys Abraham Elementary Schools, Julius Sprauve and Guy Benjamin Elementary Schools

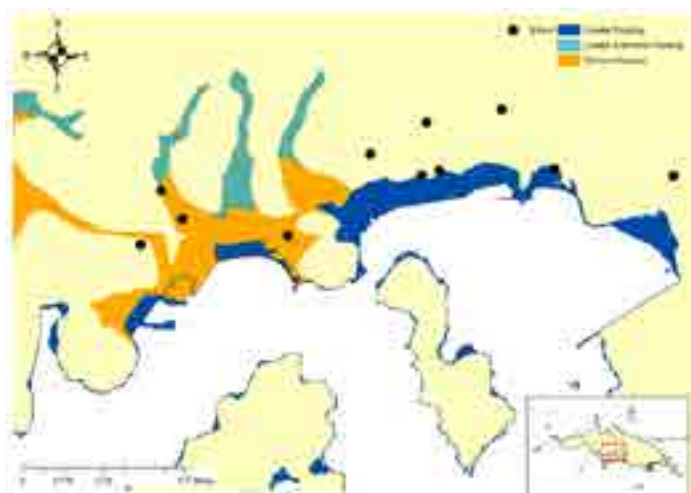


Figure 41 - Map of VIDOE Schools



Figure 42 - VIDOE Schools in Charlotte Amalie at Risk for Coastal Flooding

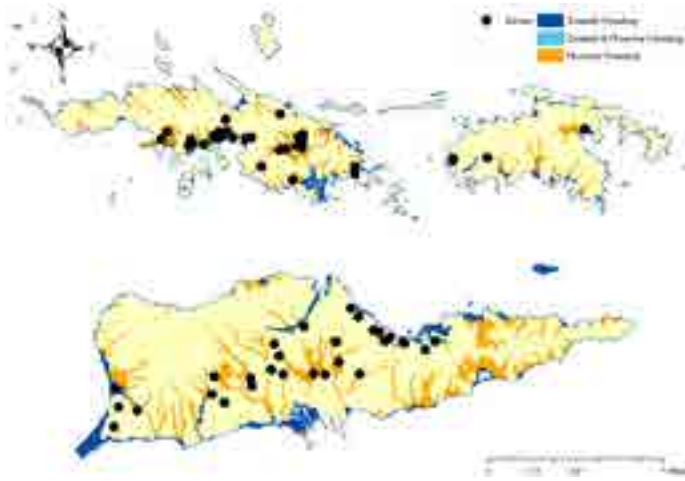


Figure 43 - VIDOE Schools in Christiansted at Risk for Coastal Flooding



Figure 44 - VIDOE Schools in Charlotte Amalie at Risk for Sea Level Rise



Figure 45 - Storm Surge for VIDOE Schools in Charlotte Amalie, Present, Predicted 50 year, Predicted 100 years

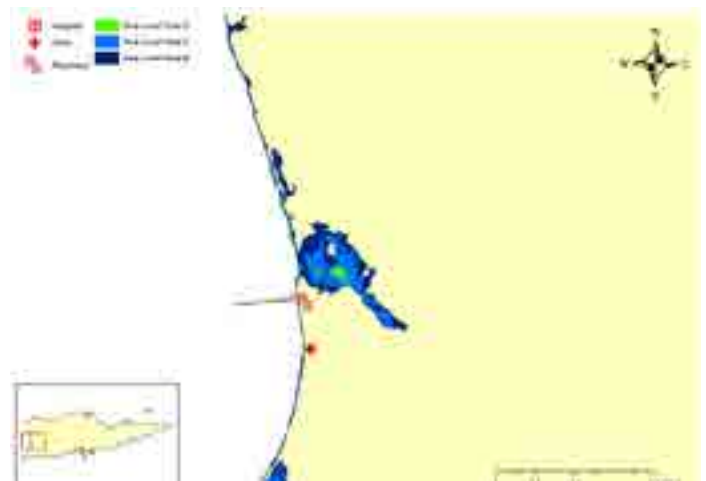


Figure 46 - DOH Health Facilities and Pharmacies at Risk of Sea Level Rise in Fredriksted

(St. John), Juanita Gardine and Pearl B. Larsen Elementary Schools, Arthur A. Richards Jr. High School, Adult Education, and Headquarters. Should these facilities be flooded by storm surge, the buildings and grounds would suffer moderate damage to complete destruction and require lengthy repairs. Finally, the heavy rainfall associated with hurricanes will overflow drains, gutters and water-ways, resulting in flooding and potentially causing the closure of classrooms and offices.

RIISING SEA LEVELS

While some VIDOE education facilities are already located on elevated ground, some are near the coastline and therefore at risk of flooding and water damage as a result of rising sea levels. Facilities near the coastline include: Leonard Dober, Jane E. Tuitt, and Lockhart Elementary Schools on St. Thomas, Guy Benjamin and Julius Sprauve Elementary Schools on St. John, and Adult Education on St. Croix. These facilities may be impacted by soil and sediment erosion and flooding during storms, hurricanes and tsunamis.

Other facilities that are at particular risk because of guts and swales running through the campuses include Joseph Gomez and Sibilly Elementary Schools and Charlotte Amalie High School on St. Thomas, and Juanita Gardine Elementary School and Adult Education on St. Croix.

INCREASES IN TEMPERATURE

As temperatures increase, facilities with air conditioning units will need more frequent maintenance and repair as a

result of increased usage, as well as the strain caused by frequent power outages and surges. The cost of purchasing additional AC units and fans, as well as the electricity to operate them, will increase operating costs. This will affect most VIDOE facilities, as most have some form of air conditioning on the premises. Some facilities have air conditioning in only certain rooms, while the other areas utilize fans and natural breezes. Few VIDOE facilities have total air conditioning, including district offices.

CHANGES IN PRECIPITATION

Decreases in overall rainfall present a moderate risk. All of VIDOE's facilities currently rely on WAPA water supply; however, a few school sites have cisterns, which permit switching over to collected rainwater during low water pressure. The facilities with cistern redundancies may be able to rely on the cisterns less than in the past.

INITIATIVES TO INCREASE RESILIENCE IN EDUCATION

Strategies to make the education system more resilient include strengthening the existing infrastructure, better preparing for the consequences of

future storms, and expanding opportunities for the Territory's students. As K-12 and university segments are run separately by two different organizations—VIDOE and UVI—the initiatives for these two parts of the education system are presented separately.

FUNDING NEEDS

VIDOE and UVI have identified emergency repair needs of \$112 million, with permanent reconstruction and additional resilience and mitigation needs totaling \$793 million. As of April 21, 2018, VIDOE had submitted \$55.6 million in projects to FEMA-PA, of which \$1 million has been obligated. VIDOE also submitted hazard mitigation projects for HMGP 56 U.S. Virgin Islands Department of Education. VIDOE will also pursue several other potential funding sources, including the U.S. Department of the Interior's Office of Insular Affairs, the USDA's Rural Development programs, and the U.S. Department of Education's Pell Grant and charter school programs. Other sources of funding for education infrastructure will be continuously monitored and unmet need will be updated accordingly to ensure no duplication of benefits.¹⁴

PREPARE FOR FUTURE STORMS [VIDOE]

Initiative 1

Develop a standard operating plan and procedures (SOP) for disasters

Current protocols and planning efforts proved insufficient in the face of hurricanes Irma and Maria in 2017, and plans must be developed that take into account the increased severity of natural disasters. VIDOE will work with the GVI and VITEMA to will write and implement a best practices standard operating plan and procedures (SOP) for responding to natural disasters (including pre- and post-hurricane measures, as well as measures for tsunamis and/or earthquakes). VIDOE will identify implementable preventative measures, such as clearing drains, gutters, and waterways susceptible to flooding, and placing sandbags at facilities to protect against flooding before future events, and outline how these measures will be carried out in the time leading up to a potential natural disaster. This information will be developed at VIDOE and disseminated in every district, and at every level. Where applicable, VIDOE can aid the effort of other Territory schools, including private and parochial, by sharing plans. As part of the SOP, VIDOE will also establish a communications plan for faculty, teachers, students, and their families that will be implemented in a disaster scenario.

¹⁴ CDBG-DR Action Plan 2018.

Initiative 2

Identify best practices for resiliency and disaster training for all stakeholders and develop a formal system of training

VIDOE will coordinate with VITEMA and other experts to identify and implement best practices for resiliency and disaster training for all stakeholders. VIDOE will develop a training and drill methodology that includes regular information sharing and practice. The key to making sure that disaster planning is effective in the event of another storm is ensuring stakeholders at all levels have access to information and know which procedures to follow at what time.

Additionally, VIDOE will develop a formal training system that is conducted upon hiring and refreshed annually in advance of hurricane season. Employees of VIDOE must certify that they have completed their disaster preparedness training and understand the processes and procedures that must be followed in the event of a natural disaster. In addition to a general training, VIDOE will provide additional training for personnel depending on their employment level and management responsibilities.



Initiative 3

Partner with federal level Department of Education emergency grant programs

The USVI can utilize School Emergency Response to Violence (SERV) funds to cope with the immediate aftermath of a natural disaster. The Department of Education established Project SERV grants to help schools and districts cope with a disaster event that causes a significant disruption to educational instruction. Funds can be used to pay overtime for teachers and staff, substitute staff, counselors and mental health professionals, emergency transportation, and other services. Although a small portion of the overall recovery effort, DE level grants can help restore the learning environment after a catastrophic event. VIDOE will work with DE to obtain funds under the SERV program.

Initiative 4

Foster independence of power resources through diversification

VIDOE will explore grants for the purchase and installation of solar panels with collaborative partners in order to lessen VIDOE's financial burden and reliance on WAPA for commercial electricity. Likewise, VIDOE will take local knowledge into consideration as it plans new buildings, in order to maximize use of breezes and location for natural cooling. The department will also undertake an internal education program

to raise awareness about energy conservation practices and how to implement them in schools and VIDOE facilities.

Initiative 7

Upgrade schools to emergency shelter standards

VIDOE schools and buildings served as provisional emergency shelters, even though they at times did not meet emergency shelter standards. Shelters were required to remain open to accommodate individuals and families whose homes were destroyed or made uninhabitable by hurricanes Irma or Maria, and the lack of alternative sheltering resources in the Territory delayed the re-opening of schools by up to one month. Through CBDG-DR funds, VIDOE can harden and upgrade schools to sheltering standards in order to serve as emergency shelters while other permanent shelters are built to serve the community in times of emergency.



PREPARE FOR FUTURE STORMS [UVI]

Initiative 8

Decrease dependence on fossil fuels and the local power grid by installing alternative energy power systems

In an effort to mitigate the cost of commercial power, as well as the University's reliance on fossil fuels, UVI has issued an RFP for the development, construction, and operation of two off-grid systems on its St. Thomas and St. Croix campuses. The solutions will be compact and will reduce the University's energy costs by 40 to 60 percent overall. This initiative will create approximately 10 full-time and five part-time new jobs and cost an estimated \$12 million to purchase and implement.

Initiative 11

Harden and reinforce designated University spaces to use as shelters

The University will use its best efforts to harden existing structures, including cafeterias, residence halls, and classrooms that also serve as shelters during times of emergencies. UVI will further ensure all in-progress and future structures are built to meet the most up-to-date building code

and disaster resiliency standards to ensure safe haven during and after emergencies.

HARDEN AND REBUILD [VIDOE]

Initiative 12

Construct all VIDEOE facilities to meet new building codes and harden existing structures

VIDOE will renovate and update damaged facilities and take retrofitting measures where they are needed to reinforce structures. VIDEOE will consult with the Department of Planning and Natural Resource (DPNR) in order to address increased code compliance and meet heightened standards for all facilities. VIDEOE will also replace non-instructional facilities on St. Thomas and St. John.

Initiative 13

Solicit services for temporary facilities and permanent repairs by utilizing FEMA-PA funding

VIDOE will collaborate with FEMA and the engineering consulting company AECOM to identify sites for modular structures and sprung shelters while permanent repairs and rebuilding are in progress in the aftermath of the storms.

Modular structures for the 2018/2019 school year are to replace damaged classrooms at 22 of 26 instructional sites. Sprung structures will replace administrative buildings, gymnasiums, kitchen, and cafeterias for the 2018/2019 academic year while the rebuilding of damaged facilities is underway. The estimated cost to purchase and construct the modular and sprung structures totals \$24 million.

HARDEN AND REBUILD [UVI]

Initiative 14

Deploy UVI Restoration and Reconstruction plan to rebuild and harden damaged university infrastructure

UVI has developed a comprehensive plan to rebuild post hurricanes Irma and Maria in the form of a Restoration and Reconstruction Plan. The plan addresses resiliency, climate risks, mitigation of future risks, hardening, and rebuilding UVI to adhere to the most recent building codes. All work will be conducted in a manner consistent with these guidelines.

The facilities to be rebuilt belong to six categories: academic buildings, dormitory buildings, administrative offices, research buildings, services and facilities buildings, and residences. Restoration costs include mold removal remediation, restoration,

CREATE OPPORTUNITIES FOR STUDENTS [VIDOE]

Initiative 16

Increase opportunities for certified Career & Technical (CTEC) students

In collaboration with the Department of Labor (DOL), VIDOE will institute academies to support workforce demands and stimulate local economic growth as a long-term resilience strategy. Certified Career & Technical (CTEC) students will explore new industries and develop business opportunities in support a more resilient and diverse local economy. This initiative will require at least 10 new skilled instructors and curriculum development.

Initiative 17

Reestablish and grow farm to school initiative

VIDOE will reestablish and grow a farm-to-school program by partnering with local farmers to grow fruits and vegetables to supply school kitchens and nearby residents with nutritious and fresh food. This may include partnering with UVI's agricultural programs, the Territory's Organic Community Supported Agriculture (CSA) program, as well as community farming

resiliency improvements, mitigation improvements, fixtures, furnishing, and equipment. Comprehensive damage assessment reports were completed by the Bourne Group for the St. Thomas campus and by RMD Consulting for the St. Croix campus. Restoration and reconstruction needs are estimated at \$46.6 million for St. Thomas and \$7.5 million for St. Croix. An additional \$5 million is estimated for the restoration of the RTPark Building.

Restoration and reconstruction costs would be covered by insurance proceeds and FEMA funding. UVI has submitted the requisite documents to FEMA and will continue to work with the agency to fill the insurance shortfall. The University will also seek federal funding for the construction of new facilities that is available as part of the disaster relief funds available to the territory, such as from CDBG-DR and others. UVI will also seek other funding opportunities and collaborations, as applicable.

Initiative 15

Construct hardened Multipurpose Complex and Student Center/Emergency Shelters on St. Croix and St. Thomas

This dual-purpose center and shelter on the St. Thomas campus will be the hub of student activities and will serve as a hardened emergency shelter for students, faculty, staff, and the community. It will include a campus store, a computer and

study lounge, small shops and eateries, and games and recreation areas. The St. Thomas facility will create approximately five full-time and 10 part-time new jobs and will cost an estimated \$10 million to develop and build.

The St. Croix Multipurpose Complex and Emergency Shelter will provide indoor assembly and sporting spaces with associated rooms. This Multipurpose Complex will create an opportunity for St. Croix to attract and host high-profile sporting and other events, boosting the local economy. It will also serve as a hardened emergency shelter during natural disasters. The St. Croix facility will create approximately 10 full-time and 15 part-time new jobs and cost an estimated \$30 million.

The University needs funding to harden other existing structures including cafeterias, residence halls, and classrooms that also serve as shelters during times of emergencies. UVI will further ensure that all in-progress and future structures are built to meet the most up-to-date building code and disaster resiliency standards to ensure safe haven during and after emergencies.



organizations. For example, Farm to School has begun with limited deliveries of fresh vegetables from Farmer's Cooperative, and farmers have been given menus for 2018-19 school year to facilitate scheduling of crops to be planted for delivery during the school year. Separately, VIDOE will seek to educate students about food and healthy eating through instruction; VIDOE is including the availability of part-time instructors and apprenticeships for students in its negotiations with contractors as part of this initiative.

CREATE OPPORTUNITIES FOR STUDENTS [UVI]

Initiative 18

Establish the Salt River Oceanic and Atmospheric Research and Education Center on St. Croix

The Salt River Oceanic and Atmospheric Research and Education Center facility will consist of a 59,000 sq. ft. campus marine research facility on 8 acres of land. It will be an advanced research center in the study of climate change, run in collaboration with National Oceanic and Atmospheric Agency (NOAA) and other sea-grant, space-grant, and land-grant institutions.

In the future, this Center will

provide up-to-the-minute and relevant oceanic and atmospheric climate change data to the territory in preparation for eminent disasters, and will support the planning and mitigation efforts of VITEMA and other local emergency response agencies and personnel for possible disasters. This facility will create approximately 10 full-time and five part-time new jobs and cost an estimated \$15 million.

Initiative 19

Increase Territory-wide sustainability capacity and readiness by establishing a Center for Resiliency and Sustainability on St. Thomas

This Center will serve as a central coordination point for the research and practice of resiliency and sustainability in areas germane to emergency and disaster preparedness, emergency and disaster management and mitigation, risk management and mitigation, and advanced planning of sustainable neighborhoods and economies. It will harness the many resiliency assets available at UVI and offer a curriculum in resiliency and sustainability leadership.

The goal of the Center will be to better position the USVI and attendees from other areas to weather financial, social, physical, psychological and other challenges resulting from natural disasters. The Center will operate as a "think tank" for new and enduring approaches to resiliency

and sustainability, and increase the resiliency and sustainability knowledge, skills, and expertise of the territory. This Center will create approximately eight full-time and four part-time new jobs and cost an estimated \$3 million.

Initiative 20

Increase opportunities for U.S. Virgin Islanders to participate in economic growth and sustainability by establishing Entrepreneurship Community Centers on St. Thomas and St. Croix

The Entrepreneurship Community Centers will serve as incubators and accelerators for disruptive inventions and entrepreneurial activities. U.S. Virgin Islanders will have the opportunity to explore and develop new technologies and business opportunities in support of the local economy. Researchers from top institutions around the nation and the world will be invited to compete for disruptive technologies patents that will be jointly held by the University. The University's RTPark will also be linked to these centers. These Centers will create approximately 20 full-time and 10 part-time new jobs and cost an estimated \$14 million.

Initiative 21

Advance aquaponics and hydroponics commercialization via the UVI Agriculture Experiment Station

The St. Croix Aquaponics and Hydroponics Center will offer sustainable organic food production and farmers’ market facilities. This Center will utilize UVI’s proven state-of-the-art vertical hydroponics, aquaponics and aeroponics food production systems, supported by climate control and renewable energy systems. The Center will also include space for exploration and discovery in collaboration with the Caribbean Green Technology Center. This Center will create approximately 100 new full-time or 200 part-time jobs, and will cost an estimated \$25 million to develop and launch.

The Center will be a readily available in-Territory food source capable of operating and producing food in emergency situations, and increase the self-sufficiency of the Territory. A green technology-driven food producing plant will result in lower food production and import costs, lower water usage, less waste, fresher food, and more jobs.



Initiative 22

Complete the School of Medicine and Simulation Center on St. Thomas and St. Croix and make them operational

The School of Medicine will be a teaching and research division of the University, accredited by the Liaison Committee on Medical Education (LCME), which is the US DE-recognized accrediting body for medical degrees in the United States). It will provide medical education for a diverse group of students and engage in research in infectious diseases and public health. With the aim of producing future physicians for the Territory, the School of Medicine will also align itself with the healthcare sector by, for example, aligning the reconstruction of Territory hospitals with the medical school so the hospitals can become teaching hospitals. The School of Medicine will create approximately 75 new full-time and 50 part-time jobs and cost an estimated \$60 million.

Initiative 23

Upgrade School of Nursing building on St. Croix

The School of Nursing is currently housed in temporary facilities on the St. Croix campus. These modular buildings were constructed nearly 20 years ago and have outlived their usefulness. In addition, in order to help meet the need for nurses in the Territory and boost

enrollment and graduation of more nurses, UVI must provide a building that can provide simulation rooms and equipment that will help satisfy the clinical requirements for graduation. This facility would not only allow the University to modernize its nursing operation, but would help attract quality faculty and students to the program.

Initiative 24

Establish Marine Science Vocational Educational Facility

The University has one of the best-known Marine Science programs in the nation. However, its focus is on degree-seeking students who enter the workplace at a very high level. In addition to those students, the USVI needs individuals who can provide basic services to the marine industry, like repairing marine engines and boats. A Marine Science vocational facility could train such individuals and could also eventually provide vocational training to students who want to engage in computer repairs and provide customer service in hospitality and business.



ECONOMY



The USVI has—or had, before the storms—a \$3.9 billion economy that depends on the territory's natural beauty to attract tourists and on tax incentive policies to attract investment by companies from the US mainland and the rest of the world. Some clusters are also emerging in industries like marine technology or agriculture.

In recent years, the territory's economy has not been doing well: in real terms, it contracted 27 percent since 2006 and lost about 6,000 jobs (albeit together with an 11,000 population decline), especially after the Hovensa refinery, a large employer, closed in 2012. Government revenue has been stagnant, public debt load has been increasing, and the Territory has been finding it more and more difficult to raise new debt to continue financing its operations.

Against this background, the 2017 hurricanes came as a particularly big blow. Physical infrastructure on which the economy's functioning depends was destroyed and did not recover for months, thousands of people left the territory for the US mainland and either did not or could not return, and tourist arrivals, on which the Territory's economy so heavily depends, almost disappeared for several months and, as of the writing of this report, were yet to fully recover.

As in disasters before, the Territory's economy will recover in three stages: first the immediate rebuilding phase will stimulate construction; then the larger-scale recovery, supported by federal funding, will stimulate construction further yet; then, finally, the economy will begin to return to its pre-crisis state.

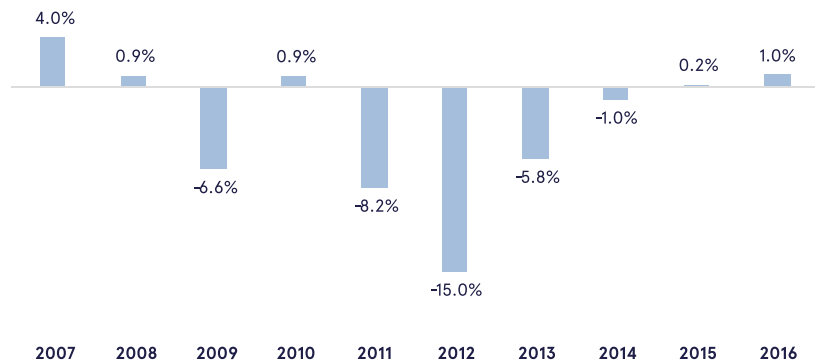
This report is not the place to lay out a comprehensive economic strategy for the territory: it only concerns itself with recovery from the 2017 storms and resilience in the face of future ones. The initiatives in the report's other chapters will help make more resilient the sectors on which the economy depends—especially power, telecom, and logistics. This chapter focuses on describing the way the USVI economy functions, capturing the hurricane damage to it based on the data that is available, and outlining several initiatives that will strengthen public ability to engage with the economy, support recovery, and help make sure that, in future storms, the Territory can recover more quickly.

OVERVIEW

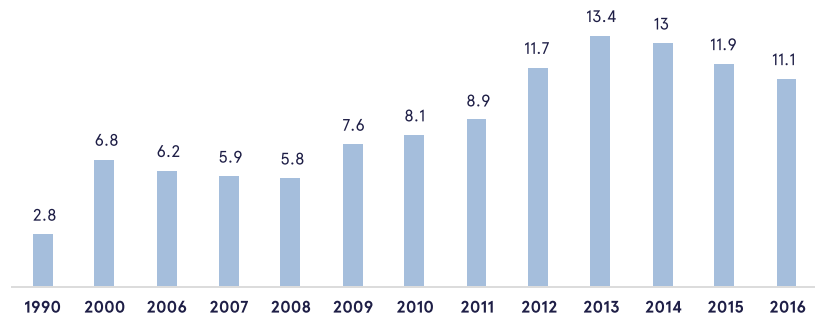
The USVI has a \$3.9 billion economy that formally employs over 43,000 people. Its main private sectors include hospitality, retail, manufacturing, and professional services; government plays a large role, too. The economy has contracted since 2008: real GTP (Gross Territorial Product) and employment both went down, as did the population (see charts: [USVI real GTP, 2006-2016](#); [USVI real GTP growth, 2007-2016](#); [USVI unemployment rate, 1990-2016](#); [USVI population, 1990-2016](#)). The Territory lost 11,000 people and 6,000 jobs, mostly in manufacturing, construction, and territorial government.



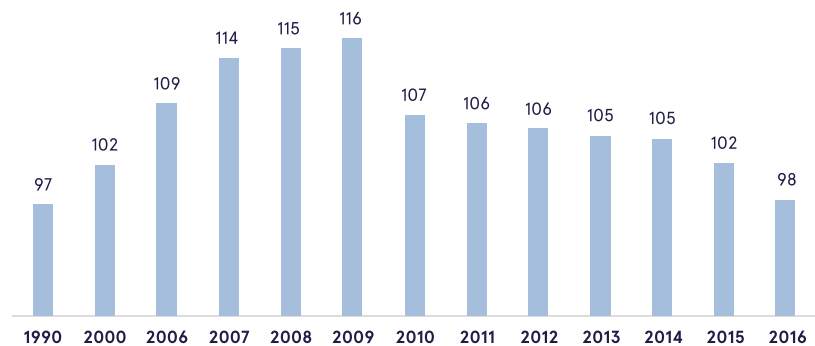
USVI real GTP, 2006-2016
In billions of 2005 dollars



USVI real GTP growth, 2007-2016
Percent, year on year

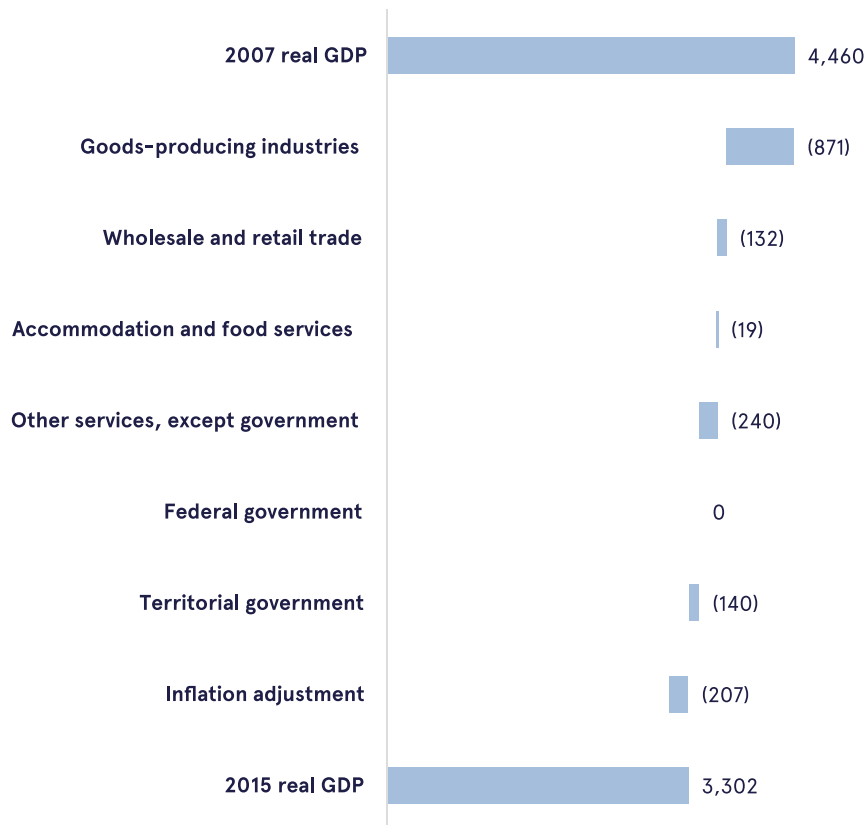


USVI real GTP growth, 2007-2016
Percent, year on year

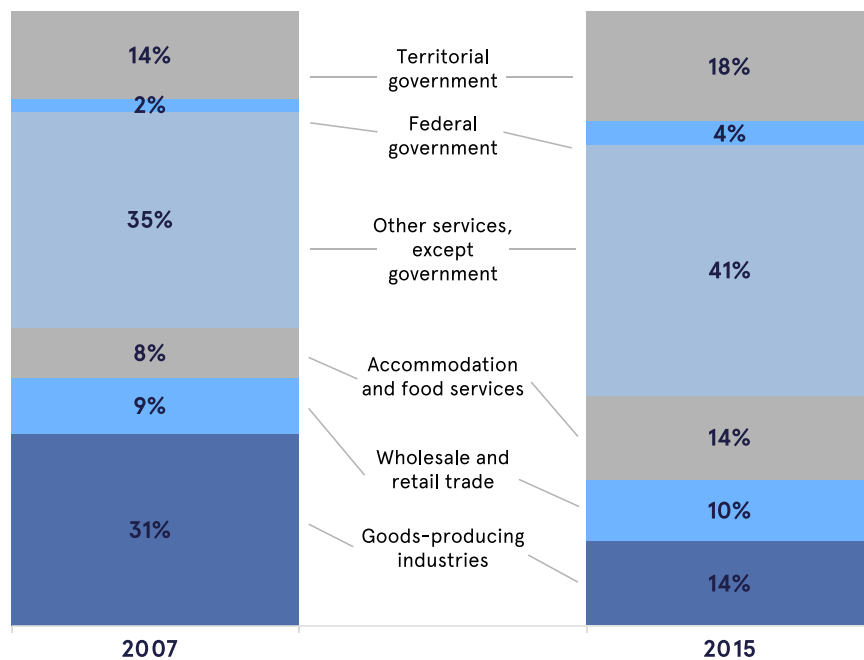


USVI real GTP growth, 2007-2016
Percent, year on year
Source: USVI Bureau of Economic Research (BER)





Change in USVI real GDP, 2007-2015; Millions of chained 2009 dollars
Source: Task Force analysis based on BER data

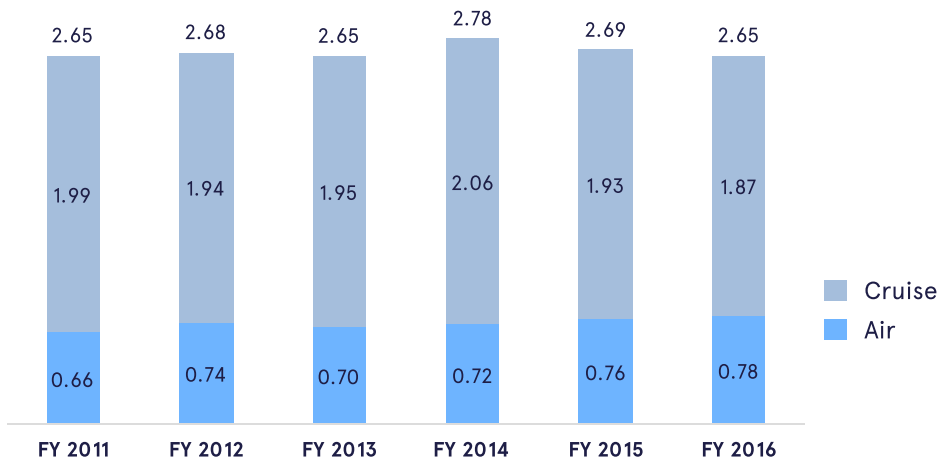


USVI GTP by industry; Percent of total; 2007 = \$4.8bn; 2015 = \$3.8bn (nominal dollars)
Source: US Bureau of Economic Analysis

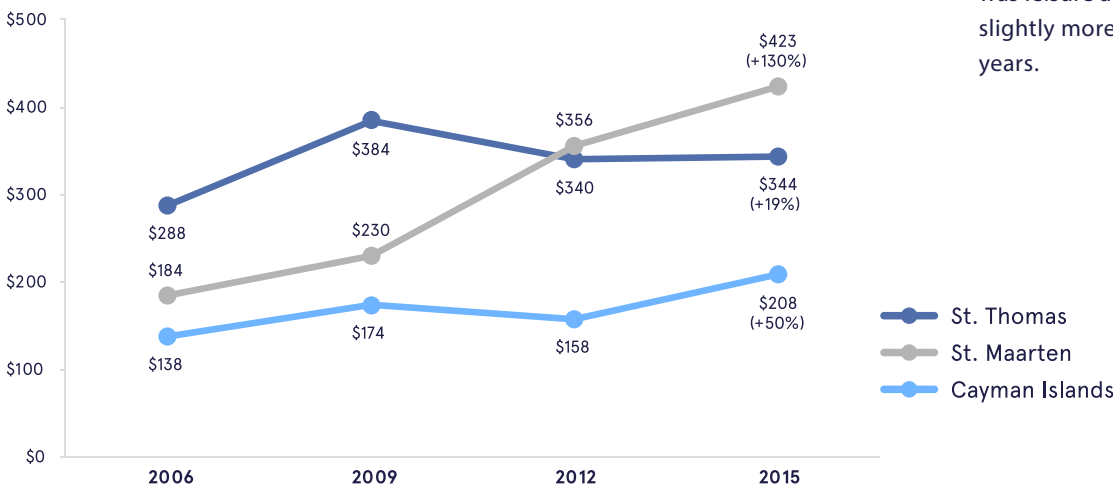
Firms and sectors

As with most of the rest of the US, services accounted for most of the territory's GDP: 65 percent. Goods production represented 14 percent and government, 21 percent. Real GTP in 2016 was 27 percent lower than in 2006, in large part because the Hovensa refinery on St. Croix closed in 2012, which reduced output by \$580 million and took away over 2,000 well-paid jobs. After the Hovensa closure, the share of goods-producing industries in the territory's GTP went from 31 percent to just 14 percent (see charts: [Change in USVI real GTP, 2007-2015](#); [USVI GTP by industry](#)).

Tourism, another major contributor to the economy, stayed at the same level in terms of visitor arrivals in 2016 as it was in 2011: 2.65 million visitors came to the USVI in both years, fewer by cruise ships and more by air in 2016 than five years prior (see chart: [Visitor arrivals in the USVI](#)). Tourism spending increased, but only moderately compared to some other Caribbean destinations: a West Indian Company Limited (WICO) report based on analysis from the Florida Caribbean Cruise Association (FCCA) found the growth to be behind destinations like St. Maarten and the Cayman Islands. While expenditures on St. Thomas—the main cruise ship destination in the USVI—grew 19 percent between 2006 and 2015, expenditures in St. Maarten and the Cayman Islands grew 130 percent and 50 percent, respectively (see table: [Tourist expenditures in selected Caribbean ports](#)).



Visitor arrivals in the USVI; Millions, 2011-2016
Source: Task Force analysis based on data from USVI BER



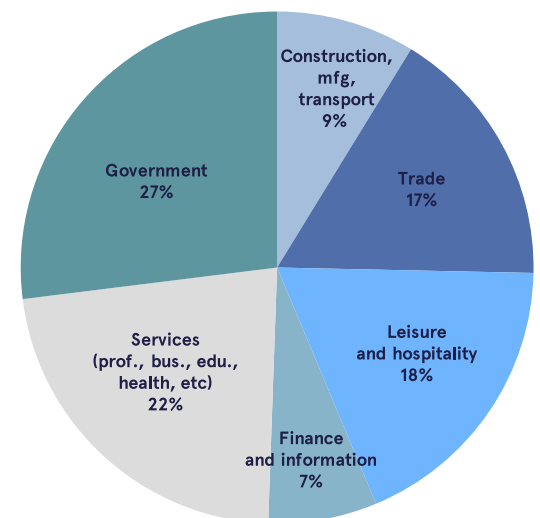
Tourist expenditures in selected Caribbean ports \$ million
Source: West Indian Company Limited based on data from Florida Caribbean Cruise Association

Some bright spots like rum exports that expanded almost twofold because Diageo, the British multinational, began production on St. Croix could not compensate for declines or stagnation elsewhere.

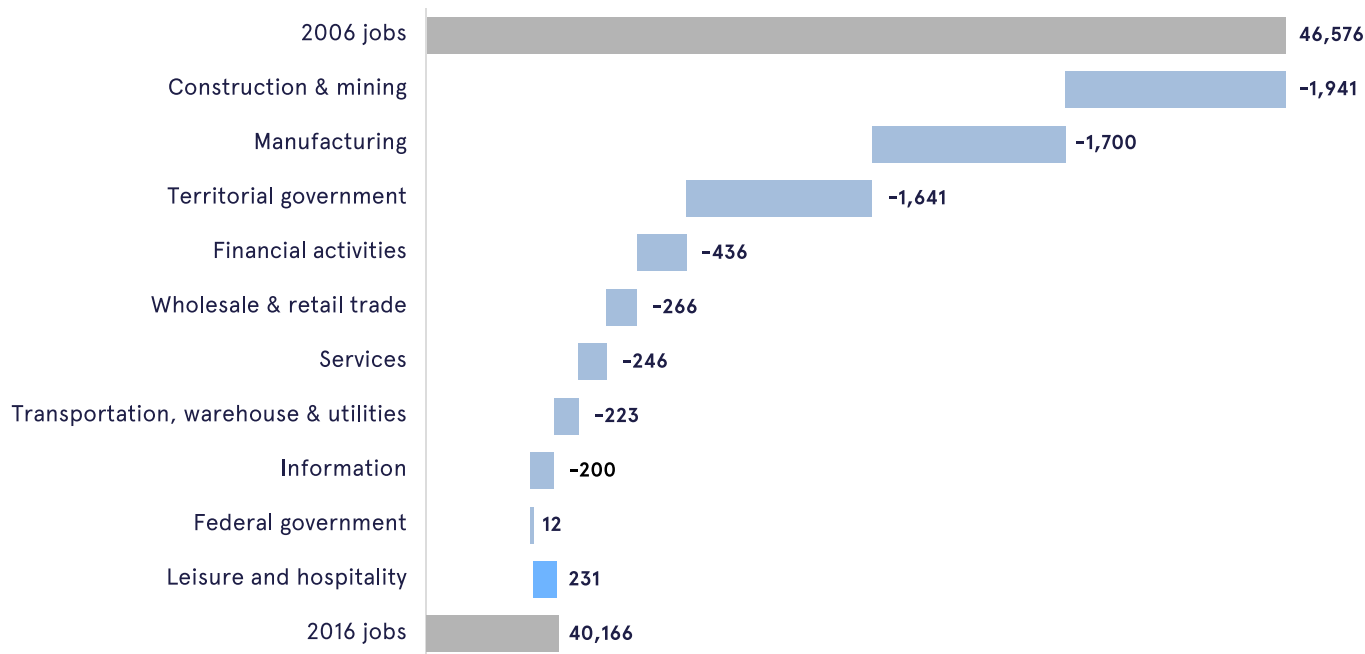
Workers

In 2016, USVI had slightly under 43 thousand formal workers (meaning those who report their employment to the government and pay taxes). Unemployment rate—defined as the share of those

who say that they are looking for work but have not found it—was at 11.1 percent. The government employed the greatest number of workers, 27 percent; professional, business, educational, health, and other services were next with 22 percent, followed by leisure and hospitality and trade with 18 percent and 17 percent respectively (see chart: [USVI job makeup by sector](#)).



USVI job makeup by sector; Percent of total, 2016
Source: BER



USVI job gains and losses by sector, 2006-2016 Number of jobs
Source: BER

Although jobs are being lost and unemployment is high, the territory suffers from a shortage of high-skilled workers: a 2015 BER study found that “approximately 38 percent of businesses indicate they have difficulties filling positions. The sectors where there are hiring difficulties include retail; professional, scientific and technical services; health care and social services; and accommodation and food services.”¹ The VI Workforce Investment Board summarized the state of the labor market as “... caught between the familiarity of and reliance on a structure characterized by varied levels of low-moderate skilled, low-moderate wage long-term employment; and the emergence of a fast paced, highly skilled, technology based global economy.”²

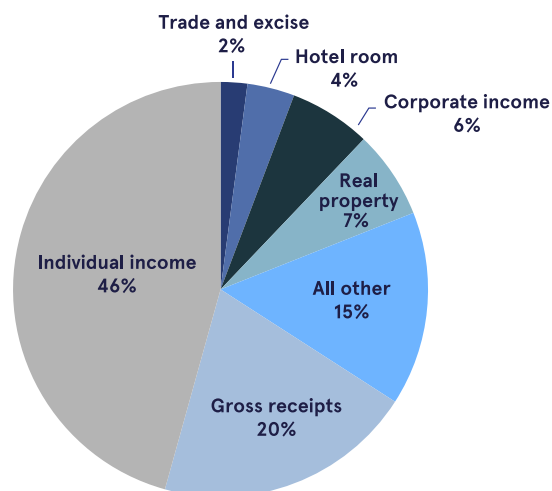
Wages

The average (mean) wages that the workers received for their work were lower than the United States average: according to BLS data from May 2016, they stood at \$18.10 as compared to \$23.86 – or 24 percent less.

accounted for 46 percent of the total. Gross receipts tax was next with 20 percent; real property, corporate, hotel room, trade/excise, and all other taxes made up the remaining 34 percent (see chart: [Tax makeup of USVI government revenues](#)).

Government revenue and taxation

Most of the territory’s revenue comes from various forms of taxation, including federal taxes, which, as a territory, the USVI directly administers and collects through its Bureau of Internal Revenue (BIR). Of all the taxes administered in the territory, individual taxes are the government’s most important source of revenue: in 2016, they



¹ Quoted in VI Workforce Investment Board, Unified State Plan for the Workforce Innovation and Opportunity Act of 2014, 16.

² Ibid.

While individual tax rates mirror the federal tax code, the gross receipts tax is specific to the territory (most states in the US rely on sales tax instead). The Territory's retail sector presents the absence of a sales tax as a benefit to visitors, but GRT—unlike sales tax or value added tax (VAT)—also has the disadvantage of being assessed each time a good or service is passed between businesses prior to final consumption, which increases the burden of tax compliance on both businesses and the government.

USVI takes in less in taxes and other revenues than it spends. As a result, debt load used to fund the deficit—mostly general government operations—has been increasing: between 2005 and 2015, according to Government Accountability Office (GAO), “the territory’s debt nearly doubled, reaching \$2.6 billion and a debt to GDP ratio of 72 percent.”³ As debt levels increased, USVI government has been finding it more difficult to borrow in the markets and was unable to find investors for a debt issue in 2017.

The Territory's budget situation is complicated by the fact that federal funding in areas like healthcare and support for low-income populations falls below what the USVI would have received had it been a state. In healthcare, Medicaid funding is capped at a lower rate than would otherwise be available, and funding for hospitals and Medicare reimbursement is lower as well. In low-income population support, the territory must fund from its revenues the Earned Income Tax Credit and Child Tax Credit programs that the federal

government funds elsewhere in the US. Finally, in highway funding, the territory also receives less funding than a state would. Considered together, these differences substantially reduce the development benefits that federal tax breaks for companies operating in the Territory are supposed to provide.

Economic development policies

The territory has a program managed by the USVI Economic Development Authority (EDA) that allows private firms from around the US and the world to get incentives that include 100 percent exemptions from some local taxes such as gross receipts and property and up to 90 percent exemption on federal taxes for the firm and its owners who reside in the territory. Several groups manage the promotion, application process, and enforcement of these benefits including the Economic Development Commission, the Virgin Islands Economic Park Development Corporation, Economic Development Bank and Enterprise Zone Commission, and RT Park, which is a division of the University of the Virgin Islands. The RT Park program extends the benefits offered by the EDA and is designed to bring innovative firms to the territory and grow the small, yet important information technology sector.

Government regulation

While part of the United States, the Territory sits outside the United States customs zone and is therefore subject to a unique combination of United States federal and local regulatory policy measures. USVI directly administers various federal policies, including areas like EPA regulations that impact permitting enforcement. A concern of some local businesses is that local agencies administering these policies are often overwhelmed, which can lead to long wait times.

Competitive standing and resources for growth

Much of USVI economic activity has its origins in exemptions from some federal policies including the Jones Act (which prohibits foreign-flagged vessels from carrying goods between American ports), agreements that benefit the production of rum, and IRS policies that allow the territory to offer significant tax incentives. Other than these incentives, the USVI's economic makeup is similar to several neighboring island nations whose economies also have a heavy reliance on tourism, retail, and manufacturing sectors—although USVI, compared to its neighbors, also has the advantages of being a US territory, including having tariff and quota-free access to the US market and—for US investors—familiar legal and regulatory structures.

³ GAO 18-160, US Territories: Public Debt Outlook.

The Territory's resources for growth include its exceptional natural landscapes, several deep-water ports, and a relatively large—for an island—amount of undeveloped land on St. Croix that is suitable for agriculture, development, and industrial activity. Potential constraints include the poor state of the territory's infrastructure (including roads and the water supply system, both of which suffer from years of deferred maintenance) and—especially—the relatively high cost of power compared to the rest of the US (around 35 cents per kWh compared to around 12-13 cents on the mainland).

USVI AND THE US MARKET

For a less wealthy, less economically sophisticated community to be part of a larger community that is overall wealthier and more economically sophisticated is both a blessing and a curse. On the one hand, the USVI has access to an enormous market—one of the largest in the world. On the other hand, people who live in the USVI can leave easily to go look for jobs elsewhere in that market—and while it may be difficult to find something to sell to the enormous market other than the beauty of the islands' geography, it can be quite easy for some of the territory's best people to leave. For those people, it means opportunities that people from, say, Jamaica do not have—but it also means that the territory is going to

keep losing its best people generation after generation, including after it has spent a lot of public money to educate them. Some of those who left will return because their families are here or because they prefer to live in the USVI—but many will not. And so the territory finds itself in a curious situation: it has access to a market that others in the Caribbean would love to have access to as well, but because that access comes with the freedom of movement that makes it easy for people to leave the territory, the USVI may find it difficult to build economic sectors that can take advantage of that access.

Current federal government policy towards US territories is based on the idea of giving them tax breaks. The logic is: if territories cannot develop sophisticated economic sectors by themselves, let companies come from the outside and bring in the required expertise and market access. That has happened, but only to some extent—and a two-track economy is the result. There is a track with relatively high-wage, high-skill jobs in part thanks to the companies that come for the tax breaks. And there is also a track in which there are a lot of lower-skill, lower-paid jobs in sectors like tourism and construction. That, of course, is a better outcome than if one had all jobs be of the lower-skill, lower-wage variety—but what can one do to have more highly-paid, high-skilled jobs yet?

The answer probably has something to do with education, but those systems are very difficult to turn around—if some of the territory's best-educated people leave system around.

A question to ask might be: is the current federal policy towards developing the more remote corners of the US adequate to the challenges that they face in an age where more and more wealth is created through skills and knowledge? In an industrial economy, tax incentives may have attracted Hess Oil to set up Hovensa and provide a lot of well-paid jobs that did not require the level of training that, say, offering IT services would require. But what happens in a post-industrial economy when many industrial jobs have moved abroad? Tax incentives can cause companies to consider the USVI, but where will their workers come from if the local education system is not training the workers that those companies need? And so, the USVI risks being left permanently behind. Can the federal government try to turn the situation around by supporting long-term, large-scale initiatives to dramatically improve education systems in the country's more isolated corners, the USVI included? The question remains open.

CULTURAL RESOURCES

USVI cultural resources suffered losses and damage from the storms. Coastal erosion damaged archaeological sites, and historic structures lost their roofs to heavy winds, exposing interiors and contents to the elements.

On St. John, Hurricane Irma damaged or destroyed several National Register of Historic Places sites. At the island's East End Schoolhouse, dating back to 1862, the hurricanes exacerbated existing deterioration. The Battery in Cruz Bay lost its entire roof and in Coral Bay the historic Emmaus Moravian Church suffered the same fate.

On St. Thomas, a few historic houses in the Charlotte Amalie Historic District that were previously damaged collapsed because of the hurricane winds. Fort Christian, built in 1671, lost the roof to its stable. In the Fort's historic Church and Governor General's Quarters, wind and rain damaged portions of the wood flooring. Wind also destroyed the historic parsonage's metal roofing of the Memorial Moravian Church site, exposing the roof rafters and interior to flooding.

On St. Croix, the Christiansted Historic District had a sheltered position from the south and overall fared

better during the storms but suffered minor damages to historic roofs and windows. Fort Frederik, a U.S. National Historic Landmark, received catastrophic damage to its doors and shutters, and a large mahogany tree fell against its eastern parapet wall. Outside the fort, the historic lime kiln's southern wall collapsed, exposing the internal firebox. A recently discovered cemetery on the fort's northern apron along the LaGrange Gut had exposed human bones displaced by flooding. Friedensfeld Midlands Moravian Church, built in 1854, suffered substantial damage to the steeple roof, downspouts and gutters, and siding. In addition, The Whim Great House, the only sugar plantation museum in the Virgin Islands, sustained extensive roof damage and water soaked the interior walls and antique furniture. Elsewhere on the island, sites such as Sandy Point and Ha'Penny Beach, which have open seafront to the west, suffered significant damage. Additionally, the Cinnamon Bay Archaeological Laboratory and Museum was completely destroyed.

Since Irma and Maria, public and private agencies, volunteers, and individuals have worked together to preserve and restore the Territory's cultural resources. An ongoing effort to identify, assess, and repair damaged historic properties, items and artifacts is undertaken by the VI State Historic

Preservation Office (VISHPO) in partnership with the Division of Libraries, Archives and Museums (DLAM), the Council on the Arts, and the Virgin Islands Territorial Emergency Management Agency (VITEMA).

NATURAL RESOURCES

From the picturesque beaches of St. Thomas to the incredible national parks on St. John to the renowned coral reefs of St. Croix, the USVI's natural resources are an extremely important asset for both residents and visitors alike. Hurricanes Irma and Maria damaged them severely. The storms ripped nearly all leafy vegetation from trees and plants, destroying native species' habitats; winds and storm surge tore hundreds of ships from their moorings, leaving them askew on beaches and tossing them into mangrove lagoons; extensive soil erosion created by the hurricanes swept mud and pollutants into the water, harming coral reefs and other aquatic life. Natural systems have begun to recover, but full restoration—if it ever occurs—will take many years. While a comprehensive analysis of natural resource damage has not been conducted, the notes below offer some highlights.

Coral reefs

Coral reefs, which are critically important ecological and economic resources for the USVI, suffered as a result of the hurricanes. Storm surges broke coral into pieces, which can be life-threatening to the habitat. While coral fragments can reattach themselves, it requires a significant amount of energy, and coral cannot be under significant amount of stress, or else coral disease or red algae are likely to set in. Trained personnel can assist in reattaching coral fragments with the use of an epoxy or cement; however, many of the organisms will succumb to the damage. The future holds additional risks: rising ocean temperatures will increase bleaching and ocean acidification, which could kill the reefs off, decreasing fish and invertebrate populations. Animals will also suffer, such as sea turtles whose nesting habitats are already threatened. The loss of coral means that mangroves and seagrass beds will lose their most important protection. It can also negatively directly or indirectly impact fish, turtle, and marine invertebrate's populations.

Seagrass beds

Storm surges scoured USVI seagrass beds, resulting in the complete loss of seagrass cover in some areas. An invasive seagrass, *Halophila stipulacea*, has rapidly replaced the original seagrass beds, transforming the habitat and displacing the marine community that had relied on it.

Turtle nesting beaches

Irma and Maria caused widespread beach erosion, removing as much as three feet of beach elevation at multiple sites, damaging coastal vegetation, and exposing roots. The reduction of vegetation cover allowed invasive plant species, particularly *Thespesia populnea*, to fill open areas. This reduced habitat quality for native species of plants and animals and degraded nesting conditions for Hawksbill sea turtles.

Tree damage

Most trees in the territory lost all their foliage to the storms; many were also damaged. Much of the damage occurred along the shoreline, and while regrowth of foliage will occur for the trees that remain, the lack of shade significantly impacts recreational beach-goers. Additionally, destroyed vegetation and trees dramatically increased available habitat for red tail boa and its prey and also made it easier for invasive plant species to settle in.

Mangroves and other wetlands

Mangroves did not suffer much damage across the territory as a result of the storms. Most mangrove populations are in protected embayments, and most of the damage as a result of the storms was to the branches. Mangroves are fairly resilient such that when their root

structures are intact, they regenerate branches at their normal rate. Other wetland species did not fare as well as mangroves; however, with the amount of rains that fell following both storms, their recovery should not be too heavily impacted. Wetland species depend on conditions of periodic or permanent inundation, and the rains following the storms, all the way into November 2017, provided those conditions. In addition, large amounts of sediment were transported through guts from the storms, which also create ideal conditions for wetland vegetation to take root.

Wildlife

The storms critically impacted three species of frugivorous bats: Jamaican Fruit-eating Bats, Antillean Fruit-eating Bats, and the rare endemic Red Fruit-eating Bat. Another visible species, the Brown-throated Parakeet, has all but disappeared, with only small groups of individuals now documented compared to previous numbers. Hurricane winds, rainfall and storm surge threatened crops and livestock and the forage they need for sustenance.

Sunken vessels

The storms caused nearly 500 vessels to sink in the USVI waters. These vessels carried a number of pollutants including 12,500 gallons of fuel and oil, 50 propane filters, more than 300 batteries, and other hazardous substances that could pollute the water. The vehicles' battering during the storm also caused anchors and moorings to drag, damaging the sea bed, sea grasses, and coral.

Water pollution

During the storms, pathogens, which are micro-organisms carried by small animals, insects and sewage, flowed through gut waters and into the sea. Storm water runoff also carried various types of "nonpoint source pollution", which occurs when small amounts of pollution from a large variety of sources are picked up by storm water runoff and carried into water bodies. This pollution damaged the mangrove lagoons and coral reefs, which provide crucial storm protection. Sediment (dirt, soil, etc.) increased seawater turbidity. Sewage from waste water treatment plants and sewer lines overflowed into the ocean from the increased rains. Health hazards created by these issues drove the authorities to close the beaches after the hurricanes; many of these beach water quality issues extended for months after the storms.

Natural resource recovery

The Virgin Islands

Department of Planning and Natural Resources, which administers and enforces laws related to preservation and conservation of fish and wildlife, trees and vegetation, coastal zones, cultural and historical resources, water resources, and air, water and oil pollution, will be working to restore the territory's natural resources as much as funding and the degree of damage allows. Measures will include coral reef restoration (including through supporting coral nurseries), restoring coastal vegetation communities and enlarging wetland buffer/setback areas to allow landward migration of mangroves, protecting sea turtle habitat, and preventing indiscriminate removal of damaged trees by cleanup crews.

IMPACT OF THE HURRICANES

The hurricanes disrupted the lives of the Territory’s workers and damaged the physical infrastructure that supported the work of their organizations. As a result, the territory’s economic activity—especially tourism—was severely reduced in the months following the storm, leading to job losses on all three islands and a total estimated economic impact of \$1.54 billion. Federal assistance coming into the territory softened some of the blow in the first two months after the storms. By November-December, some activity began to return. Still, by April 2018, tourist arrivals—on which most of the economy depends—were still more than a third lower than in the same month the year before.

Impact on workers and on physical infrastructure

Already before the hurricanes arrived, thousands of people evacuated from the territory; after the storms, the trend continued. Those people who stayed in the Territory—including those of them who were employed—spend the first several weeks after the storm taking care of their damaged homes and were often not able to come into work. Even when they were able to do so, there was often nowhere to come to: a lot of the establishments were simply not open, whether because their facilities were damaged directly, because there was not enough business, because

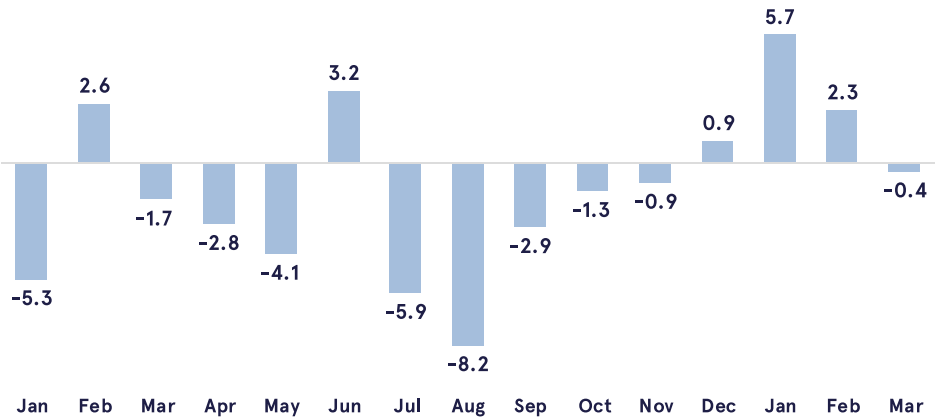
Rank	Company	Status after the storms
1	Kmart	Open
2	Ritz Carlton	Long-term closure
3	Marriott Frenchman’s Reef	Long-term closure
4	Caneel Bay Resort	Long-term closure
5	HDVI Holding [Home Depot]	Open
6	Westin Resort	Long-term closure
7	World Fresh Market [Pueblo]	Open
8	Sugar Bay Resort and Spa	Long-term closure
9	Cost-U-Less	Long-term closure
10	Buccaneer Hotel	Open

Status of ten largest private employers in the USVI
Source: USVI Labor Market Basket, 2016

the infrastructure on which they rely—especially power, telecom, ports and airports, and roads—was damaged, or all of the above. Of the territory’s ten largest employers in 2016, six—five hotels and one retail store—sustained enough damage in the storms that they were not set to reopen until at least 2019 (see table: [Status of ten largest private employers in the USVI](#)).

People outflow from the Territory continued until the end of November; in December, around a 1,000 more people came into the Territory’s airports than left

it, followed by two more months of positive net arrivals before the trend turned negative again in March (see chart: [Net airline arrivals in the USVI](#)). Some of the people who wanted to return to the Territory could not do so either because of damage to their property or—especially for those with children—because of concerns about the state of the territory’s damaged healthcare and education facilities.

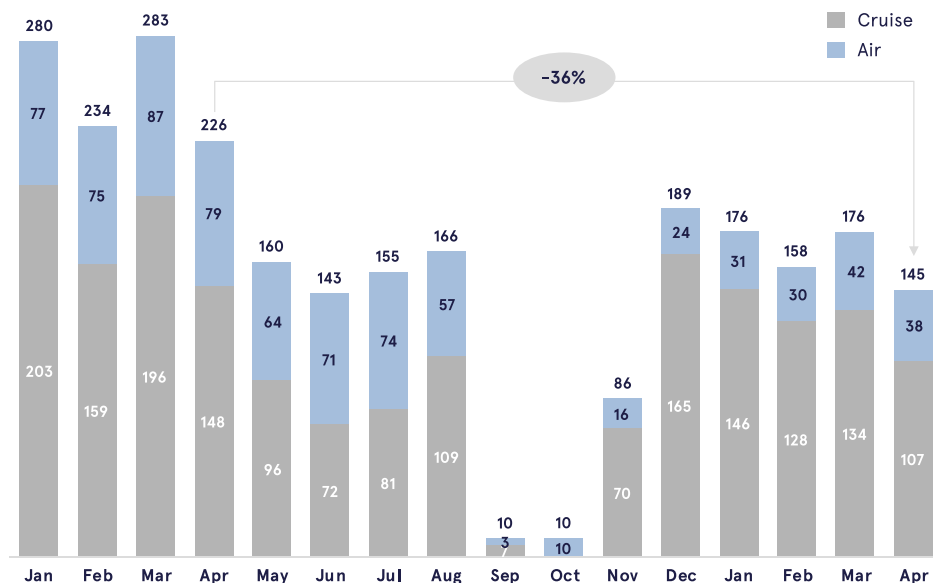


Net airline arrivals in the USVI; STX and STT airports; thousands of passengers; 2017-2018
Source: Task Force analysis based on T-100 data from US Bureau of Transportation Statistics

Impact on economic activity

Total economic impact of the hurricanes on the Territory's economy was estimated at \$1.54 billion, or nearly 40 percent of annual GTP. The number includes lost wages, lost government tax revenue, and damage to commercial property.

Damage to the territory's main source of income and employment—tourism—was equally severe. The storms brought tourism to a sudden halt, with all airports and seaports closing for several weeks due to the storms. Seaports on St. Croix, St. Thomas, and St. John closed on September 5, 2017 and did not reopen for three weeks. Both of the territory's airports closed on September 6, 2017, and while the St. Thomas airport reopened on September 28, 2017, St. Croix's airport did not reopen until October 5, 2018. Even as the airports reopened, tourism remained low because of a lack of accommodations (a result of disaster-related damage to hotels), the perception that the islands were completely decimated, damage to the British Virgin



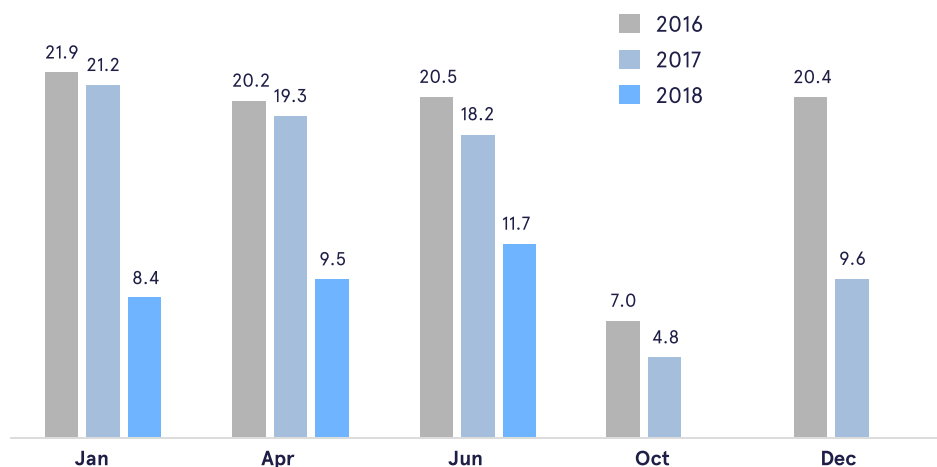
USVI visitor arrivals; Thousands, 2017/2018
Source: BER

Islands (where cruise ships often dock in addition to the USVI) and limited commercial flights (only one or two per day came into the Territory for weeks following the storms). Even by June 2018, the level of flights was still just slightly over a half of what it used to be two years before (see chart: [Major carrier flight seats by month](#)).

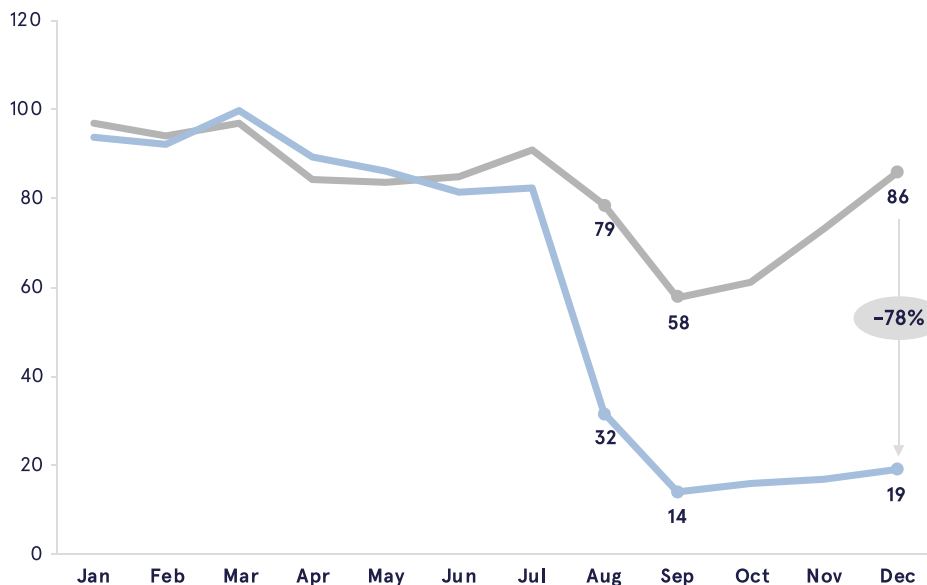
As a result, few visitors other than recovery personnel arrived in September and October 2017. Visitor arrivals picked up in

November with the return of cruise ships and further improved in December—but still, in April 2018, cruise visits were 28 percent lower and airline arrivals 52 percent lower compared to a year before, for a total drop of 36 percent (see chart: [USVI visitor arrivals](#)).

Hotel occupancy dropped as well, both because of facility damage and because of low visitor numbers: in December 2017, the territory lost 78 percent of its monthly room nights compared to December 2016, with more than 90 percent of that loss occurring in the St. Thomas/St. John district where hotel capacity was far higher than on St. Croix (119,000 monthly nights compared to 37,000) and the drop, because of the closures of several major resorts, steeper. Relatively speaking, St. Thomas/St. John lost 88 percent of its room nights in December 2017 compared to a year before, and St. Croix lost 33 percent (see chart: [Hotel room nights occupied](#)). The dramatic decrease in visitors to the islands led to a substantial



Major carrier flight seats by month; Thousands
Source: BER



Hotel room nights occupied USVI total, thousands
Source: BER

decrease in revenue across the USVI. According to the U.S. Virgin Islands Bureau of Economic Research (BER), tourists (arriving by air) spend an average of \$1,373 on their visits to the islands, and excursionists (day visitors, mostly via cruise ships) spend an average of \$224 on their visits to the territory. Before the storms, that amounted to a total monthly spend of \$84.8 million in October 2016. One year later, in October 2017, the USVI saw a loss of \$49.8 million in tourist spending and \$21.3 million in lost excursionist spending, amounting to a total

of \$71.1 million in unrealized revenue in that month alone. This is likely an underestimate of lost spending, as many of the visitors arriving by air in October 2017 were recovery workers, who spend significantly less than regular tourists.

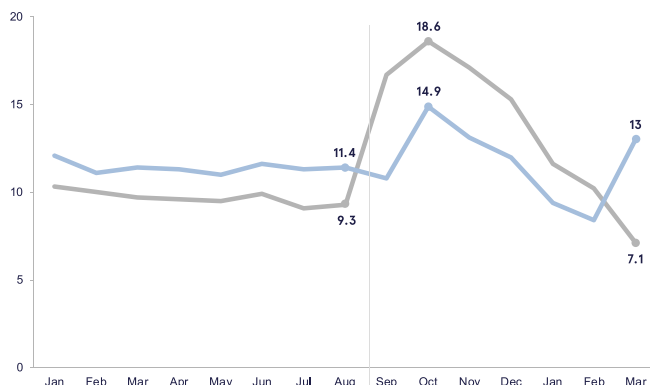
Job losses

As a result of the hurricanes, the territory lost several thousand jobs, causing an estimated 4,300

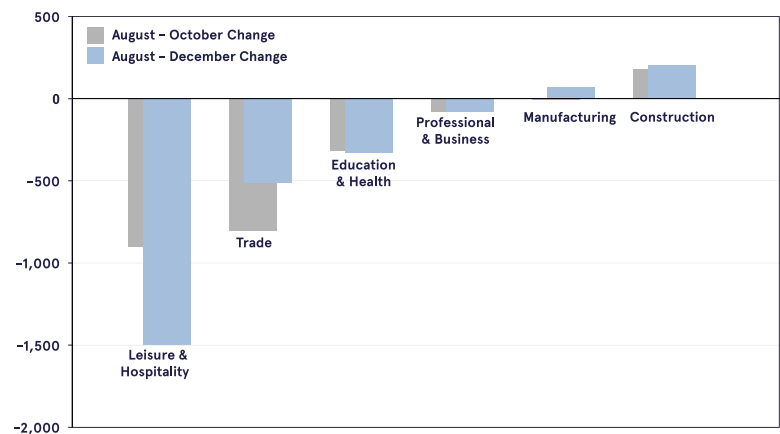
additional jobless claims—equal to 11 percent of total employment (see chart: [USVI jobless claims](#)).

Unemployment increased from 10.2 percent in August 2017 to a peak of 17.1 percent in October. St. Thomas / St. John were affected worse than St. Croix despite having a lower initial level of unemployment: there, the unemployment rate doubled, going from 9.3 to a peak of 18.6 percent, compared to a 31 percent increase on St. Croix, from 11.4 to 14.9 percent (see chart: [Unemployment rate](#)).

The worst affected sectors included leisure and hospitality, trade, and education and health. Manufacturing and construction posted modest increases because of the reconstruction activity—but nowhere near enough to compensate for the loss of jobs elsewhere. In leisure and hospitality, the drop became worse between October and December as some hotels that had initially kept their staff on were letting the staff go, as opposed to trade, where the situation improved as stores reopened, or other sectors, where the situation remained more or less the same (see chart: [Job loss by sector](#)).



Unemployment rate; Percent, 2017-2018
Source: BER



Job loss by sector; Change in Aug-Oct 2017 vs. change in Aug-Dec 2017".
Source: "Federal Reserve Bank of New York based on data from U.S. Bureau of Labor Statistics and Moody's Economy.com)

Comparative damage

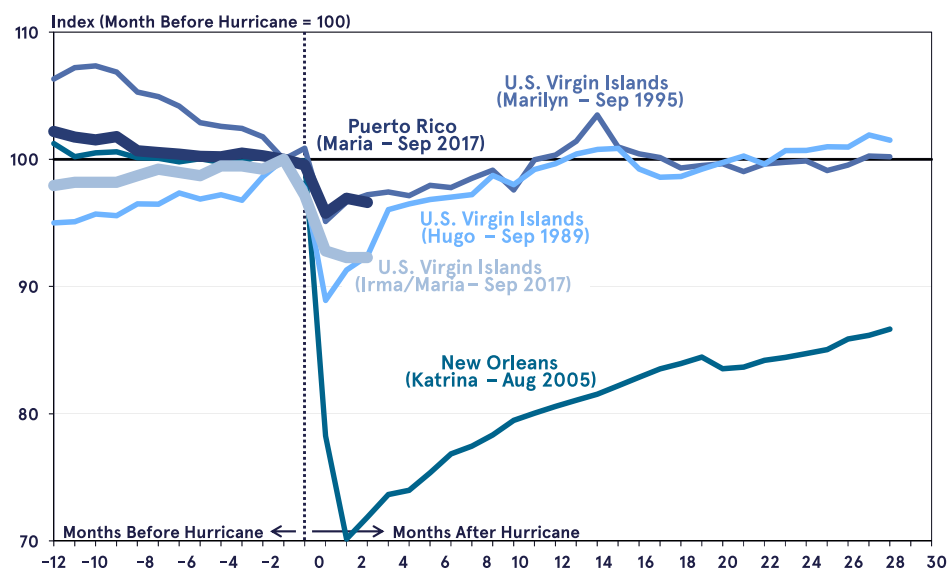
Comparatively speaking, the USVI job loss was one of the worst on record in the US in the last thirty years, second only to job loss in New Orleans after Katrina in 2005 and in the USVI itself after Hugo in 1989 (and followed by Marilyn, also in the USVI, in 1995; see chart: [Local job loss following natural disasters](#)). In comparison, New York City saw a 3.3 percent job loss in 10 months during the Great Recession.

Recovery prospects

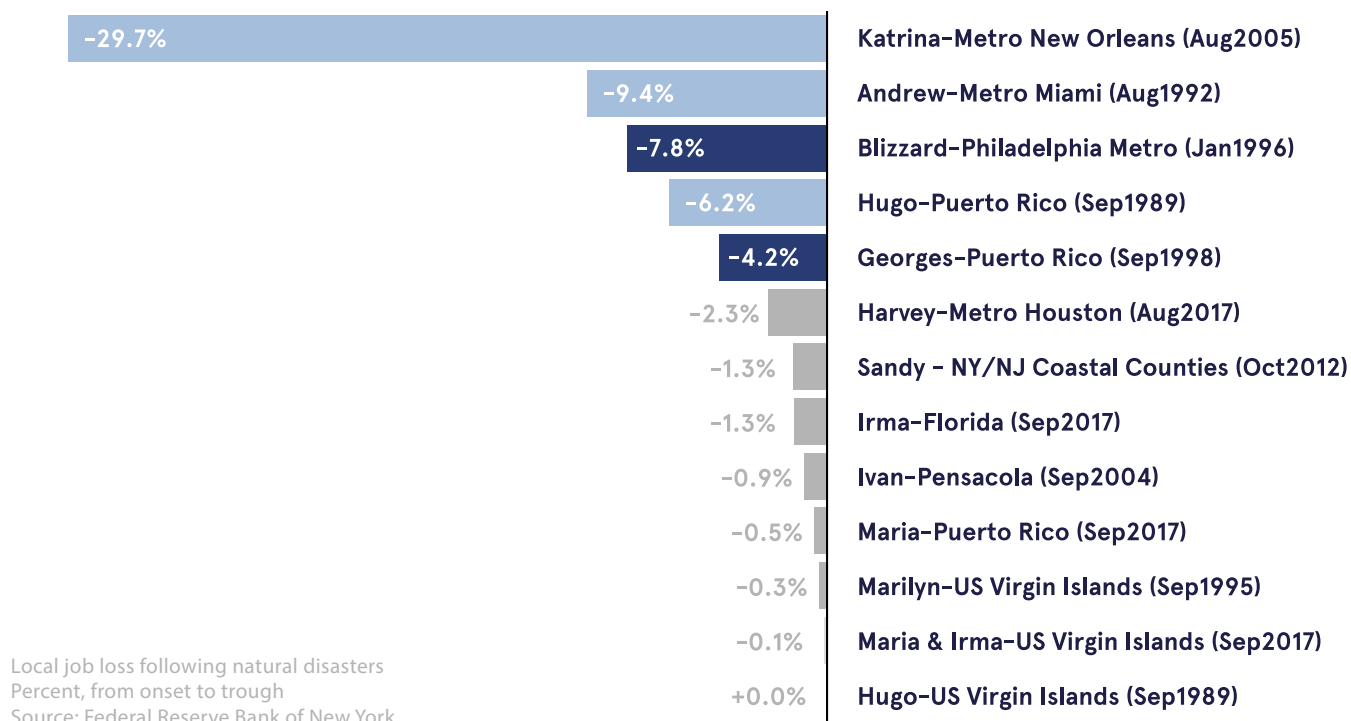
After hurricanes Marilyn and Hugo, it took the USVI 12-14 months to return to pre-hurricane levels of employment. After hurricane Katrina, with its much greater loss of jobs, New Orleans did not return to pre-storm job levels even 30 months later. The job loss in the USVI following

Irma and Maria was worse than after Hurricane Marilyn but not as bad as after Hurricane Hugo (see chart: [Employment paths after hurricanes](#)). What that means for the Territory's recovery is impossible to tell—but, if the past is any indication, the recovery's initial phase will have been fueled by federal relief spending,

followed—about a year in—by private and federal spending on infrastructure recovery. One-off deals may help as well: as of June 2018, negotiations were underway with a group of investors for restarting petroleum refining in the former Hovensa refinery on St. Croix.



Employment paths after hurricanes; Index (month before hurricane = 100)
Source: Federal Reserve Bank of New York based on data from U.S. Bureau of Labor Statistics and Moody's Economy.com



Local job loss following natural disasters
Percent, from onset to trough
Source: Federal Reserve Bank of New York

INITIATIVES FOR INCREASING THE ECONOMY'S RESILIENCE

The economy is not a sector onto itself: its functioning depends on the functioning of a lot of other sectors. As those sectors become more resilient, so will the economy: a stronger power grid, stronger telecommunications, and stronger logistics channels will contribute a lot to the economy's resilience in the face of future storms. Some improvements will benefit the economy in non-storm times, too: lower power prices as a consequence of the initiatives described in the Energy chapter are one example. Beyond those strategies, there also are initiatives that one can undertake to improve the economy's functioning directly. A full inventory of those would need a separate report; this chapter outlines several initiatives that bear a relationship to post-crisis recovery and resilience in the face of future storms, including those that can help the government better engage with the economy in crisis times, those that will help support the recovery, and those that will allow the Territory to sustain less damage in future storms.

STRENGTHEN PUBLIC ECONOMIC POLICYMAKING AND IMPLEMENTATION CAPACITY

These initiatives will strengthen the ability of the government and its partners to shape the USVI's economic policy, both in the medium term to support hurricane recovery and in the longer term to support the Territory's overall resilience.

Initiative 1

Strengthen the government's economic policymaking capacity

Strategies to improve the Territory's economy following the storms will not be worth much if there is nobody to implement them. Currently, the Territory's main economic development body, the Economic Development Authority (EDA), is more of an administrator of economic development benefits than an agency that actively shapes the Territory's economic policy. Having no agency to actively engage with the economy might work in relatively stable times, but after a major crisis, government coordination and intervention is required to prevent the economy from sliding into a recession.

The Governor's Office will work with the EDA to strengthen the government's economic policymaking and implementation capacity, either by strengthening the EDA's role or by strengthening the economic staff in the Governor's Office. The EDA and/or the Governor's Office will also improve cooperation between the different organizations in the territory that work on issues related to the economy (including BER, Department of Labor, and UVI) by regularly bringing them together.

Initiative 2

Update workforce development plans to support hurricane recovery

In the last decade, the USVI's economy has shifted towards services away from manufacturing. In the decade to come, it will shift again—certainly quite heavily towards construction in the next 2-3 years as the Territory rebuilds, as well as to some energy occupations as the USVI modernizes and updates its grid, and possibly to new manufacturing jobs, whether in old industries like petroleum refining or in emerging clusters like boatbuilding or IT. Taking advantage of these opportunities will require a well-trained workforce. In its 2016 report, the VI Workforce Investment Board proposed a number of initiatives to strengthen workforce training in the territory. Those will need updating in the face of the challenges that

⁴ One such inventory is available in a 2015 report titled USVI Comprehensive Economic Development Strategy, prepared by a consulting firm together with the territory's Bureau of Economic Research

the hurricanes brought. The Governor's Office will work with VI Workforce Investment Board, the Department of Labor, the Department of Education, and the University of the Virgin Islands to update and implement the existing workforce development plans with hurricane recovery needs in mind. Workforce development efforts will be mindful of the need to strike a balance between supporting the economy's medium term needs that will be mostly about recovery (next 2-3 years) and longer term ones that will signal a return to the economy's more stable functioning (3-10 years).

Initiative 3

Work with UVI to establish an economic development policy institute

In addition to making sure that economic recovery is successful in the next 3-5 years, there is also a need to think long term about the direction of the USVI's economy—and here, there is little agreement between the community, government, and NGOs. Without such agreement initiatives are short lived, don't meet their potential, and are subject to changes based on election cycles. The Governor's Office will work with the University of the Virgin Islands to establish an Economic Policy Institute as an extension of the UVI RTPark program to support economic policy development with a particular focus on engaging the community and on taking the long term view on economic development.

SUPPORT RECOVERY

These initiatives will support the recovery of the territory's most important sector—tourism—and support capital access for small businesses.

Initiative 4

Review tourism master plan

The Territory's tourism master plan needs an update both in the face of hurricane damage and in the face of the ever-changing tourism landscape in the Caribbean. BER, in partnership with the Department of Tourism and industry associations such as VI Hospitality and Tourism Association will revise the territory's Tourism Master Plan to develop a strategy to support, refresh, and expand the variety of tourism businesses and offerings that will help USVI attract and expand its visitors (including by focusing on cultural, heritage, eco, and agri-tourism, all of which are promising but relatively underdeveloped areas of the territory's tourism economy).

Initiative 5

Fill gaps in capital access for small businesses and entrepreneurs

Following storms, businesses' capital needs are particularly urgent—but there currently are no microlenders, community development banks, rural lending intermediaries, or similar

institutions serving the USVI. This especially affects financing available for start-ups, new entrepreneurs, and businesses seeking small loans of \$10,000-30,000.

The Governor's Office will work with federal agencies in the Economic Recovery Support Function to identify policy measures that may assist USVI businesses with securing capital, credit, insurance, bonding, and related financial capacity to meet the needs of the recovery economy. Any measures taken would be coupled with steps to promote financial literacy among prospective borrowers.

PROMOTE RESILIENCE IN THE FACE OF FUTURE STORMS

Other chapters of this report address in detail various initiatives that will help the territory and its economy weather future storms better. The initiatives mentioned here complement them.

Initiative 6

Invest in infrastructure to protect marine vessels in future storms

Hundreds of boats were destroyed in the Territory following the storms resulting in extensive environmental and economic loss and diversion of emergency repair funds to removing vessels. Part

of the reason for that is that the Territory does not have sufficient mooring or on-land storage facilities to get boats safely out of the water, making this sector non-resilient to future storms.

DPNR will update water use plans for the territory to accommodate transient vessels and work with local non-profits to develop mooring infrastructure. Subject to availability of funding, the Port Authority and DPNR will partner with private boat storage operators to establish boatyards and public ramps that can help remove vessels from the water prior to storms and service the charter boat economy.

Initiative 7

Promote an equally distributed set of small and large hotels across the territory

The vast majority of the Territory's hotel rooms is to be found in large hotels on St. Thomas. Following a disaster, large properties can find it easier to rebuild because they may have better access to credit—but they can also take longer, especially when they are owned by groups that operate multiple properties in different locations for which their USVI locations are only one part of a large portfolio. As a result, the tourism economy can be decimated by a single disaster: as noted above, in the St. Thomas/St. John district, hotel nights in December 2017 were down 88 percent compared to the year before. Encouraging the development of smaller hotels spread out across all of USVI's islands—in addition to large

ones—may allow the Territory to recover more quickly following future storms.

The EDA and Department of Tourism will work to support small businesses in establishing new small-scale eco-friendly hotels throughout the entire territory even as the two agencies work to support restoration of existing large-scale resorts on St. Thomas and St. John and to attract new large hotels to St. Croix.

Initiative 8

Introduce cloud-based systems for government IT services

Following the storms, one problem for businesses was that government services like licensing or property registration were not available for weeks if not months. Part of the reason for that is that electricity and telecommunications were out for as long as they were—in future storms, and following the implementation of the initiatives in this report, these outages will hopefully last less and government services will recover more quickly. However, some of the reasons for the long recovery had to do with the structure of the government's services itself: in just one example, a lot of the data was only stored locally, and when data was lost in a government data center on St. Croix, no off-island backup was available. Bureau of Information Technology (BIT) will work with all the different parts of the USVI government to introduce cloud-based systems for data storage and customer service

that will be more resilient to future storms (see Public Telecom chapter for more details).

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Volunteers helping restore a local day care in St. Thomas; Source: All Hands and Hearts

NONPROFIT, PHILANTHROPY AND VOLUNTARY ORGANIZATIONS

The territory's non-profit, philanthropic and voluntary organizations stepped forward immediately to play critical leadership roles in coordinating relief and recovery in both the direct aftermath of the storms, and in the long-term recovery efforts that followed.

After the storms passed, local community-based organizations and volunteers quickly rallied to offer support and assistance. Temporary shelters were opened to serve displaced residents, and supply distribution sites were established to provide food, water, clothing, medical kits and other necessities. Volunteers canvassed neighborhoods to assess damage, identify vulnerable residents, and coordinate evacuations. Teams were formed to remove debris, clean out damaged homes, and make repairs to compromised structures. As recovery progressed, these same organizations and volunteers joined together to form long-term recovery organizations focused

on identifying each community's most critical outstanding rebuilding needs.

Local philanthropic organizations played a vital role in this work. In addition to providing leadership and organizational support, millions of dollars were quickly

raised and funds were rapidly deployed to support local non-profit, public sector and private partners. This remarkable charitable effort was made possible through the compassion and generosity of donors from across the territory and globe.



All Hands and Hearts, volunteers on St. Thomas.
Source: All Hands and Hearts

As long-term recovery work continues, the sector has an important opportunity to build on the successes of the response, and leverage lessons learned for future disasters. Among the overarching problems identified by the Governor's Task Force were a lack of communication and coordination between community-based organizations and the territorial government. Local communities had minimal emergency preparedness planning completed, and were not plugged into the territory's emergency response plans. The hurricanes' damage to nonprofit service providers offices and equipment further impeded their relief efforts, which impeded the provision of necessary services. In-kind donations helped to meet vital basic needs in the immediate hours and days after the storms, but in many cases unsolicited donations of unneeded commodities became burdensome to manage. While volunteers made substantial contributions to relief and recovery operations, volunteers were not always deployed efficiently and effectively. And although monetary donations flowed to a range of worthy causes, some opportunities to maximize and further leverage those contributions were missed.

A useful first step in addressing these challenges would be the appointment by the territorial government of a dedicated, high-level non-profit recovery liaison to coordinate directly with community-based organizations on disaster relief and recovery operations. Community emergency preparedness planning and the development of continuity of operations plans for service providers would enhance

organizational and community resilience and ensure the quick restoration of essential services. The territory should also work with local non-profits to refine and strengthen volunteer and donations management plans to enable better matching of volunteers and donations with community needs. In order to support stronger charitable fundraising and maximize the impact of giving, systems should be developed to enable better coordination and communication of recovery needs and to strengthen ties to large national funders.

HOW THE SYSTEM WORKS

The Virgin Islands feature a robust and dynamic sector of community-based organizations that provide a broad range of essential services. These groups include nonprofit service providers, houses of worship and faith-based organizations, voluntary organizations and community foundations and other charitable organizations. Collectively, they provide invaluable services to the community on a daily basis with services ranging from food pantries, to healthcare and case management, to supporting children through after-school and youth development activities, to economic revitalization and workforce development programs.

Because of their close proximity and familiarity with community needs, philanthropic, nonprofit and volunteer organizations have been vital at all stages of

the territory's recovery, from coordinating initial relief operations to fostering an inclusive long-term planning process. The Territory's well-established community foundations and non-profit organizations played a critical role in mobilizing resources and volunteers. At the same time, new organizations formed to help meet the vast needs of local residents, many of them grassroots operations that evolved to play leading roles in recovery. Larger national disaster response groups, many of whom were already engaged in hurricane recovery operations across the region, also made important contributions. Each group leveraged their unique expertise, networks and resources to fill needs and gaps.

The combined leadership, generosity and spirit of collaboration of the non-profit, philanthropic and voluntary sector play important role in the Territory's recovery and rebuilding. Many families and communities across the islands still face a difficult and uncertain path forward toward recovery. Significant unmet needs still exist, as much of the territory remains vulnerable to future storms. These STET community-based organizations continue to support those still impacted by the storm and are leading the way in recovery and preparedness planning. Providing them with the resources they need to achieve their missions will enable them to help build a more resilient Virgin Islands community.



Volunteers helping restore a local day care on St. Thomas; Source: All Hands and Hearts

IMPACT OF THE HURRICANES

RELIEF AND RECOVERY OPERATIONS

Philanthropic and voluntary organizations immediately began to mobilize relief operations in the aftermath of the two record hurricanes. Initially, efforts focused on gathering and distributing essential supplies, including food, fuel, water, medical supplies, generators and even heavy equipment to be used for debris removal and repairs. Local chapters of Voluntary Organizations Active in Disaster (VOAD) groups, including volunteers from organizations such as the American Red Cross, Catholic Charities, The Salvation Army and the United Way, played a leading role in these efforts.

21 USVI Hurricane Help, (organized by retired NBA star and St. Croix native, Tim Duncan), was among the larger relief supply distribution operations. This group worked in close collaboration with VOAD groups, the VI National Guard and unaffiliated local volunteers to set up large-scale supply collection and distribution sites on St. Thomas and St. Croix.

Local community-based organizations also provided valuable help. Lutheran Social Services deployed Lutheran Disaster Response (LDR) volunteers to deliver food, provide shelter and assist with home reconstruction and mitigation work. A number of groups worked outside the scope of their regular mission. For example, My Brother's Workshop, a local youth development and job training group focused on at-risk youth, utilized the program's wood shops on St. Thomas and St. Croix to provide support to help repair 225 damaged homes and cleared and removed over 89K cubic yards of debris to date at no cost to the homeowners. The organization also lent the program's café on St. Thomas and established it as a disaster relief hub, distributing 37.5K free meals and other necessities from that location.

Other groups formed spontaneously. On St. John, Love City Strong, which began as a grassroots effort of local residents who came together in the direct aftermath of the storm, worked



Tim Duncan and Michael Bloomberg deliver supplies after the hurricanes. Source: Bloomberg Philanthropies

to mobilize volunteers to identify vulnerable residents and meet immediate recovery needs. This group later registered as a formal non-profit organization and dedicated its efforts to long-term recovery operations.

Musician Kenny Chesney launched the Love for Love City Foundation, which flew supplies and equipment to the Territory and helped to transport materials across the island.

Additional help came quickly to the territory from large national recovery organizations. Massachusetts-based All Hands and Hearts based where immediately deployed teams of skilled volunteer labor to lead debris clearance and muck-and-gut operations, as well as rebuild homes and schools on St. Thomas and St. John. AmeriCorps volunteers also worked to support volunteer and donations management, assist with blue-tarp roofing repairs, and provide valuable manpower for debris removal operations. The ecumenical Disaster Recovery Support Initiative also sent teams to St. Thomas to provide

expertise on case management and assistance with long-term recovery and rebuilding efforts.

Led by company co-founder Tom Secunda, Bloomberg LP was one of many generous corporate donors who contributed to the territory's recovery. In addition to shipping over 200 tons of supplies and equipment, Bloomberg brought in a team of emergency management and disaster experts - many from former New York City Mayor Michael Bloomberg's administration - to assist the territorial government. The company also flew a disaster medical team from Johns Hopkins University to help storm victims, coordinate evacuations, and set up emergency care centers.

These relief efforts, large and small, from well-established groups and start-up operations alike, played an important role in meeting immediate post-storm needs. Many mobilized long before government resources or larger relief groups were able to establish services. All of them depended heavily on the assistance of volunteers who generously contributed their time

and energy to assist with debris clearance, supply distribution, and other essential needs. Yet volunteer management also posed a challenge due to a lack of coordination between relief groups, Virgin Islands Territorial Emergency Management Agency (VITEMA) and government officials. Plans and systems must be put in place to more effectively connect volunteers to the groups that can best use their varied skill sets, and then thoughtfully deploy appropriate teams to areas that most need assistance. In addition, local service providers would prevent overlapping efforts, and enable a more rapid response to more victims by establishing a centralized USVI Recovery webpage that can serve as a primary platform for information on local recovery efforts; as well as serve as a portal for volunteers to learn about service opportunities and connect with community-based organizations.

Another particular challenge after the storms was the volume of unsolicited donations, clothing in particular, that accumulated at sites throughout the territory. While well intentioned, without an adequate plan for storage and distribution, these unsolicited donations are often left exposed to the elements and subsequently damaged or spoiled. These goods can overwhelm local logistics, crowd out more critically needed items and even at times pose safety and sanitary concerns. Local organizations worked together to sort and manage the extensive material donations, but it remained difficult to manage the sheer volume. The territory must create a triage system for donation collection, storage and distribution.



Bloomberg LP's Tom Secunda and Michael Bloomberg volunteer after the storms.
Source: Bloomberg Philanthropies



Catholic Charities assisting with meal distribution after Irma.
Source: Catholic Charities USVI

A lack of safe, available workspaces also posed an obstacle to the vital work being done by community-based organizations. At the same time that local groups were providing services to storm victims, in many cases, heavy damage from wind and rain and widespread power outages displaced them from their own offices. The St. Croix Foundation for Community Development and the St. John Community Foundation helped to fill this gap by opening their doors to other local nonprofits and response organizations. This enabled groups to quickly resume services, and also provided collaborative spaces that fostered communication and information exchange. The territorial government and community-based organizations should collaborate to develop continuity of operations plans to understand how the government can best support local groups to quickly resume services after disaster.

PHILANTHROPY

Local community foundations played an enormous role in the response. Their extensive knowledge of each island's demographics and their corresponding rich networks of relationships positioned them to immediately lead as conveners, information clearinghouses and coordinators of relief efforts. Philanthropic funds were used to acquire critical resources in the immediate days and weeks after the storms, and additional grants were awarded to support a multitude of areas impacted by the storms, including housing recovery, health and human services, environmental sustainability, education and youth development and economic development. The funds were deployed flexibly to meet recovery needs that were not funded by other sources or where government resources were inadequate or too slow to be helpful.

The Community Foundation for the Virgin Islands (CFVI) launched a number of funds dedicated to support recovery needs. The largest was the Fund for the Virgin Islands, a public-private philanthropic collaboration launched in partnership with Bloomberg Philanthropies and Governor Mapp. The fund raised \$8 million to support local service providers engaged in relief and recovery efforts.

The Stephenson Family Foundation, which has long-standing ties to the Virgin Islands, also partnered with CFVI to launch the HelpUSVINow! Fund, which raised \$5 million for recovery. The Stephenson family also contributed in a number of other ways, flying supplies, medical equipment, food and generators and assisting with evacuations for vulnerable USVI residents. The St. Croix Foundation for Community Development launched the Caribbean Assistance and Relief Effort (CARE) Fund, which provided immediate relief needs as well as support for longer-term recovery efforts. The St. John Community Foundation played a leading role in managing donations, identifying service gaps, and leveraged their partnerships to connect resources and funds to groups serving those with critical needs.

While funds quickly flowed to many groups engaged in recovery, others lacked strong pre-existing relationships with national funders and recovery organizations, limiting their ability to coordinate and leverage much-needed funds at a critical time. Looking forward, local charitable organizations should band together to launch a standing USVI Recovery Funders Forum, which would provide a mechanism to develop and

strengthen relationships with large philanthropic organizations and other potential funders.

Long-Term Recovery

As the response shifted from immediate relief to longer-term recovery, Federal Emergency Management Agency (FEMA) worked with VOAD groups and volunteer coalitions of civic, non-profit, and faith-based organizations to establish Long Term Recovery Groups (LTRGs) on each of the islands.

Each LTRG is made up of work groups focused on issues like housing, volunteer management, donations/resources management, health and social services, and economic and workforce development. These groups serve as inclusive forums for information sharing and resource coordination, working to identify the most pressing post-storm needs and helping to ensure the efficient and effective provision of assistance to the territory's most vulnerable residents and populations.

The LTRGs received outside support from FEMA's Voluntary Agency Liaisons (VALs), who helped build the capacity of the groups and played an important role in helping them to navigate the often overwhelming suite of federal programs and resources available to support long-term community recovery. The success of the LTRGs demonstrates the importance of collaboration between local service providers and government.



Catholic Charities distributing care packages; Source Catholic Charities USVI



Catholic Charities Distribution of pampers, toiletries, detergents and toys to families. Source: Catholic Charities USVI

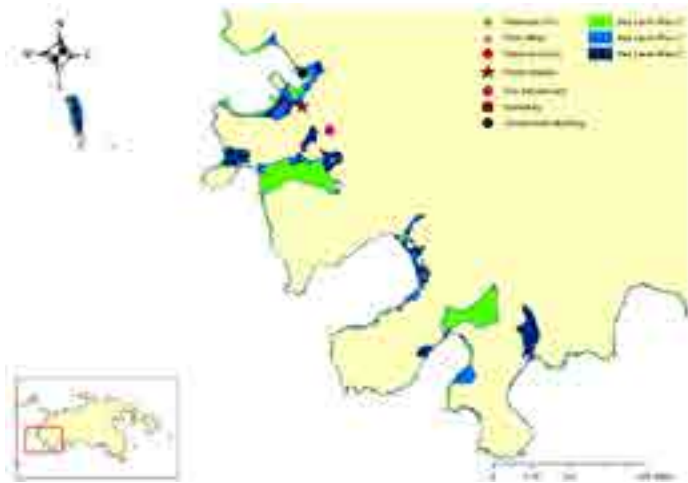
CLIMATE RISKS

The U.S. Virgin Islands will remain vulnerable to the risk posed by hurricanes, earthquakes and other natural disasters. The territory's community-based organizations will continue to face challenges, particularly in the form of damage to key facilities and equipment. While hurricanes Irma and Maria primarily resulted in damage from excessive wind and rain, future weather events may result in increased risk of storm surge and coastal flooding, which could put many service providers at risk. Furthermore, the heightened frequency and volatility of future storms will increase the demands on service providers to quickly respond and provide essential post-disaster services.



Government Assets at Risk of Sea Level Rise in Fredriksted





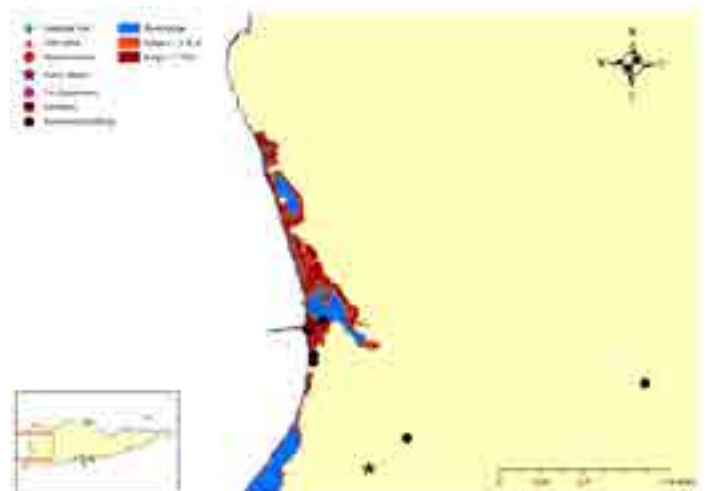
Government Assets at Risk of Sea Level Rise in Cruz Bay



Government Assets at Risk of Sea Level Rise in Charlotte Amalie St. Thomas



Storm Surge for Government Response Resources in Charlotte Amalie, Present, Predicted 50 year, Predicted 100 years



Storm Surge for Government Response Resources in Fredriksted, Present, Predicted 50 year, Predicted 100 years

RECOMMENDATIONS

The Task Force has reached out to leaders of local and national philanthropic and volunteer organizations to solicit their feedback on lessons learned. These recommendations identify initiatives that will lay the groundwork for more efficient and effective preparation and response for future disasters. If implemented, they will maximize the resilience

of local community-based organizations, establish platforms for information sharing, and strengthen relationships between local groups and national philanthropic organizations.

Initiative 1

Appoint a Non-profit Recovery Liaison

The Governor's Office should create a full-time senior staff position dedicated to coordinating directly with community-based organizations, with a primary

focus on disaster recovery and emergency planning and preparedness programs. A Recovery Liaison would serve as the principal communicator between the territorial government and community-based service providers, ensuring that the needs of the territorial government and community groups are communicated to each other, and that government resources are efficiently and effectively deployed to augment and support local recovery operations. This liaison would also work closely with VITEMA to coordinate and communicate

needs and response, as well as partner with philanthropic organizations to help identify and prioritize outstanding needs.

Initiative 2

Develop a USVI Community Emergency Planning Toolkit

Local community-based organizations should partner with VITEMA to create a Community Planning Toolkit, to provide direction and resources for local groups to develop community-based approaches to emergency preparedness and resilience. The toolkit should take into account the unique planning and preparedness needs of the Virgin Islands. This model has been used successfully in other localities to help community-based organizations identify existing assets and resources, and develop and strengthen key community networks. This approach will provide clear understanding of VITEMA plans and capabilities, and how local resources can be most effectively supported STET unified recovery effort. Workshops can be held on each island to help local organizations develop or enhance their own plans, accompanied by annual simulated emergency exercises to test and enhance the local plans.

Initiative 3

Develop Continuity of Operations Plans (COOP) for Community-based Organizations

VITEMA should develop a user-friendly template to guide local non-profits, philanthropic and volunteer organizations through the process of developing comprehensive COOP plans for their organization. These plans help organizations continue or quickly resume services after a disaster, allowing them to provide essential services to their communities. As with hurricanes Irma and Maria, electricity, telephones and computers may be offline or unavailable, and buildings may be damaged or inaccessible. Local service providers need to develop plans that pinpoint essential assets and identify alternative solutions. Organizations should create a plan which identifies alternate work sites, protects important documents and back up essential data, develop plans for communicating with essential staff or volunteers. The organization should schedule regular reviews to ensure these plans enable quick response to a disaster. Workshops should be held on each island in conjunction with community foundations and LTRGs to help groups build and refine their plans.

Initiative 4

Update and Strengthen Volunteer Management and Donations Management Plan

VITEMA should partner with FEMA and each island's VOAD and LTRGs to update and strengthen volunteer and donation management plans that address the issues of unaffiliated volunteers and unsolicited donated goods and services. These plans should detail the establishment of Volunteer Reception Centers for donated goods. An essential element of these plans should be a proactive volunteer and donations messaging strategy to be developed by the Recovery Liaison and VITEMA in conjunction with community partners to ensure unified messaging.

Initiative 5

Establish a USVI Recovery Website

The Governor's Office should establish a user-friendly clearinghouse website to serve as a centralized platform for information on recovery efforts and as a portal for volunteers to connect with service opportunities at community-based organizations engaged in relief and recovery work. The webpage will serve as a publicly accessible resource directory and compile information on all local groups engaged in recovery, including the types of services they provide the types of



volunteer support they require, and what types of donations might be needed. Local service providers and recovery groups should have access to provide updates in order to ensure real-time updates on recovery progress, resource needs and service opportunities.

Initiative 6

Launch a USVI Recovery Funders Forum

Local charitable organizations should band together to launch a standing USVI Recovery Funders Forum, which would provide a mechanism to develop and strengthen relationships with large philanthropic organizations and other potential funders. Local groups can use the forum to provide updates on recovery and communicate needs when disasters occur, and provide potential donors with the relationships and information they need to decide which projects and groups to support. The forum could offer updates on how groups are spending contributions so that donors will have a better sense of how their dollars are helping to recovery efforts across the Territory. Once established, the forum should consider hosting quarterly meetings or webinars to provide regular updates on recovery progress and maintain relationships. Each meeting could have a particular area of focus, such as housing, economic development or healthcare, highlighting the diversity of groups providing recovery services in the Territory.

GOVERNMENT RESPONSE

In one way or another, government response to disasters and emergencies includes most of the USVI government, as well as—in large events—federal partners and other states and territories. In any response effort, the Virgin Islands Territorial Emergency Management Agency (VITEMA) is the lead agency; other participants work with it to coordinate their activities.

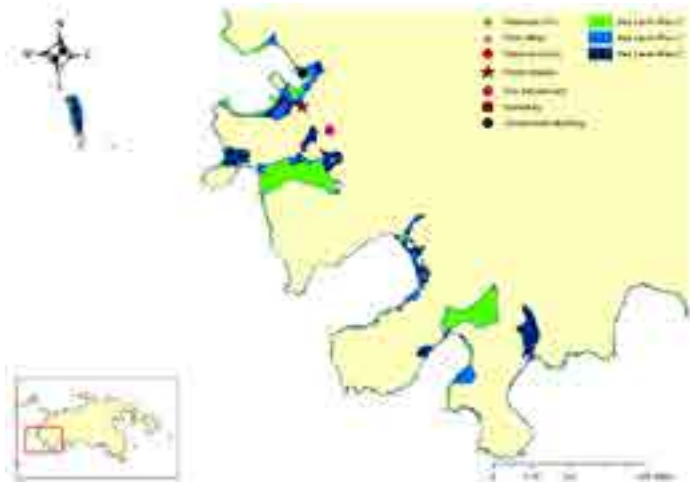
During the hurricanes, the entire emergency response system faced a test the likes of which it had not seen in decades. As the hurricanes arrived, VITEMA's Emergency Operations Centers (EOCs) monitored resources and conditions and directed response activities across multiple emergency support functions, including first responders and public safety. First responders from five different agencies worked to meet the basic emergency needs of the

Territory's residents after the worst of the storms had passed and conditions were safe enough for the responders to go out, carrying out search and rescue, doing welfare checks, fighting fires, and engaging in property protection and commodity distribution. Federal partners led by Federal Emergency Management (FEMA) provided assistance that VITEMA and other parts of the USVI government requested; help also arrived from other states and territories via the Emergency Management Assistance Compact (EMAC). Response was made difficult by damaged and blocked roadways, damaged vehicles, limited fuel resources, and damaged communications infrastructure.

As with any response effort, the hurricanes revealed areas that could be improved upon. As the Territory prepares for future disasters, a more robust

and resilient response system will include better coordination between all the different response players within the EOCs (including through the creation of a single territorial EOC to guide and direct island EOCs); enhanced preparedness of fire, police, Emergency Medicaid Service (EMS), and volunteer search and rescue groups (including through using Virgin Islands Fire Service (VIFS) stations and staff in EMS activities); much-strengthened emergency planning and pre-storm preparation across all government agencies; hardening critical response assets against weather impacts (including rebuilding the St. Croix EOC); and enhancing communications infrastructure to survive future storms.





Government Assets at Risk of Sea Level Rise in Cruz Bay



Government Assets at Risk of Sea Level Rise in Charlotte Amalie St. Thomas

DEFINING GOVERNMENT RESPONSE

‘Government response’ could be defined broadly, to mean the activities of all branches of government that have to do with responding to hurricane consequences, or more narrowly, to mean the activities of those agencies that have to do with the more immediate response needs mainly having to do with people’s safety. As the entirety of this report addresses the response of different branches of government overall, this chapter focuses on the latter, more narrow definition.

HOW GOVERNMENT RESPONSE WORKS

VITEMA is the lead emergency management agency in the U.S. Virgin Islands. Before emergencies, VITEMA’s director prepares response plans; during emergencies, the director runs response operations, allocates funding, and requests help from federal and state governments in his or her capacity as the Territorial Coordinating Officer (TCO). Beyond VITEMA, the four additional emergency response participants are the Virgin Islands Police Department (VIPD), which maintains public order and enforces the curfew, the Virgin Islands Department of Health Emergency Medical Service (VIDOH EMS), which provides EMS services, the VIFS, which provides fire and hazardous

materials protection, and four separate volunteer rescue groups, which provide search and rescue as well as some basic EMS service. The USVI Executive Branch also plays a role in that it suspends or waives statutes, rules, ordinances, and orders to the extent permitted by law if needed to assist in the response operations. Another participant is the Virgin Islands National Guard (VING), a function of the USVI government, that, while not a first responder per se, provides critical support with transportation, logistics management, resource support, external affairs, off-island support, military police, and air operations.

Federal support, when needed, comes from the FEMA, which coordinates support that comes in from other parts of the federal government, including the US Army Corps of Engineers, which provides resources such as generators, construction, public works projects and engineering management. Support from other states arrives via the EMAC.



Emergency response hierarchy

VITEMA: Emergency response plans

VITEMA develops advance plans for many possible emergencies, primarily through its Territorial Emergency Operations Plan (TEOP). The TEOP includes guidance on setting up Emergency Operations Centers (EOCs; see above), defines agency roles and responsibilities to prevent overlap and eliminate gaps in service, and establishes initial operating procedures for first responders. When the Governor declares an emergency, the declaration triggers the TEOP and emergency response coordination across all relevant USVI agencies; the threshold for activating the TEOP for a hurricane is a Category 3 storm. VITEMA's last revised and updated TEOP was published in December 2016;¹ where it was published, many of the required annexes to it were yet to be developed. The Vigilant Guard exercise in May 2017 exposed many gaps in the existing plans that highlighted areas in the TEOP that need to be corrected.

Function	Lead agency
ESF-1 Transportation	Department of Property and Procurement
ESF-2 Communication	VITEMA
ESF-3 Public Works and Engineering	Department of Public Works
ESF-4 Firefighting	VI Fire Service
ESF-5 Emergency Management	VITEMA
ESF-6 Mass Care, Emergency Assistance, Housing, and Human Services	Department of Human Services
ESF-7 Logistics Management and Resource Support	Department of Property and Procurement
ESF-8 Public Health and Medical Support	Department of Health
ESF-9 Search and Rescue	VI Fire Service

Emergency support functions in the EOCs

VITEMA: Emergency Operations Centers (EOCs)

VITEMA manages response operations via three EOCs one on St. Thomas, St. John, and one on St. Croix, each of which is run by a VITEMA Deputy Director (also playing the role of TCO Representative). Once activated either by the Governor or VITEMA Director, EOCs perform several functions:

- Serve as the place where all the different response players are physically present: as part of regular planning, individual government agencies select Emergency Support Coordinators (ESCs) from within their staff to represent each agency at each of the three EOCs; other (non-governmental) response players may also be present (see chart: [Emergency response hierarchy](#))
- Inform the public: before a storm, EOCs tell the public where they can access information on AM and FM radio stations and on the Internet; after the storm, EOCs provide updates on the situation
- Distribute resources: EOCs distribute commodities and supplies either previously stockpiled or received from various organizations outside of the territory to meet emergency needs
- Coordinate with the federal government: each EOC coordinates with FEMA and other federal partners for response and recovery support. Support ranges from tasking agencies and first responders to managing and staging supplies, equipment, and personnel provided by federal agencies or the Department of Defense
- Coordinate with state governments: EOCs are in

¹ VITEMA. The Virgin Islands Territorial Emergency Operations Plan: 2016. (USVI: VITEMA, 2016). www.vitema.vi.gov/docs/default-source/key-documents/teop-2010-09-23.pdf

charge of requesting assistance from other states via the Emergency Management Assistance Compact (see below for details).

EOCs are organized according to what is known as Emergency Support Functions (ESFs). US Department of Homeland Security's National Response Framework defines 15 ESFs; of those, nine are represented in the EOC. Each ESF is covered by a territorial agency (see table: [Emergency support functions in the EOCs](#)).

The three physical EOCs in the USVI have varying degrees of fitness for the purpose. On St. Thomas, the EOC is a hardened facility that opened in 2010 and is configured for disaster operations, but is overdue for updates to communications systems, IT infrastructure, and software. On St. Croix, VITEMA offices and EOC occupy a rented building in Christiansted with limited space that can not handle the number of personnel necessary to facilitate incident response. The EOC is also not in a hardened portion of the building and is thus vulnerable to damage due to severe weather. Similarly on St. John, the facility occupies the first floor of a two-story building that is not hardened against hurricanes.

All three facilities run WebEOC, which is a software package used throughout the FEMA system and in numerous state and local emergency management facilities. The program allows agencies to track items that need to be acted upon and also makes possible a very detailed, sequential review of all activities by emergency support function that took place in an incident, which helps with after action reports. The system

was set up with the vendor's standard format and still needs to be customized to VITEMA's needs.

VITEMA: 911 call center

The Territory has two 911/ Emergency Communications Centers (ECCs), one each on St. Thomas and St. Croix. VITEMA runs them and works with all public safety agencies (VIPD, VIFS, EMS, Rescue and others) to define the methods and procedures for how calls will be handled. The ECCs addressing capacities are in need of an upgrade—the dispatch center currently relies on memory of road layouts and other identifying landmarks to direct first responders to the incident scene, but a new Computer Aided Dispatch (CAD)/Records Management (RM) system is being procured. Addressing for the territory is also underway via a project being coordinated by the Lt. Governor's office.

Virgin Islands Police Department (VIPD)

The Virgin Islands Police Department (VIPD) is the Territory's lead law enforcement agency during emergencies. It is supported by other territorial law enforcement agencies, federal law enforcement agencies, as well as off-island state and local law enforcement agencies supplied via the EMAC process. VIPD also enforces curfew for which VITEMA develops policies and procedures.

Virgin Islands Fire Service (VIFS)

The Virgin Islands Fire Service (VIFS) is responsible for all activities related to firefighting, including fires on land (buildings, brush, vehicles) and water (boats), as well as hazardous material incidents during emergencies. The VIFS also assists volunteer search and rescue teams but does not normally perform independent search and rescue functions itself. VIFS carries out its duties with trained full-time firefighters and has begun conducting Emergency Medical Technician (EMT) training (under the direction of VIDOHS EMS) for their new recruits. Currently, VIFS does not respond to initial EMS calls but will assist when requested by EMS to do so.

The VIFS has fire stations on each island: St. Croix's four stations are located in Frederiksted, Grove Place, Christiansted, and Cotton Valley; St. Thomas' four stations can be found in Fortuna/ Bordeaux, Charlotte Amalie, Tutu, and Dorothea; St. John's two stations are located in Coral Bay and Cruz Bay. Fire Administration is located on St. Croix in Orange Grove. Only one of these 10 stations is in a hardened facility (Charlotte Amalie).

VIDOHS: Emergency Medical Service (EMS)

The Virgin Islands Department of Health (VIDOH) is responsible for EMS operations. EMS is in charge of emergency health and response operations as well as Mobile Integrated Health services for St. Croix, St. Thomas, and St. John using full time EMTs (Basic and

Intermediate) and Paramedics. Volunteer rescue squads support VIDOHS EMS when asked.

Search and Rescue (SAR) squads

St. Croix, St. Thomas, St. John, and Water Island each have volunteer search and rescue (SAR) squads to support the VIFS and EMS; Water Island Search and Rescue is the only first responder on the island. The rescue squads are trained to perform EMT, search and rescue, and vehicle extrication operations. The squads typically respond to incidents when called by the 911 Emergency Call Center (ECC), but can also respond independently, when requested by the EOC or directly from EMS, fire, or police.

Virgin Islands National Guard (VING)

Virgin Islands National Guard supports the territory with transportation, logistics management and resource support, and external affairs functions during territory-wide emergencies. VING obtains their directions from the Governor or VITEMA and can request National Guard resources from other states.

FEMA

FEMA is the lead federal agency that responds to disasters. Prior to an emergency, FEMA deploys an Incident Management Assistance Team (IMAT) to identify potential problem areas and provide federal assistance, as well as to coordinate and integrate the federal response

supporting the U.S. Virgin Islands. FEMA IMATs serve as the federal government's early presence at an incident and integrate FEMA's response capabilities into VITEMA's existing emergency management functions. In any emergency, VITEMA remains the lead.

Emergency Management Assistance Compact (EMAC)

Emergency Management Assistance Compact (EMAC) is an agreement that allows states and territories to request and share personnel, supplies, and equipment in times of disasters. VITEMA administers the process for all territorial governmental entities. The agency used the EMAC process for the first time during the 2017 hurricanes.

Communications

Emergency response operations in the territory rely on three methods of communication: a dedicated public safety radio system, amateur radio, and—when needed—commercial communications. The dedicated system is known as the Land Mobile Radio (LMR) network; it is the main communications method used by the Territory's first responders. The network has reached the end of its useful life and is due for a replacement (see Public Telecom chapter of this report for more details). Amateur radio provides a backup: the Territory has three amateur radio clubs (ARCs,) one on each of the major islands that have created a

network of seven radio repeaters across the Territory with their own funds. In a severe emergency, ARC volunteers operate out of VITEMA EOCs to support emergency communications. Finally, commercial communications—whether regular cell phones or satellite phones—may also be used.

GOVERNMENT RESPONSE DURING THE HURRICANES

During the hurricanes, the government response system faced a test the likes of which it has not seen in decades. VITEMA, VIPD, VIS, EMS, and rescue squads worked together in the face of facility damage, 911 outages, lack of staff, and communications damage. Resources and help came from VING, FEMA, and other states and territories via the EMAC system.

VITEMA EOCs

VITEMA did a partial activation of its three EOCs 72 hours prior to hurricane Irma's landfall—one on each island. A full activation then took place 24 hours prior to landfall, and the EOCs remained active through hurricane Maria. The EOCs monitored resources and conditions and directed response activities across fourteen different emergency support functions, including first responders and public safety.

All EOCs faced problems with facilities and processes. On St. John, the EOC building suffered severe roof damage during hurricane Irma, but there was no alternate space, so the EOC was forced to continue operations in the damaged facility. In all the three EOCs, one common issue was ensuring that all essential agencies were represented by a staff member with the authority to make decisions for their agency. In some cases, agencies were represented that did not have a role in response operations, and in others, critical agencies were not represented because of staff shortages. A number of agencies had assigned senior level staff as ESCs and expected them to perform response and recovery duties for their agencies. As these senior personnel serve essential functions within their agencies, they were limited in their ability to perform their additional ESC responsibilities; as a result, many of those agencies were not represented in the EOC except during update briefings, which impacted response and recovery coordination.

9-1-1 call center

Storm damage to cellular and landline phone communications systems meant callers could not reach the 911 call center. Part of the issue was related to the overall widespread damage to the communications lines throughout the territory: communications and landline telephone cables attached to Virgin Islands Water and Power Authority (WAPA) poles—or otherwise reliant on aerial attachments—failed almost universally; cellular communications also failed as a result of damaged towers

and destroyed or misaligned communications cables, antennas and radio links. There were problems specific to the call centers, too: telephone cable connections to the 911 call centers from the local phone company, Viya, were not buried at the St. Croix call center, so service to this facility was down for over 36 hours. Communications lines connecting the St. Thomas/St. John 911 center were buried, so its loss of service was the result of damage to communications infrastructure throughout the district. The Territory's LMR system also sustained major damage, which hindered the ability of the 911 public safety dispatchers to communicate with and dispatch first responders to calls. While this was not a long-term outage, service was diminished for several days until the damaged system could be repaired.

VIPD

One of VIPD's main tasks after the hurricanes was to enforce the curfews that were initiated by

the Governor eight hours before landfall in September and were cancelled in December. VIPD also provided security in shelters housing elderly and non-violent individuals. While performing these and other duties, the agency experienced challenges with its integration into the response process, vehicles, and staffing.

The agency's integration into the response process differed on St. Croix and on St. Thomas. On St. Croix, the St. Croix EOC provided daily updates to the Police Chief; the information was then passed down the line to ensure the St. Croix VIPD knew what was happening and had the plan of action—although in some instances, VIPD response was delayed because the St. Croix VIPD ESC was not authorized to make decisions and needed to seek approval from the Assistant Chief or Police Chief before initiating action. On St. Thomas, VIPD was not able to provide a regular ESC in the EOC, which disrupted its ability to receive timely updates. On top of that, St. Thomas VIPD did not anticipate requests to guard both public and private assets and thus was not



STJ firefighters meeting, Source: Kenneth Wilsey/FEMA

prepared to dispatch personnel to guard WAPA, Viya and AT&T facilities. In some cases, rescue squad members were approved by VIPD to supply armed security services. This security assignment stopped once private security personnel were hired.

Vehicles were a problem as well: the police department was already struggling with a vehicle shortage before the storms, and many existing vehicles were damaged during the storm. VIPD made temporary arrangements with the USVI Department of Property and Procurement (DPP) to borrow unused loaner vehicles from other agencies until those agencies could return to work. The motor pool inventory did not include spare tires, making it difficult to obtain replacements for tires damaged by debris and damaged roadways.

Another constraint was staffing: VIPD was understaffed by at least 100 officers prior to the storm, which created problems during post-storm operations. Many personnel also resigned or retired after the storms, which further exacerbated the problem. Funding appears to be the key issue with hiring and retaining quality personnel, and time will tell if the post-hurricane increases in pay for starting officers as well as, pay increases for some existing officers, will help with this issue.

VIFS

In addition to its regular fire response duties, VIFS conducted welfare checks and assisted various SAR organizations with their missions. The VIFS’ sole fuel truck was also pressed into service for a variety of non-

first responder and non-VIFS services. Staffing was expanded by activating double shifts (fire personnel normally work 24 hours and are off for 72 hours; in a double shift, they are working for 48 hours and are off for 48 hours). The double shift activation helped deal with the hurricanes’ consequences but also created hardships for firefighters in that they had limited time to deal with storm related damages to their personal homes and property.

VIFS facilities on St. Croix were damaged, but temporary repairs allowed for their continued use. Fire facilities on St. Thomas mostly survived with minor damages except for the Fortuna location, which suffered the loss of one portable building that had been used as living quarters. On St. John, the Coral Bay fire station was damaged enough—lost doors and windows and a leaking

roof—that operations had to be moved to the Calabash Boom Community Center complex. The Cruz Bay fire station suffered water damage from a damaged roof and water running into the building due to excessive runoff from the surrounding areas. The crews needed to relocate to temporary living quarters across the street while repairs were made to the building.

On St. John, storm damage also rendered communication between the Coral Bay fire station and the Cruz Bay fire station impossible: the Coral Bay station had no radio communication, poor cell phone connection and no landline phone service. Several groups tried to provide the Fire Service with a stopgap communication solution with limited success. In the months after the storm, the Coral Bay Fire Station had a satellite phone that worked approximately 80 percent of the time, and WiFi

District	Authorized EMS strength	Personnel available pre-hurricane	Personnel available after impact
St. Croix	22	14	10
St. Thomas/St. John	33	25	25

EMS staffing by district



New Jersey EMS transport patients back to Sea View Nursing from Red Cross shelter
Source: Jocelyn Augustino/FEMA

calling that worked about 10 percent of the time. The lack of radio communication with the Coral Bay Fire Station meant that the 911 ECC had to call the Coral Bay Station satellite phone to pass on emergency calls. A temporary solution for radio communications to the station was in place as of May 2018.

Even with the damages to the facilities, the response activities of VIFS were not negatively impacted to any significant extent. Other than the quantity of the assignments being much higher than non-disaster times, and issues dealing with passage on roadways, radio communications issues, and issues related to resupply and the procurement process, the VIFS was able to meet its mission assignments.

EMS

EMS responders were in high demand between the storms and following Hurricane Maria: in addition to typical calls, EMS was also called upon to transport patients to their homes from hospitals when released, transport non-injured yet infirm evacuees to shelters from damaged homes, coordinate and facilitate the opening of community pharmacies, coordinate donated medicine and medical supplies, transport deceased evacuees returned to the territory for burial, and provide support to emergency shelters. EMS resources were spread thin as a result of this expanded use.

Staffing was an issue already before the storms and became more so immediately afterwards (see table: [EMS staffing by district](#)). On St. Croix, EMS

did not have sufficient staff to support the high call volume in the post-storm response. In the St. Thomas/St. John district, EMS personnel could not immediately reach St. John and had to rely on volunteers and rescue squads until the ports were safe enough to use.

The lack of staffing required the use of EMAC EMS resources from New Jersey and Arkansas. The New Jersey EMS personnel were sent to St. Thomas on three separate occasions to provide additional manpower and assistance. The Arkansas EMS crews from Pafford EMS arrived on St Croix in October and stayed until June 2018. In addition to responding to emergency calls, Pafford EMS crews, working together with VIDOH EMS and nursing personnel, implemented the Mobile Integrated Health program that visited residents in their homes to provide basic healthcare services like wound care, checking blood pressure, making sure prescribed medicines were being taken, and providing health care education. This allowed residents to avoid going to temporary hospital facilities that were set up after regular hospitals were destroyed in the storms and also freed up EMS personnel staffing ambulances for addressing true emergency situations.

Search and Rescue (SAR) Squads

On St. Thomas, St. Thomas Rescue initiated SAR operations on their own in the wake of hurricane Irma; the squad also coordinated with and assisted FEMA SAR teams, including by helping them navigate the island.



VING deploy to St. Thomas for Hurricane Irma Source: VING Facebook

On St. John, St. John Rescue was the only on-island first responder group in the first days following Hurricane Irma. The group's tasks expanded beyond its usual scope to include general population evacuation (in partnership with another local group called Love City Strong), medical evacuations, generator support, fuel delivery (including the restoration of the Caneel Bay fuel dock), and communication (for which the squad initially served as the primary source in place of the destroyed communications infrastructure).

On St. Croix, St. Croix Rescue performed missions such as extensive chainsaw operations to clear roadways in remote locations, as well as some VIPD-approved security missions to secure critical infrastructure. The group's training tower structure on St. Croix was damaged during the hurricanes and must be repaired.



VIPD helping with potable water distribution after storms
Source: Kenneth Wilsey/FEMA

VING

VING assisted the Territory with security, evacuation operations, delivery and distribution of relief supplies, medical and life-saving activities, route and airport clearing, external communication, and general support services. Several issues arose during the response effort. The first one had to do with communications: a VING representative was present in one of the EOCs, but there were delays with information reaching VING because of communications issues (on St. Thomas, satellite phones were the only means of communication available). The second one had to do with contracting for meals, emergency supplies, and equipment: a workaround had to be created around the normal process with FEMA's help. The third issue was the response on St. John: VING does not have any units on the island, and no units could be sent from St. Thomas immediately, which delayed the response effort.

FEMA

Before hurricane Irma, FEMA deployed two Incident Management Assistance Teams (IMAT) teams in the territory: one on St. Thomas / St. John and one on St. Croix. FEMA's teams then worked together to preposition a stock of water and meals ready to eat (MREs) on St. Croix and St. Thomas to support initial response operations. In view of the damage on St. Thomas from Hurricane Irma, VITEMA transferred a portion of the commodities from St. Croix to St. Thomas to sustain operations until additional supplies could be flown in. Unfortunately, the impact of hurricane Maria on St. Croix was not—and could not be—anticipated, and the reallocation of supplies meant St. Croix did not have a deep supply on which to rely. The Territory lacks hardened climate controlled structures on each island to store disaster commodities prior to a storm or during response operations, which limits the amount of pre-storm

staging VITEMA and FEMA can do.

After the storm, FEMA was fully integrated into the territory's response operations and worked alongside VITEMA out of the three EOCs. Among other tasks, the agency distributed water to the population in the aftermath of water outages and in the absence of a local process for setting up bulk water distribution sites. FEMA also coordinated with the U.S. Army Corps of Engineers (USACE) to provide generators to support initial temporary power requirements on St. Thomas and St. John after Hurricane Irma, and then on St. Croix following hurricane Maria. Generator requirements exceeded availability, requiring a prioritization and management process that VITEMA oversaw.

EMAC requests

EMAC resources requested included law enforcement, health care, emergency medical services, aviation, communications, facility repair, logistics, agriculture, and numerous health services functions. The support included civilian and National Guard resources from 27 states, adding up to 69 completed missions, 1,970 personnel involved, and nearly \$65 million in costs that were covered by FEMA. Because of a lack of staff trained to use the EMAC system, VITEMA and other agencies experienced some delays with getting their requests filled until FEMA EMAC specialists could help with the process.

Communications

The hurricanes heavily damaged radio, cellular, and landline phone systems that government responders use for communications. The LMR network on which first responders rely the most was only partially available, and cell phone availability was down to 10-20 percent for several weeks after the storms (see Public Telecom chapter of this report for details on the LMR system and Private Telecom chapter for details on cell phone availability). As a result, first responders in the field had trouble communicating with dispatchers, and EOCs faced challenges contacting government agencies, as well as WAPA and the Waste Management Authority (WMA), for situation updates and even resorted to sending messengers to exchange information.

The island of St. John was hit particularly hard: public safety radio and landline communications infrastructure between Cruz Bay and Coral Bay were destroyed, the former when the sole tower serving the LMR network on Bordeaux Mountain collapsed and the latter when Viya's wired facilities came down with WAPA poles in high winds. The radio and LMR network was restored when the tower company installed two separate 100-foot temporary towers on November 17 until the replacement tower could be reinstalled. The replacement activity was due to be completed by August 2018.

The full restoration of service on all islands took many months; as the systems recovered, amateur radio resources provided crucial assistance to government responders, especially for communication between islands.

Fuel issues

Following hurricane Maria, St. Thomas experienced diesel fuel shortages that threatened to shut down critical facilities supporting response operations. Demand for fuel was higher than usual: government agencies, businesses, and residents were operating generators for extended periods as a result of the 3+ month, island-wide WAPA power outage. Supply though was constrained for two major reasons. First, fuel shipments from Puerto Rico (on which the island normally depends) were suspended for as long as three months for some of the St. Thomas fuel companies as a result of Maria's damage to the island. Second, hurricane damage rendered the St. Thomas Total (commercial fuel depot) facility unable to immediately access and distribute the fuel in their storage tanks.

Several fuel distributors and various governmental agency personnel established an impromptu Fuel Task Force in response. The Fuel Task Force was composed of personnel on St. Thomas from VITEMA, the Governor's Fuel Representative, FEMA IMAT, the federal ESF-12 representative, and local fuel suppliers and distributors. The purpose of the Fuel Task Force was to prioritize distribution of available diesel fuel to critical facilities, monitor fuel levels, monitor fuel shipment status, identify options for bringing in fuel supplies, and work with suppliers to bring their facilities back online. To help address the supply problem, the Limetree Bay Terminal on St. Croix supplied stored fuel (gasoline, diesel, jet) to barges sent from St. Thomas with tanker trucks between September 23 and November 20. By the time

regular fuel supplies recovered, the work of the Task Force averted a shutdown of critical facilities and services essential to the response effort, although the St. Thomas district was—on several occasions—down to less than a day's fuel supply.

Communication with the public

Public Service Announcements (PSA) and press conferences broadcast on the territory's public radio stations and WTJX (USVI PBS station) kept the public partially informed, although outages of both radio and television, especially in the days following the storm, made the information flow constrained. Even when broadcasts were restored, many people still came to VITEMA for information because they did not have a portable radio on which to hear the Public Service Announcements (PSAs) and press conferences. On St. John, response personnel held daily open-air town halls to keep the public informed.

FUEL SUPPLY: LIMETREE BAY TERMINAL

The Limetree Bay Terminal (LBT) on St. Croix is a bulk storage facility for various petrochemical products in the USVI, with a 22 million barrel (924 million gallon) capacity. The terminal accepts fuels from large cargo ships and can then transfer them to 9,000 gallon tanker trucks for distribution to 26 service stations on St. Croix. In non-disaster times, LBT fuel only supplies St. Croix: fuel distribution for St. Thomas is handled under an arrangement with Puerto Rico. St. John is supplied with barges from St. Thomas. After the 2017 storms, LBT did not have problems accepting or distributing fuel: supply ships did not encounter any challenges getting into the port and tanker trucks could arrive as scheduled. The terminal has an agreement with the USVI government to ensure that there is always a 30-day supply of gasoline and diesel fuel available for distribution, and there was more than that available at all times after the storms—which meant that St. Croix did not have any supply problems. St. Thomas and St. John did have problems though: once Hurricane Maria hit Puerto Rico, the islands were not receiving their regular fuel shipments. To meet the fuel needs of the two islands, the Governor's Office requested that a barge/tote arrangement

be set up to supply them from LBT. Since a similar process was already in place for St. John (receiving their fuel supply from both St. Thomas via barge), that process was replicated and amplified to meet the needs for St. Thomas and St. John both. During daytime hours, LBT handled distribution needs for St. Croix as usual; in the evening/nighttime hours, barges with tanker trucks from St. Thomas would arrive at the St. Croix container port, drive to LBT, receive fuel, reload onto the barges and then head back to St. Thomas to deliver the products.

The operation was in place on September 22 at noon, two days after Hurricane Maria, even though there had been no pre-disaster plan for it. It continued until November 20, and as a result, St. Thomas and St. John did not suffer a loss of supply – even if distribution of the fuel to the individual retail outlets on all islands was at times impacted due to impassable roads, lack of commercial power to the retail locations, and lack of personnel to staff the stores.

In future storms, LBT and its infrastructure could be an important recovery and resilience asset. The terminal fully supports its infrastructure needs by itself: it has its own power generation capabilities, water supply, and internal communications. LBT does connect with Viya for external communications, but even this connection is via a buried line to ensure survivability during

an emergency. The terminal also possesses tugboats, which it provided at no cost after the 2017 storms to help facilitate the delivery of disaster relief supplies and equipment into the container port on St. Croix. During and after the 2017 storms, the terminal held up well: it did not experience injuries to any personnel nor did it face any loss of power. Although LBT did lose communications occasionally when buried Viya lines were hit by restoration contractors, staff had satellite phones they could rely on until regular service resumed.

Integrating LBT into government response operations after the 2017 storms was, however, a challenge. The terminal did establish a line of communications with the USVI Governor's Office, which is how the improvised barge operation was created. However, the terminal could not interact with VITEMA except for occasional connections via the Marine Band Radio: no planning had been in place to allow for that, and LBT disaster plans were not included in the Territorial Emergency Operating Plan (TEOP) annexes. In the future, integrating LBT into existing government response structure instead of improvising solutions on the go would help get the most out of the terminal's capacities and help secure fuel supply for the territory. Initiative 21 in the initiatives section of this chapter proposes measures to better incorporate LBT in future response efforts.



Figure 22 - Expected Sea Level Rise at Limetree Bay Terminal

INITIATIVES FOR INCREASING RESILIENCE IN GOVERNMENT RESPONSE

The extreme challenges presented by the damage of hurricanes Irma and Maria offer VITEMA and all emergency response agencies the opportunity to review what worked, as well as where and how emergency response operations were hindered. VITEMA will work with all relevant territorial government agencies, as well as volunteer groups, to improve interagency response structures and procedures, build on current capabilities, improve response plans and pre-storm preparation, harden emergency response assets and infrastructure against weather and climate damage, and enhance backup communications solutions.

IMPROVE INTERAGENCY RESPONSE STRUCTURES AND PROCEDURES

The first and most important thing that can be done to improve government response is to improve how different agencies work together, especially within EOCs. Initiatives in this group will strengthen the EOC structure and processes and train participating staff to follow them.

Initiative 1

Establish a territory-level EOC

At present, the Territory has three EOCs one each on St. Thomas, St. Croix, and St. John, but no single EOC above them to coordinate and support their work. VITEMA will work with USVI agencies to establish a territory-level EOC. The new EOC would not duplicate the work of the existing ones, rather, its two primary tasks

would be: to support executive level coordination between the three island EOCs and serve as be the main point of communications with the public.

Initiative 2

Codify emergency command structure and decision-making authority

In the 2017 response, in some circumstances, a primary contact person for an agency was not available and it was not clear who the succeeding representative was. Other times, agency personnel were assigned to the EOCs but were not authorized to make decisions in place of their agency head, which created the need to send requests for decisions out of an EOC and back to the agencies. Both issues delayed decisions and compromised response activities.

VITEMA will work with territorial agencies to codify emergency command structure by creating a hierarchical chart of individuals assigned to each EOC and clarifying what decisions they are authorized to make without the approval of their agency head.

Initiative 3

Train responders in management tools

Emergency response relies heavily on the use of management tools to keep track of complex processes that involve many participants. The three most important tools are FEMA's Incident Command System (ICS), VITEMA's WebEOC, and EMAC. For the former two,

some ESC members were familiar with both, but some were not, which made it difficult for them to participate in the response operations and for others to work with them. For the latter, VITEMA did not have enough staff familiar with the system, which required waiting for help from FEMA before requests could be put in.

VITEMA will work with the agencies represented in the EOCs to ensure that each ESC member is trained in using these emergency response tools. It will also train its own staff in using EMAC.

Initiative 4

Train agencies to improve EOC integration

EOCs run best according to pre-established roles and protocols. In the USVI, those are established by the Emergency Management Council (EMC), which is the body that brings together VITEMA, the USVI Attorney General, VING, 14 different agencies and organizations of the USVI government, and some private sector partners to help coordinate planning, set goals and objectives for implementing the TEOP, and establish standards for response. However, not all agency representatives are familiar with the roles and protocols that EMC has established.

VITEMA will conduct quarterly trainings and exercises for EOC agency representatives on adhering to the established roles and protocols. The agency will also conduct quarterly EMC meetings and require updates from council members on

their preparedness activities. Executive level participation from every EMC member will be essential for success; to ensure that it takes place, VITEMA will report on attendance by agency and distribute the information to agency directors and commissioners.

Initiative 5

Train agencies to improve knowledge of relief funding

In a major disaster, most funding for recovery will come from the federal government – however, getting that funding requires being familiar with the requirements attached to it. VITEMA will identify types of information that should be gathered to procure disaster relief funding—including FEMA requirements—during and after a major disaster event and create a packet of essential information and training that agencies could use.

Initiative 6

Review and adhere to information sharing protocols

In a disaster, consistent public communication is one of the most important things to get right. VITEMA already has a Joint Information Center communications plan, but it will work to strengthen it, including by updating information provided to each media channel throughout storm events, and training personnel on adhering to

established information sharing protocols. VITEMA will also establish a protocol to ensure that each EOC appoints a single person as a Public Information Officer (PIO) to be responsible for listening to each government press conference and taking notes to share with their respective EOC leaders. This will ensure that the latest information will be delivered to key people in the EOC. Further, the PIO will be prepared to answer questions or educate VITEMA staff to answer questions from members of the public who come to VITEMA facilities for information.

Initiative 7

Work with FEMA to get VITEMA access to Resource Request Form process

Resource Request Form (RRF) is a FEMA process for requesting resources from the federal government that is separate from the territorial process used by the Department of Planning and Procurement (DPP). When an agency needs to request resources, it goes to VITEMA for assistance. VITEMA then fills out a paper form and forwards it to FEMA, which enters the information into a database and begins the process for acquiring the requested materials if approved. VITEMA has no access to the FEMA system to check on the status of the RRF request. This process inherently slows down the overall process for obtaining the needed federal resources. VITEMA will work with FEMA to obtain access to the RRF system.

ENHANCE PREPAREDNESS OF EXISTING EMERGENCY RESPONDERS

The territory's existing emergency responders face shortages of staff and equipment. These initiatives aim to address these shortages – especially in the case of EMS and search and rescue squads – as well as improve the way some of them organize their work.

Initiative 8

Launch unified recruitment campaign for first responders

All first responder organizations in the USVI are facing staffing shortages; VIPD and EMS have the greatest need. VITEMA will work with all the different first responder agencies to coordinate a unified hiring campaign in all first responder organizations, including the 911 Emergency Communication Center and volunteer rescue squads.

Initiative 9

Strengthen VIPD's ability to evaluate disaster situations

After a disaster, quick evaluation of the situation – building damage, fires, mass casualties, and damage to critical infrastructure – is essential, but it requires large numbers of people who can move around the territory. Of all the

territorial agencies, VIPD is best positioned to play such a role.

VITEMA will work with VIPD to assess the department's ability to perform quick evaluations of disaster situations and train all operational personnel to understand what resources are available for disasters and how to operate in these situations. In the event of building damage, VIPD should provide an immediate assessment of buildings destroyed or in imminent stage of collapse where people may be trapped. In the event of fire, VIPD should be able to quickly assess the extent of a fire, what or whom it affects (people, hazardous materials, etc.), and its danger of spreading. In the case of a mass casualty incident, VIPD should be prepared make quick assessments of the extent and number of casualties. If critical infrastructure is damaged, VIPD should quickly provide an assessment on the damage to key infrastructure facilities (power lines down, water mains broken, or communications towers toppled). In all of these cases, VIPD will relay information gathered to the dispatcher/EOC for assignment of appropriate resources.

Initiative 10

Use VIFS facilities and staff for EMS activities

The territory's current EMS response suffers from a lack of staff and from the fact that ambulances are not spread throughout each island, which means that more remote communities can wait a while for help to arrive. One way to remedy

both problems is to use the capacities of VIFS: ambulances could be located in the VIFS stations that are distributed relatively evenly throughout the territory, and at least some firefighters could be trained as EMTs (emergency medical technicians). If this were to be done, EMS could either remain part of VIDOH or be transferred fully to VIFS. Other parts of the US do it both ways: some communities run their EMS out of their fire departments, and some have standalone organizations.

In the immediate term, VIFS and VIDOH/EMS will work together to train VIFS staff to perform basic EMT skills and to secure equipment to support the staff so trained. When accomplished, VIFS personnel could be sent on EMS calls located close to their stations until ambulance crews could arrive. In the medium term, VIDOH EMS will analyze emergency call data and begin allocating ambulances to fire stations based on that data as well as work with VIFS to expand training to make sure that at least one paramedic-level firefighter is assigned to every fire station on every shift. The two agencies, working with the Governor's Office, will determine which organizational setup – merging EMS into VIFS or keeping it with VIDOH – will best serve the purposes of service improvement.

Initiative 11

Strengthen EMS staffing and equipment

VIDOH/EMS may not have enough staff and equipment to

EMTs	St. Croix (30)	St. Thomas/St. John (40)	Total = 70
Paramedic	12 (3 supervisory personnel)	15 (3 supervisory personnel)	27
Advance/ Intermediary EMT	10	12	22
Basic EMT	8	10	18
Boat Captain/ Coxswain		1	1
Boat Mate		2	2

Potential EMS staffing levels

provide the level of care that is available elsewhere in the US.

When it comes to staffing, the agency will assess call data to evaluate whether their staffing levels are adequate and determine the mix of EMT levels needed per shift (Basic, Intermediate, Paramedic). One recommendation could be to bring the total staffing level to 70 from the current 39 (see table: [Potential EMS staffing levels](#))

When it comes to equipment, VIDOH/EMS and rescue squads need to procure mini ambulances and ASAP (Alternative Support Apparatus) vehicles to operate on the territory's steep and narrow roads instead of using existing ambulances that are only designed to operate on standard width, hard surface roads. EMS has identified a need for five of the mini ambulances, with two each on St. Croix and St. Thomas, and one on St. John and has begun the process of ordering one vehicle for each island. VIDOH will also work to enhance the existing integrated mobile healthcare services

function in order to eliminate needless calls for emergency care and support, which will free up emergency response personnel and equipment for genuine emergencies.

Initiative 12

Develop protocols for sending the right response resources for specific incident types

In any incident requiring emergency response, it is important for the dispatch center to be able to send the resources that the incident requires. In the recent storms, many calls required the resources of rescue teams and/or fire personnel in addition to EMS and VIPD – however, no standard protocol was in place to dispatch the appropriate resources on every type of call. The new records management/CAD dispatching system being installed in the territory's ECCs will have this

capability – but first responders will need to develop the protocols to use it.

VITEMA will work with first responder agencies to determine what resources should be sent to what types of calls and when those resources should be dispatched.

Initiative 13

Work with rescue squads to develop a territorial search and rescue plan

The Territory does not have a comprehensive search and rescue (SAR) plan to address SAR operations for each island, understand the capacities that are available, and coordinate territorial and federal resources. The situation is made more complicated by the fact that each island is unique and service delivery not the same; organizational structure, quantity of trained personnel, standard operating policies/procedures and facilities for housing equipment and training also differ widely.

VIFS will work with USVI rescue squads to assess the current rescue squad organizational and response structures, identify best practices, and establish standards to enact a more responsive and efficient system. VITEMA will also work with VIFS and rescue squads to develop agreements and procedures for calling out and employing rescue squads, which will include a definition of the squads' formal roles and responsibilities. These procedures will include specific plans for disaster response, muster points, and coordination with other

agencies; they will be regularly reviewed and updated, with training events taking place at least twice per year.

Initiative 14

Assist St. John and St. Croix rescue groups with equipment needs

The St. John Search and Rescue squad is in need of support and equipment, including additional search and rescue training and specially trained personnel such as a public safety diver, staff to handle medical evacuations, an emergency medical technician, and a paramedic. The squad's boat needs to be upgraded to support personnel and equipment transport between Cruz Bay and Coral Bay. The squad also needs a general-purpose four-wheel-drive (4WD) vehicle and a 4WD pickup truck for cargo transportation. The squad's smaller gear needs include medical equipment and supplies, as well as extrication gear and airbags for lifting.

The St. Croix rescue group needs a review of all existing equipment and vehicles to assess their needs. Further, they need support with the repair of their training tower that was damaged in the hurricanes, which will allow them to continue to train the territory's first responders instead of sending them off island.

Funding for both groups would come via fundraisers organized by the groups themselves as well as money provided by VITEMA, with the specifics depending on eventual role that the groups would be expected to play in future emergency response.

IMPROVE EMERGENCY RESPONSE PLANNING

The territory's agencies mostly have emergency plans in place—however, many of them need to be updated and expanded. These initiatives will review these plans, update them when needed, develop pre-disaster checklists, and develop contingency plans in case Puerto Rico is also affected.

Initiative 15

Review and update government agencies' emergency plans

Many agencies have their own emergency operations plans, but they need to be updated and streamlined. Most agencies also face challenges in supporting sufficient staff trained to develop and maintain their plans. VITEMA will coordinate with the appropriate agencies and organizations to review and update plans, as well as create new plans to address gaps in service.

Initiative 16

Develop execution checklists for disaster response

The actions that each government agency needs to take before a major storm – reposition vehicles, inspect and fuel generators, account for staff – are entirely predictable and need to be included in a checklist that VITEMA can verify through

WebEOC. At present, however, only a few agencies have such checklists—and VITEMA has no way of easily tracking them. VITEMA will work with each agency and organization within the Government Response sector to develop execution checklists addressing essential tasks in support of disaster response operations. These will be included in annexes to the TEOP. VITEMA will also define the template for the checklist to ensure standardization and ease of integration into WebEOC.

Initiative 17

Annually review and test emergency management plans and procedures

In addition to completing the TEOP annexes, each first responder agency will review its emergency management and response plans every year. Agencies will schedule plans to be tested twice a year, with at least one of these events focused on cross-functional/interdepartmental level training activities, including the dispatcher and amateur radio organizations. Agencies will assess current gaps and report their findings to VITEMA, which will work with the agencies to fulfill identified needs.



Initiative 18

Review and improve the process for issuing curfew passes

In a hurricane, the Governor issues a curfew to make sure that citizens do not move around in the dark when it is not safe to do so. People who need to move around after the curfew to perform their duties are issued curfew passes in advance. The current process, however, needs to be reviewed to make sure that it is adequate and that it pays sufficient attention to the needs of response personnel in the private sector – which was an issue during the 2017 storms.

Initiative 19

Develop contingency plan if Puerto Rico is impacted simultaneously

A lot of the USVI's response plans assume, implicitly or explicitly, that Puerto Rico can be relied upon to participate in any response – including, for example, by serving as a logistics hub for the storage and transportation of supplies. Should a simultaneous event occur in the future as happened in September 2017, the USVI must be prepared to shoulder more of the support burden by itself. VITEMA will develop a way to reduce or eliminate dependence on Puerto Rico for response activities, including by stocking increased levels of materials in secure, conditioned facilities and developing alternative supply arrangements.

IMPROVE PRE-STORM PREPARATION

These initiatives will position vehicles and commodities before hurricane events in such a way as to be better prepared to face the eventual impacts.

Initiative 20

Secure and disperse vehicles

In the recent storms, many government vehicles were damaged and a few were destroyed. Several organizations reported problems with tire damage and lack of replacement tires and wheels in inventory pre-storm. VITEMA will work with all government agencies to establish protocols to evaluate all vehicles before a storm to ensure proper operation, full fuel tanks, and availability of spare tires and wheels. Vehicles should also be dispersed across various locations to ensure maximum potential for survivability.

Initiative 19

Pre-stage commodities across the territory

Emergency response tends to require the same type of commodities – water, food, tarps – and ample supplies of these need to be on hand and not out of date. VITEMA, through the EOCs, will pre-stage these commodities in multiple locations, maintain an inventory of them, and develop a resupply process to make sure that

the levels of these commodities remain adequate.

Initiative 21

Pre-stage equipment and supplies in St. John's Coral Bay

Without either a port or an airport, St. John is the most isolated of the three major islands; within St. John, the areas surrounding Coral Bay in the eastern part of the island are more isolated yet. These areas need to be able to support emergency response with local resources for at least a week until logistics and transportation can be restored following major storms. VITEMA will work with the relevant government agencies to pre-stage equipment, supplies, emergency commodities, and fuel in Coral Bay to support response operations by VIPD, VIFS, EMS, and rescue organizations for a minimum of seven days. VITEMA will also coordinate with relevant agencies to develop maritime options for transporting equipment, personnel, and supplies to Coral Bay.

DEVELOP PLANS FOR RESPONSE AREAS NOT CURRENTLY COVERED

Several areas of response do not have set plans in place; response efforts had to be improvised. These initiatives will develop plans for three particularly important areas: fueling, route

clearance, and bulk water distribution.

Initiative 22

Integrate Lime Tree Bay terminal into response process

Lime Tree Bay terminal (LBT) on St. Croix controls large amounts of stored fuel that proved critical during the response effort when St. Thomas was facing fuel shortages. LBT, however, is not integrated into the territory's response activities – it is, for example, not part of the response plans, it does not have a connection to WebEOC, and it does not take part in disaster drills as an active participant. VITEMA will work with LBT to integrate it in the TEOP, provide it with a connection to WebEOC, and incorporate it in future disaster drills as an active participant.

Initiative 23

Streamline and improve the fueling process for first responder vehicles

Current fueling of government vehicles depends on fuel coupons, which are not accepted at very many commercial gas stations. VITEMA will work with the Governor's Office to retire the fuel coupons and institute a fuel card process in which cards are assigned to individual vehicles. Fuel cards were already being used on St. Thomas as a trial program when the hurricanes occurred, and their use should be

adopted throughout the territory. Arranging fuel depots at key government locations using card access should also be considered.

Initiative 24

Develop route clearance team and procedures

After the 2017 hurricanes, one of the common concerns from all first responder agencies was the inability to get to citizens in need due to a lack of process for dealing with roads that the storms had made impassable. An ad hoc process was implemented to try and deal with this issue, but creating a team in advance with appropriate resources and with the key transportation routes prioritized before the disaster event will greatly assist first response efforts in future disasters. VITEMA will work with the appropriate agencies to identify emergency response routes and contingency plans (particularly for St. John). The agency will also lead the effort to create multi-agency route assessment teams on each island that can deploy quickly after a hurricane to evaluate routes and conduct initial route clearance; teams should include, at a minimum, representatives from the Department of Public Works (DPW), VIFS, VIPD, and WAPA. Teams will be strategically staged pre-landfall in order to deploy as soon as it is safe to do so, and be equipped to conduct initial route clearance operations and support for minor tire repairs.

Initiative 25

Develop a bulk water distribution plan

The territory currently does not have a bulk water distribution plan and, after the damage to the water system in the 2017 hurricanes, had to rely instead on limited distribution of bottled water by FEMA. VITEMA, in partnership with WAPA and the DPP, will develop a bulk water distribution plan and process for each island that includes both static and mobile distribution sites. Part of this initiative will include the procurement of an economical bulk water distribution system that can be quickly set up but easily stored when not needed.

ADDRESS FUNDING, CONTRACTING, AND PROCUREMENT ISSUES

Procurement and contracts were an issue during the hurricane response in that they often slowed down a process that was already difficult and complicated. These initiatives will aim to remove as many of these difficulties as possible.

Initiative 26

Add budget line to fund emergency activation of VING

In the USVI budget, there are no defined processes for allocating funds for an emergency activation of VING. The Governor's Office will work with the USVI legislature and VING to add a budget line item that funds the emergency activation of VING.

Initiative 27

Develop a standardized process for agencies to access cash

After the hurricanes, response agencies like VIDOH found it difficult to acquire goods like adult diapers or diabetic testing kits that were needed for the response effort as the local businesses were unable to accept credit cards due

to power and telecommunication outages. As a result, agency staff had to use personal funds. The Governor's Office, working with the Department of Finance, will develop a standardized process for responder agencies to access cash in emergency situations.

Initiative 28

Educate agencies on emergency procurement procedures

During response and recovery after the 2017 hurricanes, many agencies did not appear to know how to work the local, territorial, or regional procurement process before asking for assistance. Department of Property and Procurement (DPP) has an emergency procurement process in place, but multiple agencies were not aware of it. When it came to working with the federal government, territorial budget shortfalls led territorial agencies

to view FEMA as the primary source of funding and to assume that requested resources would be available immediately, when it often took weeks.

VITEMA will work with the Department of Property and Procurement (DPP) to develop an education process for first responder agencies on how the existing emergency procurement process is to be utilized in a disaster situation, with a particular focus on how to obtain items when there is no access to electronic procurement systems because of power or communication failures. To strengthen the process, DPP will solicit input from all departments and agencies (especially first responder organizations) to understand needs and develop an appropriate education program to meet those needs during and after emergencies.

Initiative 29

Establish pre-disaster emergency contracts

Some items and services that are needed in emergencies are predictable—water, food, batteries, healthcare—and contracts for those can be put in place in advance. DPP will work with agencies and potential vendors in the territory to develop such contracts, including for bulk water distribution as described above.



FEMA employee helps survivor register for disaster assistance
Source: Kenneth Wilsey/FEMA

HARDEN CRITICAL EMERGENCY RESPONSE ASSETS

As with every sector, some amount of asset hardening will be necessary for government response—especially for EOC and EMS facilities, many of which were severely damaged in the storms.

Initiative 30

Build a new EOC facility on St. Croix

The St. Croix building that was housing the St. Croix EOC was not built to do so and was damaged in the hurricanes. VITEMA will build a new facility that will support an EOC and 911 dispatching/ECC functions on St. Croix at the old Herman Hill site. The facility will be constructed to withstand Category 5 hurricanes and will include climate-controlled storage space for disaster response equipment and supplies. Dual critical infrastructure feeds for power and communications will be incorporated into the design as well.

Initiative 31

Repair and harden EOC facility on St. John

The St. John facility, just like the one on St. Croix, was damaged in the hurricanes. Unlike on St. Croix, where the leased EOC building is wholly inadequate to the task in size, location, and strength of construction, St. John

EOC is housed in a government-owned solid concrete building the only disadvantage of which is a very weak roof that can, however, be fixed. VITEMA will repair and harden the facility, including acquiring and renovating the building's second floor space to improve operations and support for the island. The agency will also incorporate redundant power and telecommunication feeds into the facility design.

Initiative 32

Build co-use facilities to support response operations

Many of the first responder agencies need similar facilities to support the storage of equipment, supplies, and vehicles, as well as provide a workspace and dormitory areas. Operating individual facilities for all of them would not be cost effective, so VITEMA will work with individual agencies to build strategically located co-use facilities on each island to support EMS, VIFS, VIPD, and rescue operations.

Initiative 33

Rebuild EMS facilities

Before the storms, EMS facilities were located on all three islands in annexes to the main buildings of Schneider Regional Medical Center, Juan Luis Hospital, and Charles Harwood Memorial Complex. All of the EMS facilities were condemned as a result of storm damage, and VIDOH is working with FEMA to construct temporary modular units for

EMS personnel on St. Thomas and St. Croix. The units will have space for sleeping quarters, training and radio rooms, and work space. Once these are set up, VIDOH will begin work on designing a new state of the art Health Department building that will include space for EMS as well. In the future, joint use facilities potentially shared with VIFS may become an important solution for more resilient facilities for EMS equipment and personnel.

Initiative 34

Procure, maintain, and regularly test emergency generators

Although WAPA is going to be investing major resources into strengthening the electricity grid, some outages in future storms are still likely – and when those outages occur, emergency generators need to be filled with fuel and ready to go. VITEMA will work with government agencies to identify critical facilities in need of backup generators and will develop a procurement and installation plan. The agency will also help develop fueling plans and ongoing maintenance programs, with priority given to obtaining the services of companies that specialize in the maintenance of this kind of equipment.

10-CODES IN EMERGENCY COMMUNICATIONS

10-codes are verbal shortcuts that are often used in public safety voice communications. These codes started in 1937 to allow “brevity” and standardization of message traffic, but – ironically – there is no standardized list of them, so they vary in meaning from one agency to another (so “10-55” might mean “intoxicated driver” in one location and something completely different in another location). The Association of Public Safety Communications Officials (APCO), which sets the industry standards, has recommended eliminating these codes in favor of plain language. However, they are still used in the Territory, which causes significant communications issues when other agencies (federal or mainland mutual aid agencies) come to work with USVI first responders, as the outside agencies are entirely unfamiliar with the Territory’s specific codes. Since 2006, FEMA has required the use of plain language as part of its Incident Command System (ICS) for multi-agency events, and federal preparedness grant funding is contingent on using plain language in any incidents requiring aid from other agencies or jurisdictions.

ENHANCE EMERGENCY COMMUNICATIONS INFRASTRUCTURE, ASSETS, AND PROCEDURES

Communications were a major issue in the 2017 storms, with first responders often being unable to communicate. These initiatives will strengthen and expand communication options, as well as update protocols for using them.

Initiative 35

Strengthen communication links of 911 call centers

The call centers in the territory are not connected to the local phone provider, Viya, in a resilient manner. The St. Thomas ECC has only one communication connection to Viya; the connection is buried and performed well during the recent hurricanes, but it is only a matter of time before the single connection is damaged or cut, impacting calls to the 911 call center. The St. Croix ECC only has a single aerial connection to the Viya network; that connection was destroyed in the storms. On St. Thomas, VITEMA will work with Viya to plan and construct a second route from the ECC and ensure it is routed to the central switching center via a diverse buried route. On St. Croix, VITEMA will work with Viya to immediately bury the aerial connection and install a second buried diverse route to Viya’s switching center.

Initiative 36

Improve government’s access to satellite phones

In the aftermath of the 2017 hurricanes, satellite phones were often the only somewhat reliable means of communication for first responders—but not enough of them were available. VITEMA will coordinate with first responder agencies to ensure that each agency has several portable satellite phones that are activated, tested and ready to use. Further, VITEMA will work to upgrade the satellite phones in the EOCs to stationary versions that allow use from inside the facilities.

Initiative 37

Integrate amateur radio networks into response planning

With most regular communications down and satellite phones scarce, amateur radio networks provided a vital communications channel for the Territory’s first responders. VITEMA and BIT, together with first responder agencies, will work with the Territory’s Amateur Radio Clubs (ARCs) to assess their networks for operational readiness. This is currently routinely performed within the amateur radio system; VITEMA and BIT will develop an interagency process to test the system as a whole, so capabilities and processes are clear. A new amateur radio repeater network is already being installed.

Initiative 38

Switch to plain language for emergency communications

The territory's first responders currently use so-called 10-codes to communicate through the LMR system (see sidebar: [10-codes in emergency communications](#)).

These codes, while familiar to users in the Territory, are completely unfamiliar to any first responders who arrive from elsewhere, creating confusion and making it more difficult for different responders to work together. VITEMA will work with VIPD, VIFS, EMS, and rescue groups to switch over to plain language in emergency communications.

if the VIPD has a special incident (SWAT event, hostages, homicide etc.), the department would move their communications to an assigned tactical channel. VIFS may move all communications to a "Fire Ground" channel for all working fires, and VIDOH EMS may use the "major event" channel in a mass casualty incident. In a large-scale single event, all communications for all agencies could be directed to one or more major event channels for a more unified communications effort.

Initiative 39

Review and enforce rules for using first responder communication channels

The radio system that first responders use has multiple channels, each to be used for a different purpose. However, the system's users generally ignore the channel designations and only use the main channel instead, which can create a lot of confusion during on important event. VITEMA will work with VIPD, VIFS, VIDOH EMS, and search and rescue squads to develop the rules for how the radio channels will be used. For example, the dispatch channel would only be used for dispatch and for routine communications by the VIPD, and

FUNDING

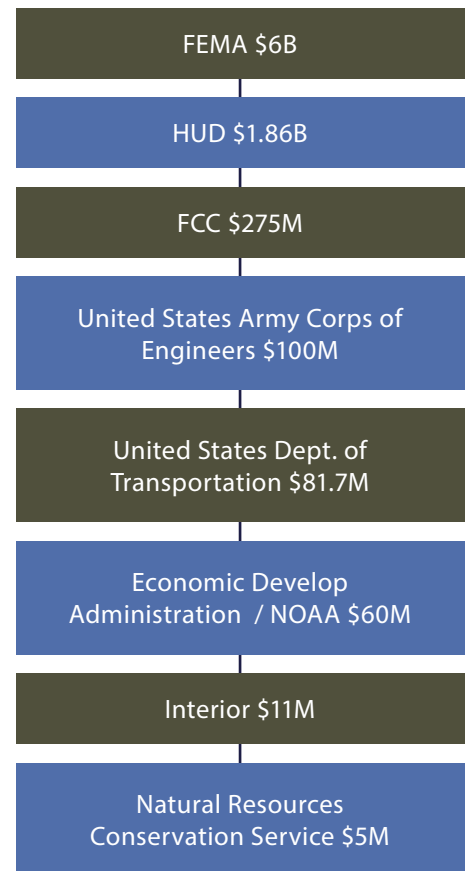
2017 was the costliest year to date on record for disasters in the United States. As of May 2018, damages to housing, infrastructure and the economy after Hurricanes Irma and Maria have been estimated at \$10.76 billion in the USVI. In response, the US Congress made a series of appropriations in 2017 and 2018 to help fund disaster recovery in the most severely impacted states and territories.

In the wake of the storms, the President announced a Major Disaster Declaration for Irma (DR-4335) and another for Maria (DR-4340) to make federal disaster assistance available to the territory. In response, Congress approved the Supplemental Appropriations for Disaster Relief U.S. Virgin Islands' CDBG-DR Action Plan Requirements, 2017 (Pub. L. 115-56) on September 8, 2017, which made available \$7.39 billion in Community Development Block Grant Disaster Recovery (CDBG-DR) funds to assist in long-term recovery from 2017 disasters. On February 9, 2018, Congress approved a bill appropriating an additional \$28 billion CDBG-DR funds, of which \$11 billion was set aside to address the remaining unmet needs,

including those of the U.S. Virgin Islands and Puerto Rico from Hurricane Maria. The balance of funds within the Bipartisan Budget Act are dedicated to other federal agencies responsible for delivering disaster response and recovery efforts. Funds are allocated to these agencies and then distributed to affected communities either through direct allocation or competitive grants.

In addition to federal funding, resources have been made available from other private and philanthropic sources targeted to specific recovery goals.

As of June 2018, the total USVI hurricane recovery funding is \$8.5 billion (actual plus expected). The breakdown can be seen in the chart that follows. Given the complexity of the funding landscape, the Task Force recommendations contemplate a smart and leveraged expenditure of these federal recovery funds, and ongoing partnerships with private property owners, investors and businesses, along with a realignment of existing Territorial projects and funding streams to support a full and resilient recovery. While we await



additional federal government decisions and guidance about their own expenditures (particularly FEMA) and the use of the bulk of the long-term recovery dollars, this report provides a current snapshot of how that funding is broken out.

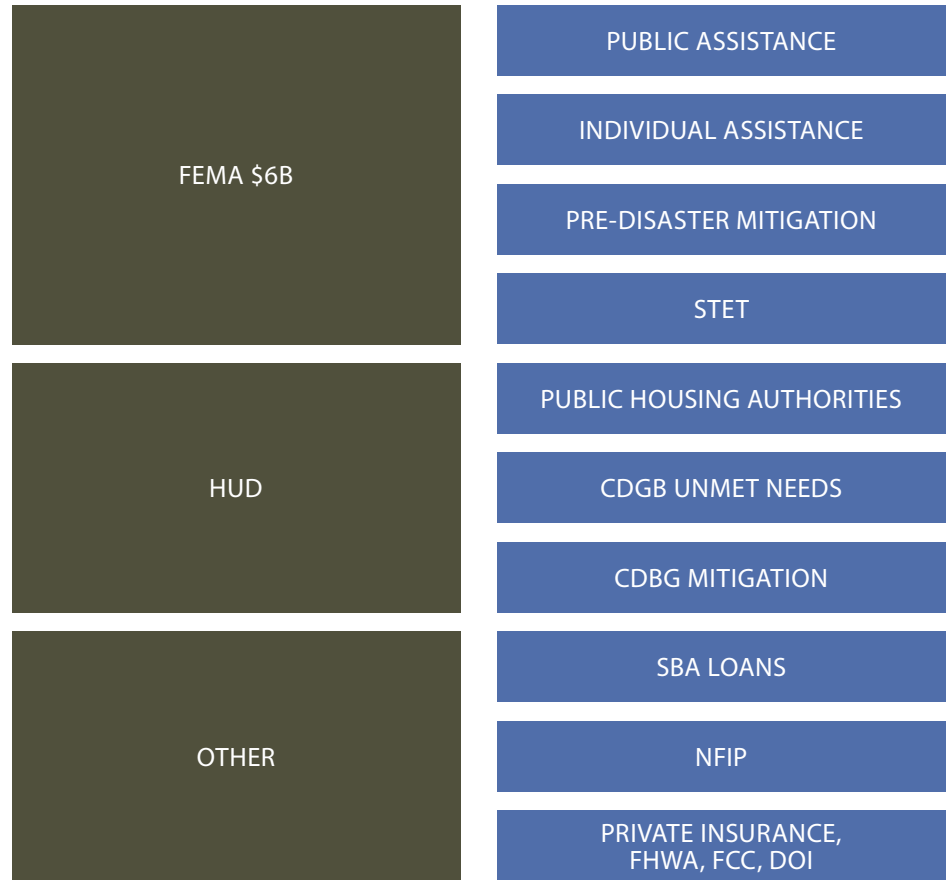
HOW FUNDING WORKS

Resources for emergency response and short and long-term recovery comes through two main channels; STET the Disaster Relief Fund (DRF) and Congressional appropriations. After hurricane events such as the ones that impacted the Territory in 2017, the federal Disaster Relief Fund (DRF), funds FEMA's operations for support of: (1) the repair and restoration of qualifying disaster-damaged public infrastructure; (2) hazard mitigation initiatives; and (3) financial assistance to eligible disaster survivors.

Congressional appropriations dedicate funds to the DRF, as well as to federal agencies to support emergency response and recovery efforts. Resources appropriated by Congress to federal agencies flow down to corresponding state and territorial counterparts through two main methods – dedicated block grants or competitive grant processes.

While there are multiple sources of funding made available through different channels in the aftermath of a disaster, there are a few key sources that provide the majority of the funding resources. Specifically, these key sources would be: (1) the Federal Emergency Management Agency (FEMA); (2) the U.S. Department of Housing and Urban Development (HUD); and (3) other important sources.

Types of Funding Resources



FEMA

FEMA is the federal agency responsible for emergency response and provision of immediate and long-term recovery resources for individuals and governments. FEMA funding typically flows through three main channels: (1) Individual Assistance, which provides funding to individuals and households so that post-disaster housing and other necessities of life can be obtained by survivors; (2) Public Assistance, which provides grant funding for the repair and/or replacement of damaged public (and certain private non-profit) infrastructure that local taxpayers would otherwise be responsible

for funding; and (3) Hazard Mitigation Assistance, which provides funding to improve local resiliency in both the private and public sectors. Each of these will be discussed below in the context of recent happenings in the U.S. Virgin Islands.

FEMA Public Assistance

As indicated above, FEMA's Public Assistance Program (PA) provides grant funding to state, local and tribal governments, and certain private non-profit entities, to allow for the repair and/or replacement of damaged infrastructure. Eligible types of work for PA funding include Emergency Work (debris

operations and emergency protective measures), and Permanent Work (permanent repairs and/or replacements of damaged public facilities).

As of June 2018, more than \$1.56 billion has been assessed or obligated to the Territory under FEMA's PA Program, with approximately \$965 million of that total being earmarked for Emergency Work, and \$591.5 million designated for Permanent Work.

Debris removal operations as a result of the two hurricanes resulted in approximately \$135.5M in costs to be paid for through FEMA's PA Program, including over 270 vessels in marine debris, over 1,300 transformers (hazardous waste) that were removed and scrapped, along with over 2,800 damaged power poles and almost 2,000,000 feet of damaged conductor wire, over 7,000 destroyed refrigerators, air conditioning units and more.

Emergency Protective Measures are part of FEMA PA. They are generally thought of as those measures necessary before, during and after an event, to safeguard public health, safety and to minimize property damage. To date, approximately \$490.1 million in Emergency Protective Measures have been paid for through FEMA's PA Program.

A more recent innovation in Emergency Protective Measures under the PA Program is a program known as the Sheltering and Temporary Essential Power (STEP) Program, which seeks to make emergency repairs to survivors' homes, so that the pressure on public shelters can be reduced. Additionally, studies have shown that STEP aids in

shortening the survivors' reliance on public and social services, as when survivors are able to remain in their property, then the time to complete necessary repairs on the home (of a more permanent nature) is greatly reduced. To date, approximately \$339.5 million has been allocated for the STEP program in the Territory. As of June 2018, over 10,000 applications were received for STEP, about 7000 initial site inspections were conducted, and about 2200 constructions were completed.

On the other hand, "Permanent Work" applies to repairs and/or replacement of facilities of a more permanent nature (defined as providing more than five years of improved life for the facility). There are several different categories of permanent work that FEMA will fund, with those categories being: STET roads and bridges, water control facilities, public buildings and contents, public utilities, parks, recreational and other facilities. To date, FEMA has allotted over \$591.4 million for permanent work throughout the Territory, although such permanent work is ongoing, and will likely continue for years to come.

Cost Share

To foster state and local engagement and responsibility in the recovery process, the funding of FEMA PA is split into a federal share and a non-federal share, with the non-federal share typically split between the state and local governments as provided for by state law. However, in the Territory of the U.S. Virgin Islands, there are effectively no "local government"

entities to be dealt with, so any non-federal share would need to be paid for by the Territory itself.

Typically, the federal/non-federal cost shares are arranged in a 75 percent (federal) / 25 percent (non-federal) arrangement, but the federal share may be raised in certain cases by the President, and in certain cases by FEMA, acting under the Insular Areas Act. In response to Hurricanes Irma and Maria, the cost share is as follows:

- Debris Operations – 100 percent federal / 0 percent non-federal,
- Emergency Protective Measures (non-STEP) – 100 percent federal / 0 percent non-federal for work completed through May 2018; 90 percent federal / 10 percent non-federal for work completed thereafter,
- Emergency Protective Measures (STEP) – 100 percent federal / 0 percent non-federal through the current end-date of the program (August 15, 2018),
- Permanent Work – 90 percent federal / 10 percent non-federal.

Note that most federal disaster recovery programs do contain a cost share, which may or may not be different than the cost shares utilized in the FEMA programs discussed in this section. Based on current projections, the projected non-federal share for FEMA programs alone is anticipated to total at least \$500 million by the time that all eligible costs are funded. CDBG-DR funding (to be discussed later) is one of the only sources of federal funding that can be used by a state or locality to pay for non-federal share.

FEMA Individual Assistance

The FEMA Individual Assistance Program (IA) provides financial assistance directly to disaster survivors for the necessary and serious needs that cannot be met through insurance or low-interest Small Business Administration (SBA) disaster loans. Assistance to private individuals and households is provided through the IA Program, and was capped at \$33,300 per household for Irma and Maria. In total, 20,004 applications for IA assistance were approved by FEMA across the Territory, with FEMA providing over \$78.2 million directly to these survivors through IA Individuals and Households Program funding.

FEMA Hazard Mitigation Assistance

FEMA funds mitigation measures to prevent or lessen the effects of a future disaster through the Hazard Mitigation Assistance (HMA) Program. In the Stafford Act, Hazard Mitigation is outlined through Section 404 Mitigation and Section 406 Mitigation, which is a part of the Public Assistance Program. Section 404 Mitigation funding is allotted after a disaster is declared, with the amount based as a percentage of funding allotted under the PA Program, and this funding may be utilized on any cost effective project proposed within the area declared by the President to be eligible for such projects. Section 406 Mitigation funding is only available for cost effective mitigation on disaster-damaged facilities. While costs for Section 406 Mitigation are “wrapped

up” into PA funding, funding for Section 404 Mitigation is designated separately by the following program.

Hazard Mitigation Grant Program (HMGP)

The Hazard Mitigation Grant Program, part of Hazard Mitigation Assistance, assists in implementing long-term hazard mitigation planning and projects following a Presidential major disaster declaration. The HMGP program allows states and territories to receive locally generated mitigation project applications, and fund those proposed projects on a competitive basis. As noted above, the amount of funding that a State or territory will receive as a result of HMGP is set as a percentage of the eligible PA funding (15% to states / territories with a “standard” FEMA approved hazard mitigation plan, and 20% to states / territories with an “enhanced” FEMA approved hazard mitigation plan. Funding amounts for HMGP are “locked in” at the 30-day, 6 month and 1-year date after the disaster.

As a result of hurricanes Irma and Maria, the current amount available for HMGP in the Territory is “locked in” at \$455.9M. Projects are currently still being evaluated for the Territory for funding under this program. Note that the President has waived any non-federal cost share for HMGP in the Territory as a result of hurricanes Irma and Maria.

FEMA Pre-disaster Mitigation Program (PDM):

The FEMA Pre-disaster Mitigation Program (PDM) is designed to assist states and territories in implementing a sustained pre-disaster natural hazard mitigation program. The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on federal funding in the event of future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disasters strike. PDM grants are funded annually by Congressional appropriations and are awarded on a nationally competitive basis.

FEMA has approved, though not yet obligated, approximately \$6.2 million in PDM grants for four projects in the U.S. Virgin Islands for FY 2017. The four projects are: (1) the Territorial Hazard Mitigation Plan Update; (2) Fire Station Retrofits; (3) King Street Frederiksted Underground Electric Distribution; and (4) Queen Street Christiansted Underground Electric Distribution.

FEMA Flood Mitigation Assistance (FMA)

The FEMA Flood Mitigation Assistance Program (FMA) provides funds for planning and implementing projects to reduce or eliminate the risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP). The

FMA program makes awards on an annual basis. While the U.S. Virgin Islands did not receive funding under the FMA program in the 2017-18 funding period, that does not mean that the Territory will not receive such funding in future application cycles.

Types of eligible activities that may be undertaken under each of the three types of Hazard Mitigation programs offered by FEMA:

FMA Eligible Activities			
Mitigation Project	FMGP	PDM	FMA
Property Acquisition and Structure Demolition or Relocation	✓	✓	✓
Structure Elevation			✓
Mitigation Reconstruction	✓	✓	✓
Dry Flood proofing of Historic Residential Structures	✓	✓	✓
Dry Flood proofing of Non-residential Structures	✓	✓	✓
Localized Flood Reduction Projects	✓	✓	✓
Structural Retrofitting of Existing Buildings and Facilities	✓	✓	
Non-structural Retrofitting of Existing Buildings and Facilities	✓	✓	✓
Safe Room Construction	✓	✓	
Wind Retrofits	✓	✓	
Infrastructure Retrofit	✓	✓	
Soil Stabilization	✓	✓	
Wildfire Mitigation	✓	✓	
Post-disaster Code Enforcement	✓		
Generators	✓	✓	
Advance Assistance	✓		
5 percent Initiatives	✓		
Mitigation Planning	✓	✓	✓
Management Costs	✓	✓	✓

https://www.fema.gov/media-library-data/1500492450991_a184700543173395f0f707a3874c5d1b/HazardMitigationv2.508

Federal Disaster Relief Program	Total Project Amount	Total Amount Obligated (Federal Share)	Federal Share of Total Project Amount		Nonfederal Share Estimate of Total Project Amount	
			%	\$	%	\$
FEMA PA Category A (Debris Removal) [Emergency Work]*	\$135,514,558	\$53,238,012	100%	\$135,514,558	0%	\$0
FEMA PA Category B (STEP)[Emergency Work]*	\$339,549,349	\$186,650,000	100%	\$339,549,349	0%	\$0
FEMA PA Category B (except STEP) [Emergency Work]*	\$490,076,857	\$428,298,285	100%	\$490,076,857	0%	\$0
FEMA PA Categories C-G [Permanent Work]*	\$591,476,120	\$342,409,740	90%	\$532,328,508	10%	\$59,147,612
FEMA HMGP **	\$455,920,388	\$12,212,402	100%	\$455,920,388	0%	\$0
FEMA PDM	\$8,222,164	\$0	75%	\$6,166,623	25%	\$2,055,541
FEMA FMA	\$0	\$0	100%	\$0	0%	\$0
TOTAL	\$2,020,759,436	\$1,022,808,439		\$1,959,556,283		\$61,203,153

* Federal Cost Share for Non-STEP Category B Work was 100 percent through May 15; 90 percent thereafter

** Includes six-month lock-in amounts of \$33,324,269.32 for Hurricane Irma and \$422,596,118.68 for Hurricane Maria.

Note that PA data (all categories) shown as of June 8, 2018.

Summary Chart of FEMA Disaster Recovery Funding Sources in the U.S. Virgin Islands

Please see the chart that follows summarizing funding amounts currently anticipated and obligated through FEMA programs as of June 2018. Note that the amounts shown are simply that of a snapshot in time; the amounts in all categories are anticipated to rise significantly as the recovery continues.

HUD CDBG-DR FUNDING

Community Development Block Grant – Disaster Relief (CDBG-DR) funding is provided by HUD, with the design that funds are to be utilized for unmet recovery needs where projects are intended to be beneficial to low- and moderate-income

housing needs of the impacted jurisdiction. In the sequence of federal funding sources, CDBG-DR resources are to be used as the funding of last resort. This means that communities should maximize the recovery from other federal funding sources, such as FEMA and SBA funding, before dedicating CDBG-DR resources to their “unmet needs.” HUD defines unmet needs as the financial resources necessary to recover from a disaster that are not likely to be addressed by other public or private sources of funds, including, but not limited to FEMA Individual Assistance, FEMA Public Assistance, FHWA Emergency Relief Program, SBA Disaster Loans and private insurance.

HUD’s funding is generally considered to be more flexible than other sources of federal funding. As an example, CDBG-DR funds can pay for things FEMA will not cover. CDBG-DR is one of few sources of federal funding that can be used as the local match for FEMA PA, HMGP and other federal recovery funding. However, like

other funding sources, CDBG-DR follows a set of rules and regulations on programmatic eligibility. In regard to project eligibility, all CDBG-DR activities must: (1) have a tie to the disaster; (2) meet a HUD Eligible Activity; and (3) meet a HUD National Objective (typically related to housing needs). Along these lines, it is important to note that at least 70 percent of CDBG-DR funds must broadly benefit low- and moderate-income persons and communities.

In regard to the prospective use of CDBG-DR funding in the U.S. Virgin Islands, the CDBG-DR Action Plan outlining the Territory’s proposal for using the funding was submitted for public comment on May 3, 2018, and was based on data locked down on April 27, 2018. At that time, estimated damage for the U.S. Virgin Islands was \$10.76 billion, and \$3.17 billion in other funding sources had been obligated, leaving a total unmet need of \$7.58 billion. Of that, the unmet needs addressed in tranches 1, 2 and 3 of CDBG-DR funding are:

Tranche 1:

- Housing: \$72,000,000
- Infrastructure: \$125,549,800
- Economic Revitalization: \$33,000,000
- Administration and Planning: \$12,134,200

Tranche 2:

- Additional Unmet Needs: \$846,870,000

Tranche 3:

- Mitigation: \$774,188,000

The following table outlines the Program Allocations from the proposed first tranche of CDBG-DR funding as of June 2018:

Program Allocations from Tranche 1 CDBG-DR Funds.

Program		Funds Allocated: Tranche 1	Projected Low- and Moderate-Income Benefit	
			\$	%
Housing	Rehabilitation, Reconstruction, and New Construction of Owner-Occupied and Rental Housing for Disaster-Impacted Households	\$ 57,000,000	\$ 47,000,000	82%
	Owner-Occupied Rehabilitation and Reconstruction	\$ 25,000,000	\$ 15,000,000	60%
	First-Time Homebuyer New Construction			
	Rental Rehabilitation and Reconstruction			
	Public and Affordable Housing New Development	\$ 32,000,000	\$ 32,000,000	100%
	Supportive Housing and Sheltering Programs	\$ 15,000,000	\$ 15,000,000	100%
Infrastructure	Local Match for Disaster Relief Programs	\$ 50,549,800	\$ 37,685,896	75%
	Match for Public Housing and other STET-assisted housing	\$ 30,000,000	\$ 27,000,000	90%
	Match for Infrastructure	\$ 20,549,800	\$ 10,685,896	52%
	Infrastructure Repair and Resilience	\$ 30,000,000	\$ 15,600,000	52%
	Electrical Power Systems Enhancement and Improvement	\$ 45,000,000	\$ 36,000,000	80%
Economic Revitalization	Ports and Airports Enhancement	\$ 23,000,000	\$ 6,900,000	30%
	Tourism Industry Support Program	\$ 5,000,000	\$ 1,500,000	30%
	Workforce Development	\$ 5,000,000	\$ 5,000,000	100%
	Neighborhood Revitalization	\$ -	\$ -	
	Small Business and Entrepreneurship Technical Assistance	\$ -	\$ -	
	Planning	\$ -	\$ -	
	Administration*	\$ 12,134,200		N/A
	Total Programs	\$ 230,549,800	\$ 164,685,896	71.4%
	TOTAL	\$242,684,000		

The CDBG-DR Action Plan was approved by HUD in early July 2018. After approval the Territory can access program funds.

Other funding sources

In addition to the federal funding sources discussed above, there are additional funding sources (federal and non-federal) that may be drawn upon in order to continue the Territory's recovery.

Small Business Administration (SBA) Loans

The Small Business Administration (SBA) provides low-interest disaster loans to businesses of all sizes, nonprofit organizations, homeowners, and renters, and the program can be invoked even if a FEMA PA or IA declaration is not granted. SBA disaster loans can be used to repair or replace items damaged or destroyed in a disaster, including residential property, personal property, machinery and equipment, and inventory and business assets. Homeowners may apply for up to \$200,000 to replace or repair their primary residences, and both renters and homeowners may borrow up to \$40,000 to replace or repair personal property, such as clothing, furniture, cars and appliances. As of June 2018, total SBA dollar approved for Irma and Maria was \$513,303,700.

The National Flood Insurance program (NFIP)

The National Flood Insurance Program makes flood insurance affordable to those living in designated flood zones. Typically, NFIP coverage is limited to \$250,000 per insured property.

Private Insurance

The primary source of recovery funding for homeowners and businesses is intended to be private market insurance. In fact, many of the federal funding sources that provide disaster recovery assistance carry a requirement that when federal funds are received, the recipient is then required to obtain at least that much coverage (against the same type of peril) of private market insurance. As such, the hope is that properties and recipients will eventually be weaned off of the federal recovery roll, and onto the roll of those covered by private market insurance.

Federal Highway Administration Emergency Relief (FHWA)

The Federal Highway Administration (FHWA) also offers several funding programs, including an Emergency Relief program (FHWA-ER). FHWA-ER is for the repair or reconstruction of federal aid highways and roads on federal lands that have suffered serious damage as a result of: (1) natural disasters or

(2) catastrophic failures from an external cause. FHWA-ER funds have the following federal share requirements for permanent work: 90 percent for interstates and 80 percent for all other federal-aid highways. Since the U.S. Virgin Islands has no interstates, the federal share for permanent work is expected to be 80 percent. For costs incurred in the first 180 days after the disaster, the federal share for FHWA-ER is normally 100 percent. Therefore, the FHWA-ER "quick release" funds made available in November 2017 and January 2018 were not subject to the nonfederal cost share requirement. As of March 21, 2018, projects that may be FHWA-ER eligible have been identified in the amount of \$32 million, and \$8.4 million in funds have been obligated at 100 percent federal cost share.

Federal Communications Commission (FCC)

On March 6, 2018, the Federal Communications Commission proposed providing funding to the U.S. Virgin Islands' telecommunications providers, for repair and hardening of telecommunications infrastructure. As of April 27, 2018, the FCC had not yet obligated or disbursed any funds, nor had the FCC given any further information on expected timing or requirements for the use of funding for the U.S. Virgin Islands.

U.S. Department of the Interior (DOI)

The U.S. Department of the Interior's Office of Insular Affairs (OIA) has indicated that it will provide the U.S. Virgin Islands with hurricane recovery funds of between \$4 million and \$6 million. On March 13, 2018, the DOI-OIA announced that \$2.8 million of these funds would be dedicated to structural repairs to public schools, road rehabilitation on St. Croix, and upgrades for meter-reading technology for the Virgin Islands Water and Power Authority (WAPA). These funds can also be used to fund the local match for hazard mitigation grants under FEMA HMGP.

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IMPLEMENTATION AND MONITORING

Sector	Big Group	Strategy name	Agency responsible
Private Telecom	Harden physical infrastructure	Work with tower operators to upgrade tower design standards	Governor's Office; PSC, private tower operators
Private Telecom	Harden physical infrastructure	Work with WAPA to strengthen or bury power cables serving communications infrastructure	Governor's Office ; WAPA
Private Telecom	Harden physical infrastructure	Work with WAPA and telecom operators to evaluate potential for micro grids for most critical infrastructure	Governor's Office ;WAPA; telecommunications companies (AT&T, Sprint, and VIYA)
Private Telecom	Harden physical infrastructure	Work with aerial cable owners to bury cables where possible	Governor's Office; aerial cable owners
Private Telecom	Improve preparedness for power outages	Schedule and ensure proper generator maintenance	Governor's Office; PSC; operators
Private Telecom	Improve preparedness for power outages	Stockpile spare parts for essential equipment and resolve servicing issues	Governor's Office; government and private sector entities
Private Telecom	Improve preparedness for power outages	Increase on-Island generator inventory	Governor's Office; VITEMA; private telecommunications companies; public critical infrastructure providers
Private Telecom	Improve preparedness for power outages	Set standards for pre-emergency communications site preparation	The U.S. Virgin Islands Bureau of Information Technology (BIT)
Private Telecom	Improve preparedness for power outages	Prepare and stage sufficient fuel	USVI Governor's Office; private companies
Private Telecom	Update legislative and regulatory framework to support resilience	Work with federal government to advocate the possibility of providing emergency assistance to private telecom carriers	USVI Governor's Office will work with its partners in the Federal Government

Private Telecom	Update legislative and regulatory framework to support resilience	Work with PSC to review and enforce part of Virgin Islands Code giving it authority over telecommunications services	USVI Governor's Office; Legislature
Private Telecom	Update legislative and regulatory framework to support resilience	Develop mechanism for deferring customs and excise tax in emergencies	USVI Governor's Office; BIR
Private Telecom	Update legislative and regulatory framework to support resilience	Issue curfew passes for movement of essential personnel	USVI Governor's Office
Private Telecom	Update legislative and regulatory framework to support resilience	Fund and implement "Call Before You Dig"	USVI Governor's Office; Legislature
Public Telecom	Reinforce existing systems	Bury viNGN's aerial cables	viNGN
Public Telecom	Reinforce existing systems	Work with WAPA to bury the power cables that feed viNGN fiber access points (FAPs)	viNGN; WAPA
Public Telecom	Reinforce existing systems	Protect public telecom infrastructure against rising seas and storm surge	viNGN; BIT
Public Telecom	Reinforce existing systems	Improve network and facility resiliency for WTJX public broadcasting	WTJX
Public Telecom	Change system design and operations	Design and build a new public safety radio system	BIT; FEMA; VITEMA
Public Telecom	Change system design and operations	Introduce cloud-based systems for data storage	BIT
Public Telecom	Change system design and operations	Switch the government's phone systems to VoIP on buried fiber	BIT; viNGN
Public Telecom	Change system design and operations	Consolidate government's IT operations	BIT; Gov Office
Public Telecom	Improve emergency preparedness and response	Procure satellite phones for all government agencies	VITEMA; BIT
Public Telecom	Improve emergency preparedness and response	Work with viNGN to deploy additional public Wi-Fi hotspots	viNGN; FEMA
Public Telecom	Improve emergency preparedness and response	Ensure power generators can operate for long periods of time	BIT, viNGN, and WTJX
Vulnerable Categories	Rebuild and strengthen client service and program support buildings	Rebuild, strengthen, and expand Herbert Grigg Home for the Elderly	DHS
Vulnerable Categories	Rebuild and strengthen client service and program support buildings	Rebuild, strengthen, and expand Queen Louise Home for the Elderly	DHS
Vulnerable Categories	Rebuild and strengthen client service and program support buildings	Rebuild and strengthen Youth Rehabilitation Center	DHS
Vulnerable Categories	Rebuild and strengthen client service and program support buildings	Rebuild and strengthen Commissioner Office and office facilities at Mars Hill	DHS
Vulnerable Categories	Expand capacity and upgrade program delivery to serve underserved segments	Investigate the possibility of creating a new senior center on the West End of St. Croix	DHS
Vulnerable Categories	Expand capacity and upgrade program delivery to serve underserved segments	Expand child services capacity	DHS

Vulnerable Categories	Rebuild and strengthen connectivity, power supply, and transportation	Strengthen connectivity and power backup options in support facilities	DHS; viNGN; Viya
Vulnerable Categories	Rebuild and strengthen connectivity, power supply, and transportation	Secure additional vehicles and create transportation redundancies	DHS
Vulnerable Categories	Improve emergency planning and preparedness	Develop emergency plans for each program	DHS
Vulnerable Categories	Improve emergency planning and preparedness	Expand special needs shelter capacity	DHS
Vulnerable Categories	Improve emergency planning and preparedness	Magnify community communication through public relations	DHS
Vulnerable Categories	Improve emergency planning and preparedness	Include nonprofits in the emergency planning process	DHS
Philanthropy	N/A	Appoint a Non-Profit Recovery Liaison	Governor's office
Philanthropy	N/A	Develop a USVI Community Emergency Planning	Local community based orgs; VITEMA
Philanthropy	N/A	Develop Continuity of Operations Plans (COOP) for Community-Based Organizations	VITEMA
Philanthropy	N/A	Develop Update and Strengthen Volunteer Management and Donations Management plan	VITEMA; FEMA; VOAD; LTRG
Philanthropy	N/A	Establish a USVI Recovery website	Governor's office
Philanthropy	N/A	Launch a USVI Recovery Funders Forum	Local charities
Housing	Increase Resiliency in Housing	Develop sector-hardening programs to reduce volume of vulnerable properties through buyouts or demolition	VI Legislature
Housing	Increase Resiliency in Housing	Create and implement accurate data collection methods on structure status	VIHA; DPNR; VITEMA
Housing	Increase Resiliency in Housing	Work with DPNR to improve construction standards and enforcement to Category 5 standard	DPNR
Housing	Increase Resiliency in Housing	Work with VITEMA to develop plans for evacuation and sheltering vulnerable properties	The Governor's office; VITEMA; DPNR
Housing	Increase Resiliency in Housing	Work with VIHA and VIHFA to build and/or designate a sufficient supply of temporary housing	VIHA; VIHFA; Governor's Office; DPNR
Housing	Increase Resiliency in Housing	Stabilize structures and make temporary repairs within specified timeframe	The Governor's office; FEMA; local government agencies; VIHA; VIHFA; DPNR, and private contractors
Housing	Increase Resiliency in Housing	Work with federal and local government agencies to expedite funding	The Governor's Office; federal government
Housing	Increase Resiliency in Housing	Work with DPNR to protect housing in coastal and waterfront areas	VIHA; DPNR

Government Response	Improve interagency response structures and procedures	Establish a territory-level EOC	VITEMA will work with USVI agencies
Government Response	Improve interagency response structures and procedures	Codify emergency command structure and decision-making authority	VITEMA will work with territorial agencies
Government Response	Improve interagency response structures and procedures	Train responders in management tools	VITEMA will work with the agencies represented in the EOCs
Government Response	Improve interagency response structures and procedures	Train agencies to improve EOC integration	VITEMA, EOC agency reps
Government Response	Improve interagency response structures and procedures	Train agencies to improve knowledge of relief funding	VITEMA
Government Response	Improve interagency response structures and procedures	Review and adhere to information sharing protocols	VITEMA
Government Response	Improve interagency response structures and procedures	Work with FEMA to get VITEMA access to Resource Request Form process	VITEMA will work with FEMA
Government Response	Enhance preparedness of existing emergency responders	Launch unified recruitment campaign for first responders	VITEMA will work with all the different first responder agencies
Government Response	Enhance preparedness of existing emergency responders	Strengthen VIPD's ability to evaluate disaster situations	VITEMA will work with VIPD
Government Response	Enhance preparedness of existing emergency responders	Use VIFS facilities and staff for EMS activities	VIFS and VIDOHS/EMS, Governor's office
Government Response	Enhance preparedness of existing emergency responders	Strengthen EMS staffing and equipment	VIDOHS/EMS and rescue squads
Government Response	Enhance preparedness of existing emergency responders	Develop protocols for sending the right response resources for specific incident types	VITEMA will work with first responder agencies
Government Response	Enhance preparedness of existing emergency responders	Work with rescue squads to develop a territorial search and rescue plan	VIFS will work with USVI rescue squads, VIFS
Government Response	Enhance preparedness of existing emergency responders	Assist St. John and St. Croix rescue groups with equipment needs	St. John Search and Rescue, The St. Croix rescue group, VITEMA
Government Response	Improve emergency response planning	Review and update government agencies' emergency plans	VITEMA
Government Response	Improve emergency response planning	Develop execution checklists for disaster response	VITEMA and each agency and organization within the Government Response sector
Government Response	Improve emergency response planning	Annually review and test emergency management plans and procedures	Agencies, VITEMA
Government Response	Improve emergency response planning	Develop contingency plan if Puerto Rico is impacted simultaneously	VITEMA
Government Response	Improve pre-storm preparation	Secure and disperse vehicles	VITEMA will work with all government agencies
Government Response	Improve pre-storm preparation	Pre-stage commodities across the territory	VITEMA
Government Response	Improve pre-storm preparation	Pre-stage equipment and supplies in St. John's Coral Bay	VITEMA will work with the relevant government agencies
Government Response	Develop plans for response areas not currently covered	Integrate Lime Tree Bay Terminal into response process	VITEMA will work with Lime Tree Bay Terminal

Government Response	Develop plans for response areas not currently covered	Streamline and improve the fueling process for first responder vehicles	VITEMA will work with the Governor's Office
Government Response	Develop plans for response areas not currently covered	Develop route clearance team and procedures	VITEMA will work with the appropriate agencies; teams should include, at a minimum, representatives from the Department of Public Works (DPW), VIFS, VIPD, and WAPA.
Government Response	Develop plans for response areas not currently covered	Develop a bulk water distribution plan	VITEMA, WAPA and the DPP
Government Response	Address funding, contracting, and procurement issues	Add budget line to fund emergency activation of VING	The Governor's Office, USVI legislature and VING
Government Response	Address funding, contracting, and procurement issues	Develop a standardized process for agencies to access cash	The Governor's Office, working with the Department of Finance
Government Response	Address funding, contracting, and procurement issues	Educate agencies on emergency procurement procedures	VITEMA, DPP
Government Response	Address funding, contracting, and procurement issues	Establish pre-disaster emergency contracts	DPP will work with agencies and potential vendors
Government Response	Harden critical emergency response assets	Build a new EOC facility on St. Croix	VITEMA
Government Response	Harden critical emergency response assets	Repair and harden EOC facility on St. John	VITEMA
Government Response	Harden critical emergency response assets	Build co-use facilities to support response operations	VITEMA will work with individual agencies
Government Response	Harden critical emergency response assets	Rebuild EMS facilities	VIDO, FEMA
Government Response	Harden critical emergency response assets	Procure, maintain, and regularly test emergency generators	VITEMA will work with government agencies
Government Response	Enhance emergency communications infrastructure, assets, and procedures	Strengthen communication links of 911 call centers	VITEMA will work with Viya
Government Response	Enhance emergency communications infrastructure, assets, and procedures	Improve government's access to satellite phones	VITEMA
Government Response	Enhance emergency communications infrastructure, assets, and procedures	Integrate amateur radio networks into response planning	VITEMA and BIT, together with first responder agencies, Amateur Radio Clubs
Government Response	Enhance emergency communications infrastructure, assets, and procedures	Switch to plain language for emergency communications	VITEMA will work with VIPD, VIFS, EMS, and rescue groups
Government Response	Enhance emergency communications infrastructure, assets, and procedures	Review and enforce rules for using first responder communication channels	VITEMA will work with VIPD, VIFS, VIDO, EMS, and search and rescue squads
Energy	Transform the generation portfolio	Increase utility scale renewables	WAPA
Energy	Transform the generation portfolio	Reform power purchase process	The Governor's Office will work with the PSC and WAPA
Energy	Transform the generation portfolio	Replace aging fossil fuel generators with smaller, more efficient units	WAPA

Energy	Transform the generation portfolio	Update WAPA's tariff structure to enable grid-tied distributed renewable generation	The Governor's Office will work with WAPA and the PSC; USVI Legislature; DPNR
Energy	Transform the generation portfolio	Establish St. John as a global model for energy sustainability and resilience	WAPA
Energy	Transform the generation portfolio	Expand energy efficiency programs	The USVI Energy Office and WAPA's VIEnergize program
Energy	Transform the generation portfolio	Explore new funding mechanism for energy efficiency	WAPA will work with the PSC
Energy	Transform the generation portfolio	Strengthen building code compliance	USVI government
Energy	Modernize the grid	Accelerate the deployment of advanced control systems	WAPA
Energy	Fortify infrastructure against climate risks	Reinforce all generation, transmission and distribution assets	WAPA
Energy	Fortify infrastructure against climate risks	Update design and construction standards	WAPA will work with FEMA and industry associations; DPNR
Energy	Strengthen energy planning and governance structures	Update WAPA's Integrated Resource Plan	WAPA
Energy	Strengthen energy planning and governance structures	Update and strengthen maintenance policies and procedures	WAPA
Energy	Strengthen energy planning and governance structures	Revise WAPA's emergency plan	WAPA
Energy	Strengthen energy planning and governance structures	Restructure financial commitments as needed to improve WAPA's fiscal solvency	WAPA
Energy	Strengthen energy planning and governance structures	Realign energy governance structure	WAPA; WAPA Board; PSC; Governor's Energy Office could play a role; the Legislature
Energy	Strengthen energy planning and governance structures	Support workforce development	WAPA; UVI; USVI schools
Water	Harden the existing system	Harden and rehabilitate the existing distribution system	WAPA will work with Department of Public Works
Water	Harden the existing system	Harden and rehabilitate pump stations, storage tanks, and administrative buildings	WAPA will work with DPNR
Water	Harden the existing system	Develop a cistern testing system	DPNR will work with the Governor's office
Water	Expand the system	Expand the water system to serve isolated communities	WAPA
Water	Expand the system	Strengthen water infrastructure on the west end of St. Croix	WAPA
Water	Expand the system	Develop a new distribution master plan	WAPA
Water	Prepare for the hurricanes	Install backup generators at all major pump stations	WAPA
Water	Prepare for the hurricanes	Develop a water safety public education program	WAPA will work with DPNR
Water	Prepare for the hurricanes	Develop a water rationing plan	WAPA will work with VITEMA
Water	Prepare for the hurricanes	Develop a 72-hour pre-landfall playbook	WAPA will work with VITEMA

Water	Prepare for the hurricanes	Form water-sharing partnerships with private facilities	WAPA to contact private facilities with reverse osmosis systems (hotels and resorts)
Economy	Strengthen public economic policymaking and implementation capacity	Strengthen the government's economic policymaking capacity	The Governor's Office will work with the EDA
Economy	Strengthen public economic policymaking and implementation capacity	Update workforce development plans to support hurricane recovery	The Governor's Office will work with VI Workforce Investment Board, the Department of Labor, the Department of Education, and the University of the Virgin Islands
Economy	Strengthen public economic policymaking and implementation capacity	Work with UVI to establish an economic development policy institute	Governor's Office will work with the University of the Virgin Islands
Economy	Support Recovery	Review tourism master plan	BER, in partnership with the Department of Tourism and industry associations such as VI Hospitality and Tourism Association
Economy	Support Recovery	Fill gaps in capital access for small businesses and entrepreneurs	The Governor's Office will work with federal agencies in the Economic Recovery Support Function
Economy	Promote resilience in the face of future storms	Invest in infrastructure to protect marine vessels in future storms	DPNR ; Port Authority and DPNR will partner with private boat storage operators (depending on funding)
Economy	Promote resilience in the face of future storms	Promote an equally distributed set of small and large hotels across the territory	The EDA and Department of Tourism
Economy	Promote resilience in the face of future storms	Introduce cloud-based systems for government IT services	Bureau of Information Technology (BIT) will work with all the different parts of the USVI government
Climate	Prevent negative impacts of climate change	Help educate the general population, agency staff, and members of the various econ sectors about the impacts of climate change and the associated hazards on the territory, and on best practices to adapt in order to country the impacts of climate change	Governor's Office with UVI
Climate	Prevent negative impacts of climate change	Continue, update, improve and/or augment the collection and curation of climate data in the territory, starting with temperature, rainfall and groundwater measurements	Governor's Office with UVI
Climate	Prevent negative impacts of climate change	The creation and continual update and maintenance of asset management tools to better track the conditions, repairs and upgrades made or needed for critical infrastructure, including for building and drainage infrastructure	Governor's office with territorial agencies and UVI

Transportation	Harden and repair the existing system	Complete latent system repairs and improve road system to meet federal standards	DPW will work with FHWA, FTA, and the GVI
Transportation	Harden and repair the existing system	Utilize concrete as the most suitable building material for roads	DPW
Transportation	Harden and repair the existing system	Repair storm damage at ports and airports	VIPA will work with airlines, TSA, FAA, and CBP where necessary
Transportation	Harden and repair the existing system	Repair and harden Henry E. Rohlsen Airport (HERA) and Cyril E. King Airport (CEKA)	VIPA
Transportation	Harden and repair the existing system	Expand and modernize Cyril E. King Airport	Governor's Office
Transportation	Harden and repair the existing system	Facilitate completion of existing capital improvement projects and "shovel-ready" projects	DPW
Transportation	Improve capacity to rebuild	Study measures to expedite building materials importing into the territory	DPW will work with VIPA and US Customs officials
Transportation	Improve capacity to rebuild	Study measures to expand local availability of materials	The Governor's Office, together with DPW, will work with both new and existing suppliers and vendors of asphalt, concrete, and aggregate
Transportation	Improve capacity to rebuild	Grow contractor and workforce capacity	The Governor's Office will coordinate with the Departments of Labor, Education, and private contractors
Transportation	Alter road and street design to support resilience	Utilize roundabouts instead of street lights at intersections	DPW
Transportation	Alter road and street design to support resilience	Implement Safe Routes to Schools	DPW will work with the territory's non-profit groups
Transportation	Alter road and street design to support resilience	Deploy walkability recommendations	The Governor's Office will work with VIDO, DPW, and the Walkability Institute
Transportation	Expand and improve ports and customs processing	Expand container port on St. Thomas	VIPA
Transportation	Expand and improve ports and customs processing	Conduct dredging and expansion in Gallows Bay Port	VIPA will continue to work with USACE, and federal and private partners
Transportation	Expand and improve ports and customs processing	Modernize and expand customs clearance in Red Hook	VIPA will work with CBP, USACE, and other federal partners
Transportation	Expand and improve ports and customs processing	Deploy Automatic Customs Environment system to improve customs processing	The Governor's Office and VIPA will continue to work with FEMA, CBP, Department of Homeland Security Infrastructure Protection, and the U.S. Army Corps of Engineers
Transportation	Improve road system planning and asset management	Conduct a comprehensive drainage study of the territory's transportation network and apply results by improving the road drainage system	DPW, in collaboration with the University of the Virgin Islands (UVI) and DPNR

Transportation	Improve road system planning and asset management	Develop and implement asset and resource management system for all territorial roadways	DPW
Transportation	Improve preparedness and post-storm restoration	Update response plan for ports and airports to support restoration of critical baseline services after storms	The Governor's Office will work with VITEMA and VIPA
Transportation	Improve preparedness and post-storm restoration	Institute a debris removal plan	DPW will work with the Department of Property and Procurement (DPP) and the Waste Management Authority (WMA)
Transportation	Improve preparedness and post-storm restoration	Provide power backup source for signalized intersections	DPW
Transportation	Improve preparedness and post-storm restoration	Conduct temporary patching and emergency system repairs	DPW will work with DPP
Transportation	Improve preparedness and post-storm restoration	Update VIPA emergency plans to stockpile repair materials	VIPA
Education	Prepare for future storms (VIDOE)	Develop a standard operating plan and procedures (SOP) for disasters	VIDOE will work with GVI and VITEMA
Education	Prepare for future storms (VIDOE)	Identify best practices for resiliency and disaster training for all stakeholders and develop a formal system of training	VIDOE will work with VITEMA
Education	Prepare for future storms (VIDOE)	Partner with federal level Department of Education emergency grant programs	VIDOE will work with DOE
Education	Prepare for future storms (VIDOE)	Foster independence of power resources through diversification	VIDOE
Education	Prepare for future storms (VIDOE)	Upgrade schools to emergency shelter standards	VIDOE
Education	Prepare for future storms (UVI)	Decrease dependence on fossil fuels and the local power grid by installing alternative energy power systems	UVI
Education	Prepare for future storms (UVI)	Harden and reinforce designated university spaces to use as shelters	UVI
Education	Harden and rebuild (VIDOE)	Construct all VIDOE facilities to meet new building codes and harden existing structures	VIDOE
Education	Harden and rebuild (VIDOE)	Solicit services for temporary facilities and permanent repairs by utilizing FEMA-PA funding	VIDOE will work with FEMA and AECOM
Education	Harden and rebuild (UVI)	Deploy UVI Restoration and Reconstruction plan to rebuild and harden damaged university infrastructure	UVI will work with FEMA
Education	Harden and rebuild (UVI)	Construct hardened Multipurpose Complex and Student Center/Emergency Shelters on St. Croix and St. Thomas	UVI

Education	Create opportunities for students (UVI)	Establish the Salt River Oceanic and Atmospheric Research and Education Center on St. Croix	UVI
Education	Create opportunities for students (UVI)	Increase territory-wide sustainability capacity and readiness by establishing a Center for Resiliency and Sustainability on St. Thomas	UVI
Education	Create opportunities for students (UVI)	Increase opportunities for Virgin Islanders to participate in economic growth and sustainability by establishing Entrepreneurship Community Centers on St. Thomas and St. Croix	UVI
Education	Create opportunities for students (UVI)	Advance aquaponics and hydroponics commercialization via the UVI Agriculture Experiment Station	UVI
Education	Create opportunities for students (UVI)	Complete the School of Medicine and Simulation Center on St. Thomas and St. Croix and make them operational	UVI
Education	Create opportunities for students (UVI)	Upgrade School of Nursing building on St. Croix	UVI
Education	Create opportunities for students (UVI)	Establish Marine Science Vocational Educational Facility	UVI
Waste	Conduct waste and wastewater system studies	Perform waste categorization study	VIWMA will work with the EPA
Waste	Conduct waste and wastewater system studies	Conduct rigorous inspections of wastewater infrastructure	VIWMA
Waste	Conduct waste and wastewater system studies	Execute telemetry study and develop remote monitoring capabilities	VIWMA
Waste	Conduct waste and wastewater system studies	Develop a maintenance plan for wastewater systems and infrastructure; link it to financial planning	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Update VIWMA facilities	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Strengthen access roads to wastewater pumping stations	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Upgrade perimeter fencing around wastewater facilities	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Procure and install backup generators at landfills, pumping stations, and wastewater treatment plants	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Procure and install solar and battery backup power solutions	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Improve and harden VIWMA communications and technology systems	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Reconfigure solid waste systems for EPA compliance and resiliency	VIWMA

Waste	Harden existing VIWMA facilities and infrastructure	Close existing Bovoni and Anguilla landfills	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Plan and build additional landfills	VIWMA
Waste	Harden existing VIWMA facilities and infrastructure	Increase the number of vehicles in the waste collection and hauling fleet	VIWMA
Waste	Reduce solid waste volume	Convert waste collection sites and improve collection facilities	VIWMA
Waste	Reduce solid waste volume	Mandate a territory-wide recycling program	VIWMA will work with the Governor's office and VI Legislature
Waste	Reduce solid waste volume	Designate recyclables monofills	VIWMA
Waste	Reduce solid waste volume	Develop organic waste processing program	VIWMA
Waste	Reduce solid waste volume	Mandate specific materials for reuse; develop alternate uses for scrap tires	VIWMA will work with VIHA
Waste	Reduce solid waste volume	Enforce existing Plastic Bag Ban	VIWMA
Waste	Modernize wastewater infrastructure and drainage systems	Separate wastewater from storm water systems	VIWMA
Waste	Modernize wastewater infrastructure and drainage systems	Educate the public on greywater system implementation	VIWMA
Waste	Modernize wastewater infrastructure and drainage systems	Eliminate some existing pump stations	VIWMA
Waste	Modernize wastewater infrastructure and drainage systems	Floodproof components of wastewater system	VIWMA
Waste	Modernize wastewater infrastructure and drainage systems	Strengthen underground elements of wastewater system	VIWMA
Waste	Modernize wastewater infrastructure and drainage systems	Provide backup pumps for wastewater pumping stations	VIWMA
Health	Improve physical infrastructure	Build new buildings to withstand climate risks and respond to local climate conditions	VIDOH, DPNR
Health	Improve physical infrastructure	Retrofit old buildings to withstand climate risks, respond to local climate conditions, and become more energy efficient	DOH
Health	Improve physical infrastructure	Reduce reliance of facilities on central energy grid	DOH
Health	Upgrade data and telecommunication protocols and technology	Develop protocols and technical capacity for immediate post-disaster communications	VIDOH, VITEMA
Health	Upgrade data and telecommunication protocols and technology	Enhance data resiliency by establishing a health information exchange system	HHS, VIDOH, FHC, JFLH, EEMC
Health	Upgrade data and telecommunication protocols and technology	Transition to cloud storage of medical data	VIDOH

Health	Upgrade data and telecommunication protocols and technology	Transition to electronic health records	VIDOH
Health	Upgrade data and telecommunication protocols and technology	Develop capacity to deliver medical care through Telemedicine	VIDOH
Health	Improve management of emergency response assets	Establish formal public/private partnerships for post-disaster medication storage	VIDOH
Health	Improve management of emergency response assets	Preposition EMS assets in underserved locations in advance of storms	VIDOH
Health	Improve management of emergency response assets	Ensure adequate supplies of pharmaceuticals	VIDOH
Health	Improve management of emergency response assets	Establish single point of accountability for management of donated relief supplies	VIDOH
Health	Improve management of emergency response assets	Assess morgue capacity, portable refrigerated trailers, and spaces capable of additional cooling	VIDOH
Health	Improve emergency planning and communication	Involve partners from within and outside the government in the emergency planning process	VIDOH
Health	Improve emergency planning and communication	Develop an internal communications plan and the capacity to implement it	VIDOH
Health	Improve emergency planning and communication	Work with behavioral health community to inform and educate patients about storms	VIDOH
Health	Improve emergency planning and communication	Educate the broader community on new and existing emergency plans	VIDOH
Health	Effect policy changes for expanded healthcare coverage	Afford policy changes to negotiate better reimbursement rates for Medicaid	Governor's Office
Health	Effect policy changes for expanded healthcare coverage	Reduce number of uninsured patients by reconsidering the creation of a Territory Healthcare Exchange	Governor's Office, HHS, federal and local partners
Health	Enhance healthcare system through workforce development and clear governance structures	Assess current state of healthcare workforce in the Virgin Islands	VIDOH
Health	Enhance healthcare system through workforce development and clear governance structures	Support healthcare workforce development through public and private partnerships in education and employment	VIDOH will coordinate with the Virgin Islands Department of Labor (VIDOL), VIDOE, the Career and Technical Education Board and UVI to
Health	Enhance healthcare system through workforce development and clear governance structures	Evaluate efficacy of healthcare governance structures and reform oversight mechanisms, beginning with hospitals' Board of Directors	VIDOH



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