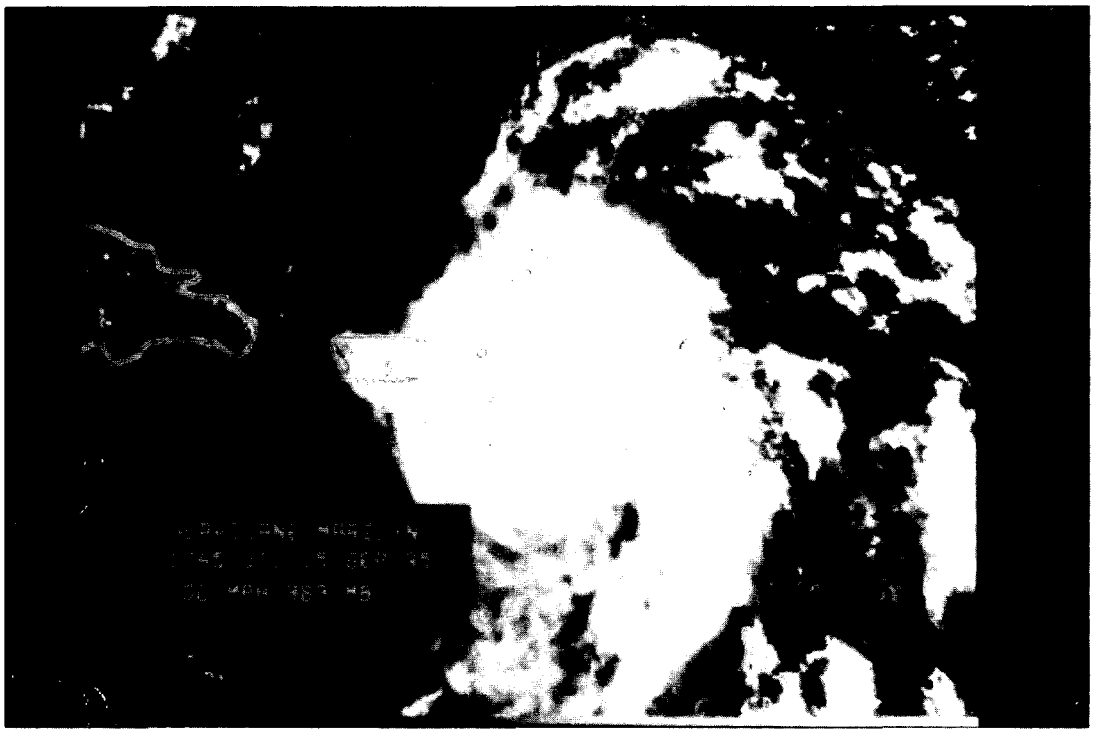
Natural Disaster Survey Report

Hurricane Marilyn
September 15-16, 1995



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service, Silver Spring, Maryland

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Front Cover: NOAA Geostationary Operational Environmental Satellite image of Hurricane Marilyn taken at 1:45 p.m., AST, September 15, 1995, as the storm approached the U.S. Virgin Islands and Puerto Rico.

Natural Disaster Survey Report

Hurricane Marilyn
September 15-16, 1995

January 1996

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U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
Dr. D. James Baker, Administrator

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Dr. Elbert W. Friday, Jr., Assistant Administrator

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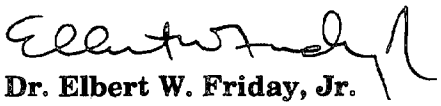
Preface

Hurricane Marilyn wreaked havoc in the U.S. Virgin Islands and Puerto Rico. This was just a week after Hurricane Luis posed a major threat to the same islands. Much the same region was devastated in 1989 by Hurricane Hugo. It is a tribute to the people of the region that they are rebuilding once again. Our thoughts and prayers reach out to each person who has survived these ordeals and is forging ahead. Furthermore, I congratulate all of those in the National Weather Service (NWS) who provided excellent services even in the face of a significant threat to themselves and their families. Their dedication and professionalism are an inspiration for all of us.



Dr. Elbert W. Friday, Jr.

January 1996

Foreword

This report on Hurricane Marilyn was prepared by the Disaster Survey Team (DST) after 4 days of visits to the affected areas, including interviews with a number of individuals who experienced the full fury of the storm on St. Thomas. The team also visited the NWS offices that provided the warning, watch, and forecast services to Puerto Rico and the U.S. Virgin Islands and spoke with Federal, Commonwealth, and local officials in the impacted areas.

The team is grateful to the many officials who took time from their duties in support of the recovery efforts to share with us their impressions of the events before and during the onslaught of the hurricane. The evaluations and insights they provided form the basis of the many findings and recommendations contained in this Report. We also appreciate the patience of the numerous citizens who spoke with us while still dealing directly with repairing the damage done to their personal lives.

In carrying out our assignment, we were impressed with the dedication and resolve of all of those dedicated in the response. We gratefully applaud each of the individuals involved. They can be proud of what they accomplished in preparing for the storm, in responding to the devastation resulting from the passage of Hurricane Marilyn, and in mitigating the impacts of future hurricanes.

The Disaster Survey Team

The Disaster Survey Team

Hurricane Marilyn struck the U.S. Virgin Islands and the eastern portions of Puerto Rico on September 15 and 16, 1995. As is frequently done after major weather events, the NWS formed a DST on September 18 for the purpose of reviewing NWS performance during Marilyn.

Those services were provided by the National Hurricane Center (NHC), located in Miami, Florida, and the Weather Service Forecast Office (WSFO) in San Juan, Puerto Rico. Consequently, the DST visited both of those offices. One team member also visited the Hydrometeorological Prediction Center (HPC) of the National Centers for Environmental Prediction (NCEP), located outside Washington, D.C. NCEP is the parent organization of NHC, and the HPC provides backup for NHC and assistance in determining the forecast track of each tropical cyclone. The data all team members gathered during their visits as well as follow up contacts forms the basis of this Report.

The team members and their affiliation are listed below.

Team Members

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Acronyms and Abbreviations

AP	Associated Press
ASOS	Automated Surface Observing System
AST	Atlantic Standard Time
AVN	Global Spectral Model for Aviation
CD	Civil Defense
CPCS	Common Program Control Station
DST	Disaster Survey Team
EAS	Emergency Alert System
EBS	Emergency Broadcast System
FEMA	Federal Emergency Management Agency
FFA	Flash Flood Watch
FFG	Flash Flood Guidance
FFW	Flash Flood Warning
HLS	Hurricane Local Statement
HPC	Hydrometeorological Prediction Center
kt	knot
MAR	Modernization and Associated Restructuring
mb	millibar
MIC	Meteorologist in Charge
mph	miles per hour
NCEP	National Centers for Environmental Prediction
NGWLMS	Next Generation Water Level Measurement System
NHC	National Hurricane Center
nm	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NOW	NWS Identifier for the Short Term Forecast
NWR	NOAA Weather Radio
NWS	National Weather Service
NWWS	NOAA Weather Wire Service
PSA	Public Service Announcement
RFC	River Forecast Center
SAB	Synoptic Analysis Branch
SERFC	Southeast River Forecast Center
SRH	Southern Region Headquarters
TCD	Tropical Cyclone Discussion
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VITEMA	Virgin Islands Territorial Emergency Management Agency
WCM	Warning Coordination Meteorologist
WSFO	Weather Service Forecast Office
WSR-88D	Weather Surveillance Radar-1988 (Doppler)

Executive Summary

Marilyn was the first hurricane to strike the U.S. Virgin Islands and Puerto Rico since Hugo devastated the islands, almost to the day, 7 years earlier. Although Marilyn was not as intense, its effects were still dramatic. Eight deaths occurred, mostly on St. Thomas, mainly as a result of persons trying to ride out the storm on their boats. Preliminary damage estimates from the Federal Emergency Management Agency (FEMA) totaled $2.1 billion with a majority of that centered on the city of Charlotte Amalie on St. Thomas. This figure does not include indirect costs, such as the loss of tourism.

The tropical depression that became Hurricane Marilyn formed just east of the Windward Islands on September 12, 1995. The depression rapidly increased to tropical storm strength (i.e., maximum 1-minute sustained winds between 39 and 73 miles per hour [mph]) later that same night and to hurricane force (i.e., 74 mph or greater) late on the evening of September 13. Initial computer model forecasts projected the storm to move west across the northern Windward Islands and into the central Caribbean Sea. Succeeding forecasts adjusted the track of the storm to a more northwesterly course until the northern Leeward Islands and Puerto Rico were forecast to be affected. Overall, official forecast track errors were dramatically less than the 10-year average which is an exceptionally good performance by NHC (see appendix E).

A hurricane watch was issued by the NHC for the U.S. Virgin Islands at 8 a.m., Atlantic Standard Time (AST), Thursday, September 14. This watch was extended to include Puerto Rico at 11 a.m., AST. The watch was in effect 33 to 38 hours prior to landfall in the U.S. controlled islands. The hurricane watches were upgraded to hurricane warnings at 5 p.m., AST, Thursday, which provided 24 hours advance warning for St. Croix and 30 hours advance warning for St. Thomas and Puerto Rico. This included nearly a full daylight period for the U.S. Virgin Islands which is NHC's goal for planning warning issuances.

Marilyn's eye passed across the east end of St. Croix where an amateur radio operator reported an unconfirmed wind gust of 127 mph around 5 p.m., AST, Friday, September 15. The eye then passed between St. Thomas and Culebra with the most devastating portion of the eyewall moving across the west part of St. Thomas. Here, both storm surge and wind caused widespread destruction. The Automated Surface Observing System (ASOS), located at the St. Thomas airport, recorded sustained winds of 104 mph with a maximum gust to 129 mph around midnight, September 15-16. These are the strongest recorded winds associated with Marilyn. Wind gusts approaching 140 mph were estimated from an aerial damage survey conducted soon after the hurricane's passage. Heavy rains, mudslides, and strong winds pounded Culebra and Vieques where damage was also considerable. Marilyn did not severely impact the main island of Puerto Rico although some strong winds and heavy rains did affect the island.

The WSFO in San Juan has warning and forecast responsibility for all of Puerto Rico, its associated islands, and the U.S. Virgin Islands. The office has moved to its new quarters as part of the NWS modernization but has not yet had its Doppler weather surveillance radar (WSR-88D) installed. The radar installation is scheduled for February 1996.

The WSFO was very proactive in preparing all of the emergency managers, the media, and the general public. There were a variety of activities conducted by the WSFO staff in 1995. Those activities ranged from a training workshop in hurricane preparedness for emergency managers and the media, to a hurricane awareness week for Puerto Rico in June 1995 in cooperation with the Puerto Rico Civil Defense (CD) Agency, to numerous individual school visits and presentations.

The effectiveness of these contacts was directly reflected in the interviews by the DST with the emergency managers and media. Those interviews were all extremely positive with literally each of the interviewees giving high praise to the local NWS staff for their efforts, availability, and hard work before, during, and after the passage of Marilyn. Perhaps even more telling of the effectiveness of the preparedness efforts by the WSFO staff was the extraordinarily low death toll in relation to the magnitude of the devastation in the U.S. Virgin Islands and the islands off the eastern tip of Puerto Rico.

Although warnings and watches from NHC were issued well in advance and releases from the WSFO were timely and highly detailed, the media, emergency managers, and the public did not expect the storm to be as strong or as devastating as it was. Many of those interviewed attributed this to the perceived small size of Hurricane Marilyn as compared to Hurricane Luis which had threatened them the previous week. Similarly, many local officials and residents did not appreciate that the hurricane was forecast to increase in strength overnight from its category 1 intensity on the Saffir-Simpson scale that was observed Thursday night, September 14, and early Friday, September 15. This suggests that the NWS should explore additional means to communicate the effects of storms in their products and services.

Major Findings and Recommendations

Finding 1-1: NHC advisories only contain forecasts for surface winds at standard anemometer heights (33 ft) even though stronger winds occur at higher elevations within hurricanes.

Recommendation 1-1: To enhance their public advisories, NHC should adopt specific wording related to stronger winds at higher elevations for use in the Caribbean where elevation frequently increases rapidly close to the coast.

Finding 3-1: WSFO San Juan conducted an aggressive preparedness education campaign with local emergency managers and the media in both Puerto Rico and the U.S. Virgin Islands.

Recommendation 3-1: The WSFO staff should continue these excellent efforts, with the WCM and MIC leading an areawide campaign.

Finding 3-2: VITEMA officials were not able to attend the FEMA-funded training in hurricane preparedness that was conducted at NHC in January 1995. This training would have been useful in responding to the threat of Marilyn.

Recommendation 3-2: The NWS and FEMA should encourage VITEMA officials to take advantage of future training opportunities.

Finding 3-3: The coordination between NWS Headquarters and FEMA, prior to Marilyn's landfall, assisted FEMA in the prepositioning of recovery personnel and equipment.

Recommendation 3-3: Direct involvement of NHC and WSFO San Juan would have further enhanced FEMA's efforts with less potential for inconsistencies. NWS Headquarters should develop a formal plan for coordination between FEMA and the NWS field offices for implementation prior to the next hurricane season.

Finding 4-1: The NWWS is not affordable in the Caribbean with the result that there are very few drops in the region. Some NWS products, most notably the Short Term Forecast (NOW), were not broadcast by the media and were only available over NWR.

Recommendation 4-1: The NWS should work with emergency management officials, the media, and the private sector to explore additional opportunities for the delivery of critical weather information in the region.

Finding 4-2: There were too few playback decks on the San Juan old technology NWR console. This caused difficulty in preparing broadcast text and keeping the program up to date. Many emergency management officials and media outlets noted that the NWR Spanish broadcasts were not timely.

Recommendation 4-2: WSFO San Juan should be provided with a digital NWR console to improve the flexibility and reliability of the NWR programming system.

Finding 4-3: The WSFO staff was invited to participate in the Governor's press conferences which were held at a considerable distance from the WSFO. Although these press conferences were highly effective, they placed an additional burden on the staff.

Recommendation 4-3: Plans should be developed for using the WSFO multipurpose room as a media center with video-teleconferencing capabilities to provide briefings and conferences with local officials. Puerto Rico Civil Defense and the media have expressed a willingness to share costs in establishing this capability.

Finding 4-4: The Commonwealth of Puerto Rico Civil Defense allows concerned agencies to directly coordinate with each other, regarding EBS/EAS activations, rather than forcing all coordination through the Emergency Operations Center. Except for the San Juan CPCS-1 station, however, broadcast stations in Puerto Rico and the U.S. Virgin Islands were not ready for the implementation of the new EAS.

Recommendation 4-4: The NWS should continue to work vigorously with the Federal Communications Commission and FEMA to establish the EAS in Puerto Rico and the U.S. Virgin Islands.

Finding 4-5: On St. Thomas, both VITEMA and the public felt that they were not adequately apprised of what Marilyn's intensity would be once she made landfall.

Recommendation 4-5: NHC and WSFO personnel must continue to work with users to determine the best way to communicate intensity changes.

Finding 5-1: NHC's track forecasts for when Marilyn affected the U.S. Virgin Islands and Puerto Rico were highly accurate with errors less than one-third the usual magnitude.

Finding 5-2: The NHC telephone system became overloaded during storms when up to 1,200 calls an hour were received. At these times, the NHC staff could not make vital coordination calls.

Recommendation 5-2: A separate phone system should be provided to handle the recorded advisories. Isolating the NHC operational staff from that system will facilitate coordination and data collection.

Finding 5-3: In the event that NHC loses operational capabilities, the HPC of the NCEP may not be adequately prepared to provide immediate operational backup for NHC since the Backup Hurricane Operations Plan has not been fully tested.

Recommendation 5-3: The Backup Hurricane Operations Plan should be tested at least twice a year.

Finding 5-4: A revised method of depicting both the official hurricane position and forecast track is needed to convey the radius of influence of the storm and the uncertainty in the forecast.

Recommendation 5-4: The NWS should work with its customers to identify new methods of representing both the radius of damaging winds and forecast track uncertainty.

Finding 5-5: Some users focused on several model scenarios presented in the TCD and, despite the reasoning presented in the products, made their own interpretations of the official NHC forecasts.

Recommendation 5-5: In order to discourage this practice, the TCD should convey first and foremost the official forecast track, with a discussion of forecast uncertainty due to differences between numerical models.

Finding 5-6: The entire WSFO San Juan staff showed great devotion to duty and exhibited the highest level of professional performance during Hurricane Marilyn.

Recommendation 5-6: The NWS should provide appropriate recognition for the WSFO San Juan staff.

Finding 5-7: The WSFO San Juan's HLSs were too long which made it difficult for users to find specific information.

Recommendation 5-7: WSFO San Juan should segment their HLSs to ensure customers can quickly locate desired information.

Finding 5-8: Although the WSFO issued effective short-term forecasts to complement their HLSs and provide additional details on Marilyn, further specificity would have been available if the WSR-88D was installed.

Recommendation 5-8: The WSR-88D should be installed, accepted, and commissioned as soon as possible.

Finding 5-9: The hydrologic data collection network in the WSFO area of responsibility is insufficient. This hampered efforts to determine how much rain fell throughout the region during Marilyn. In the past, the WSFO has provided warnings with only qualitative data reports.

Recommendation 5-9: The hydrologic data collection network should be expanded, taking into consideration (a) required density of gages, (b) adequacy of maintenance of gages, and (c) reliability of the communications link to the WSFO.

Chapter 1

The Event and Its Impact

The number of deaths directly related to Marilyn was eight with most of those occurring on St. Thomas and mostly as a result of people trying to ride out the storm on their sailboats. The total death toll was remarkably low considering the severity of the damage. This was perhaps a testimony to the quality of the forecasts and preparedness activities that took place before the storm. See appendix A for a listing of the deaths directly related to Marilyn. The preliminary damage estimates have been set by FEMA at $2.1 billion with the city of Charlotte Amalie and the rest of St. Thomas suffering the major part of the destruction.

Most of the damage to the U.S. Virgin Islands was the result of wind except for the storm surge along the immediate coast. This included 21,000 homes damaged or destroyed, 5,800 utility poles damaged, desalinization plant on St. Thomas inoperative, and repair of two sewage treatment plants required.

In contrast, most of the damage in Puerto Rico was the result of flooding. Ten municipalities on the mainland of Puerto Rico were declared disaster areas due to the flooding—Aguas Buenas, Barranquitas, Canovanas, Carolina, Fajardo, Juncos, Loiza, Naguabo, Ceiba, and Comerio. Two other municipalities, San Lorenzo and Ciales, were declared eligible for infrastructure help only. Damage estimates for Puerto Rico, including Culebra and Vieques, were set at $10 million.

Tropical Depression Fifteen formed just east of the Windward Islands on Tuesday, September 12, 1995. The depression rapidly increased in intensity to tropical storm strength and was named Marilyn late that same night. Marilyn was further upgraded to a hurricane Wednesday afternoon, September 13. Computer models of the atmosphere initially projected Marilyn to move west across the northern Windward Islands and into the central Caribbean Sea. This was reflected in the official forecasts prepared by NHC. Succeeding forecasts adjusted the track of the storm to the right or on a more northwesterly course until the northern Leeward Islands and Puerto Rico were forecast to receive a direct strike from the hurricane.

A hurricane watch was issued by NHC for the U.S. Virgin Islands at 8 a.m., AST, Thursday, September 14. This watch was extended west to Puerto Rico at 11 a.m., AST, that same morning. The watch was in effect 33 to 38 hours prior to landfall in the U.S. controlled islands. Even before the hurricane watch was posted, WSFO San Juan alerted the emergency management officials in Puerto Rico and the U.S. Virgin Islands, other government officials, and the media to the threat posed by the developing tropical cyclone. Through these agencies and media, word of the approaching storm was relayed to the general public in Puerto Rico and the U.S. Virgin Islands, and preliminary preparations were begun. It should be noted that this was just 1 week after the area was threatened by a category 4 hurricane—Hurricane Luis. See Appendix B, Saffir-Simpson Hurricane Scale. Notifications and preparations increased from the WSFO once the hurricane watch

was placed into effect. The hurricane watches were replaced by hurricane warnings at 5 p.m., AST, Thursday, September 14, or about 24 hours in advance of landfall of the eye on St. Croix.

Tropical storm-force gusts accompanied by heavy rain were felt on the U.S. Virgin Islands, beginning Friday morning, September 15. Winds increased steadily throughout the day, and gusts to hurricane force were first felt on St. Croix about 4 p.m., AST, causing power outages, communications failures, and widespread devastation to the islands. Amateur radio operators were in contact with the Virgin Islands Territorial Emergency Management Agency (VITEMA) officials on St. Croix and St. Thomas as well as with the civil defense officials in Puerto Rico. As other communications failed, the amateur radio operators became the only means of gathering information from the islands. Much of this information was relayed to the WSFO in San Juan. The radio operators reported sustained winds over 50 mph and gusts to 91 and 97 mph shortly after 4 p.m., AST. A report from VITEMA-St. Croix estimated the sustained winds near 90 mph at 4:40 p.m., AST, and at about the same time there were several gusts reported over 100 mph. The highest reported wind gust on St. Croix was 127 mph at about 5:15 p.m., AST, but this report is unconfirmed. The eye of Hurricane Marilyn passed across the east end of the island near 6 p.m., AST, September 15.

Figures 1-1a and 1-1b show wind speed and air pressure traces from the U.S. Department of Agriculture (USDA) equipment located on the western part of St. Croix. These readings are considered unofficial since they had not been calibrated recently. In addition to the winds from the hurricane, the island also had to contend with the storm surge and torrential rains that fell for hours at a time.

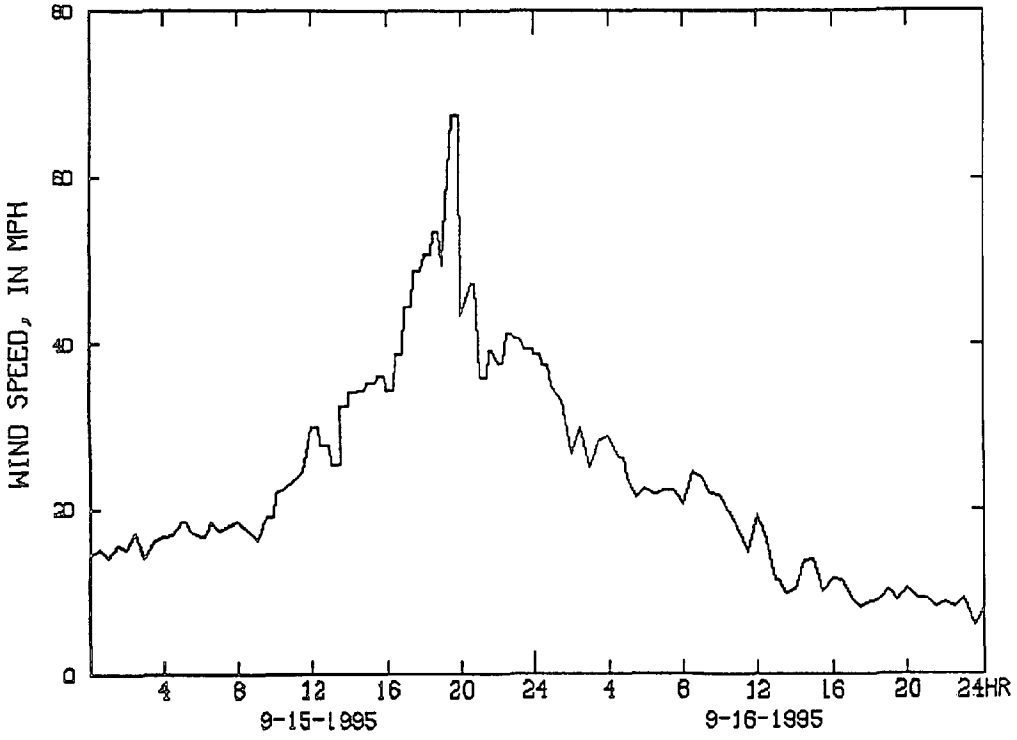

Figure 1-1a. USDA Wind Speed Record from St. Croix.

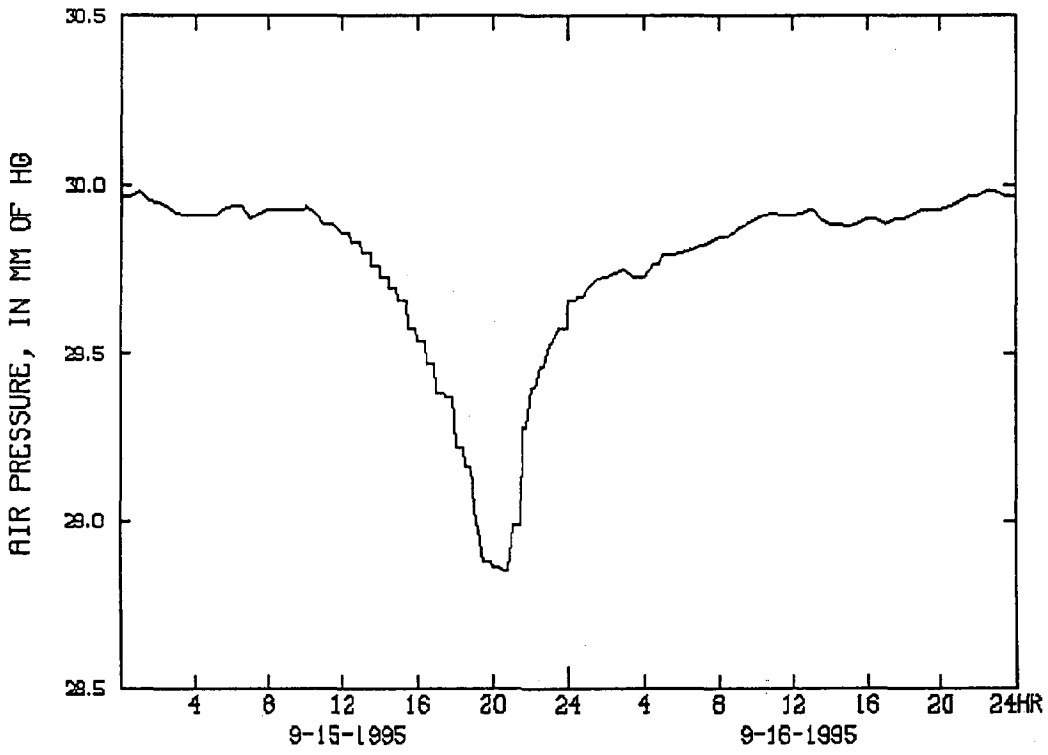

Figure 1-1b. USDA Air Pressure Record from St. Croix.

Measurements of the storm tide by the U.S. Geological Survey (USGS) on St. Croix found most areas had heights of 5-6 feet, but there was one location on the north coast that was hit with a storm tide of 11.7 feet. Figure 1-2 shows National Ocean Service (NOS) measurements versus the astronomical prediction of the water level from its Next Generation Water Level Measurement System (NGWLMS) at Limetree Bay on the south coast of St. Croix. See figure 1-3 for USGS storm tide height measurements on St. Croix. Rainfall of almost 12 inches was measured on St. Croix at Annaly, located on the west side of the island.

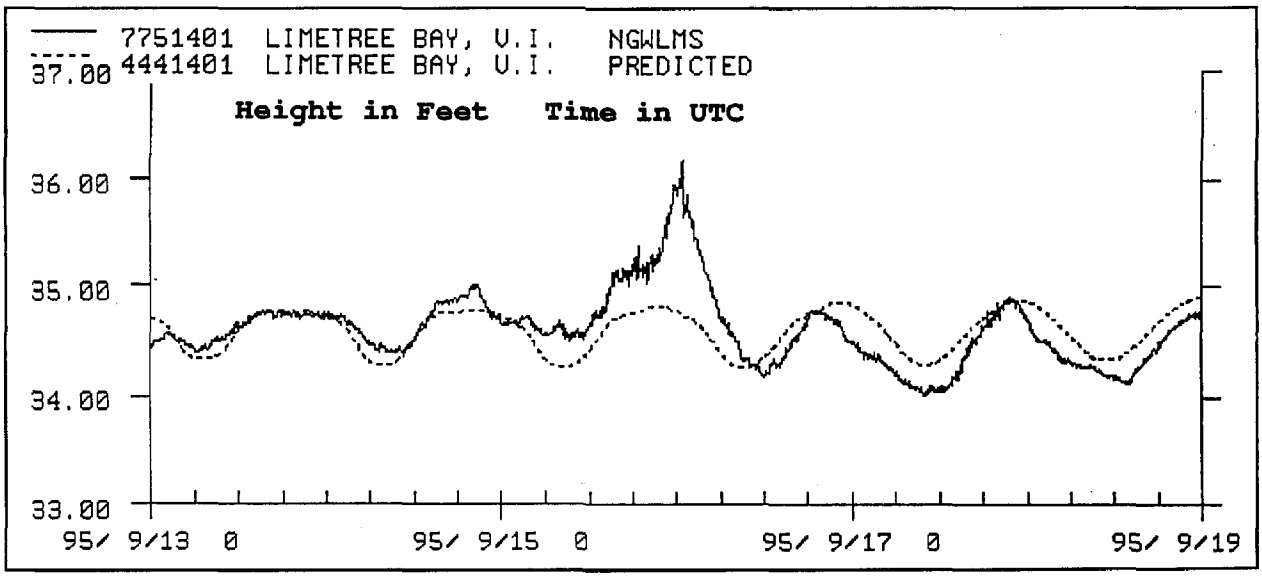

Figure 1-2. NOS NGWLMS Record from Limetree Bay, St. Croix.

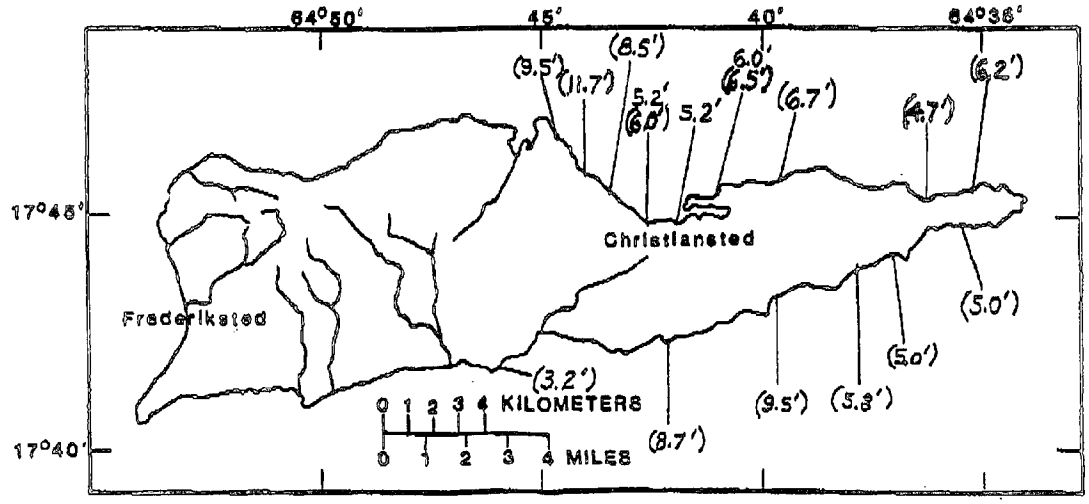

Figure 1-3. USGS Storm Tide Measurements on St. Croix.

As frightening as it must have been and as badly as the island was damaged, it was much less than St. Croix had experienced with the passage of Hurricane Hugo in 1989. This was because the island was largely on the left side of the storm, and typically that side is not as strong as the front right quadrant of a tropical cyclone and because Hugo was at least one Saffir-Simpson category stronger. Changes in construction code were made following Hugo, and these likely lessened the damage on St. Croix as well.

St. Thomas was not as fortunate, however, as Hurricane Marilyn continued on a northwest course and gained some strength during the evening hours. The eye passed between St. Thomas and Culebra with the most destructive part of the eyewall moving directly across the west part of St. Thomas, causing near total devastation.

By 7 p.m., AST, September 15, gusts to 75 mph were reported on St. Thomas. Conditions continued to deteriorate throughout the evening hours. Electric power was lost across the island about 8 p.m., AST, and measurements of the winds were no longer possible in most locations. Traces of the air pressure and wind speed from meteorological equipment at the University of the Virgin Islands are contained in figures 1-4a and 1-4b. They show that the pressure was still falling and winds increasing at the time the record ceased. Hurricane-force winds blew out all of the windows of the airport control tower around midnight. The ASOS at St. Thomas' Cyril E. King Airport recorded maximum sustained winds of 104 mph at 11:52 and 11:53 p.m., AST, and was followed soon after by the peak gust for the storm of 129 mph. This site also recorded the lowest official barometric pressure in the U.S. Virgin Islands. A reading of 956.7 millibars (mb) was recorded at 12:22 a.m., AST, Saturday, September 16. WVWI Radio reported unofficial sustained winds of 150 mph on its anemometer, but this is not confirmed. There were also unsubstantiated reports of wind gusts estimated at 175 mph from an unknown location on St. John.

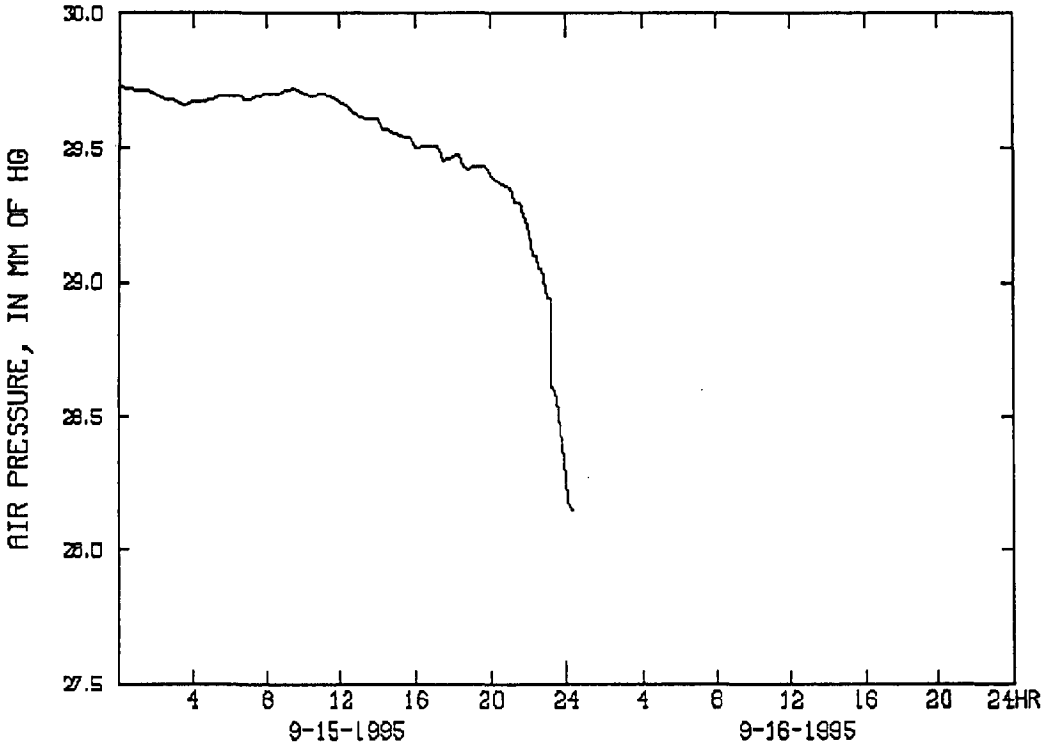

Figure 1-4a. USDA Wind Speed Record from St. Thomas.

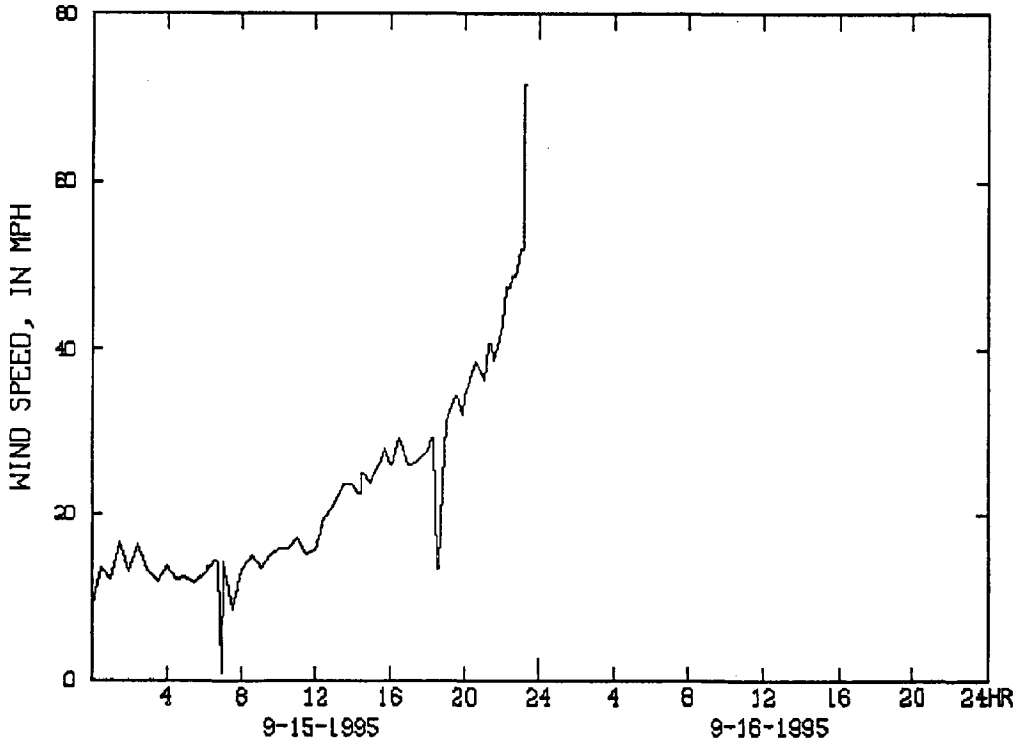

Figure 1-4b. USDA Air Pressure Record from St. Thomas.

Each of these reports may be a result of several factors. It is a common occurrence for reports of extraordinary winds to be received after the passage of a hurricane simply because few people have any experience with hurricane-force winds and do not have any reliable means of estimating strong winds accurately. It is also possible that winds higher than those forecast by NHC did occur over higher terrain areas. This would be due to funneling effects of the terrain and the higher elevation of the station. NHC wind forecasts are for 1-minute sustained winds at the surface (near sea level), and it is known that winds increase with elevation in a hurricane.

Finding 1-1: NHC advisories only contain forecasts for surface winds at standard anemometer heights (33 ft) even though stronger winds occur at higher elevations within hurricanes.

Recommendation 1-1: To enhance their public advisories, NHC should adopt specific wording related to stronger winds at higher elevations for use in the Caribbean where elevation frequently increases rapidly close to the coast.

An anecdotal report of 100 mph sustained winds in the Charlotte Amalie Harbor was relayed from an unknown sailboat riding out the storm in the harbor. The Coast Guard vessel *Point Ledge* was also attempting to ride out the storm in the harbor while tied to a 6-ton mooring anchor with at least one additional anchor and its engines engaged to relieve some of the strain from the mooring system. The mooring anchor began to drag, however, and the *Point Ledge* abandoned the mooring and attempted to power to safety. Unfortunately, it was carried onto the harbor bulkhead by the winds and waves (figure 1-5). Storm tide heights on the shores of St. Thomas (figure 1-6) were 6-7 feet. Rainfall reports were as much as 10 inches but few gages survived the storm, and it is likely that there were greater amounts at some locations. Figure 1-7 depicts the NOS tide gage measurements in Charlotte Amalie Harbor. It shows that the storm tide rapidly rose about 3 feet between 10 p.m., AST, Friday, September 15, and 1 a.m., AST, Saturday, September 16.

Perhaps the most effective means of conveying the power of Marilyn and the devastation it brought to St. Thomas is through pictures of the aftermath. See figures 1-8 to 1-15. Figure 1-16 shows the areas of wind damage on St. Thomas. A full description of the wind damage in the U.S. Virgin Islands and across the islands east of the main island of Puerto Rico is contained in appendix C.

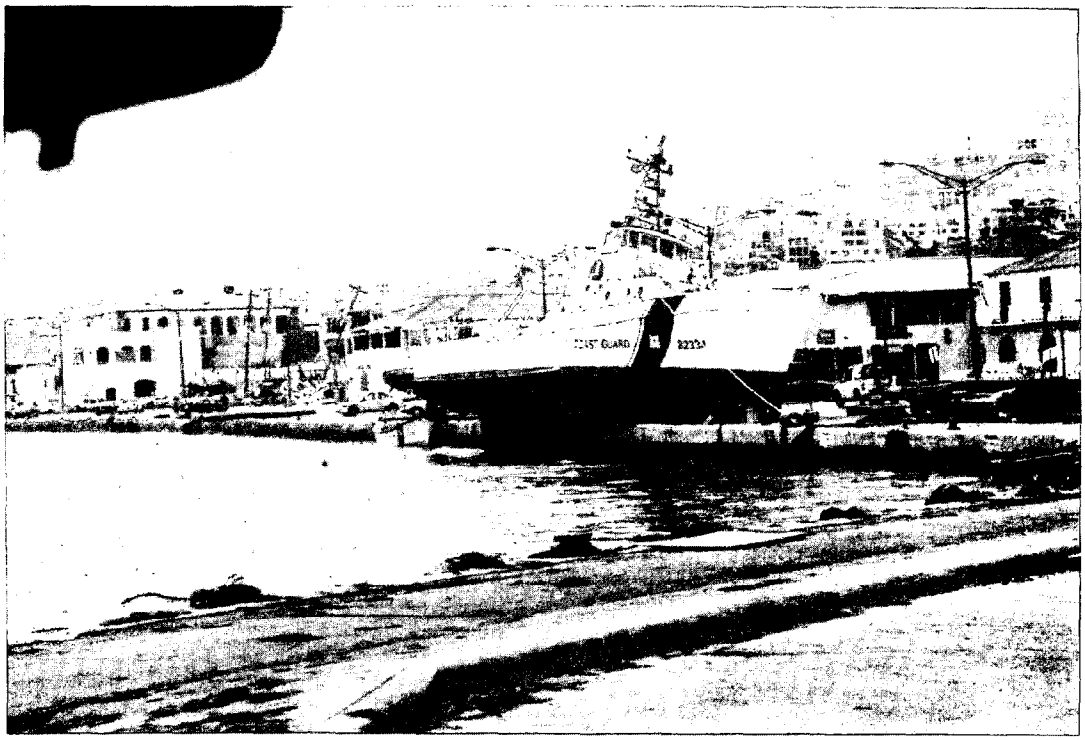

Figure 1-5. Coast Guard vessel ***Point Ledge*** *on the bulkhead in Charlotte Amalie Harbor. (Photo courtesy of Matt Stout)*

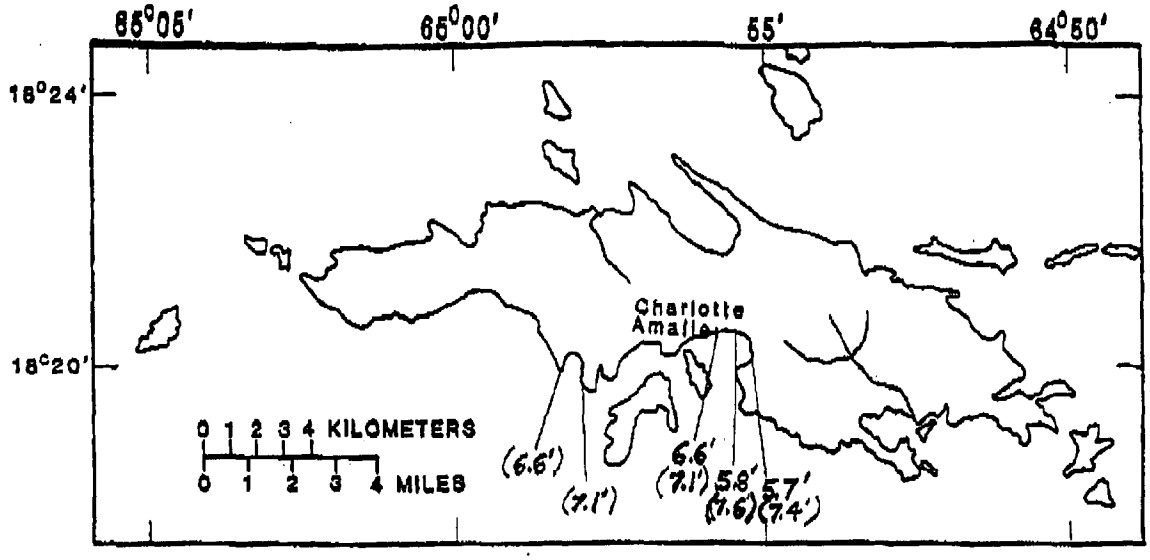

Figure 1-6. USGS Storm Tide Measurements on St. Thomas.

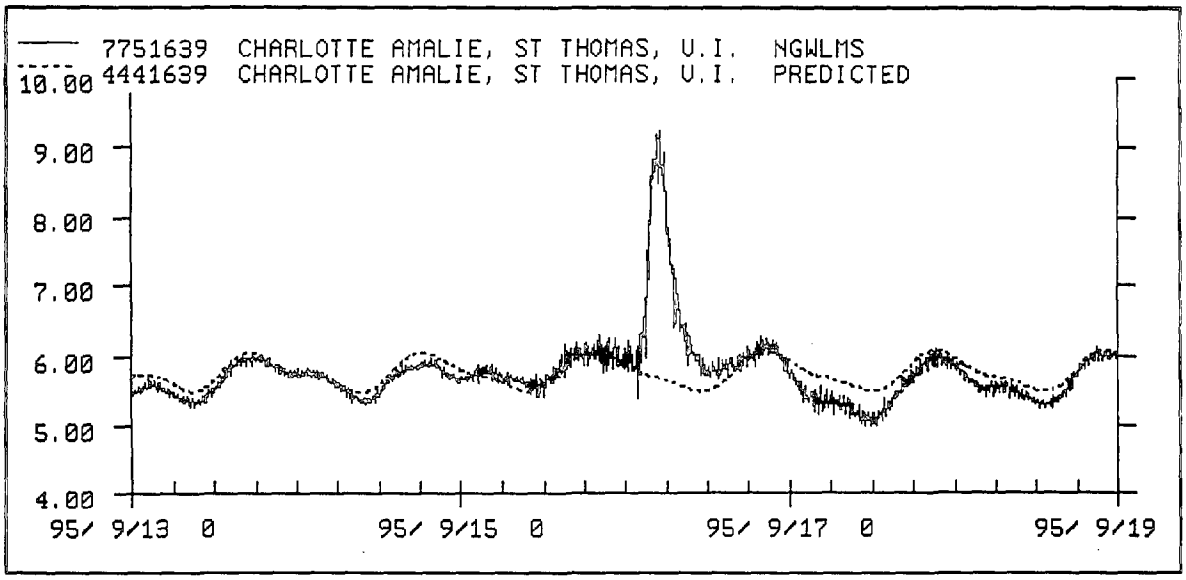

Figure 1-7. NOS Water Level Measurements in Charlotte Amalie Harbor.

Figure 1-8. Broken palm trees and damaged homes on St. Thomas. (Photo courtesy of Matt Stout)

Figure 1-9. Sailboats washed ashore and buildings damaged along Charlotte Amalie Harbor.
(Photo courtesy of Brian Smith)

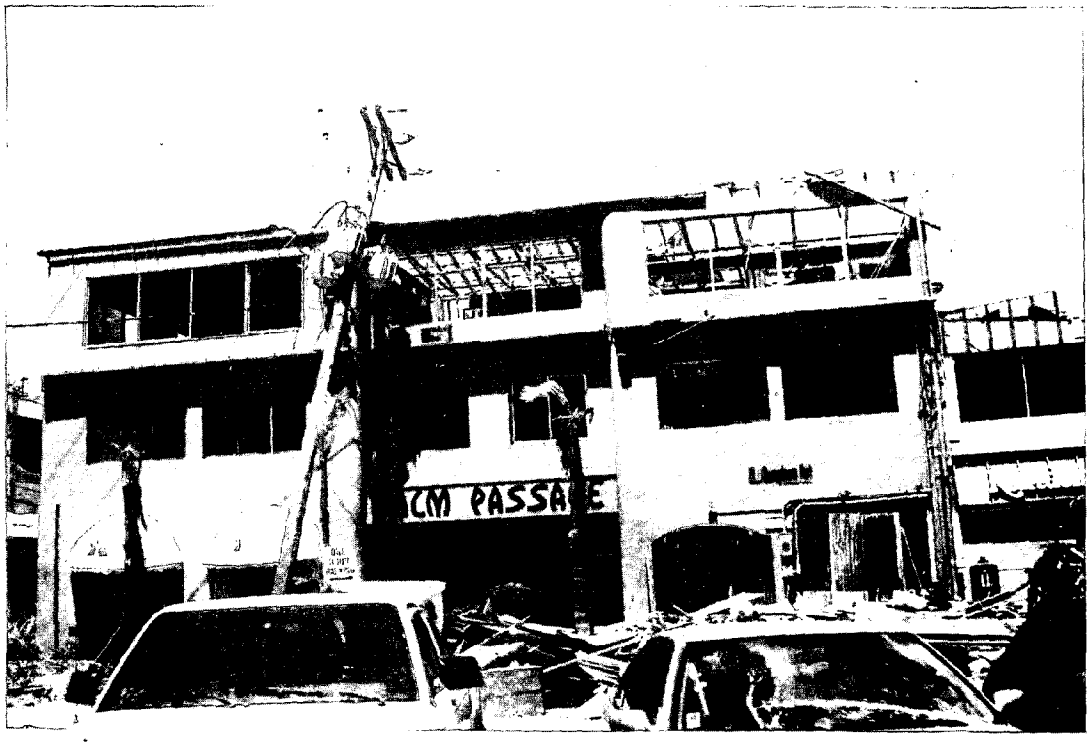

Figure 1-10. Damaged commercial building along the Charlotte Amalie Harbor.
(Photo courtesy of Matt Stout)

Figure 1-11. Destroyed apartments in Charlotte Amalie.
(Photo courtesy of Brian Smith)

Figure 1-12. Another sailboat brought ashore by Marilyn.
(Photo courtesy of Matt Stout)

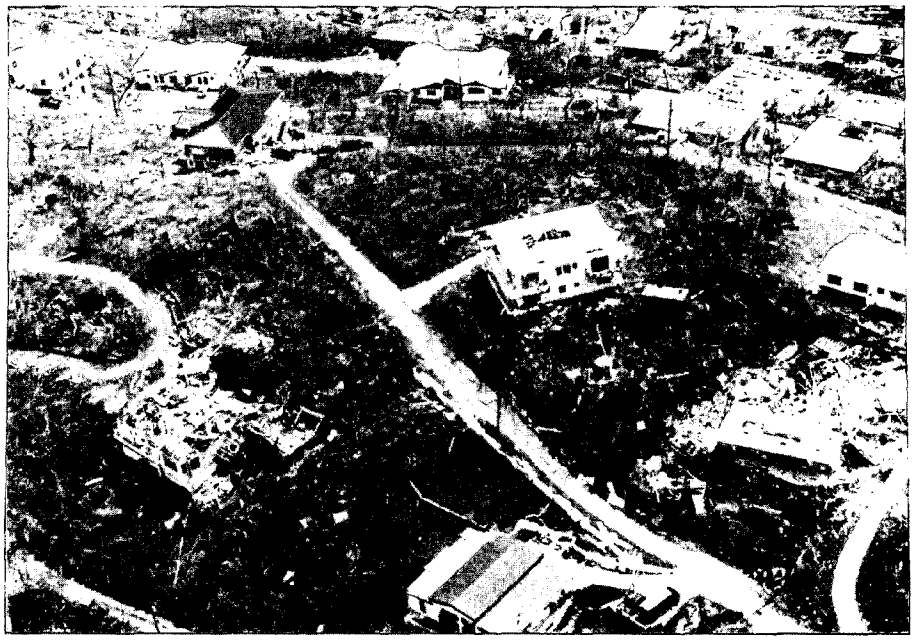

Figure 1-13. Residential damage on St. Thomas.
(Photo courtesy of Brian Smith)

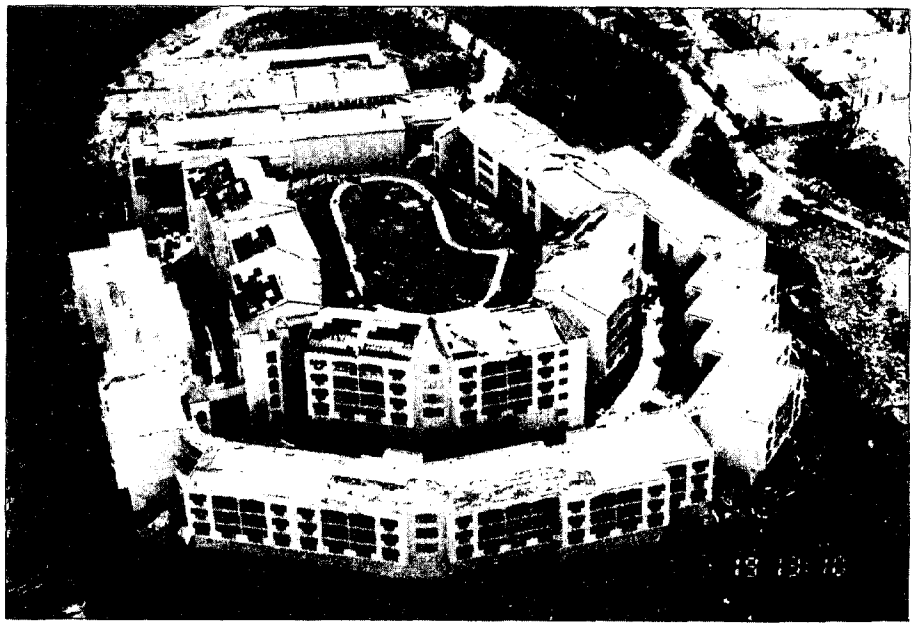

Figure 1-14. Apartment buildings damaged by Marilyn.
(Photo courtesy of Brian Smith)

Figure 1-15. More damaged homes on St. Thomas.
(Photo courtesy of Brian Smith)

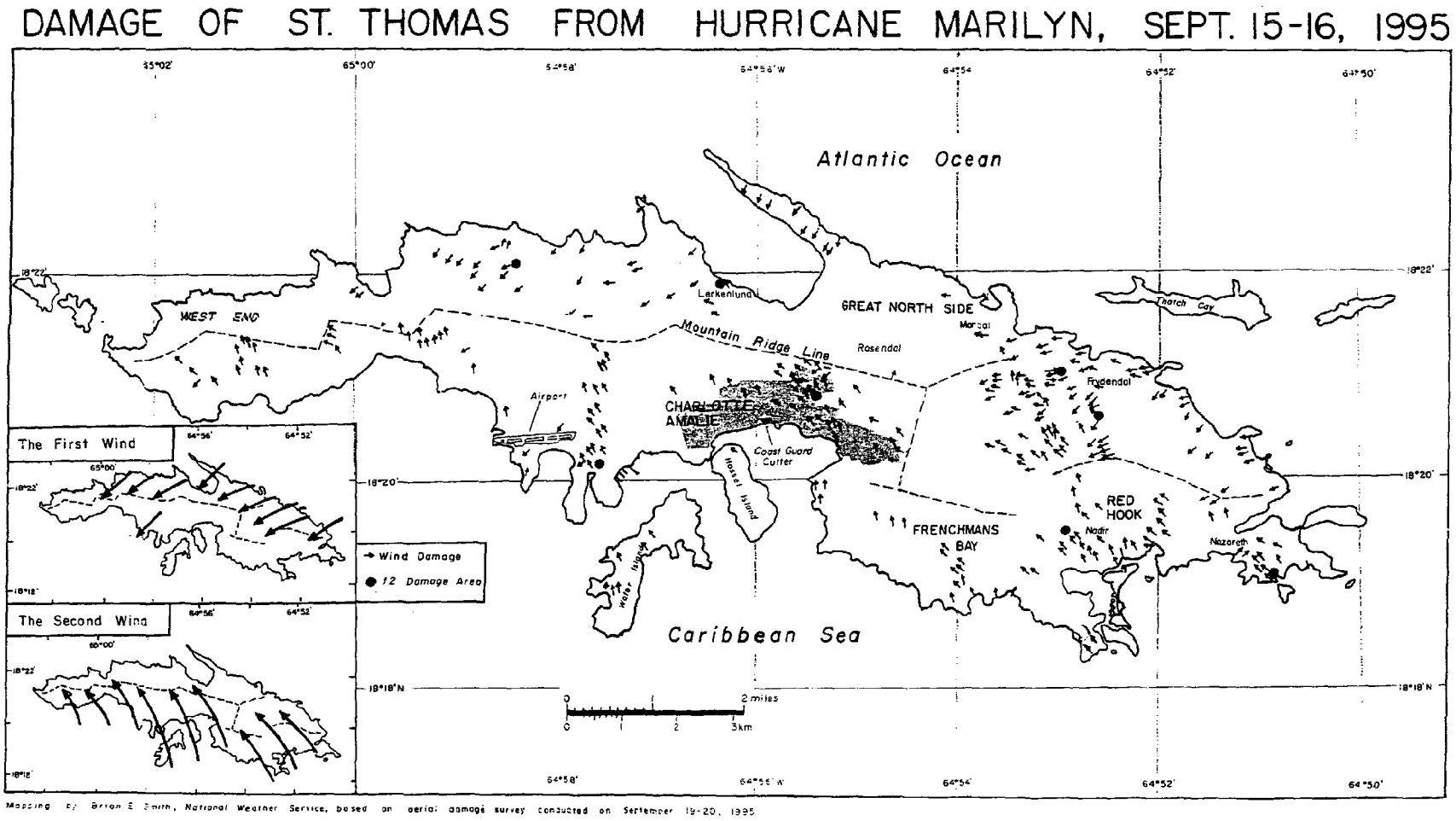

Figure 1-16. Map depicting the distribution of strong winds on St. Thomas. (Map prepared by Brian Smith)

The small islands of Culebra and Vieques are located off the east end of the mainland of Puerto Rico. Each island was heavily damaged by the passage of the hurricane, but the strong winds began a bit later than on St. Thomas. An amateur radio report at 10:40 p.m., AST, Friday, September 15, told of sustained winds of 66 mph on Vieques with power out. About midnight, the winds were reported to be sustained at 100 mph. By 1 a.m., AST, on Saturday, September 16, Culebra was bearing the brunt of the strongest winds with the local civil defense reporting sustained winds in excess of 100 mph. These extreme winds persisted for nearly an hour on Culebra. The difference in the winds on Culebra and Vieques from those that impacted St. Thomas was that they were from the west rather than the northeast. This indicated that the eye was to the north of Culebra when the strongest winds occurred.

There were no recordings of rainfall on the island of Culebra, but the mayor reported that it rained heavily from 8 p.m., AST, Friday, September 15, until about 7 a.m., AST, Saturday, September 16. The result was flash flooding and mudslides on the island. The most affected areas were at both sides of the airport, where runoff from the hills transported mud toward the runway area, leaving homes full of mud all the way to the bay. The mayor pointed out that these same areas have had flooding problems in the past. Figures 1-17 to 1-20 depict examples of the wind and flooding damages on Culebra.

Figure 1-17. Homes destroyed on Culebra by Marilyn.
(Photo courtesy of Kevin McCarthy)

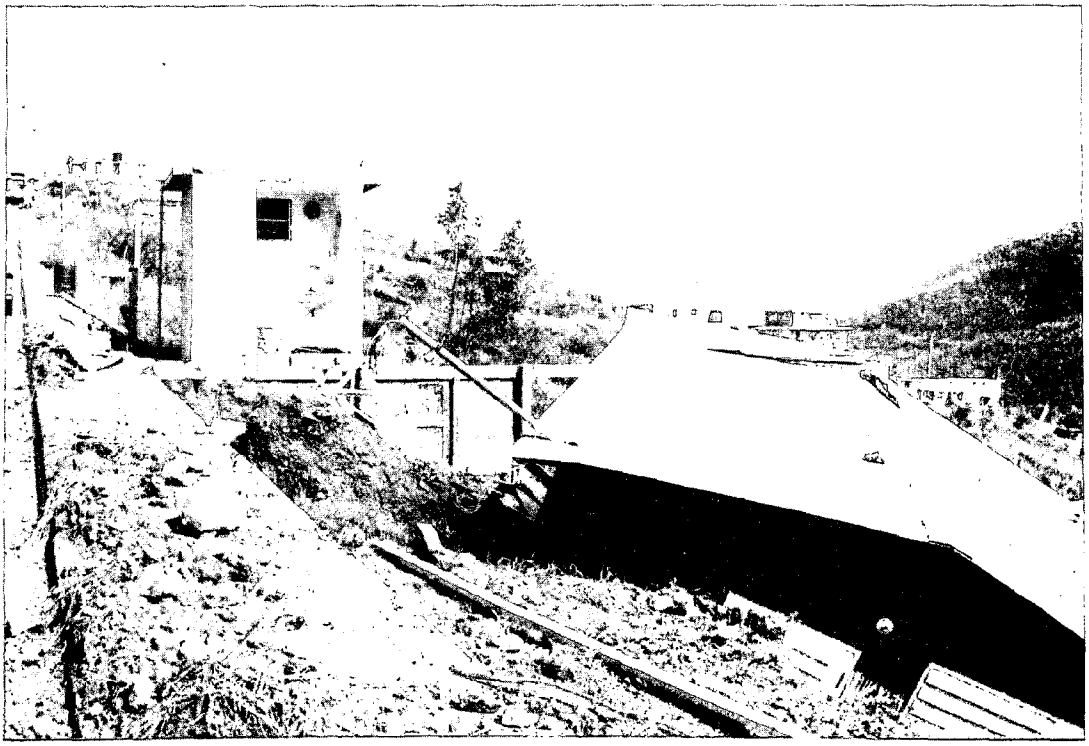

Figure 1-18. Home washed off its footings by flash flooding on Culebra. (Photo courtesy of Don Wernly)

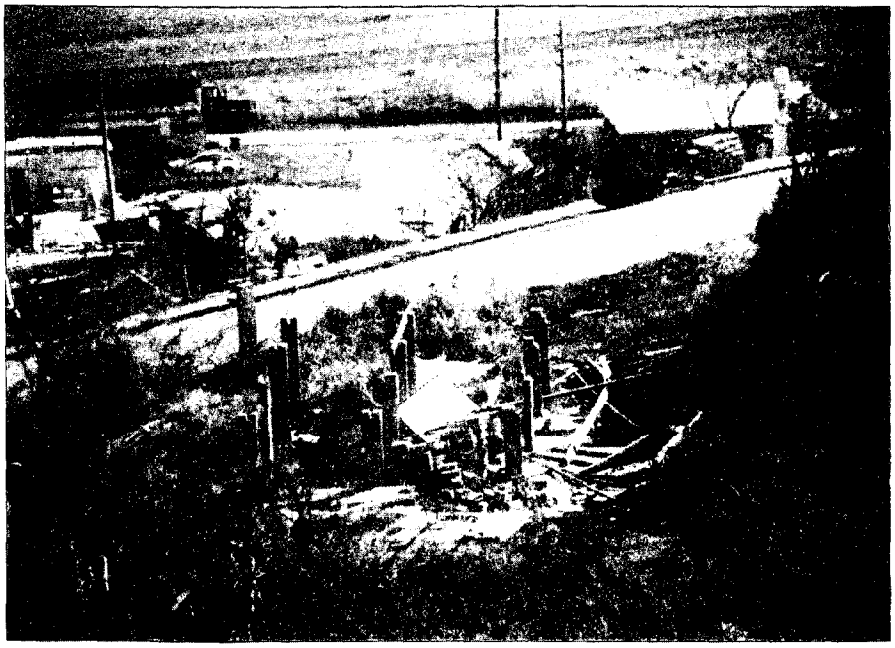

Figure 1-19. Home flipped off its pilings. (Photo courtesy of Reggina Garza)

Figure 1-20. Eroded streambed alongside airport on Culebra.
(Photo courtesy of Don Wernly)

The main island of Puerto Rico was not severely impacted by Marilyn although some strong winds and heavy rains did affect the island. The highest recorded wind gust was 58 mph at the U.S. Naval Station Roosevelt Roads, located at Ceiba on the extreme east end of the island. The Naval Station also had the lowest pressure in Puerto Rico with a reading of 996.5 mb at 2 a.m., AST, Saturday, September 16. Rainfall storm totals for the main island of Puerto Rico ranged from 3 to 7 inches. The maximum official rainfall amount was 7.2 inches at Toro Negro in the western interior section of the island. A higher unofficial report of 8.81 inches of rainfall was recorded at Rio Icacos near Naguabo at a USGS site.

The heavy rainfall over Puerto Rico ended by late afternoon on Saturday, September 16. Daily rainfall records show that most of the rain occurred on Saturday, except for the upper part of the Rio Grande do Loiza Basin where the maximum 24-hour precipitation was highest on Friday, September 15. Numerous mudslides were reported particularly in the eastern half of the island. See figure 1-21 for locations of mudslides.

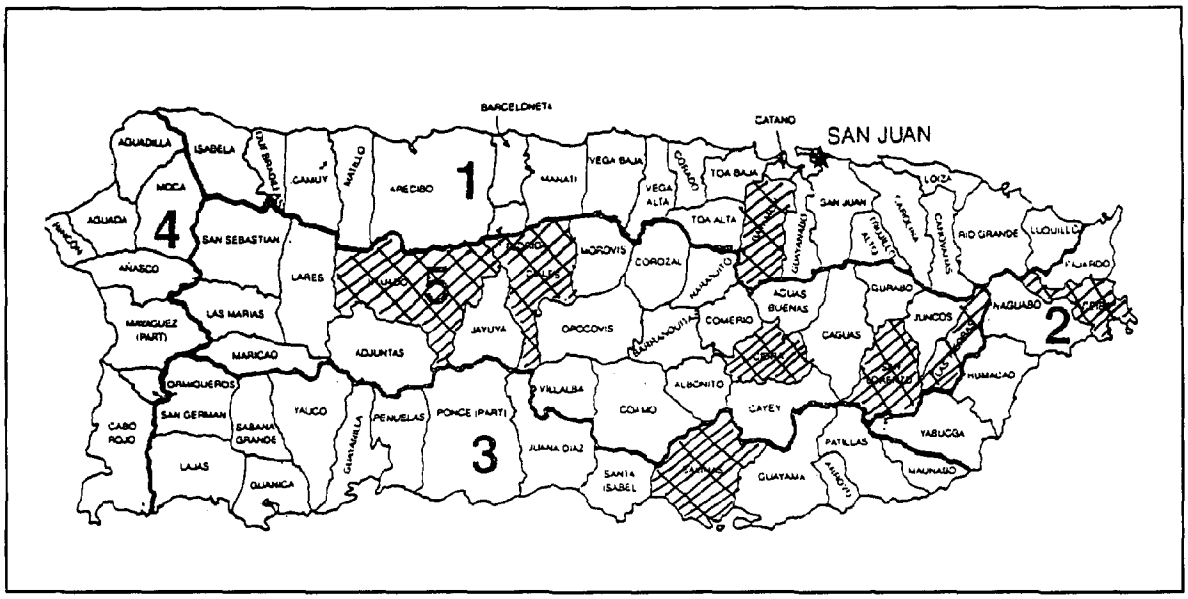

Figure 1-21. Hatched areas show general locations of mudslides on Puerto Rico. (Map prepared by Eloy Colon)

Along the northeast coast, the onshore wind flow led to reduced outflow from the rivers and resulted in some lowland flooding in that area. Flooding did not exceed any previous records but was significant in the east part of the island. See Appendix D, Preliminary USGS River Gage Heights and Discharges during Hurricane Marilyn. Only three locations registered heights exceeding flood stage—one in the Rio Grande de Manati Basin and two in the basin of the Rio de la Plata.

Chapter 2

Hydrometeorological Analysis

General Background

The 1995 Atlantic Basin hurricane season was the most active since 1933. By early September, 14 tropical depressions had formed, with 12 of these strengthening to tropical storm status. Of these 14, most originated as tropical waves coming off the African coast. Appendix E contains a description of the NHC models and the general process used at NHC in preparing tropical cyclone advisories.

The Development of Marilyn

In early September, the tropical waves did not significantly strengthen on or before moving off the African coast. Instead, strengthening was delayed until the tropical waves reached the central Atlantic. On September 10, 1995, the Synoptic Analysis Branch (SAB), located at the NCEP, noted a cloud system associated with a tropical wave centered near 9.4N, 34.7W. Over the next 2 days, this wave moved west and intensified as it came under the influence of an anticyclone aloft just east of the Leeward and Windward Islands. At 6 p.m., AST, Tuesday, September 12, the NHC issued the first advisory on Tropical Depression Fifteen, located at latitude 11.9N and 52.6W. The maximum sustained winds were estimated to be 35 mph, and the minimum central pressure was estimated at 1008 mb. Although a depression, this system was strengthening, and a tropical storm warning was issued for Barbados, while tropical storm watches were posted for St. Vincent, St. Lucia, the Grenadines, and Grenada.

At 11 p.m., AST, Tuesday, September 12, the depression was upgraded to Tropical Storm Marilyn, located at 12.1N, 53.9W, with estimated maximum sustained winds of 40 mph and a central pressure of 1005 mb. At this time, the Tropical Analysis and Forecast Branch at NHC and the SAB were using satellite imagery for classification of cyclone position and intensity. In each satellite observation, it appeared that Marilyn was moving nearly due west along latitude 12N. The final advisory without the benefit of aircraft reconnaissance data was issued at 11 a.m., AST, on Wednesday, September 13. At that time, the center of Marilyn was estimated near 11.7N, 56.2W, with maximum sustained winds near 50 mph and a minimum pressure of 999 mb.

At 11:54 a.m., AST, Wednesday, September 13, the first reconnaissance data on Marilyn indicated that the positions estimated by satellite were south of the actual circulation center. The center of Marilyn was repositioned to 12.5N and 56.5W. In addition, the minimum central pressure was determined to be 990 mb, or lower than in the previous satellite estimate. The relocation of the center, and the finding that the storm was more intense than had been estimated 4 hours earlier, meant that the computer models were initialized with a model storm that was too far south and probably too weak. The timing

of this information was such that it was not until 8 p.m., AST, that evening that this new information could be incorporated into the global models that serve as initial conditions for the dynamical models run for NHC. The continued strengthening and northward shift in initialized position prompted the issuance of hurricane warnings at 5 p.m., AST, Wednesday, September 13, for Barbados, St. Vincent, St. Lucia, and the Grenadines. A hurricane watch was issued for Dominica at the same time.

At 11 p.m., AST, Wednesday, September 13, while located at 13.1N, 58.6W, Marilyn was upgraded to a hurricane with maximum sustained winds of 75 mph and a minimum central pressure of 987 mb. The hurricane watch for Dominica was upgraded to a hurricane warning.

As Marilyn neared Barbados early on Thursday, September 14, hurricane warnings were issued for Martinique and recommended for Guadeloupe. At this time, the official forecast track of Marilyn was shifted more toward the west-northwest and then northwest in response to a weakness in the subtropical ridge over the central Atlantic. Marilyn continued to slowly strengthen. During the afternoon and evening of September 14, the storm passed 45 nautical miles (nm) north of Barbados, then just north of Martinique, over Dominica, and southwest of Guadeloupe. The maximum sustained winds observed on Dominica were 59 mph with gusts to near 85 mph. The island of Guadeloupe experienced extremely heavy rains with Saint-Claude measuring 20 inches in a 12-hour period.

Marilyn continued moving to the northwest and strengthened to a category 2 hurricane before hitting the island of St. Croix Friday afternoon, September 15. During this period, hurricane hunter aircraft reported hail, an unusual occurrence for a tropical cyclone, and noted a 20 nm diameter eye. The western portion of the eye crossed the eastern tip of St. Croix which placed the strongest winds offshore. Unfortunately, the strongest portion of the eastern eyewall moved across St. Thomas as Marilyn approached category 3 intensity. The gradual strengthening of Marilyn from a category 1 to near category 3 may have been due to the influence of an upper level low positioned to the west and northwest of Marilyn. This feature appeared to enhance the upper level outflow as determined by satellite imagery analysis.

After passing through the U.S. Virgin Islands, the island of Culebra was also heavily damaged. Marilyn passed just east of the main island of Puerto Rico early on Saturday, September 16. Upon passing to the north of Puerto Rico and the U.S. Virgin Islands, Marilyn was again over the Atlantic Ocean. The storm reached its peak intensity of 949 mb with sustained winds of 100 knots (kt) at 5 p.m., AST, on September 16, while moving north away from Puerto Rico and the U.S. Virgin Islands. Hurricane hunter aircraft found evidence of concentric eyewalls about this time, and as the interior eyewall disintegrated, dramatic weakening was observed.

Marilyn ceased generating deep convection late on September 21 after passing within 150 nm of Bermuda on September 19. The tropical cyclone was classified extratropical on September 22, and the remnants of the storm meandered in the central Atlantic for another 10 days before being absorbed into a frontal system.

Chapter 3

Preparedness Activities

Internal

NWS offices continually test their readiness through internal training and drills. WSFO San Juan conducted a number of drills during 1995, covering a wide variety of topics. These drills included hurricane operations, flood and flash flood services, and emergency operations during communications failures. The objective of these drills was to ensure that all office staff were familiar with emergency operations policies and to identify any areas that might have needed revision or enhancement.

External

In addition to ensuring their own readiness, a major function of each WSFO is to assist in the readiness and preparedness of the officials and general public in its area of responsibility. The San Juan WSFO takes this responsibility extremely seriously and conducts a highly aggressive and effective preparedness program. Each year, the WSFO MIC or the WCM contacts each emergency management director in the Commonwealth and the U.S. Virgin Islands.

For 1995, the WSFO assembled hurricane drill packages for Puerto Rico and the U.S. Virgin Islands for a March 13-14 exercise, "CARIBEX95." This drill included representatives from the 2nd Army and FEMA as well as the emergency management community. FEMA's requirement to move Hurricane Shelia at 60 mph was not as realistic and practical from the NWS operational perspective although it proved to be a healthy challenge in which to test the readiness and response activities of other organizations. Additionally, the WCM conducted two separate 3-day seminars on St. Croix and St. Thomas, covering hurricane planning, coordination, preparedness, operations, and tropical meteorology. The MIC also met with VITEMA representatives from St. Thomas and St. Croix to discuss hurricane forecasting issues and the NWS modernization and associated restructuring (MAR).

At the beginning of each hurricane season, the WSFO and the Puerto Rico Civil Defense collaborate to host a Commonwealth Hurricane Conference. The Conference was held in Caguas on June 14, 1995. The Conference was attended by about 400 emergency managers as well as other local government and Federal agencies. Main points of emphasis in the Conference included review of the previous hurricane season, hurricane preparedness, etc. This year, the WSFO also presented information on changes at NHC.

The WSFO organized a variety of preparedness activities throughout the year geared for school-age children and the general public. Members of the WSFO staff regularly participate as judges in island-wide science fairs. The staff also operated a hurricane

information booth at the Plaza Las Americas shopping center. The booth was one of the WSFO's more successful campaigns as nearly 10,000 people received valuable hurricane safety information. In all, WSFO San Juan conducted 48 public safety presentations during the year, with most of these presentations discussing hurricanes. A total of 15,785 people attended the programs. The programs conducted by WSFO San Juan were highly successful. See appendix F for a listing of the major preparedness programs that were conducted by the WSFO or in which they participated in the year prior to Marilyn.

All of the concerned agencies were familiar with the WSFO operations and the hurricane-related products issued by NHC and the WSFO during times of threatening weather. Local media and government officials knew who the primary contact points were at the WSFO. This knowledge and coordination likely contributed to the relatively small loss of life as Marilyn impacted the area.

Finding 3-1: WSFO San Juan conducted an aggressive preparedness education campaign with local emergency managers and the media in both Puerto Rico and the U.S. Virgin Islands.

Recommendation 3-1: The WSFO staff should continue these excellent efforts, with the WCM and MIC leading an areawide campaign.

A final aspect of the WSFO hurricane preparedness activities for 1995 was the participation in the annual NHC workshops. Each year, NHC hosts a series of 1-week workshops funded by FEMA for local and state emergency managers. The workshops feature discussions of NHC operations and products, hurricane tracking and forecasting, the effects of hurricanes, including storm surge, evacuation decisions, and evacuation exercises geared toward the home areas of the emergency managers. In 1995, representatives from Puerto Rico and the U.S. Virgin Islands were invited to attend one of these workshops. Figure 3-1 shows attendees at the NHC workshop. Approximately 15 people attended from Puerto Rico.

Finding 3-2: VITEMA officials were not able to attend the FEMA-funded training in hurricane preparedness that was conducted at NHC in January 1995. This training would have been useful in responding to the threat of Marilyn.

Recommendation 3-2: The NWS and FEMA should encourage VITEMA officials to take advantage of future training opportunities.

Discussions with the FEMA Region II Caribbean Desk Director revealed that the FEMA personnel could benefit from weather training as much as the emergency managers. The WSFO staff should pursue this opportunity to develop even closer bonds with FEMA.

NWS Headquarters has similarly developed an increasing working relationship with the FEMA national headquarters staff during the past several years. During Marilyn, NWS Headquarters personnel participated in FEMA-led coordination calls that included the director of FEMA, FEMA Region IV staff, Emergency Response Team members, and the local emergency manager in the affected islands.

Figure 3-1. NHC training class participants, showing WSFO San Juan and Puerto Rico Civil Defense staff members. (Photo provided by WSFO San Juan)

Finding 3-3: The coordination between NWS Headquarters and FEMA, prior to Marilyn's landfall, assisted FEMA in the prepositioning of recovery personnel and equipment.

Recommendation 3-3: Direct involvement of NHC and WSFO San Juan would have further enhanced FEMA's efforts with less potential for inconsistencies. NWS Headquarters should develop a formal plan for coordination between FEMA and the NWS field offices for implementation prior to the next hurricane season.

Local Non-NWS Preparedness Campaigns

Several of the emergency management and media officials in the affected areas conducted their own preparedness activities near the start of hurricane season. Some of these campaigns were coordinated with the WSFO while others were independent of the NWS.

Many of the media outlets in the San Juan area attended the pre-season hurricane preparedness conference conducted by the WSFO. The media used the information

distributed at this conference to prepare public service announcements (PSA), special reports, and other materials describing hurricane preparedness. Several of the San Juan television stations produced hurricane preparedness videos (with some assistance from the WSFO), while others translated private sector videos into Spanish. Several of the weathercasters provided preparedness talks to schools, focusing on hurricane terminology (watch versus warning, the difference between a hurricane and a tropical storm, etc.) and safety.

On the U.S. Virgin Islands, public preparedness campaigns were conducted by VITEMA and the local media. Local newspapers produced safety articles and brochures, and newspapers and television stations prepared and distributed hurricane tracking maps. Other radio stations prepared PSAs for periodic broadcast during the hurricane season.

Chapter 4

User Response

Introduction

WSFO San Juan communicated information, regarding Marilyn, in a variety of ways. The primary means of dissemination was NOAA Weather Radio (NWR) and the NOAA Weather Wire Service (NWWS). Local media and civil defense/emergency managers in the impacted area also took an active role in providing information to the citizens. Dissemination methods outside of the NWS ranged from facsimile transmissions to live television and radio broadcasts.

Finding 4-1: The NWWS is not affordable in the Caribbean with the result that there are very few drops in the region. Some NWS products, most notably the Short Term Forecast (NOW), were not broadcast by the media and were only available over NWR.

Recommendation 4-1: The NWS should work with emergency management officials, the media, and the private sector to explore additional opportunities for the delivery of critical weather information in the region.

Response in the Commonwealth of Puerto Rico

The San Juan NWS office has one NWR console with six playback decks. The console drives two transmitters, one located near San Juan and the other near Maricao. The limitation in playback deck space severely affected NWR programming during Marilyn. Since products were broadcast in English and Spanish, long tapes containing both versions needed to be prepared. The time involved in preparing these tapes led to a delay in broadcasting the updated information. Also, the lack of deck space limited San Juan's flexibility in preparing the NWR broadcasts.

Finding 4-2: There were too few playback decks on the San Juan old technology NWR console. This caused difficulty in preparing broadcast text and keeping the program up to date. Many emergency management officials and media outlets noted that the NWR Spanish broadcasts were not timely.

Recommendation 4-2: WSFO San Juan should be provided with a digital NWR console to improve the flexibility and reliability of the NWR programming system.

The Puerto Rico Civil Defense received weather information via NWR and NWWS. NWR was so valued by the Puerto Rico Civil Defense Headquarters in San Juan that they placed it on their telephone system for broadcast to persons on hold. Information from

NWWS is relayed to each of the nine regional civil defense offices. The Commonwealth Civil Defense communicated with local emergency management offices by radio network, facsimile transmission, and telephone. As Hurricane Marilyn approached, the Commonwealth Civil Defense and the Governor of Puerto Rico held press conferences updating citizens on the storm's status. The press conferences were broadcast by most of the local media.

Finding 4-3: The WSFO staff was invited to participate in the Governor's press conferences which were held at a considerable distance from the WSFO. Although these press conferences were highly effective, they placed an additional burden on the staff.

Recommendation 4-3: Plans should be developed for using the WSFO multi-purpose room as a media center with video-teleconferencing capabilities to provide briefings and conferences with local officials. Puerto Rico Civil Defense and the media have expressed a willingness to share costs in establishing this capability.

The media outlets in Puerto Rico were well prepared to handle the flow of information related to Marilyn. WKAQ radio, the Puerto Rico Common Program Control Station (CPCS-1) for the Emergency Broadcast System (EBS), had already upgraded to the Emergency Alert System (EAS). The EAS was activated four times during Marilyn, and all but one of the EBS stations on the island participated in the activations. The WSFO has been actively meeting and working with the EBS stations in the U.S. Virgin Islands to assist them in upgrading to the EAS. For example, a meeting was scheduled for the Monday following the passage of Marilyn but was canceled due to the widespread destruction.

Finding 4-4: The Commonwealth of Puerto Rico Civil Defense allows concerned agencies to directly coordinate with each other, regarding EBS/EAS activations, rather than forcing all coordination through the Emergency Operations Center. Except for the San Juan CPCS-1 station, however, broadcast stations in Puerto Rico and the U.S. Virgin Islands were not ready for the implementation of the new EAS.

Recommendation 4-4: The NWS should continue to work vigorously with the Federal Communications Commission and FEMA to establish the EAS in Puerto Rico and the U.S. Virgin Islands.

The direct coordination and activation of the EBS/EAS allowed time-critical weather information to be broadcast in a very efficient manner. This was perhaps a lesson learned from Hurricane Hugo when central control of the EBS by the civil defense delayed weather products in Puerto Rico.

Several of the local media outlets from Puerto Rico sent representatives to the WSFO and to the Commonwealth Civil Defense. The reporters stayed on-site at the WSFO for up to 38 hours. WSFO and civil defense staff provided frequent interviews during the event—as often as every half-hour during the most critical periods. Very few of the media outlets have NWWS so most of them were dependent on private vendors (WSI, Accu-Weather,

etc.) and local authorities for their information. Although a few outlets attempted to "hype" the approach of Marilyn and added their own speculation regarding the storm's forecasts, most were responsible and provided only official information.

Local government officials noted that the citizens of Puerto Rico responded well to the threat posed by Hurricane Marilyn. Publicity from the media, the Governor's press conferences, and the island's recent near-miss from Hurricane Luis helped raise the public's awareness of the threat and spurred them to make appropriate preparations as the storm approached.

Response in the U.S. Virgin Islands

- **St. Thomas**

NWR broadcasts are available on St. Thomas through a service contract with radio station WAH. The relationship between the NWS and WAH arose from a need to provide St. Thomas with NWR programming while expending a minimum of NWS funds on the operation. WAH receives information from WSFO San Juan via NWWS with telephone facsimile used as backup. WAH employees then prepare and broadcast the NWR programming. WAH's NWR transmitter operates at 100 watts, and it is sufficient for covering St. Thomas and St. John, but it is not powerful enough to reliably reach St. Croix. After the storm struck, WAH was off the air for several days while repairs were made to its antenna.

The St. Thomas office of the VITEMA has the U.S. Virgin Islands' NWWS drop provided by the NWS. The system was operational until late Friday evening. The VITEMA-St. Thomas office was also in frequent telephone contact with the WSFO. Coordination calls were made twice a day, beginning on Wednesday, September 13.

Overall, the VITEMA-St. Thomas staff were not satisfied with the information they received during the event. They felt that the forecast track information was good, but that the intensity was significantly under forecast. St. Thomas was impacted by Hurricane Hugo in 1989 and had recently had a close encounter with Hurricane Luis; both were large, powerful hurricanes. Marilyn caused damage on St. Thomas that was much more than the residents and officials expected. They apparently focused on an earlier description of Marilyn as a small category 1 hurricane and were not prepared for a direct hit from an intensifying storm. In fact, the 11 a.m., AST, Friday, September 15, NHC public advisory stated clearly that Marilyn was a category 2 hurricane. This issuance was about 12 hours prior to the hurricane striking St. Thomas. The headline from that advisory was "MARILYN APPROACHING THE U.S. VIRGIN ISLANDS AS A CATEGORY 2 HURRICANE ON THE SAFFIR-SIMPSON SCALE." Stronger terminology was included in the Tropical Cyclone Discussion (TCD) issued 7 to 8 hours before Marilyn's closest approach to St. Thomas which suggested Marilyn could become a category 3 before exiting the Caribbean, with the strongest winds spreading across St. Thomas. See Appendix G, Sample Products from NHC.

In spite of the claimed shortcoming of the forecasts and advisories, VITEMA was more proactive than during Hugo, with its hurricane action plan in operation a day before

Marilyn moved through the islands. It was noted that the products from NHC and the WSFO indicated that Marilyn was expected to continue to strengthen as it moved through the region.

Finding 4-5: On St. Thomas, both VITEMA and the public felt that they were not adequately apprised of what Marilyn's intensity would be once she made landfall.

Recommendation 4-5: NHC and WSFO personnel must continue to work with users to determine the best way to communicate intensity changes.

The St. Thomas media outlets' reaction was similar to that of the local officials. They also assumed that since Marilyn was a compact storm, much smaller than Hugo or Luis, it would be a fairly minor event. Very few of the St. Thomas stations subscribe to NWWS; most receive their weather information from the Associated Press (AP) wire service and the VITEMA office. The media felt that the forecast data they received was timely, and they began preparing for the storm as early as Wednesday. As with the VITEMA staff, though, they were not expecting such an intense storm.

- **St. Croix**

As described earlier, NWR is not reliably available on St. Croix. Thus, officials and residents on the island relied on VITEMA and local media for information on Hurricane Marilyn. The St. Croix VITEMA office also made direct contact with the WSFO in San Juan for information. While some aspects of dissemination and response were similar to those on St. Thomas, there were some noteworthy differences.

The VITEMA-St. Croix office does not have NWWS. They depend on the St. Thomas office to relay pertinent NWWS information to them via telephone facsimile. This system is generally acceptable, but if St. Thomas loses telephone, electric, or NWWS (as happened during Marilyn), then the information does not get to St. Croix. This had a considerable impact on VITEMA-St. Croix's operations. They were able to contact the WSFO via telephone, but the staff refrained from this whenever possible due to the time and workload demands at both offices.

VITEMA-St. Croix began activating their hurricane action plan about 2 days before the storm's arrival. The VITEMA deputy director notified the Governor and worked with the WSFO and local media early in Marilyn's development. Overall, VITEMA-St. Croix was satisfied with NWS products and services. VITEMA staff felt that the track forecast was slightly inaccurate, but they understood the errors inherent in tropical cyclone forecasting. There were a few questions about Marilyn's intensity forecast, but this issue was much less widespread than on St. Thomas. Interestingly, the VITEMA-St. Croix staff remarked that before Hugo, it had been 100 years since the island received a direct strike from a major hurricane. They had hoped that the 100-year cycle would continue; obviously, it did not.

The media on St. Croix handled the event much differently than on St. Thomas. Many of the media outlets dramatized the approaching storm and described the potential impacts

of the hurricane on the island. Some local officials viewed the media as overzealous and "hyping" the storm. However, this may have had the effect of spurring people on in their preparedness activities. WSTX Radio is the CPCS-1 station for St. Croix, and WSVI-TV is the primary television station for the island. Neither of these stations, nor any of the other media outlets on St. Croix, receive information via NWWS. Rather, they use the AP wire and the local VITEMA office as sources of weather data. The media were generally satisfied with the information they received, but some representatives expressed a need for more frequent (hourly) updates when hurricane landfall is imminent. WSFO San Juan issued short-term forecasts that would have met this need. However, without availability of NWWS, these were not received by many who needed them. Some of the media outlets broadcast hurricane safety rules in English and Spanish. However, all of the forecast and advisory information, regarding Marilyn, was broadcast only in English.

Figure 4-1. WSTX radio's tower collapsed during Marilyn. (Photo courtesy of Matt Stout)

Chapter 5

National Weather Service Performance

Operations at NHC and HPC

The initial NHC forecast track when Marilyn was a tropical storm moved the cyclone on a generally west track into the central Caribbean. Further forecasts (see figure 5-1), starting with the one issued at 6 p.m., AST, Wednesday, September 13, moved the track to the right of the original track or on a more northwest course. This northwesterly course was closer to the actual track that Marilyn followed over the next 3 days before exiting the Caribbean Sea north of Puerto Rico and the U.S. Virgin Islands. The eye of Hurricane Marilyn moved over the east part of St. Croix near 6 p.m., AST, Friday, September 15, and between St. Thomas and Culebra around 11 p.m., AST. See figure 5-2 for the NHC "best" track of Marilyn.

<u>Finding 5-1</u>: NHC's track forecasts for when Marilyn affected the U.S. Virgin Islands and Puerto Rico were highly accurate with errors less than one-third the usual magnitude.

The 36-hour forecast issued when the watch was posted was off by 46 nm compared to the long-term average of 150 nm. The 24-hour forecast issued when the warning was raised was off by only 8 nm compared to the long-term average of 100 nm. Corresponding intensity forecasts were about 10-15 kts too low which is slightly better than normal intensity forecast errors for a strengthening hurricane.

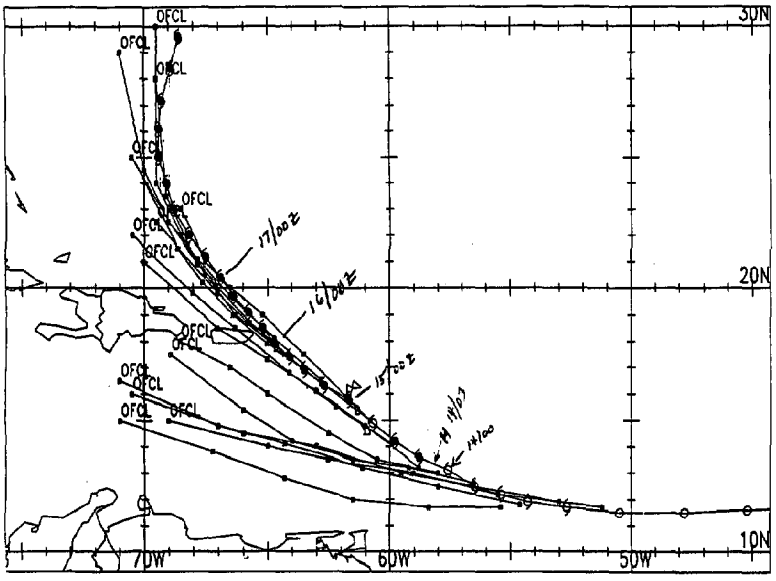

Figure 5-1. Composite of NHC forecast tracks associated with Marilyn. (Chart provided by NHC)

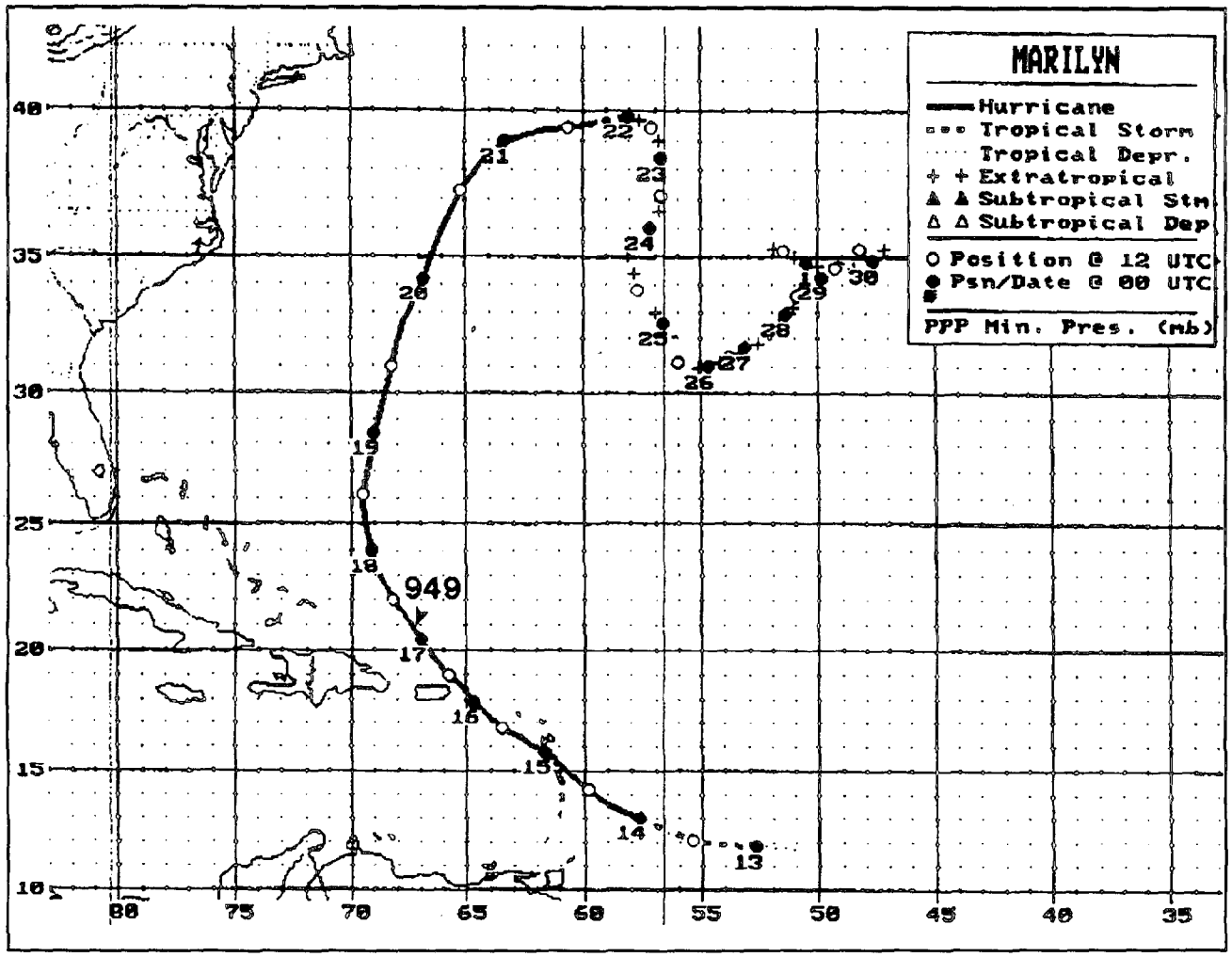

Figure 5-2. NHC's "best" track of Hurricane Marilyn.
(Chart provided by NHC)

NHC issued a hurricane watch for the U.S. Virgin Islands at 8 a.m., AST, Thursday, September 14, providing 33 hours of lead time. The hurricane watch was extended west to Puerto Rico and its islands at 5 p.m., AST, September 14. This provided 36 hours of preparation time for Culebra and Vieques. Hurricane warnings were issued for the U.S. Virgin Islands and Puerto Rico at 5 p.m., AST, September 14. This was 24 hours and 30 hours advance warning for the respective locations, including nearly a full daylight period for the U.S. Virgin Islands as is the NHC's goal in planning the issuance of warnings.

NHC coordinated closely with WSFO San Juan on the areas to be included and the timing of the warnings and watches and gave full weight to the WSFO suggestions. This coordination was facilitated by the use of the Hurricane Hot Line that was installed at WSFO San Juan after Hurricane Hugo struck the region in 1989. Additionally, the

coordination between NHC and HPC of the predicted positions was extremely smooth during Marilyn and reflects the increased cooperation apparent during the 1995 season.

There are several enhancements to the NHC operations that could improve the efficiency of the procedures in use for coordination and forecast communication to users.

Finding 5-2: The NHC telephone system became overloaded during storms when up to 1,200 calls an hour were received. At these times, the NHC staff could not make vital coordination calls.

Recommendation 5-2: A separate phone system should be provided to handle the recorded advisories. Isolating the NHC operational staff from that system will facilitate coordination and data collection.

Finding 5-3: In the event that NHC loses operational capabilities, the HPC of the NCEP may not be adequately prepared to provide immediate operational backup for NHC since the Backup Hurricane Operations Plan has not been fully tested.

Recommendation 5-3: The Backup Hurricane Operations Plan should be tested at least twice a year.

Despite the training provided by the WSFO, VITEMA-St. Thomas placed too much emphasis on the track and initial intensity of Marilyn when making preparations for the storm. Consequently, even though the storm moved very near to the forecast track and increased in intensity as forecast, the officials and populace were not prepared for the full fury of the storm.

Finding 5-4: A revised method of depicting both the official hurricane position and forecast track is needed to convey the radius of influence of the storm and the uncertainty in the forecast.

Recommendation 5-4: The NWS should work with its customers to identify new methods of representing both the radius of damaging winds and forecast track uncertainty.

Finding 5-5: Some users focused on several model scenarios presented in the TCD and, despite the reasoning presented in the products, made their own interpretations of the official NHC forecasts.

Recommendation 5-5: In order to discourage this practice, the TCD should convey first and foremost the official forecast track, with a discussion of forecast uncertainty due to differences between numerical models.

Meteorological Operations at WSFO San Juan

Finding 5-6: The entire WSFO San Juan staff showed great devotion to duty and exhibited the highest level of professional performance during Hurricane Marilyn.

Recommendation 5-6: The NWS should provide appropriate recognition for the WSFO San Juan staff.

Shortly after Marilyn formed on Tuesday, September 12, the office began coordination with the emergency management community and immediately began to provide interviews for the media, describing the potential peril. As the threat increased, the MIC and the WCM led a proactive and effective coordination effort with emergency management, media, and government officials. The MIC participated in several live telecast news conferences with the Governor of Puerto Rico, the Commonwealth Civil Defense director, the FEMA regional director, and several Commonwealth agency heads. This was a most effective way to inform the public of the impending threat. The effectiveness was amply demonstrated to the DST when the MIC was repeatedly recognized by many people while he escorted team members during the survey.

Following coordination with the WSFO, NHC included the U.S. Virgin Islands in the hurricane watch issued Thursday morning. This gave the U.S. Virgin Islands several additional hours to prepare for the hurricane. The WSFO action logs showed strong, proactive phone coordination was conducted with VITEMA at 4:30, 4:40, and 5:10 a.m., AST, Friday, September 15. This reinforced the warning information contained in NHC and WSFO products.

The WSFO prepared excellent Hurricane Local Statements (HLS). Three of note were issued at 2:45, 5:40, and 8:45 p.m., AST, Friday, September 15, and are contained in appendix H. These included specific information for St. Croix, St. Thomas, St. John, Culebra, Vieques, and extreme east Puerto Rico, concerning the timing of the beginning of hurricane conditions. Although the information contained in the HLS was excellent, they were cumbersome because they were all-inclusive. As discussed in chapter 4, this was caused in part by the need to have a single message for use on the old technology NWR console in use at the WSFO.

Finding 5-7: The WSFO San Juan's HLSs were too long which made it difficult for users to find specific information.

Recommendation 5-7: WSFO San Juan should segment their HLSs to ensure customers can quickly locate desired information.

Some of the products issued by the WSFO during Marilyn were not necessary. For example, coastal flood and heavy surf information should be highlighted in HLS only and offices should not issue separate products. This policy is outlined in Weather Service Operations Manual Chapter C-43, "Coastal Flood Program."

As the effects of Marilyn were being felt over the U.S. Virgin Islands and Puerto Rico, the WSFO prepared NOWs to complement their HLS. This was the first year for this policy,

and the San Juan office proved the effectiveness of this concept. Several of the NOWs contained particularly timely and powerful information to those at peril from Marilyn. An excellent example of the use of the NOW was the issuance at 10:05 p.m., AST, Friday, September 15, that indicated hurricane conditions were occurring across St. Thomas and St. John and rainfall rates exceeding 3 inches an hour were occurring. Appendix H also contains the San Juan NOWs issued between 6:50 and 10:05 p.m., AST, Friday, September 15.

The most significant problem discovered with the NOW program was that few of the mass media disseminators relay the NOW to users. It appears that cable television, i.e., The Weather Channel, was the only dissemination vehicle for this effective product in the Caribbean region. This may also be true in other locations around the country. All WCMs need to conduct aggressive education programs to ensure that all users/customers of NWS products are aware of the NOW product.

Finding 5-8: Although the WSFO issued effective short-term forecasts to complement their HLSs and provide additional details on Marilyn, further specificity would have been available if the WSR-88D was installed.

Recommendation 5-8: The WSR-88D should be installed, accepted, and commissioned as soon as possible.

WSFO San Juan used the HURRTRAK software, designed to display tropical cyclone positions and forecast information, and a laptop computer to conduct briefings for Commonwealth and local government officials. The HURRTRAK software, which was provided by SRH, allowed the MIC and WCM to develop detailed, high resolution briefing materials centered on Puerto Rico and the U.S. Virgin Islands.

Hydrological Operations at WSFO San Juan

As already noted, the hurricane watch for the U.S. Virgin Islands and Puerto Rico was upgraded to a hurricane warning on Thursday evening, September 14. That advisory indicated that 5 to 8 inches of rain were possible along the path of the hurricane. Flash flooding and the possibility of mudslides over mountainous terrain were major concerns at the WSFO. Therefore, at 5:30 p.m., AST, Thursday, September 14, the WSFO issued a flash flood watch (FFA) for the U.S. Virgin Islands. As Marilyn continued on a course that would impact the region, the WSFO issued a flash flood warning (FFW) for all of the U.S. Virgin Islands at 9 a.m., AST, on Friday, September 15.

For Puerto Rico and the islands off the eastern tip of the mainland, a FFA for all of Puerto Rico was released at 2:30 p.m., AST, Friday, September 15. As the hurricane tracked closer and based on the rainfall reports from the area plus the response of the rivers on the main island of Puerto Rico, a FFW was issued for the east half of Puerto Rico, including Vieques and Culebra at 5:15 p.m., AST, on Friday, September 15. See figure 5-3. At 9:23 a.m., AST, Saturday, September 16, the warning was extended to include the northwest part of the main island as it was being impacted by the spiral bands from Marilyn. See figure 5-4. Although this warning applied to a large area and several rivers were involved, retrospective data showed that only two of them went above

flood stage: Rio Grande de Manati and Rio de la Plata. See Appendix D, Preliminary USGS River Gage Heights and Discharges during Hurricane Marilyn. Rio de la Plata crested about 22 hours after the FFW for that area had been issued, while for the area drained by the Rio Grande de Manati, the FFW was issued 3 hours before it crested. Figure 5-5 shows the rainfall distribution from Marilyn across Puerto Rico.

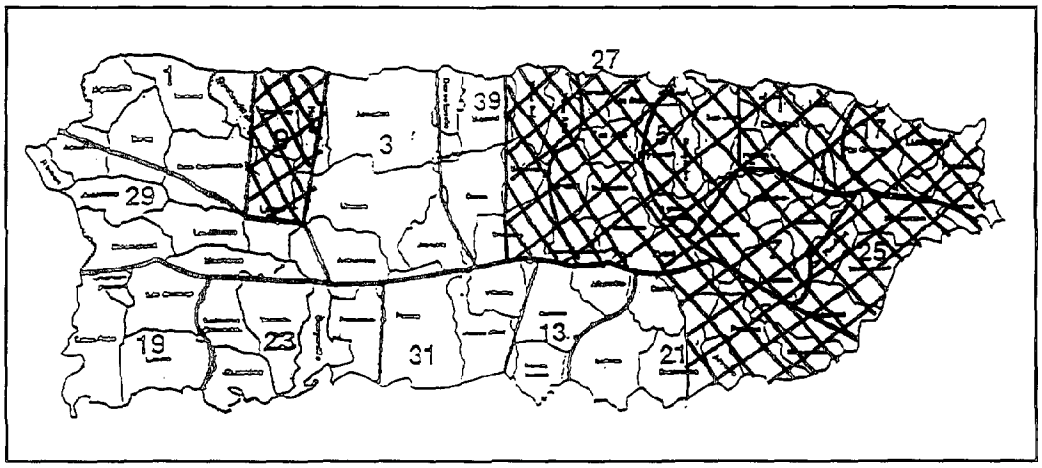

Figure 5-3. Map showing FFW areas effective 5:15 p.m., AST, Friday, September 15. (Map courtesy of WSFO San Juan)

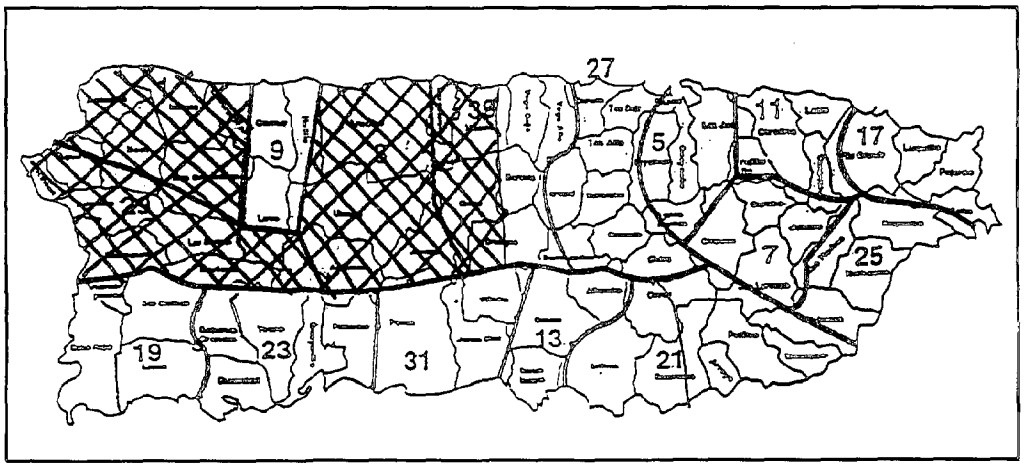

Figure 5-4. Map showing FFW areas effective 9:23 a.m., AST, Saturday, September 16. (Map courtesy of WSFO San Juan)

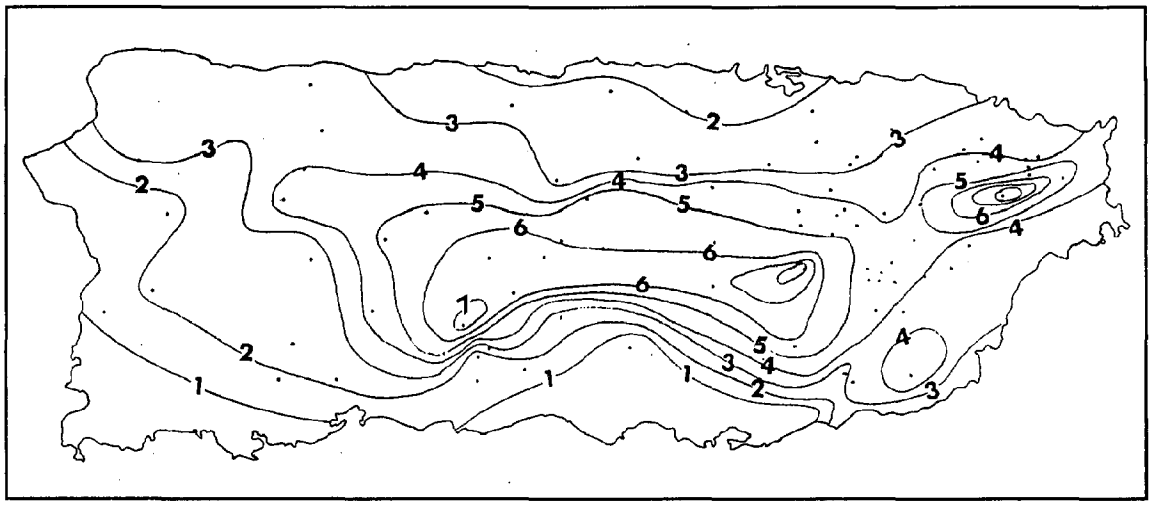

Figure 5-5. Map showing rainfall distribution from Marilyn across Puerto Rico. (Map courtesy of Reggina Garza, using USGS data)

Hydrologic data collection at WSFO San Juan is accomplished through a variety of systems. For example, in Puerto Rico, the civil defense contracted with private industry to provide, through the Automated Local Evaluation in Real Time system, rainfall and river gage readings for many locations in Puerto Rico. The USGS has a separate system spread across Puerto Rico and the U.S. Virgin Islands. Siting and maintenance requirements of the systems not under the control of the WSFO make it difficult to get sufficient data density throughout the WSFO area of responsibility. Therefore, while much of the hydrologic data was valuable during Marilyn, there was some question about the specific values from certain gages. Those responsible for operation of the USGS gages, however, were quite responsive before, during, and after Marilyn and provided valuable assistance to the WSFO.

Finding 5-9: The hydrologic data collection network in the WSFO area of responsibility is insufficient. This hampered efforts to determine how much rain fell throughout the region during Marilyn. In the past, the WSFO has provided warnings with only qualitative data reports.

Recommendation 5-9: The hydrologic data collection network should be expanded, taking into consideration (a) required density of gages, (b) adequacy of maintenance of gages, and (c) reliability of the communications link to the WSFO.

The WSFO was scheduled to begin using the NWS hydrologic data collection system, HYDROMET, for access and collection of rainfall and river gage information in December 1995. This should help to improve the data availability, allow the WSFO to quality control the data in real-time, and at the same time reduce the cost to collect the data.

Once each week, the WSFO in San Juan prepares their own Flash Flood Guidance (FFG). At most other locations in the NWS, this is a responsibility of the servicing River Forecast

Center (RFC). RFCs generally update the FFG on a daily basis. In Puerto Rico, on September 15, the conditions used to generate the FFG were from September 8 and indicated saturated soils in most of Puerto Rico.

It is unlikely that the WSFO would not have issued a FFA with a hurricane approaching. However, under the existing system of local preparation of the FFG, it was likely that the program did not reflect current conditions as well as it would have if the FFG were updated daily. The WSFO, SRH, and the SERFC were aware of the need to update the San Juan FFG system prior to the occurrence of Marilyn, but due to the busy hurricane season, planned trips to the WSFO by SRH and SERFC personnel were postponed. The computer program used to generate FFG for Puerto Rico and the U.S. Virgin Islands was being further evaluated at the time of the preparation of this Report in order to speedily improve the entire hydrologic guidance system.

Appendix A

Listing of Deaths
Directly Associated with Hurricane Marilyn

Sex	Age	Location	Cause
Woman	48	St. John	Drowning
Man	40	St. Thomas	Drowning
Man	62	St. Thomas	Drowning
Man	50	St. Thomas	Drowning
Man	50	St. Thomas	Head Trauma
Man	65	St. Thomas	Drowning
Man	53	Culebra	Drowning
Man	60	St. Croix	Drowning

Appendix B

Saffir-Simpson Hurricane Scale*

Category	Definition—Likely Effects
ONE	**Winds 74-95 mph:** No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal road flooding and minor pier damage.
TWO	**Winds 96-110 mph:** Some roofing material, door, and window damage to buildings. Considerable damage to vegetation, mobile homes, and piers. Small craft in unprotected anchorages break moorings.
THREE	**Winds 111-130 mph:** Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.
FOUR	**Winds 131-155 mph:** More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Major damage to lower floors of structures near the shore. Terrain may be flooded well inland.
FIVE	**Winds greater than 155 mph:** Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.

* In operational use, the scale corresponds to the 1-minute average sustained wind speed as opposed to gusts which could be 20 percent higher or more.

Appendix C

Report on Aerial Survey of Damage from Hurricane Marilyn

Introduction

After Hurricane Marilyn passed across the U.S. Virgin Islands on September 15-16, 1995, NWS Headquarters requested an aerial damage survey. On September 19 and 20, an aerial survey was conducted using a Puerto Rico National Guard UH-1 Huey Helicopter. Brian E. Smith, WCM, WSFO Omaha, Nebraska, led the survey and was accompanied by Rafael Mojica, WCM, of the San Juan WSFO; two employees of the USGS; and a cameraman from the Puerto Rico Public Broadcast television station, Channel 6. Total flight time on these 2 days was around 16 hours.

More than 800 photographs were taken over damage areas of the islands of Culebra, Vieques, St. Thomas, St. John, and St. Croix. The following describes the destruction encountered on each island.

- **Culebra**

The island of Culebra is located approximately 20 miles east of the east tip of Puerto Rico and about 15 miles west of St. Thomas. Hurricane Marilyn moved between Culebra and St. Thomas. Thus, Culebra would have had winds from the north or northeast (first wind) as the hurricane moved east and southeast of the island. These winds shifted to the northwest (second wind) as the hurricane moved northeast of Culebra. From the aerial survey, Culebra was struck by both the first and second winds. But the second wind, coming out of the northwest was the most prevalent. This could either be the result of strengthening of the storm as it was nearing St. Thomas or because the island was physically closer to the damaging winds from the storm. Much of the island is rural and mountainous, with much of the population living in the town of Dewey, located on the southwest portion of the island. This is where the bulk of the wind damage occurred.

Damage was also noted over the northeast part of the island, especially with structures on peaks or ridge lines. The majority of damage to structures was due to the loss of roofs. Some structures did sustain outer wall failures, but some of these were most likely from substandard construction. In the town of Dewey, damage was also primarily limited to roof failure. Also at the airport, aircraft were flipped over. Peak gusts on Culebra appear to be in the upper F1 range (around 100 mph) on the Fujita Tornado Intensity Scale. (See table at the end of this appendix for a description of the Fujita scale.)

- **Vieques**

Vieques is another island that is located 10 miles to the southeast of the mainland. The major town is Isabel Segunda, which is located on the north side of the island. Some damage from northwest winds was noted at Isabel Segunda, but it was minimal. Unfortunately, because of restricted airspace, we could not survey the east half of the island which probably sustained damage similar to the island of Culebra.

- **St. Thomas**

By far, the worst damage from Hurricane Marilyn was on the island of St. Thomas. Nearly 75 percent of all buildings sustained damage. Maximum damage appears to be on the high end of F2 (115-157 mph). It is estimated that peak gusts on the island reached around 140 mph. Besides structural damage, much of the island's trees were defoliated. The center of Marilyn's track moved from south St. Thomas to just west of the island. Because of this, the island was subject to two major winds. The first wind occurred when the center of Marilyn was south of the island after crossing St. Croix. The main wind affecting St. Thomas at this time was a northeast wind. Because of the east-west mountain ridge line that runs across much of the island, primarily the north side of the island felt the effects of this wind. Several areas on the north side did reach F2 winds, perhaps with gusts to 120 mph. The most severe damage to residences occurred between Mandal and Frydendal. Numerous roofs of homes were blown off and some buildings were flattened.

As Marilyn moved north-northwest, the storm slowed down. This allowed the second wind from the south to pound St. Thomas for a long period of time. This time, winds were predominately confined to the south side of the island. There were some exceptions, such as the area between Mandal and Frydendal on the north side, which was affected by both the first and second wind. This was due to the mountain ridge line splitting on the east side of the island and a major valley in the Red Hook area. The south wind flowed up the valley to the northeast side of the island. Again, winds reached F2 strength and in some cases a strong F2 (approximately 140 mph). Funneling effects from the wind were quite evident in the Nadir region. Winds funneled up this valley and produced strong F2 damage to residences. Other vulnerable areas were exposed structures built along ridge lines that bore the full brunt of the winds. Some areas on the east side of Charlotte Amalie also had severe damage. Some factory buildings were severely damaged and some homes were torn apart. The west side had damage as well, but some structures were protected by Hassel Island and Water Island.

Another area which had extreme destruction was just east of the airport. Large oil storage tanks had their tops peeled off by the winds. Several residential complexes on the south side of the West End had lost roofs or outer walls. The Air Traffic Control radar on top of Klok Hill on the West End was torn off of its tower.

In final analysis, topography played a key role in damage on the island. Unfortunately, topography, in some cases, enhanced the wind damage. Building construction probably also played a key role in determining whether a structure was damaged severely or not.

It is uncertain what building codes or standards are on St. Thomas, but stringent codes on construction, hurricane clips, or bracing would have helped save some of the structures.

- **St. John**

St. John is located immediately to the east of St. Thomas (approximately 3 miles). Much of the island is very mountainous. The eastern two-thirds of the island are a national forest with few structures. The majority of the population lives in the town of Cruz Bay, which is located on the western tip of the island. Damage was not as severe as on St. Thomas. Estimates of peak gusts were on the high end of F1 (100-110 mph). Some buildings in Cruz Bay were sheltered by the high winds. However structures on ridge lines and hill peaks had the worst damage. Another area where damage was severe to buildings were on points. Since points of land were relatively unobstructed, the full force of the wind buffeted the buildings.

Identifiable damage extended to eastward for about 2 1/2 miles along the south coast. The north side of the island received little damage except for some defoliation of trees.

- **St. Croix**

The island of St. Croix is located about 50-60 miles southeast of the eastern tip of Puerto Rico. This island has two major cities, Christiansted, located on the north-central part of the island, and Frederiksted, located on the west side. Although the island is primarily mountainous, there is a large plain area on the south and west sides. Damage on the island appeared to be scattered, with some structures having considerable damage and others not. Improvements in building construction since the island was devastated by Hurricane Hugo in 1989 may have played a role in limiting the damage on the island.

From the aerial survey, the eye of Marilyn appears to have crossed the island just east of Christiansted. Radar data from San Juan also supports this. Much of the western part of the island was affected by a west or northwest wind, while the area east of Christiansted had southeast and northeast winds as the eye moved north across the island. Much of the damage was in the F1 range. Some structures that were hit hard were substandard construction, such as Kingshill, a poorer area of the island.

However, some structures survived the wind which had gusts up to 110 mph. Another area which sustained damage was east of Frederiksted. This area is a flat region with little trees to obstruct the wind flow. The airport also sustained damage as hangers were severely damaged and several small aircraft were flipped.

Conclusions and Acknowledgements

Hurricane Marilyn inflicted severe damage to the U.S. Virgin Islands and the island of Culebra as it moved across the eastern side of St. Croix to west of St. Thomas. The hurricane strengthened while it was located in the Caribbean Sea south of St. Thomas, which was severely impacted by an extended period of damaging winds. Construction

practices as well as topography played an important role in the amount of destruction that took place.

I would like to thank Skip Wright and Bobbie Palmer from the Office of the Federal Coordinator for Meteorological Services and Supporting Research in assisting with necessary arrangements for the survey. I would also like to thank Israel Matos, MIC, and Rafael Mojica, WCM, of the San Juan WSFO for their support in obtaining maps, helicopter, and ground transportation for the survey team. I wish to thank the entire WSFO San Juan staff for their gracious help during my stay in San Juan. Also, a hearty thanks to the Puerto Rico Army National Guard for supplying the Huey helicopter and their excellent crews we had during the survey. Finally, many thanks to Don Wernly, NWS Headquarters, for making this survey possible.

Fujita Tornado Intensity Scale*

Category	Definition-Effective
(F0)	**Gale tornado (40-72 mph): Light damage.** Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage sign boards.
(F1)	**Moderate tornado (73-112 mph): Moderate damage.** The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads.
(F2)	**Significant tornado (113-157 mph): Considerable damage.** Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
(F3)	**Severe tornado (158-206 mph): Severe damage.** Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
(F4)	**Devastating tornado (207-260 mph): Devastating damage.** Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.
(F5)	**Incredible tornado (261-318 mph): Incredible damage.** Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

* Note that this scale was developed in the U.S. Midwest and is based on the building practices and codes in effect there.

Appendix D

Preliminary USGS River Gage Heights and Discharges during Hurricane Marilyn

Summary of gage heights and discharges during Hurricane Marilyn floods of September 15-16, 1995 at selected U.S. Geological Survey streamflow gaging stations throughout Puerto Rico and the U.S. Virgin Islands

STATION NUMBER	STATION NAME	DRAINAGE AREA mi2	PERIOD OF RECORD	MAXIMUM PREVIOUSLY RECORDED				RECURRENCE INTERVAL Yrs	DAY	MAXIMUM DURING SEPT. 15-16, 1995 FLOOD		
				DATE	GAGE HEIGHT ft	DISCHARGE				GAGE HEIGHT ft	DISCHARGE	
						ft^3/sec	$ft^3/sec/mi^2$				ft3/sec	ft3/sec/mi2
50010500	Rio Guajataca at Lares PR	3.16	1969-95	10/07/90	21.30	5300			16	10.10	282	
50014600	Rio Camuy at Tres Pueblos Sinkhole, Lares PR	ND	1990-95	10/31/91	12.42	1030	ND		16	10.78	671	ND
50014800	Rio Camuy nr Bayaney, PR	ND	1984-95	10/07/85	17.66	6450	ND		16	11.96	2220	ND
50015700	Rio Camuy nr Hatillo, PR	ND	1984-95	10/07/85	27.75	10700	ND		16	18.48	4650	ND
50021700	Rio Grande de Arecibo abv Utuado, PR	36.0							16	11.25	S.O.	
50025155	Rio Saliente at Coabey nr Jayuya, PR	9.25	1989-95	06/02/94	13.92	5900			16	11.41	2690	
50027750	Rio Grande de Arecibo abv Arecibo, PR	200	1982-95	05/18/85	18.22	45800			16	12.32	8240	
50028000	Rio Tanamá nr Utuado PR	18.4	1960-95	05/18/85	17.45	12200						
50028400	Rio Tanamá at Charco Hondo PR	57.6	1969-95	05/18/85	17.95	15000						
50030460	Rio Orocovis at Orocovis PR	5.03	1981-95	01/05/92	11.53	2320			16	11.14	1020	
50031200	Rio Grande de Manatí nr Morovis PR	55.2	1965-95	05/18/85	17.89	48000			16	5.90	2830	
50034000	Rio Bauta nr Orocovis PR	16.7	1969-95	10/09/70	21.90	17800			16	11.68	1650	
50035000	Rio Grande de Manatí at Ciales PR	128	1946-95	10/09/70	24.00	125000			16	8.59	12400	
50038100	Rio Grande de Manatí at Hwy 2 nr Manatí PR	197	1970-95	10/07/85	33.79	97200			16	31.17	35000	
50038320	Rio Cibuco blw Corozal PR	15.1	1969-95	11/07/79	19.80	13600			16	8.90	1410	
50039500	Rio Cibuco at Vega Baja PR	99.1	1973-95	04/12/87	19.10	34000			16	14.83	2770	
50043000	Rio de la Plata at Proyecto La Plata PR	63.0	1960-95	01/05/92	36.39	73600			16	13.39	9610	
50043800	Rio de la Plata at Comerio PR	109	1989-95	01/05/92	29.22	127000			16	11.71	11600	
50044830	Rio Guadiana at Guadiana PR	9.19	1990-95	01/05/92	13.36	6670			16	7.89	1270	
50045010	Rio de la Plata blw La Plata Damsite PR	173	1989-95	01/05/92	34.76	127000			16	17.24	20300	
50046000	Rio de la Plata at Hwy 2 at Toa Alta PR	208	1960-95	01/05/92	26.39	118000			16	19.60	25400	
50047560	Rio de Bayamón blw Lago de Cidra PR	8.31	1991-95	07/11/93	16.56	2090			16	8.80	18	
50047850	Rio de Bayamón nr Bayamón PR	41.8	1964-95	10/09/70	20.20	28000			16	10.00	2880	
50048770	Rio Piedras at El Señorial PR	7.49	1988-95	08/24/88	16.08	4680			16	7.54	518	
50049100	Rio Piedras at Hato Rey PR	15.2	1972-95	06/17/70	20.77	8640			16	11.81	1800	
50050900	Rio Grande de Loiza at Quebrada Arenas PR	6.00	1978-95	11/05/83	14.78	11700			16	7.43	1190	
50051150	Quebrada Blanca at El Jagual PR	3.25	1984-95	05/17/85	14.58	7400			16	6.20	215	
50051180	Quebrada Salvatierra nr San Lorenzo PR	3.74	1984-95	05/17/85	17.10	9320			16	6.89	594	
50051310	Rio Cayaguas at Cerro Gordo PR	10.2	1977-95	08/31/79	9.44	13200			16	5.99	182	
50051800	Rio Grande de Loiza at Hwy 183 San Lorenzo PR	25.0	1990-95	01/05/92	27.36	28200			16	11.79	2280	
50053025	Rio Turabo abv Borinquen, PR	7.14	1990-95	01/05/92	14.37	3590			16	10.83	973	
50055000	Rio Grande de Loiza at Caguas PR	89.8	1960-95	09/06/60	31.17	71500			16	13.61	9400	
50055100	Rio Caguitas nr Aguas Buenas PR	5.30	1990-95	09/18/93	18.28	2290			16	12.85	596	
50055170	Rio Caguitas nr Caguas PR	8.27	1992-95	09/18/93	26.10	3010			16	21.32	347	

Summary of gage heights and discharges during Hurricane Marilyn floods of September 15-16, 1995 at selected U.S. Geological Survey streamflow gaging stations throughout Puerto Rico and the U.S. Virgin Islands

STATION NUMBER	STATION NAME	DRAINAGE AREA mi2	PERIOD OF RECORD	MAXIMUM PREVIOUSLY RECORDED				RECURRENCE INTERVAL Yrs	D A Y	MAXIMUM DURING SEPT. 15-16, 1995 FLOOD		
				DATE	GAGE HEIGHT ft	DISCHARGE ft^3/sec	DISCHARGE $ft^3/sec/mi^2$			GAGE HEIGHT ft	DISCHARGE ft3/sec	DISCHARGE ft3/sec/mi2
50055225	Rio Caguitas at Villa Blanca at Caguas PR	11.71	1991-95	01/05/92	19.91	13400			16	11.27	1010	
50055390	Rio Bairoa at Bairoa PR	5.08	1991-95	01/05/92	12.32	1580			16	8.13	286	
50055750	Rio Gurabo blw El Mango PR	22.3	1990-95	11/08/91	17.38	5870			16	15.32	3070	
50056400	Rio Valenciano nr Juncos PR	16.4	1971-95	12/08/87	25.63	40000			15	8.09	1990	
50057000	Rio Gurabo at Gurabo PR	60.2	1960-95	09/06/60	27.70	74600			16	15.36	4660	
50058350	Rio Cañas at Rio Cañas PR	7.53	1990-95	10/17/90	20.55	3830			16	13.01	545	
50059050	Rio Grande de Loiza blw Damsite PR	209	1987-95	11/27/87	39.57	124000			15	20.25	22004	
50061000	Rio Grande de Loiza at Carolina PR	243							15	19.13	S.O.	
50061800	Rio Canovanas nr Campo Rico PR	9.84	1967-95	09/13/82	13.10	15000			15	9.75	1960	
50063440	Quebrada Sonadora nr El Verde PR	1.01	1983-95	12/07/87	9.42	2230						
50063500	Quebrada Toronjo at El Verde PR	0.064	1983-95	08/13/90	2.61	101			16	1.64	14	
50063800	Rio Espiritu Santo nr Rio Grande PR	8.62	1966-95	08/13/90	15.74	19200			16	6.29	1760	
50064200	Rio Grande nr El Verde PR	7.31	1967-95	09/16/75	15.50	17400			15	8.68	947	
50065500	Rio Mameyes nr Sabana PR	6.88	1967-95	09/18/89	13.91	20500			16	5.05	1180	
50067000	Rio Sabana at Sabana PR	3.96	1980-95	01/05/92	19.74	9600			16	12.08	1460	
50071000	Rio Fajardo nr Fajardo,PR	14.9	1961-95	09/18/89	20.00	23500			16	6.07	2120	
50074950	Quebrada Guaba nr Naguabo PR	0.05	1992-95	05/01/93	10.11	64			15	8.65	0.55	
50075000	Rio Icacos nr Naguabo PR	1.26	1945-95	04/21/83	8.96	2860			16	3.89	335	
50081000	Rio Humacao at Las Piedras PR	6.65	1974-95	09/06/60	34.40	20800			16	2.66	304	
50090500	Rio Maunabo at Lizas PR	5.38	1971-95	09/20/94	17.46	9950			16	6.42	434	
50092000	Rio Grande de Patillas nr Patillas PR	18.3	1966-95	01/05/92		30900			16	7.56	1340	
50100200	Rio Lapa nr Rabo del Buey PR	9.92	1988-95	01/05/92	17.82	15700						
50100450	Rio Majada at La Plena PR	16.7	1973-95	01/05/92	17.19	1520						
50106100	Rio Coamo at Coamo PR	43.5	1987-95	09/06/60	34.40	20800			16	5.83	196	
50108000	Rio Descalabrado nr Los Llanos PR	12.9	1966-95	10/07/85	24.37	30000						
50110900	Rio Toa Vaca abv Lago Toa Vaca PR	7.64	1989-95	01/05/92	13.24	8700			16	7.64	1880	
50111500	Rio Jacáguas at Juana Díaz PR	49.8	1984-95	10/07/85	29.42	40000			16	5.99	62	
50112500	Rio Inabón at Real Abajo PR	9.70	1964-95	10/07/85	25.30	19000			16	5.05	311	
50113800	Rio Cerrillos abv Lago Cerrillos nr Ponce PR	15.4	1989-95	01/05/92	9.65	8140			16	5.15	1620	
50114000	Rio Cerrillos blw Lago Cerrillos nr Ponce PR	17.8	1991-95	01/06/92	6.07	1100			16	3.57	175	
50114390	Rio Bucaná at Hwy 14 Bridge nr Ponce PR	24.9	1987-95	10/07/85	13.48	17400			16	7.95	137	
50115000	Rio Portugues nr Ponce PR	8.82	1964-95	10/07/85	20.20	21000			16	5.68	779	
50124200	Rio Guayanilla nr Guayanilla PR	18.9	1981-95	09/12/82	20.40	14700			15	5.78	< 10	

Summary of gage heights and discharges during Hurricane Marilyn floods of September 15-16, 1995 at selected U.S. Geological Survey streamflow gaging stations throughout Puerto Rico and the U.S. Virgin Islands

STATION NUMBER	STATION NAME	DRAINAGE AREA mi2	PERIOD OF RECORD	MAXIMUM PREVIOUSLY RECORDED				RECURRENCE INTERVAL Yrs	D A Y	MAXIMUM DURING SEPT. 15-16, 1995 FLOOD		
				DATE	GAGE HEIGHT ft	DISCHARGE ft³/sec	DISCHARGE ft³/sec/mi²			GAGE HEIGHT ft	DISCHARGE ft3/sec	DISCHARGE ft3/sec/mi2
50131990	Rio Guanajibo at Hwy. 119 at San Germán PR	34.6	1991-95	01/06/92	13.23	6610			16	8.66	1510	
50136400	Rio Rosario nr Hormigueros, PR	18.3	1986-95	08/24/88	13.64	7480			16	6.33	844	
50138000	Rio Guanajibo nr Hormigueros PR	120	1973-95	09/16/75	28.50	128000			16	17.10	1090	
50144000	Rio Grande de Añasco nr San Sebastian PR	134	1963-95	09/16/75	33.90	140000			16	8.40	7830	
50147800	Rio Culebrinas at Hwy 404 nr Moca PR	71.2	1967-95	09/16/75	36.60	69000			16	16.53	2980	
50232000	Quebrada La Mina nr Esperanza, Vieques PR	0.68							16	9.11	S.O.	
50252000	Bonne Resolution Gut at Bonne Resolution, St. Thomas USVI	0.49	1963-95	04/18/83	7.00	1650			15	3.28	164	
50274000	Turpentine Run at Mt. Zion, St Thomas USVI	2. 33	1963-95	05/23/69	5.00*	5415			16	10.76	4580	
50295000	Guinea Gut at Bethany, St. John USVI	0.37	1963-95	04/18/83	5.33	946			15	3.52	268	
50333500	River Gut at Golden Grove, St. Croix USVI	5.40							16	97.00	S.O.	
50333700	River Gut at Fairplains, St. Croix USVI	5.89							16	90.18	12	
50334500	Bethlehem Gut at Fairplains, St. Croix USVI	4.11							16	99.26	24	
50345000	Jolly Hill at Jolly Hill, St. Croix USVI	2.10	1964-95	11/07/84	4.33*	491			15	15.38	936	

ND - Not determined
S.O. - Stage only
* - Datum then in use

Appendix E

Description of NHC Forecast Procedures and Forecast Errors Associated with Hurricane Marilyn

The forecast process applied to tropical cyclones is one of conveying the critical concept of uncertainty to a general public in search of pinpoint accuracy in, quite possibly, a life and death situation. NHC is tasked with forecasting the location, motion, maximum sustained winds, maximum wind gusts, and radii of 34 kt, 50 kt, and 64 kt winds for each tropical cyclone in its area of responsibility. In addition, information on cyclone intensity, storm surge, precipitation, and possible tornadic activity are included in each advisory.

To accomplish these tasks, the NHC hurricane specialist must assimilate all the available data (satellite, reconnaissance aircraft, surface and upper air observations, radar, etc.), and combine this information with the numerical atmospheric computer model information available from an array of models. The purpose is to use all of this information in creating a forecast of the storm's track and intensity and then to warn the individuals in the path of the storm through the issuance of warnings and watches in coordination with NWS field offices. In the Caribbean, this is further complicated by the need to coordinate the warning and watch issuances with foreign governments as well. Discussion at NHC indicated that this requirement can be extremely time consuming.

In preparing the forecasts of track and intensity of tropical cyclones, NHC uses a variety of numerical models. The three types of models are: statistical, dynamical, and combination (statistical and dynamical). Statistical models forecast future track and intensity using current information about the storm and comparing it to historical knowledge of the behavior of similar storms. Dynamical models use the physical characteristics of the storm and the surrounding environment to forecast future intensity and motion. Combination models attempt to capitalize on the strengths of each of the other two types: combining knowledge of historical storms with current and forecast atmospheric flow characteristics. Each of the three types of models are designed to take advantage of the variety of data acquisition zones (data sparse to data rich) which occur.

The available numerical guidance is reviewed by the NHC specialists for consistency with the synoptic-scale atmospheric flow pattern. Satellite imagery designed to sense mid- and upper-tropospheric moisture content is the primary method to ascertain background flow conditions where little surface or upper air observations are available as is typical over oceanic regions. If the model in question is consistent with the synoptic-scale pattern, it becomes useful guidance. Furthermore, the performance of the model must be assessed based on the size and strength of the particular tropical cyclone. Each model handles cyclone initialization differently, and the hurricane specialist must be aware of the behavior and tendencies of each of the models. Large-scale models, such as the aviation model (AVN), are used to diagnose trends in the large-scale flow field, then the individual hurricane forecast models are studied relative to these fields.

Once the specialist has compared the previous official forecast track to the new model guidance and observational data, decisions are made concerning the new official forecast

track. If the new guidance is similar to the previous forecast track, it is relatively simple to update the previous forecast and make small adjustments to the track, warnings, watches, etc. Occasionally, the hurricane specialist will make a "consensus" forecast using several models with similar solutions. This approach takes advantage of the strengths of each model. There are times, however, where the specialist's knowledge and experience cause them to reject all of the models and prepare a forecast independent of the numerical model guidance. The decision process is even more complex if the new information differs drastically from the previous forecast. In this latter scenario, emphasis is placed on population centers for warning and watch purposes, and typically the specialist will compromise between the previous track and new forecast track. A complete switch to a "new" track will not be made unless there is compelling evidence to abandon the previous track. A "windshield wiper" effect, whereby NHC drastically shifts the official forecast track (and associated warnings and watches) back and forth, would result in a lack of confidence and respect for NHC.

Shown below is a summary of the forecast errors related to Hurricane Marilyn. Track errors were computed for all forecasts associated with Marilyn (i.e., for the tropical storm and hurricane phases of the tropical cyclone). Note that the NHC official forecast track error at 72 hours averaged 222 nm (and 93 nm in the vicinity of the Caribbean Sea). These errors were considerably smaller than the 1985-1994 average error of 296 nm. This was an exceptionally good performance for the NHC.

Preliminary Forecast Evaluation For Hurricane Marilyn
(Number of forecasts in parenthesis)

		Average Error by Length of Forecast (nm)				
Model	Type	12hr	24hr	36hr	48hr	72hr
GFDI		38 (37)	71 (37)	91 (35)	112 (33)	189 (29)
GFDL*	d	39 (19)	64 (19)	91 (19)	102 (18)	155 (16)
VBAR*	d	40 (37)	75 (37)	107 (36)	151 (35)	210 (31)
AVNI	d	40 (38)	86 (38)	141 (36)	158 (32)	306 (28)
BAMD	d	48 (39)	91 (39)	144 (37)	205 (35)	335 (31)
BAMM	d	47 (39)	87 (39)	126 (37)	168 (35)	268 (31)
BAMS	d	52 (38)	95 (38)	130 (36)	161 (35)	261 (31)
A90E	c	47 (39)	94 (39)	143 (37)	200 (35)	284 (31)
CLIP	s	49 (39)	105 (39)	167 (37)	218 (35)	323 (31)
NHC Official		38 (39)	71 (39)	102 (37)	142 (35)	222 (31)
NHC Official@ (for northeastern Caribbean from 14/06-18/00 Coordinated Universal Time)		21 (16)	36 (16)	48 (16)	65 (16)	93 (16)
NHC Official (1985-94 10-year average)		50	98		194	296

* GFDL output not available until after forecast issued. VBAR output sometimes not available until after forecast issued.

@ For the period associated where Marilyn affected the U.S. Virgin Islands and Puerto Rico.

Appendix F

Fiscal Year 1995 Preparedness Activities of WSFO San Juan, Puerto Rico

Date	Location Visited	Topics	Comments
Puerto Rico			
January 9-13	NHC, Miami	Hurricane planning	PR CD & Univ. of PR participated
February 14	San Juan CD	Hurricane brochure	Translation to Spanish
April 7	Rio Piedras	EAS implementation	Spanish-English discussed
April 22	WSFO	Open House	Earth Week
April 22	Radio 11Q	General preparedness	Talk show
June 2	Ponce	Climate, heat stress	Medical conference
June 3	Radio 11Q	Hurricane preparedness	Talk show
June 14	Caguas	Annual CD Hurricane Conference	
June 19	Rio Piedras	Hurricanes & flash flooding	Univ. of PR staff
June 20-22	San Juan	Hurricanes, flash flooding, NWR	Environmental week
June 20	WSFO	Hurricane training	Part of series for media
June 21	Rio Piedras	Hurricane preparedness	Dept. of Housing, joint radio interviews
June 27	Manati	Hurricane preparedness	DuPont Electronics
July 9	Carolina	Hurricane preparedness	National Guard Unit
July 17	WSFO	Hurricanes, EAS, NWR	Interview
July 19	San Juan	1995 hurricane season & preparedness	TV show
July 26	WSFO	Hurricane Workshop for TV weathercasters	SRH & NHC participants

Date	Location Visited	Topics	Comments
Puerto Rico (cont'd)			
July 31	San Juan	1995 hurricane season & preparedness	Public Broadcast Station talk show w/CD director
August 5	WSFO	1995 hurricane season & preparedness	Interview for later broadcast
August 6	San Juan	1995 hurricane season & talk show	Preparedness w/CD & FEMA
August 7-13	San Juan	Hurricane preparedness	Safety Fair at mall, 10k people
August 9	San Juan	Hurricane preparedness, dissemination, MAR	AP office
August 30	WSFO	General preparedness	San Juan Star paper
August 30	San Juan	Iris aftermath	Training video for CD
August 30	Carolina	General preparedness	CD Zone IX
U.S. Virgin Islands			
September 23	St. Croix	MAR, EBS/EAS, gen. preparedness	Semi-annual meeting
October 26	St. Croix	NWS operations/products, MAR	VITEMA
November 11	St. Croix	Hurricane preparedness, MAR	"1st Annual Congress on Disaster Prep."
May 16-19	St. Croix	Hurricane planning/evacuation, NHC SJU hurricane products, Hugo-based exercise	New VITEMA managers
May 23-24	St. Thomas	Same as above	Met new director
June 7	St. Thomas	Hurricanes, flash floods, MAR	New managers
August 15	St. Thomas	Hurricanes	Annual meeting

Appendix G

Sample Products from NHC

ZCZC MIATCPAT5
TTAA00 KNHC 150847
BULLETIN
HURRICANE MARILYN ADVISORY NUMBER 12
NATIONAL WEATHER SERVICE MIAMI FL
5 AM AST FRI SEP 15 1995

...HURRICANE MARILYN CONTINUES MOVING NORTHWESTWARD ACROSS THE LEEWARD ISLANDS...

HURRICANE WARNINGS CONTINUE IN EFFECT FROM GUADALOUPE NORTHWARD AND NORTHWESTWARD TO PUERTO RICO INCLUDING THE U.S. VIRGIN ISLANDS AND THE BRITISH VIRGIN ISLANDS. FRENCH OFFICIALS HAVE ISSUED A HURRICANE WATCH FOR ST. BARTHELEMY AND THE FRENCH PORTION OF ST. MARTIN. THE WARNINGS FOR GUADALOUPE... ANTIGUA...BARBUDA...MONTSERRAT...NEVIS AND ST KITTS WILL BE LOWERED SHORTLY.

AT 5 AM AST...0900Z...THE CENTER OF MARILYN WAS LOCATED NEAR LATITUDE 16.9 NORTH... LONGITUDE 63.2 WEST OR ABOUT 120 MILES...190 KM...EAST SOUTHEAST OF ST CROIX. THIS POSITION IS ALSO ABOUT 95 MILES...155 KM...WEST OF ANTIGUA.

MARILYN IS MOVING TOWARD THE NORTHWEST NEAR 13 MPH...20 KM/HR...AND THIS MOTION IS EXPECTED TO BRING THE HURRICANE NEAR THE VIRGIN ISLANDS AND PUERTO RICO LATER TODAY.

MAXIMUM SUSTAINED WINDS ARE NEAR 85 MPH...140 KM/HR...OVER A SMALL AREA NEAR THE CENTER. SOME STRENGTHENING IS POSSIBLE DURING THE NEXT 24 HOURS.

HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 30 MILES...45 KM...FROM THE CENTER... AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 90 MILES...150 KM.

ESTIMATED MINIMUM CENTRAL PRESSURE IS 978 MB...28.88 INCHES.

RAINFALL TOTALS OF 5 TO 8 INCHES ARE LIKELY ALONG THE PATH OF THE HURRICANE...WITH THE THREAT OF FLASH FLOODING AND MUD SLIDES OVER MOUNTAINOUS TERRAIN.

STORM TIDES OF 2 TO 4 FEET...ALONG WITH BATTERING WAVES...CAN BE EXPECTED NEAR THE CENTER OF MARILYN.

REPEATING THE 5 AM AST POSITION...16.9 N... 63.2 W. MOVEMENT TOWARD...NORTHWEST NEAR 13 MPH. MAXIMUM SUSTAINED WINDS... 85 MPH. MINIMUM CENTRAL PRESSURE... 978 MB.

AN INTERMEDIATE ADVISORY WILL BE ISSUED BY THE NATIONAL HURRICANE CENTER AT 8 AM AST FOLLOWED BY THE NEXT COMPLETE ADVISORY ISSUANCE AT 11 AM AST.

LAWRENCE

ZCZC MIATCDAT5
TTAA00 KNHC 150836
...FOR INTERGOVERNMENTAL USE ONLY...
HURRICANE MARILYN DISCUSSION NUMBER 12
NATIONAL WEATHER SERVICE MIAMI FL
5 AM EDT FRI SEP 15 1995

INITIAL MOTION ESTIMATE IS 310/11...THE SAME AS THE PREVIOUS ADVISORY AND MARILYN SEEMS TO BE ON THE FORECAST TRACK. THE VARIOUS GUIDANCE MODELS ARE IN GOOD AGREEMENT SHOWING A CONTINUATION OF THE INITIAL MOTION WITH SOME DECELERATION THROUGH 72 HOURS. THE OFFICIAL TRACK FORECAST GOES ALONG WITH THIS AND IS SIMILAR TO THE PREVIOUS ADVISORY. THE CIRCULATION WHICH IS THE REMNANT OF TROP DEP FOURTEEN IS SHOWN BY THE AVIATION MODEL TO MOVE WESTWARD TO NEAR FLORIDA IN 72 HOURS...THIS FEATURE CONTRIBUTES TO THE DECELERATION AND COULD ULTIMATELY CAUSE MARILYN TO MOVE NORTHWARD.

LATEST RECON REPORTED 978 MB CENTRAL PRESSURE...96 KNOTS AT 700 MB AND A 15 N MI DIAMETER EYE. SO THE HURRICANE APPEARS TO BE INTENSIFYING A LITTLE. THE INITIAL WIND SPEED IS INCREASED TO 75 KNOTS AND FORECAST TO 85 KNOTS IN 24 HOURS IF NOT SOONER.

LAWRENCE

FORECAST POSITIONS AND MAX WINDS

INITIAL	15/0900Z	16.9N	63.2W	75 KTS
12HR VT	15/1800Z	18.1N	64.7W	80 KTS
24HR VT	16/1600Z	19.7N	66.5W	85 KTS
36HR VT	16/1800Z	21.1N	67.8W	85 KTS
48HR VT	17/0600Z	22.5N	69.0W	85 KTS
72HR VT	18/0600Z	25.0N	70.5W	85 KTS

ZCZC MIATCMAT5
TTAA00 KNHC 150837
HURRICANE MARILYN FORECAST/ADVISORY NUMBER 12
NATIONAL WEATHER SERVICE MIAMI FL
0900Z FRI SEP 15 1995

HURRICANE WARNINGS CONTINUE IN EFFECT FROM GUADALOUPE NORTHWARD AND NORTHWESTWARD TO PUERTO RICO INCLUDING THE U.S. VIRGIN ISLANDS AND THE BRITISH VIRGIN ISLANDS. FRENCH OFFICIALS HAVE ISSUED A HURRICANE WATCH FOR ST. BARTHELEMY AND THE FRENCH PORTION OF ST. MARTIN. THE WARNINGS FOR GUADALOUPE... ANTIGUA...BARBUDA...MONTSERRAT...NEVIS AND ST KITTS WILL BE LOWERED SHORTLY.

HURRICANE CENTER LOCATED NEAR 16.9N 63.2W AT 15/0900Z
POSITION ACCURATE WITHIN 20 NM

PRESENT MOVEMENT TOWARD THE NORTHWEST OR 310 DEGREES AT 11 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 978 MB
EYE DIAMETER 20 NM
MAX SUSTAINED WINDS 75 KT WITH GUSTS TO 90 KT

64 KT.....	25NE	25SE	0SW	0NW
50 KT.....	50NE	50SE	25SW	25NW
34 KT.....	80NE	80SE	50SW	50NW
12 FT SEAS..	80NE	80SE	50SW	50NW

ALL QUADRANT RADII IN NAUTICAL MILES

REPEAT...CENTER LOCATED NEAR 16.9N 63.2W AT 15/0900Z
AT 15/0600Z CENTER WAS LOCATED NEAR 16.5N 62.8W

FORECAST VALID 15/1800Z 18.1N 64.7W
MAX WIND 80 KT...GUSTS 95 KT
64 KT... 25NE 25SE 0SW 0NW
50 KT... 50NE 50SE 25SW 25NW
34 KT... 80NE 80SE 50SW 50NW

FORECAST VALID 16/0600Z 19.7N 66.5W
MAX WIND 85 KT...GUSTS 105 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 50NE 50SE 50SW 50NW
34 KT... 100NE 100SE 100SW100NW

FORECAST VALID 16/1800Z 21.1N 67.8W
MAX WIND 85 KT...GUSTS 105 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 50NE 50SE 50SW 50NW
34 KT... 100NE 100SE 100SW100NW

STORM TIDES OF 2 TO 4 FEET...WITH BATTERING WAVES ABOVE...CAN BE EXPECTED NEAR THE CENTER OF MARILYN. SMALL CRAFT IN THE WARNED AREA SHOULD REMAIN IN PORT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 16.9N 63.2W

EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE

OUTLOOK VALID 17/0600Z 22.5N 69.0W
MAX WIND 85 KT...GUSTS 105 KT
50 KT... 50NE 50SE 50SW 50NW

OUTLOOK VALID 18/0600Z 25.0N 70.5W
MAX WIND 85 KT...GUSTS 105 KT
50 KT... 50NE 50SE 50SW 50NW

NEXT ADVISORY AT 15/1500Z

LAWRENCE

STRIKE PROBABILITIES ASSOCIATED WITH THIS ADVISORY NUMBER CAN BE FOUND UNDER AFOS HEADER MIASPFAT5 AND WMO HEADER WTNT75 KNHC.

MIATCPAT5
TTAA00 KNHC 151450
BULLETIN
HURRICANE MARILYN ADVISORY NUMBER 13
NATIONAL WEATHER SERVICE MIAMI FL
11 AM AST FRI SEP 15 1995

...MARILYN APPROACHING THE U.S. VIRGIN ISLANDS AS A CATEGORY 2 HURRICANE ON THE SAFFIR-SIMPSON SCALE...

HURRICANE WARNINGS CONTINUE IN EFFECT FROM ST. EUSTATIUS NORTHWESTWARD THROUGH PUERTO RICO INCLUDING THE U.S. VIRGIN ISLANDS AND THE BRITISH VIRGIN ISLANDS...EXCEPT FOR ST. BARTHELEMY AND THE FRENCH PORTION OF ST. MARTIN WHERE FRENCH OFFICIALS HAVE ISSUED A TROPICAL STORM WARNING. THE GOVERNMENT OF THE DOMINICAN REPUBLIC HAS ISSUED A HURRICANE WATCH FOR THE NORTHEAST COAST OF THE

DOMINICAN REPUBLIC FROM CABRERA TO CABO ENGANO...EFFECTIVE AT 11 AM AST...1500Z. THE WARNINGS FOR GUADELOUPE...ANTIGUA...BARBUDA...MONTSERRAT...NEVIS AND ST. KITTS HAVE BEEN DISCONTINUED.

PREPARATIONS IN THE WARNED AREA SHOULD BE RUSHED TO COMPLETION.

AT 11 AM AST...1500Z...THE CENTER OF MARILYN WAS LOCATED NEAR LATITUDE 17.2 NORTH... LONGITUDE 63.9 WEST OR ABOUT 70 MILES...110 KM...EAST-SOUTHEAST OF ST. CROIX.

THE FORWARD MOTION OF MARILYN HAS DECREASED A LITTLE...TO NORTHWEST NEAR 10 MPH...17 KM/HR. THIS MOTION IS EXPECTED TO CONTINUE THROUGH TONIGHT AND WILL BRING THE CENTER OF MARILYN ACROSS THE U.S. VIRGIN ISLANDS AND TO THE VICINITY OF PUERTO RICO.

MAXIMUM SUSTAINED WINDS HAVE INCREASED TO NEAR 100 MPH...160 KM/HR...WITH HIGHER GUSTS. SOME ADDITIONAL SLOW STRENGTHENING IS POSSIBLE DURING THE NEXT 24 HOURS.

HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 30 MILES... 45 KM...FROM THE CENTER...AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 115 MILES...185 KM.

LATEST MINIMUM CENTRAL PRESSURE REPORTED BY RECONNAISSANCE AIRCRAFT WAS 972 MB...28.70 INCHES.

RAINFALL TOTALS OF 5 TO 10 INCHES ARE LIKELY ALONG THE PATH OF THE HURRICANE...WITH THE THREAT OF FLASH FLOODING AND MUD SLIDES OVER MOUNTAINOUS TERRAIN. A FLASH FLOOD WARNING IS IN EFFECT FOR THE U.S. VIRGIN ISLANDS.

STORM TIDES OF 3 TO 5 FEET...ALONG WITH BATTERING WAVES...CAN BE EXPECTED NEAR THE CENTER OF MARILYN.

REPEATING THE 11 AM AST POSITION...17.2 N... 63.9 W. MOVEMENT TOWARD...NORTHWEST NEAR 10 MPH. MAXIMUM SUSTAINED WINDS...100 MPH. MINIMUM CENTRAL PRESSURE... 972 MB.

AN INTERMEDIATE ADVISORY WILL BE ISSUED BY THE NATIONAL HURRICANE CENTER AT 2 PM AST FOLLOWED BY THE NEXT COMPLETE ADVISORY AT 5 PM AST.

RAPPAPORT

STRIKE PROBABILITIES ASSOCIATED WITH THIS ADVISORY NUMBER CAN BE FOUND UNDER AFOS HEADER MIASPFAT5 AND WMO HEADER WTNT75 KNHC.

MIATCDAT5
TTAA00 KNHC 151453
...FOR INTERGOVERNMENTAL USE ONLY...
HURRICANE MARILYN DISCUSSION NUMBER 13
NATIONAL WEATHER SERVICE MIAMI FL
11 AM EDT FRI SEP 15 1995

MARILYN HAS SLOWED DOWN TO ABOUT 9 KNOTS OVER THE PAST 10 HOURS AND THE TRACK HAS EASED A SMIDGEN TO THE LEFT...TO 300/305 DEGREES. GIVEN THE TROUGH ALOFT SEEN IN WATER VAPOR IMAGES TO EXTEND NNE FROM EASTERN CUBA...THIS IS MORE LIKELY A SHORT-TERM WOBBLE THAN A THE START OF A PROLONGED MOVE TO THE WEST. IN EITHER CASE...THE THREAT TO THE U.S. VIRGIN ISLANDS AND PUERTO RICO IS INCREASING. CENTRAL PRESSURE IS AROUND 972 MB. PEAK FLIGHT-LEVEL WINDS WERE 105 KNOTS AND ESTIMATED ONE-MINUTE SURFACE WINDS ARE NOW 85 KNOTS.

THE TRACK FORECAST HAS NO SIGNIFICANT CHANGES. IT FOLLOWS THE GFDL AND STATISTICAL-DYNAMICAL MODEL WHICH ARE IN CLOSE AGREEMENT...ESPECIALLY THROUGH

36 HOURS...WITH THE REMAINDER OF THE GUIDANCE. THE SUITE OF TRACKS ALSO SHOWS A NW MOTION THROUGH 72 HOURS...BUT THE 06Z AVNX AND THE 00Z MRFX SUGGEST A PROBABLY TEMPORARY WESTWARD BEND AFTER PASSING PUERTO RICO. THE NAVY NOGAPS MODEL EVEN HINTS AT A STALL NORTH OF THAT ISLAND.

RAPPAPORT

FORECAST POSITIONS AND MAX WINDS

INITIAL	15/1500Z	17.2N	63.9W	85 KTS
12HR VT	16/0000Z	17.9N	65.0W	85 KTS
24HR VT	16/1200Z	19.0N	66.4W	90 KTS
36HR VT	17/0000Z	20.2N	67.6W	90 KTS
48HR VT	17/1200Z	21.5N	68.6W	90 KTS
72HR VT	18/1200Z	25.0N	70.5W	90 KTS

MIATCMAT5
TTAA00 KNHC 151452
HURRICANE MARILYN FORECAST/ADVISORY 13
NATIONAL WEATHER SERVICE MIAMI FL
1500Z FRI SEP 15 1995

HURRICANE WARNINGS CONTINUE IN EFFECT FROM ST. EUSTATIUS NORTHWESTWARD THROUGH PUERTO RICO INCLUDING THE U.S. VIRGIN ISLANDS AND THE BRITISH VIRGIN ISLANDS...EXCEPT FOR ST. BARTHELEMY AND THE FRENCH PORTION OF ST. MARTIN WHERE FRENCH OFFICIALS HAVE ISSUED A TROPICAL STORM WARNING. THE GOVERNMENT OF THE DOMINICAN REPUBLIC HAS ISSUED A HURRICANE WATCH FOR THE NORTHEAST COAST OF THE DOMINICAN REPUBLIC FROM CABRERA TO CABO ENGANO...EFFECTIVE AT 11 AM AST...1500Z. THE WARNINGS FOR GUADELOUPE...ANTIGUA...BARBUDA...MONTSERRAT...NEVIS AND ST KITTS HAVE BEEN DISCONTINUED.

HURRICANE CENTER LOCATED NEAR 17.2N 63.9W AT 15/1500Z
POSITION ACCURATE WITHIN 20 NM

PRESENT MOVEMENT TOWARD THE NORTHWEST OR 305 DEGREES AT 9 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 972 MB
EYE DIAMETER 20 NM
MAX SUSTAINED WINDS 85 KT WITH GUSTS TO 105 KT

64 KT.....	25NE	25SE	0SW	0NW
50 KT.....	75NE	50SE	25SW	25NW
34 KT.....	100NE	80SE	50SW	100NW
12 FT SEAS..	100NE	80SE	50SW	100NW

ALL QUADRANT RADII IN NAUTICAL MILES

REPEAT..CENTER LOCATED NEAR 17.2N 63.9W AT 15/1500Z
AT 15/1200Z CENTER WAS LOCATED NEAR 16.9N 63.5W

FORECAST VALID 16/0000Z 17.9N 65.0W
MAX WIND 85 KT...GUSTS 105 KT

64 KT...	25NE	25SE	0SW	0NW
50 KT...	75NE	50SE	25SW	25NW
34 KT...	100NE	80SE	50SW	100NW

FORECAST VALID 16/1200Z 19.0N 66.4W
MAX WIND 90 KT...GUSTS 110 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 75NE 50SE 50SW 50NW
34 KT... 100NE 100SE 100SW 100NW

FORECAST VALID 17/0000Z 20.2N 67.6W
MAX WIND 90 KT...GUSTS 110 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 75NE 50SE 50SW 50NW
34 KT... 100NE 100SE 100SW 100NW

STORM TIDES OF 3 TO 5 FEET...WITH BATTERING WAVES ABOVE...CAN BE EXPECTED NEAR THE CENTER OF MARILYN. SMALL CRAFT IN THE WARNED AREA SHOULD REMAIN IN PORT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 17.2N 63.9W

EXTENDED OUTLOOK....USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE

OUTLOOK VALID 17/1200Z 21.5N 68.6W
MAX WIND 90 KT...GUSTS 110 KT
50 KT... 75NE 50SE 50SW 50NW

OUTLOOK VALID 18/1200Z 25.0N 70.5W
MAX WIND 90 KT...GUSTS 110 KT
50 KT... 75NE 50SE 50SW 50NW

NEXT ADVISORY AT 15/2100Z

RAPPAPORT

STRIKE PROBABILITIES ASSOCIATED WITH THIS ADVISORY NUMBER CAN BE FOUND UNDER AFOS HEADER MIASPFAT5 AND WMO HEADER WTNT75 KNHC.

MIATCPAT5
TTAA00 KNHC 152040
BULLETIN
HURRICANE MARILYN ADVISORY NUMBER 14
NATIONAL WEATHER SERVICE MIAMI FL
5 PM AST FRI SEP 15 1995

...HURRICANE MARILYN STRIKES U.S. VIRGIN ISLANDS...

HURRICANE WARNINGS CONTINUE IN EFFECT FROM ST. EUSTATIUS NORTHWESTWARD THROUGH PUERTO RICO INCLUDING THE U.S. VIRGIN ISLANDS AND THE BRITISH VIRGIN ISLANDS...EXCEPT FOR ST. BARTHELEMY AND THE FRENCH PORTION OF ST. MARTIN WHERE FRENCH OFFICIALS HAVE ISSUED A TROPICAL STORM WARNING. A HURRICANE WATCH IS IN EFFECT FOR THE NORTHEAST COAST OF THE DOMINICAN REPUBLIC FROM CABRERA TO CABO ENGANO.

PREPARATIONS IN THE WARNED AREA SHOULD BE RUSHED TO COMPLETION.

AT 5 PM AST...2100Z...THE CENTER OF MARILYN WAS LOCATED NEAR LATITUDE 17.8 NORTH... LONGITUDE 64.6 WEST OR NEAR ST. CROIX.

MARILYN IS MOVING TOWARD THE NORTHWEST NEAR 12 MPH...19 KM/HR...AND THIS MOTION IS EXPECTED TO CONTINUE INTO SATURDAY. ON THIS COURSE...THE CENTER OF MARILYN WILL

MOVE ACROSS THE U.S. VIRGIN ISLANDS AND NEAR THE EASTERN TIP OF PUERTO RICO TONIGHT.

MAXIMUM SUSTAINED WINDS ARE NEAR 100 MPH...160 KM/HR...WITH HIGHER GUSTS. WIND GUSTS TO 82 MPH OCCURRED EARLIER AT THE ST. CROIX AIRPORT. SUBSEQUENT AMATEUR RADIO REPORTS OF 97 MPH GUSTS ON THAT ISLAND HAVE BEEN RECEIVED. SOME ADDITIONAL SLOW STRENGTHENING IS POSSIBLE AND MARILYN COULD INTENSIFY FROM A CATEGORY 2 TO CATEGORY 3 HURRICANE ON THE SAFFIR-SIMPSON SCALE TONIGHT OR SATURDAY.

HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 30 MILES...45 KM...FROM THE CENTER... AND TROPICAL STORM FORCE WINDS EXTEND OUTWARD UP TO 115 MILES...185 KM.

LATEST MINIMUM CENTRAL PRESSURE REPORTED BY RECONNAISSANCE AIRCRAFT WAS 970 MB...28.64 INCHES.

RAINFALL TOTALS OF 5 TO 10 INCHES ARE LIKELY ALONG THE PATH OF THE HURRICANE... WITH THE THREAT OF FLASH FLOODING AND MUD SLIDES OVER MOUNTAINOUS TERRAIN. A FLASH FLOOD WARNING IS IN EFFECT FOR THE U.S. VIRGIN ISLANDS.

STORM TIDES OF 3 TO 5 FEET...ALONG WITH BATTERING WAVES...CAN BE EXPECTED NEAR THE CENTER OF MARILYN.

REPEATING THE 5 PM AST POSITION...17.8 N... 64.6 W. MOVEMENT TOWARD...NORTHWEST NEAR 12 MPH. MAXIMUM SUSTAINED WINDS...100 MPH. MINIMUM CENTRAL PRESSURE... 970 MB.

AN INTERMEDIATE ADVISORY WILL BE ISSUED BY THE NATIONAL HURRICANE CENTER AT 8 PM AST FOLLOWED BY THE NEXT COMPLETE ADVISORY AT 11 PM AST.

RAPPAPORT

STRIKE PROBABILITIES ASSOCIATED WITH THIS ADVISORY NUMBER CAN BE FOUND UNDER AFOS HEADER MIASPFAT5 AND WMO HEADER WTNT75 KNHC.

MIATCDAT5
TTAA00 KNHC 152050
...FOR INTERGOVERNMENTAL USE ONLY...
HURRICANE MARILYN DISCUSSION NUMBER 14
NATIONAL WEATHER SERVICE MIAMI FL
5 PM EDT FRI SEP 15 1995

ALTHOUGH UPPER-LEVEL OUTFLOW IS COMPRESSED E-W...MARILYN REMAINS A CATEGORY 2 HURRICANE MOVING ON A COURSE TOWARD 305/10 KT. AN EYE HAS APPEARED ON SATELLITE PICTURES AND HURRICANE HUNTERS REPORTED A CENTRAL PRESSURE OF 969 MB AND THEN 970 MB THIS AFTERNOON WITH FLIGHT-LEVEL WINDS AGAIN AS HIGH AS 105 KT. ESTIMATED SUSTAINED SURFACE WINDS ARE 85 KT. MARILYN COULD STRENGTHEN ENOUGH... 10-15 KNOTS...OVER THE NEXT 12 HOURS TO REACH CATEGORY 3 BEFORE EXITING THE CARIBBEAN.

MARILYN IS FORECAST TO CONTINUE NORTHWESTWARD FOR THE NEXT 36 HOURS. THE CENTER IS NEAR ST. CROIX AND WILL PASS NEAR THE EASTERN TIP OF PUERTO RICO. THE STRONGEST WINDS ARE IN THE N AND NE PART AND COULD SPREAD OVER THE ST. THOMAS AREA.

BY 48 HOURS...THE STEERING FLOW AHEAD OF THE LEAD VORTICITY MAXIMUM WITHIN THE DEVELOPING U.S. LONGWAVE TROUGH IS EXPECTED TO TURN MARILYN MORE TOWARD THE NNW OR N...AROUND 70W. THIS IS CONSISTENT WITH ALL 12Z GUIDANCE.

RAPPAPORT

FORECAST POSITIONS AND MAX WINDS

INITIAL	15/2100Z	17.8N	64.6W	85 KTS
12HR VT	16/0600Z	18.7N	65.7W	95 KTS
24HR VT	16/1800Z	20.1N	67.1W	95 KTS
36HR VT	17/0600Z	21.6N	68.2W	95 KTS
48HR VT	17/1800Z	23.5N	69.1W	95 KTS
72HR VT	18/1800Z	28.0N	69.5W	95 KTS

MIATCMAT5
TTAA00 KNHC 152054
HURRICANE MARILYN FORECAST/ADVISORY NUMBER 14
NATIONAL WEATHER SERVICE MIAMI FL
2100Z FRI SEP 15 1995

HURRICANE WARNINGS CONTINUE IN EFFECT FROM ST. EUSTATIUS NORTHWESTWARD THROUGH PUERTO RICO INCLUDING THE U.S. VIRGIN ISLANDS AND THE BRITISH VIRGIN ISLANDS...EXCEPT FOR ST. BARTHELEMY AND THE FRENCH PORTION OF ST. MARTIN WHERE FRENCH OFFICIALS HAVE ISSUED A TROPICAL STORM WARNING. A HURRICANE WATCH IS IN EFFECT FOR THE NORTHEAST COAST OF THE DOMINICAN REPUBLIC FROM CABRERA TO CABO ENGANO.

HURRICANE CENTER LOCATED NEAR 17.8N 64.6W AT 15/2100Z
POSITION ACCURATE WITHIN 15 NM.

PRESENT MOVEMENT TOWARD THE NORTHWEST OR 305 DEGREES AT 10 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 970 MB
EYE DIAMETER 20 NM
MAX SUSTAINED WINDS 85 KT WITH GUSTS TO 105 KT
64 KT..... 25NE 25SE 25SW 25NW
50 KT..... 75NE 50SE 30SW 30NW
34 KT..... 100NE 100SE 50SW 50NW
12 FT SEAS.. 100NE 100SE 50SW 50NW
ALL QUADRANT RADII IN NAUTICAL MILES

REPEAT...CENTER LOCATED NEAR 17.8N 64.6W AT 15/2100Z
AT 15/1800Z CENTER WAS LOCATED NEAR 17.5N 64.2W

FORECAST VALID 16/0600Z 18.7N 65.7W
MAX WIND 95 KT...GUSTS 115 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 75NE 50SE 50SW 50NW
34 KT... 100NE 100SE 75SW 75NW

FORECAST VALID 16/1800Z 20.1N 67.1W
MAX WIND 95 KT...GUSTS 115 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 75NE 50SE 50SW 50NW
34 KT... 100NE 100SE 75SW 75NW

FORECAST VALID 17/0600Z 21.6N 68.2W
MAX WIND 95 KT...GUSTS 115 KT
64 KT... 25NE 25SE 25SW 25NW
50 KT... 75NE 50SE 50SW 50NW
34 KT... 100NE 100SE 75SW 75NW

STORM TIDES OF 3 TO 5 FEET...WITH BATTERING WAVES ABOVE...CAN BE EXPECTED NEAR THE CENTER OF MARILYN. SMALL CRAFT IN THE WARNED AREA SHOULD REMAIN IN PORT.

REQUEST FOR 3 HOURLY SHIP REPORTS WITHIN 300 MILES OF 17.8N 64.6W

EXTENDED OUTLOOK...USE FOR GUIDANCE ONLY...ERRORS MAY BE LARGE

OUTLOOK VALID 17/1800Z 23.5N 69.1W
MAX WIND 95 KT...GUSTS 115 KT
50 KT... 75NE 50SE 50SW 50NW

OUTLOOK VALID 18/1800Z 28.0N 69.5W
MAX WIND 95 KT..GUSTS 115 KT
50 KT... 75NE 50SE 50SW 50NW

NEXT ADVISORY AT 16/0300Z

RAPPAPORT

STRIKE PROBABILITIES ASSOCIATED WITH THIS ADVISORY NUMBER CAN BE FOUND UNDER AFOS HEADER MIASPFAT5 AND WMO HEADER WTNT75 KNHC.

Appendix H

Sample Hurricane Local Statements and Short Term Forecasts From WSFO San Juan

1. HLS Issued at 245 p.m., AST, Friday, September 15, 1995.

BULLETIN - IMMEDIATE BROADCAST REQUESTED
HURRICANE MARILYN LOCAL STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PR
245 PM AST FRI SEP 15 1995

...HURRICANE WARNINGS IN EFFECT FOR U.S. VIRGIN ISLANDS AND PUERTO RICO...
...SMALL CRAFT IN THE U.S. VIRGIN ISLANDS AND PUERTO RICO SHOULD REMAIN IN PORT...
...FLASH FLOOD WARNING IN EFFECT FOR U.S. VIRGIN ISLANDS...
...FLASH FLOOD WATCH IN EFFECT FOR PUERTO RICO...
...COASTAL FLOOD WARNING IN EFFECT FOR U.S. VIRGIN ISLANDS...
...COASTAL FLOOD WATCH IN EFFECT FOR EAST AND SOUTH COASTS OF PUERTO RICO FROM PUNTA PICUA TO PUNTA GUAYANILLA INCLUDING CULEBRA AND VIEQUES...
...HEAVY SURF ADVISORY IN EFFECT FOR U.S. VIRGIN ISLANDS...
...HEAVY SURF ADVISORY IN EFFECT FOR THE NORTH AND EAST COASTS OF PUERTO RICO...

AT 200 PM AST THE CENTER OF HURRICANE MARILYN WAS LOCATED NEAR LATITUDE 17.6 NORTH... LONGITUDE 64.2 WEST...OR ABOUT 30 MILES EAST-SOUTHEAST OF ST CROIX...OR ABOUT 100 MILES SOUTHEAST OF ST THOMAS...80 MILES SOUTHEAST OF VIEQUES...AND ABOUT 130 MILES SOUTHEAST OF SAN JUAN PUERTO RICO.

MAXIMUM SUSTAINED WINDS ARE NEAR 100 MPH WITH HIGHER GUSTS. SOME ADDITIONAL SLOW STRENGTHENING IS POSSIBLE DURING THE NEXT 24 HOURS AS MARILYN MOVES THROUGH THE LOCAL AREA. HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 30 MILES FROM THE CENTER...WITH TROPICAL STORM FORCE WINDS EXTENDING OUT TO 100 MILES FROM THE CENTER. THE LATEST MINIMUM CENTRAL PRESSURE REPORTED BY THE HURRICANE HUNTER AIRCRAFT WAS 972 MB OR 28.70 INCHES OF MERCURY.

HURRICANE FORCE WINDS AND HIGHER GUSTS IN SQUALLS ARE EXPECTED TO PRODUCE SEAS NEAR 12 FEET WITHIN 100 MILES NORTH AND EAST OF THE CENTER. IN ADDITION...A STORM SURGE OF 3 TO 4 FEET CAN BE EXPECTED. BATTERING WAVES ON TOP OF THIS MAY PRODUCE COMBINED STORM TIDES OF 4 TO 6 FEET ACROSS EAST AND SOUTH FACING COASTS AND BAYS ACROSS THE VIRGIN ISLANDS...AND EASTERN SECTIONS OF PUERTO RICO. A COASTAL FLOOD WATCH REMAINS IN EFFECT FOR THE U.S. VIRGIN ISLANDS AND THE EAST AND SOUTH PARTS OF PUERTO RICO FROM RIO GRANDE TO PONCE. A HEAVY SURF ADVISORY IS IN EFFECT FOR THE U.S. VIRGIN ISLANDS AND THE NORTH AND EAST COASTS OF PUERTO RICO.

AT 200 PM AN OUTER RAINBAND ASSOCIATED WITH MARILYN WAS MOVING ACROSS THE EASTERN SECTIONS OF PUERTO RICO...WITH A SOLID AREA OF RAIN AND SHOWERS SPREADING ACROSS THE ENTIRE VIRGIN ISLANDS. HURRICANE FORCE WINDS WILL LIKELY MOVE INTO ST CROIX BEFORE 400 PM AND THEN ACROSS THE REMAINDER OF THE VIRGIN ISLANDS AROUND 600 PM. MARILYN APPEARS TO BE ON A STEADY COURSE AND SHOULD THUS BRING ITS FULL FORCE TO THE VIRGIN ISLANDS...AND LIKELY TO THE NORTHEAST COAST OF PUERTO RICO LATER THIS EVENING.

MARILYN APPEARS TO BE A POTENTIAL HEAVY RAIN MAKER FOR OUR ISLANDS. RAINFALL TOTALS OF 5 TO 8 INCHES SHOULD BE EXPECTED ALONG THE PATH OF THE HURRICANE...WITH FLASH FLOODING AND MUDSLIDES VERY POSSIBLE OVER MOUNTAINOUS TERRAIN.

RESIDENTS OF ST THOMAS...ST JOHN...AND ST CROIX...VIEQUES AND CULEBRA SHOULD BE SECURE IN SHELTERS OR INDOORS AT THIS TIME. PREPARE YOURSELF TO SETTLE IN AND WAIT OUT THE HURRICANE. THE GREATEST AND MOST IMMINENT THREAT THAT MARILYN POSES FOR OUR ISLANDS IS FROM THE

INITIAL STORM SURGE AND RELATED COASTAL FLOODING...THEN FROM FLASH FLOODING DUE TO CONTINUED VERY HEAVY RAINFALL. RESIDENTS IN COASTAL LOCATIONS OF LOWER ELEVATIONS SHOULD HAVE ALREADY MOVED TO HIGHER AND SECURE SHELTER. BE ALERT TO RISING AND RUSHING WATER NEAR YOUR SHELTER LATER THIS AFTERNOON AND TONIGHT. RESIDENTS OF THE VIRGIN ISLANDS SHOULD BE AWARE THAT THE EYE MAY PASS OVERHEAD. DO NOT BE FOOLED BY CALM WINDS IN THE CENTER OR EYE OF MARILYN. REMAIN IN SHELTER!

RESIDENTS OF PUERTO RICO SHOULD HAVE COMPLETED HURRICANE PREPAREDNESS AT THIS TIME. RAINBANDS PRODUCING GUSTS ABOVE 30 MPH ARE ALREADY AFFECTING THE EAST HALF OF THE ISLAND. INCREASING SHOWERS...SQUALLS...AND WIND SHOULD BE EXPECTED BEFORE 500 PM. FINALIZE PREPARATION FOR YOUR HOME AND PROPERTY NOW. STAY TUNED TO NOAA WEATHER RADIO OR OTHER MEDIA SOURCES FOR THE LATEST INFORMATION ON HURRICANE MARILYN. THE NEXT STATEMENT FROM THE SAN JUAN OFFICE WILL BE ISSUED AROUND 600 PM THIS AFTERNOON.

STRIPLING

2. HLS Issued at 540 p.m., AST, Friday, September 15, 1995.

BULLETIN - IMMEDIATE BROADCAST REQUESTED
HURRICANE MARILYN LOCAL STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PR
540 PM AST FRI SEP 15 1995

...HURRICANE MARILYN STRIKES U.S. VIRGIN ISLANDS...
...HURRICANE WARNINGS IN EFFECT FOR U.S. VIRGIN ISLANDS AND PUERTO RICO...
...SMALL CRAFT IN THE U.S. VIRGIN ISLANDS AND PUERTO RICO SHOULD REMAIN IN PORT...
...FLASH FLOOD WARNING IN EFFECT FOR U.S. VIRGIN ISLANDS...
...FLASH FLOOD WARNING IN EFFECT FOR THE EAST HALF OF PUERTO RICO...
...FLASH FLOOD WATCH IN EFFECT FOR THE WEST HALF OF PUERTO RICO...
...COASTAL FLOOD WARNING IN EFFECT FOR U.S. VIRGIN ISLANDS...
...COASTAL FLOOD WARNING IN EFFECT FOR EAST AND SOUTH COASTS OF PUERTO RICO FROM PUNTA BORINQUEN TO BAHAI JOBOS AND FOR THE SOUTH COAST FROM SALINAS EAST...
...COASTAL FLOOD WATCH IN EFFECT FOR SOUTH COAST OF PUERTO RICO FROM GUAYANILLA EAST TO SALINAS...
...HEAVY SURF ADVISORY IN EFFECT FOR U.S. VIRGIN ISLANDS...
...HEAVY SURF ADVISORY IN EFFECT FOR THE NORTH AND EAST COASTS OF PUERTO RICO...

AT 500 PM AST THE CENTER OF HURRICANE MARILYN WAS LOCATED NEAR LATITUDE 17.8 NORTH... LONGITUDE 64.6 WEST...OR ALMOST ON TOP OF ST CROIX...OR ABOUT 35 MILES EAST-SOUTHEAST OF ST THOMAS...OR 50 MILES SOUTHEAST OF VIEQUES AND ABOUT 100 MILES SOUTHEAST OF SAN JUAN PUERTO RICO.

MAXIMUM SUSTAINED WINDS ARE NEAR 100 MPH WITH HIGHER GUSTS. SOME ADDITIONAL SLOW STRENGTHENING IS POSSIBLE DURING THE NEXT 24 HOURS AS MARILYN MOVES THROUGH THE LOCAL AREA. HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 30 MILES FROM THE CENTER...WITH TROPICAL STORM FORCE WINDS EXTENDING OUT TO 115 MILES FROM THE CENTER. THE LATEST MINIMUM CENTRAL PRESSURE REPORTED BY THE HURRICANE HUNTER AIRCRAFT WAS 970 MB OR 28.64 INCHES OF MERCURY.

MARILYN WAS MOVING TOWARD THE NORTHWEST AT NEAR 12 MPH AND THIS MOTION IS EXPECTED TO CONTINUE INTO SATURDAY. THIS TRACK WILL BRING THE CENTER OF MARILYN ACROSS THE U.S. VIRGIN ISLANDS AND TO NEAR THE EASTERN TIP OF PUERTO RICO TONIGHT. HURRICANE FORCE WINDS HAVE ALREADY BEEN RECORDED AT ST CROIX. THIS INCLUDED HAM OPERATOR OBSERVATIONS OF WIND GUSTS TO 127...110...107...97 AND 91 MPH BETWEEN 4 AND 515 PM. SIMILAR GUSTS ARE EXPECTED ACROSS CULEBRA...VIEQUES...ST THOMAS AND ST JOHN BY 7 PM. RESIDENTS OF THE VIRGIN ISLANDS...CULEBRA AND VIEQUES SHOULD ALREADY BE IN A SHELTER. RESIDENTS OF MAINLAND EASTERN PUERTO RICO SHOULD BE ENTERING THEIR SHELTERS NOW.

HURRICANE FORCE WINDS AND HIGHER GUSTS IN SQUALLS ARE EXPECTED TO PRODUCE SEAS NEAR 12 FEET WITHIN 100 MILES NORTH AND EAST OF THE CENTER. IN ADDITION...A STORM SURGE OF 3 TO 4 FEET CAN BE EXPECTED. BATTERING WAVES ON TOP OF THIS MAY PRODUCE COMBINED STORM TIDES OF 4 TO 6 FEET ACROSS EAST AND SOUTH FACING COASTS AND BAYS ACROSS THE VIRGIN ISLANDS AND EASTERN SECTIONS OF PUERTO RICO.

AT 530 PM...AN OUTER RAINBAND WAS MOVING ACROSS CENTRAL PUERTO RICO. A SECOND RAINBAND WAS MOVING ACROSS VIEQUES AND CULEBRA. THEY WILL SPREAD TORRENTIAL SHOWERS AND NEAR ZERO

VISIBILITIES TO EASTERN PUERTO RICO INCLUDING VIEQUES AND CULEBRA. DURING THE EVENING... HURRICANE GUSTS AND PERSISTENT HEAVY SHOWERS IN THE WALL CLOUD SURROUNDING THE HURRICANE EYE WILL AFFECT THE U.S. VIRGIN ISLANDS. THESE EXTREMELY DANGEROUS CONDITIONS WILL SPREAD TO EASTERN PUERTO RICO INCLUDING THE SAN JUAN METROPOLITAN AREA LATER TONIGHT AND OVERNIGHT. MARILYN WILL ALSO BE A HEAVY RAIN MAKER FOR OUR ISLANDS. RAINFALL TOTALS OF 5 TO 10 INCHES SHOULD BE EXPECTED ALONG THE PATH OF THE HURRICANE...WITH FLASH FLOODING AND MUDSLIDES IMMINENT TONIGHT...ESPECIALLY OVER MOUNTAINOUS TERRAIN.

RESIDENTS OF ST THOMAS...ST JOHN...AND ST CROIX...VIEQUES AND CULEBRA AND THE EAST HALF OF PUERTO RICO SHOULD BE SECURE IN SHELTERS OR INDOORS AT THIS TIME. PREPARE YOURSELF TO SETTLE IN AND WAIT OUT THE HURRICANE. THE GREATEST AND MOST IMMINENT THREAT THAT MARILYN POSES FOR OUR ISLANDS IS FROM THE INITIAL STORM SURGE AND RELATED COASTAL FLOODING...THEN FROM FLASH FLOODING DUE TO CONTINUED VERY HEAVY RAINFALL. RESIDENTS IN COASTAL LOCATIONS OF LOWER ELEVATIONS SHOULD HAVE ALREADY MOVED TO HIGHER AND SECURE SHELTER. BE ALERT TO RISING AND RUSHING WATER NEAR YOUR SHELTER LATER THIS AFTERNOON AND TONIGHT. RESIDENTS OF THE VIRGIN ISLANDS SHOULD BE AWARE THAT THE EYE WILL LIKELY PASS OVERHEAD. DO NOT BE FOOLED BY CALM WINDS IN THE CENTER OR EYE OF MARILYN. REMAIN IN SHELTER!

RESIDENTS OF PUERTO RICO SHOULD HAVE COMPLETED HURRICANE PREPAREDNESS AT THIS TIME. RAINBANDS PRODUCING GUSTS ABOVE 30 MPH ARE ALREADY AFFECTING THE EAST HALF OF THE ISLAND. INCREASING SHOWERS...SQUALLS...AND WIND SHOULD BE EXPECTED THIS EVENING AND THEN OVERNIGHT. FINALIZE PREPARATION FOR YOUR HOME AND PROPERTY NOW.

STAY TUNED TO NOAA WEATHER RADIO OR OTHER MEDIA SOURCES FOR THE LATEST INFORMATION ON HURRICANE MARILYN. THE NEXT STATEMENT FROM THE SAN JUAN OFFICE WILL BE ISSUED AROUND 900 PM THIS EVENING.

3. HLS Issued at 845 p.m., AST, Friday, September 15, 1995.

BULLETIN - IMMEDIATE BROADCAST REQUESTED
HURRICANE MARILYN LOCAL STATEMENT
NATIONAL WEATHER SERVICE SAN JUAN PR
845 PM AST FRI SEP 15 1995

...EYE OF MARILYN CROSSES ST. CROIX WITH GUSTS TO 129 MPH...
...HURRICANE WARNINGS IN EFFECT FOR U.S. VIRGIN ISLANDS AND PUERTO RICO...
...SMALL CRAFT IN THE U.S. VIRGIN ISLANDS AND PUERTO RICO SHOULD REMAIN IN PORT...
...FLASH FLOOD WARNING IN EFFECT FOR U.S. VIRGIN ISLANDS...
...FLASH FLOOD WARNING IN EFFECT FOR THE EAST HALF OF PUERTO RICO...
...FLASH FLOOD WATCH IN EFFECT FOR THE WEST HALF OF PUERTO RICO...
...COASTAL FLOOD WARNING IN EFFECT FOR U.S. VIRGIN ISLANDS...
...COASTAL FLOOD WARNING IN EFFECT FOR EAST AND SOUTH COASTS OF PUERTO RICO FROM PUNTA BORINQUEN TO BAHAI JOBOS AND FOR THE SOUTH COAST FROM SALINAS EAST...
...COASTAL FLOOD WATCH IN EFFECT FOR SOUTH COAST OF PUERTO RICO FROM GUAYANILLA EAST TO SALINAS...

AT 800 PM AST THE CENTER OF HURRICANE MARILYN WAS LOCATED NEAR LATITUDE 17.9 NORTH... LONGITUDE 64.8 WEST...OR JUST NORTH OF ST CROIX...OR ABOUT 25 MILES SOUTH OF ST THOMAS...OR 350 MILES EAST SOUTHEAST OF CULEBRA OR 40 MILES SOUTHEAST OF VIEQUES AND ABOUT 95 MILES SOUTHEAST OF SAN JUAN PUERTO RICO.

MAXIMUM SUSTAINED WINDS ARE NEAR 100 MPH WITH HIGHER GUSTS. SOME ADDITIONAL SLOW STRENGTHENING IS POSSIBLE DURING THE NEXT 24 HOURS AS MARILYN MOVES THROUGH THE LOCAL AREA. HURRICANE FORCE WINDS EXTEND OUTWARD UP TO 30 MILES FROM THE CENTER...WITH TROPICAL STORM FORCE WINDS EXTENDING OUT TO 115 MILES FROM THE CENTER. THE LATEST MINIMUM CENTRAL PRESSURE REPORTED BY THE HURRICANE HUNTER AIRCRAFT WAS 968 MB OR 28.48 INCHES OF MERCURY.

MARILYN WAS MOVING TOWARD THE NORTHWEST AT NEAR 12 MPH AND THIS MOTION IS EXPECTED TO CONTINUE INTO SATURDAY. THIS TRACK WILL BRING THE CENTER OF MARILYN ACROSS THE ST THOMAS AND ST JOHN DURING THE NEXT TWO HOURS...NEAR THE EASTERN TIP OF PUERTO RICO BY 1030 PM AND NORTH OF SAN JUAN BY 1 AM. HURRICANE FORCE WIND GUSTS UP TO 129 MPH WERE FELT AROUND 515 PM AT ST CROIX. ST THOMAS REPORTED 75 MPH EARLIER THIS EVENING. GUSTS EXCEEDING 100 MPH ARE EXPECTED AT ST THOMAS MOMENTARILY. SIMILAR GUSTS ARE EXPECTED ACROSS CULEBRA AND VIEQUES BEFORE MIDNIGHT AND POSSIBLY EASTERN PUERTO RICO DURING THE PREDAWN HOURS. RESIDENTS OF

THE VIRGIN ISLANDS...CULEBRA AND VIEQUES AND EASTERN PUERTO RICO SHOULD ALREADY BE IN A SHELTER.

HURRICANE FORCE WINDS AND HIGHER GUSTS IN SQUALLS ARE EXPECTED TO PRODUCE SEAS NEAR 12 FEET WITHIN 100 MILES NORTH AND EAST OF THE CENTER. IN ADDITION...A STORM SURGE OF 3 TO 5 FEET CAN BE EXPECTED. BATTERING WAVES ON TOP OF THIS MAY PRODUCE COMBINED STORM TIDES OF 5 TO 7 FEET ACROSS EAST AND SOUTH FACING COASTS AND BAYS ACROSS THE VIRGIN ISLANDS AND EASTERN SECTIONS OF PUERTO RICO.

AT 830 PM...A LARGE AREA OF HURRICANE FORCE AND TORRENTIAL RAINS ASSOCIATED WITH THE EYE WILL MOVE ACROSS THE NORTHERN U.S. VIRGIN ISLANDS...CULEBRA AND VIEQUES DURING THE NEXT FEW HOURS. THIS WILL PRODUCE WINDS IN EXCESS OF 100 MPH...FLASH FLOODING...COASTAL FLOODING AND MUDSLIDES. RAINFALL RATES EXCEEDING 3 INCHES WILL AFFECT THE NORTHERN VIRGIN ISLANDS THROUGH 10 PM.

TROPICAL STORM CONDITIONS WILL SPREAD TO EASTERN PUERTO RICO INCLUDING THE SAN JUAN METROPOLITAN AREA DURING THE LATE EVENING AND THEN INTO THE OVERNIGHT HOURS. IF THE STORM TAKES A MORE WESTWARD WOBBLE THE HURRICANE FORCE WINDS AND HEAVIEST RAINS FOR THE SAN JUAN AREA WILL OCCUR BETWEEN 1 AM AND 5 AM SATURDAY MORNING.

MARILYN WILL ALSO BE A HEAVY RAIN MAKER FOR THE ISLANDS. RAINFALL TOTALS OF 5 TO 10 INCHES SHOULD BE EXPECTED ALONG THE PATH OF THE HURRICANE...WITH FLASH FLOODING AND MUDSLIDES IMMINENT TONIGHT...ESPECIALLY OVER MOUNTAINOUS TERRAIN.

STAY TUNED TO NOAA WEATHER RADIO OR OTHER MEDIA SOURCES FOR THE LATEST INFORMATION ON HURRICANE MARILYN. THE NEXT STATEMENT FROM THE SAN JUAN OFFICE WILL BE ISSUED AROUND 1145 PM LATE THIS EVENING.

4. NOW Issued at 650 p.m., AST, Friday, September 15, 1995.

SHORT TERM FORECAST FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
650 PM AST FRI SEP 15 1995

.NOW...
...HURRICANE WARNING IN EFFECT...
...FLASH FLOOD WARNING AND COASTAL FLOOD WARNING FOR U.S. VIRGIN ISLANDS AND PARTS OF PUERTO RICO...

RESIDENTS ON THE NORTH COAST OF ST CROIX...ST THOMAS...ST JOHN AND THE ADJACENT ISLANDS SHOULD PREPARE FOR A 3 TO 5 FOOT STORM SURGE WITH BATTERING WAVES ON TOP...DURING THE NEXT HOUR.
&&
AT 640 PM...RADAR...SATELLITE AND SURFACE REPORTS INDICATED THAT THE EYE OF HURRICANE MARILYN WAS PASSING OVER THE EASTERN PART OF ST CROIX. AN UNOFFICIAL WIND GUST OF 129 MPH WAS REPORTED BY A HAM RADIO OPERATOR NEAR THE CENTER OF ST CROIX AT 602 PM.

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WRIGHT/SEELEY

5. NOW Issued at 806 p.m., AST, Friday, September 15, 1995.

SHORT TERM FORECAST FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
806 PM AST FRI SEP 15 1995

.NOW...
...HURRICANE WARNING IN EFFECT...
...FLASH FLOOD WARNING AND COASTAL FLOOD WARNING FOR U.S. VIRGIN ISLANDS AND PARTS OF PUERTO RICO...

HURRICANE CONDITIONS ARE OCCURRING ACROSS ST THOMAS...ST JOHN AND THE ADJACENT ISLANDS. FLASH FLOODING...COASTAL FLOODING AND MUDSLIDES ARE LIKELY. THE HURRICANE FORCE WILL BE ACCOMPANIED BY A STORM SURGE OF 3 TO 5 FEET WITH BATTERING WAVES.
&&
PERSONS IN VIEQUES AND CULEBRA SHOULD BE PREPARED FOR SIMILAR CONDITIONS BY 1000 PM. AT 800 PM...RADAR...AND SATELLITE INDICATED THAT THE EYE OF HURRICANE MARILYN WAS MOVING NORTHWEST THROUGH THE U.S. VIRGIN ISLANDS AT 12 MPH.

$$

WRIGHT/DICKMAN

6. NOW Issued at 830 p.m., AST, Friday, September 15, 1995.

SHORT TERM FORECAST FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
830 PM AST FRI SEP 15 1995

.NOW...
...HURRICANE WARNING IN EFFECT...
...FLASH FLOOD WARNING AND COASTAL FLOOD WARNING FOR U.S. VIRGIN ISLANDS AND PARTS OF PUERTO RICO...

HURRICANE CONDITIONS ARE OCCURRING ACROSS ST THOMAS...ST JOHN AND THE ADJACENT ISLANDS. THESE ISLANDS WILL EXPERIENCE THE FULL BRUNT OF THE STORM DURING THE NEXT FEW HOURS WITH WINDS IN EXCESS OF 100 MPH...FLASH FLOODING...COASTAL FLOODING AND MUDSLIDES LIKELY.
&&
RAINFALL RATES EXCEEDING 3 INCHES AN HOUR WILL MOVE INTO THE NORTHERN VIRGIN ISLANDS DURING THE NEXT HOUR. HURRICANE FORCE WINDS WILL BE ACCOMPANIED BY A SURGE OF 3 TO 5 FEET WITH BATTERING WAVES.

PERSONS IN VIEQUES AND CULEBRA SHOULD BE PREPARED FOR POSSIBLE SIMILAR CONDITIONS BY 1000 PM. AT 800 PM...RADAR...AND SATELLITE INDICATED THAT THE EYE OF HURRICANE MARILYN WAS MOVING NORTHWEST THROUGH THE U.S. VIRGIN ISLANDS AT 12 MPH.

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DICKMAN

7. NOW Issued at 900 p.m., AST, Friday, September 15, 1995.

SHORT TERM FORECAST FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
900 PM AST FRI SEP 15 1995

.NOW...
...HURRICANE WARNING IN EFFECT...
...FLASH FLOOD WARNING AND COASTAL FLOOD WARNING FOR U.S. VIRGIN ISLANDS...AND NORTH AND EASTERN PUERTO RICO...

THE FIRST MAJOR RAINBANDS ASSOCIATED WITH HURRICANE MARILYN ARE MOVING ACROSS THE EAST AND NORTHEAST COASTS OF PUERTO RICO. DURING THE NEXT HOUR VERY HEAVY RAINFALL AND GUSTING NORTHEAST WINDS OF 40 MPH WILL AFFECT ALL OF NORTHEAST PUERTO RICO AND MUCH OF THE EAST COAST. THIS WEATHER WILL SPREAD TO THE SAN JUAN AREA BY 1000 PM THEN TO THE INTERIOR.
&&
THE CENTER OF MARILYN IS NOW DUE SOUTH OF ST THOMAS AND ST JOHN. HURRICANE FORCE WINDS AND SQUALLS WITH GUSTS ABOVE 80 MPH WILL REACH THESE ISLANDS BY 945 PM. RESIDENTS SHOULD NOW PREPARE FOR THE BRUNT OF THE HURRICANE.

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STRIPLING

8. NOW Issued at 1005 p.m., AST, Friday, September 15, 1995.

SHORT TERM FORECAST FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS
NATIONAL WEATHER SERVICE SAN JUAN PR
1005 PM AST FRI SEP 15 1995

.NOW...
...HURRICANE WARNING IN EFFECT...
...FLASH FLOOD WARNING AND COASTAL FLOOD WARNING FOR U.S. VIRGIN ISLANDS...AND NORTH AND EASTERN PUERTO RICO...

HURRICANE CONDITIONS ARE OCCURRING ACROSS ST THOMAS...ST JOHN AND ADJACENT ISLANDS.
HURRICANE CONDITIONS IMMINENT AT CULEBRA AND VIEQUES IN EASTERN PUERTO RICO.
&&
ALL OF THESE ISLANDS WILL EXPERIENCE THE FULL BRUNT OF THE STORM DURING THE NEXT FEW HOURS WITH WINDS IN EXCESS OF 100 MPH...FLASH FLOODING...COASTAL FLOODING AND MUDSLIDES LIKELY. RAINFALL RATES EXCEEDING 3 INCHES AN HOUR WILL MOVE INTO THE CULEBRA AND VIEQUES DURING THE NEXT HOUR. HURRICANE FORCE WINDS WILL BE ACCOMPANIED BY A STORM SURGE OF 3 TO 5 FEET WITH BATTERING WAVES. PERSONS IN EASTERN MAINLAND PUERTO RICO SHOULD BE PREPARED FOR POSSIBLE SIMILAR CONDITIONS SHORTLY AFTER MIDNIGHT. AT 800 PM...RADAR...AND SATELLITE INDICATED THAT THE EYE OF HURRICANE MARILYN WAS MOVING NORTHWEST THROUGH THE U.S. VIRGIN ISLANDS AT 12 MPH.

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DICKMAN

DATE DUE

8-25-97

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