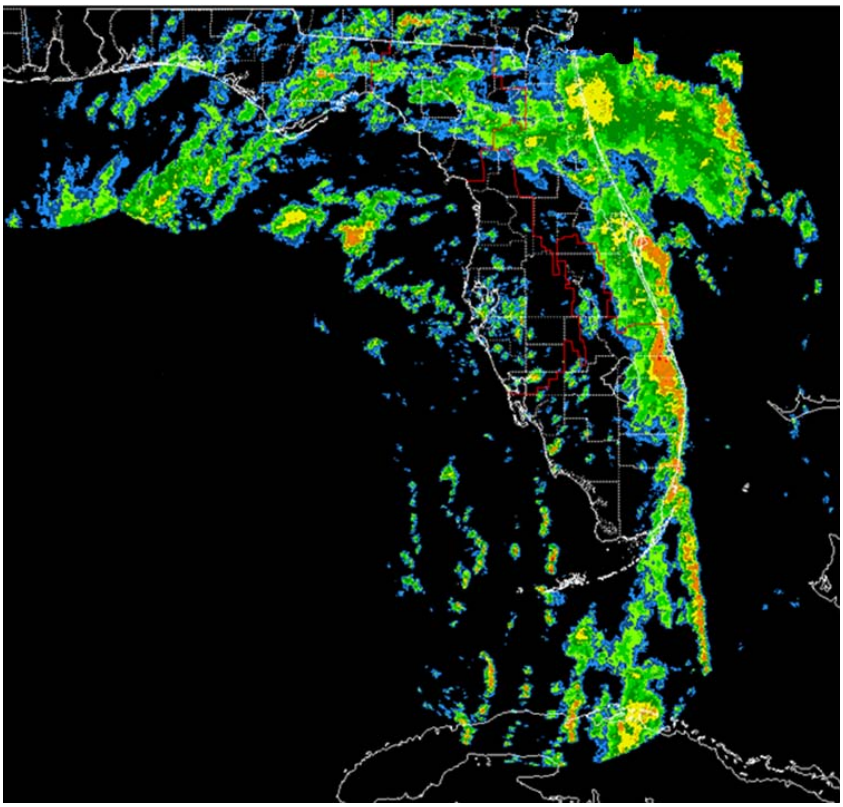
Tropical Storm / Hurricane Isaac

After-Action Assessment



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January 2013

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INTRODUCTION

This report is an After-Action Assessment of the South Florida Water Management District's (SFWMD) operations and the operating criteria during Tropical Storm/Hurricane Isaac focusing on actions taken before, during and after the event.

The principle purpose of the assessment is to identify possible system/infrastructure improvements which may be implemented to prevent or reduce long term risk to life and property from future similar natural hazards. This report identifies pertinent issues and challenges surrounding the SFWMD's actions and performance prior to, during and following Tropical Storm/Hurricane Isaac.

The impacts of Tropical Storm Isaac (TS Isaac) can be best understood by the substantial rainfall that fell into the Lower East Coast from Broward County north into the Treasure Coast and west into Central Florida during the period of August 26, 2012, to August 28, 2012. The impacted areas averaged about nine inches of rainfall with the heaviest rainfall occurring in West Palm Beach, producing localized flooding in the Indian Trails Improvement District, Village of Wellington, Village of Royal Palm Beach, Loxahatchee Groves Improvement District, City of Greenacres and other nearby areas.

This assessment will concentrate on the following SFWMD's water control facilities within the populated and agricultural areas that experienced the most significant impacts from the storm:

A. Palm Beach County & Everglades Agricultural Areas (EAA)
B. Ocean (L13), Bolles (L21) & Cross, L16 Canals
C. JW Corbett Wildlife Management Area

In anticipation of TS Isaac, the SFWMD initiated pre-storm drawdown of canals in the coverage area. The purpose of this was to prepare the system and to allow for additional discharge from secondary canals which were also being drawn down by the responsible 298 Drainage District and local municipalities.

To ensure continual and efficient flow of information, the SFWMD's Water Control Operations conducted daily conference calls from August 23, 2012 to August 29, 2012, with the 298 Districts and local municipalities to provide updates on District-wide water operations conditions, coordinate pre-storm drawdown efforts and identify any entities having problems getting their system ready. The SFWMD's Intergovernmental Representatives communicated conditions and updates to local government officials as needed prior to, during and after the storm event. In addition, approximately 34 staff members were assigned as County and State Liaisons throughout the various counties that encompass the SFWMD. Liaisons acted as direct links between the respective County or State Emergency Operations Center (EOC) and the SFWMD EOC. Critical pump stations were staffed around the clock beginning Sunday morning, August 26, 2012.

The Federal Emergency Management Agency (FEMA) issued a disaster declaration, FEMA-4084-DR, dated October 18, 2012, for Hurricane Isaac. The declaration lists the designations and types of approved assistance for Hurricane Isaac as follows:

A. Individual Assistance to individuals and households,
B. Public Assistance for emergency work and the repair or replacement of disaster-damaged facilities, and
C. Hazard Mitigation Grant Program assistance for actions taken to prevent or reduce long term risk to life and property from natural disasters.

Public Assistance is available for the following counties: Bay, Collier, Escambia, Franklin, Gulf, Martin, Monroe, Okaloosa, Palm Beach, St. Lucie, and Santa Rosa Counties.

SYSTEMS OPERATIONS

The SFWMD operated the Central and Southern Florida (C&SF) system in accordance with the US Army Corps of Engineers (USACE) Water Control Plans and other facilities such as Stormwater Treatment Areas in accordance with the approved operating plans as set forth by the applicable permits. Weather conditions changed significantly across large areas of the SFWMD as a nearly stationary rainfall feeder band focused over the east coast and into central Florida, with a heavy focus on Palm Beach County resulting in rapid and complex changes in water conditions. Pumping and drainage from the agricultural areas, municipalities, and residential areas were dynamic in response to rainfall intensity, distribution and water levels in the tertiary and secondary canals. This resulted in rapid water level increases in the regional canal system. All SFWMD automated water control systems were monitored and adjusted on a 24-hour basis by water managers through the Operations Control Center located at the SFWMD headquarters and the operational actions performed before, during, and after the storm were based on the information available at the time. The operational goal was to minimize flooding.

On Monday, August 27, 2012, as Tropical Storm Isaac moved into the Gulf of Mexico, a nearly stationary feeder band produced an average of 8.6 inches of rainfall with local maxima of 12.8 inches over the Lower East Coast from Broward County to the Treasure Coast and into Central Florida with a heavy focus on Palm Beach County, Florida. The C-51 Basin in western Palm Beach County was one of the hardest hit areas where 14.7 inches of rain fell over 72 hours from August 26-28. This three day rainfall event is estimated to have a return frequency of 100 years. The 100-year flood has a one-percent chance of being equaled or exceeded during any given year. One-, three- and seven-day rainfall amounts for specified periods throughout the District are depicted in Figure 5. These amounts were estimated from rain gauge data and from Radar. Lakes within the Kissimmee Basin were below their regulation schedule prior to TS Isaac and were returned to their schedule within 15-days post event. Lake Okeechobee's water level was 12.48 feet, National Geodetic Vertical Datum of 1929 (ft, NGVD 29), at the early stages of the storm and increased to 15.88 ft, NGVD 29 post storm. High water levels were recorded in the Stormwater Treatment Areas (STAs) and the Everglades Agricultural Area (EAA) with rapidly rising water levels in the S-2/S-6, S-3/S-7, S-5A, L-8 and C-51 basins. Pump Stations S-2 and S-3 reached their flood control operation level and pumping was initiated to move water from the EAA into Lake Okeechobee to prevent localized flooding. Water Control structures located within the C-51 Canal were operated at full capacity moving simultaneously over 5,700 cfs eastward through gravity at S-155 and 4,500 cfs westward through pumping at S-319, the highest rates ever recorded. As the rainfall continued to focus

over the S-5A, L-8 and C-51 basins, in order to maintain flood control and protect human health and safety in the S-5A and C-51 West Basins, to ensure safe operation of STA-1E and STA-1W and ensure the hydraulic capacity of the STAs were not exceeded, and to avoid conditions that would threaten the survival of STA vegetation and treatment efficiency, the SFWMD initiated an unanticipated diversion to WCA-1 through G-300 and G-301 at approximately 4:00 pm on August 27, 2012. On Monday August 27, 2012 at 4 pm, the L-8 canal water level reached 18 feet. While the storm progressed, consideration was given to the financial risk to the Design/Build contract versus the possibility of the water levels continuing to rise. Early Tuesday, the canal reached 19 feet and at that point a decision was made to open the gates to the culvert structure from the L-8 canal into the reservoir. The reservoir filled to its maximum storage capacity at 12.3 feet by September 6, 2012. Opening the reservoir earlier would not have made considerable difference in the amount of flooding observed during the event.

The total volume of pumped water is about 471,366 acre-feet (ac-ft) mostly from S2_6_7 basin (133,842 ac-ft, actual pumping date 8/20/12 to 9/5/12), STA-3/4 basin (130,147 ac-ft, actual pumping date 8/20/12 to 9/5/12), S5A basin (78,157 ac-ft, actual pumping date 8/20/12 to 9/4/12), C-51 West basin (60,602 ac-ft, actual pumping date 8/20/12 to 9/5/12), S-131+S-3 basin (4,995 ac-ft, actual pumping date 8/20/12 to 9/3/12). The total combined duration that all pumping units operated was about 8,795 hours (the equivalent of 364 days) during TS Isaac. Palm Beach County was the most impacted area where the pumping volume was about 406,946 ac-ft, about 86% of the total amount (see Attachment A – Pumping Analysis).

Volumes Discharged by County
August 24, 2012 – September 5, 2012

County	Volume Discharged (billion gallons)
Palm Beach County	88.1
Broward	29.2
Miami-Dade	44.3

Total inflow into Lake Okeechobee
August 24, 2012 to September 5, 2012

Runoff into Lake Okeechobee	150.7 billion gallons

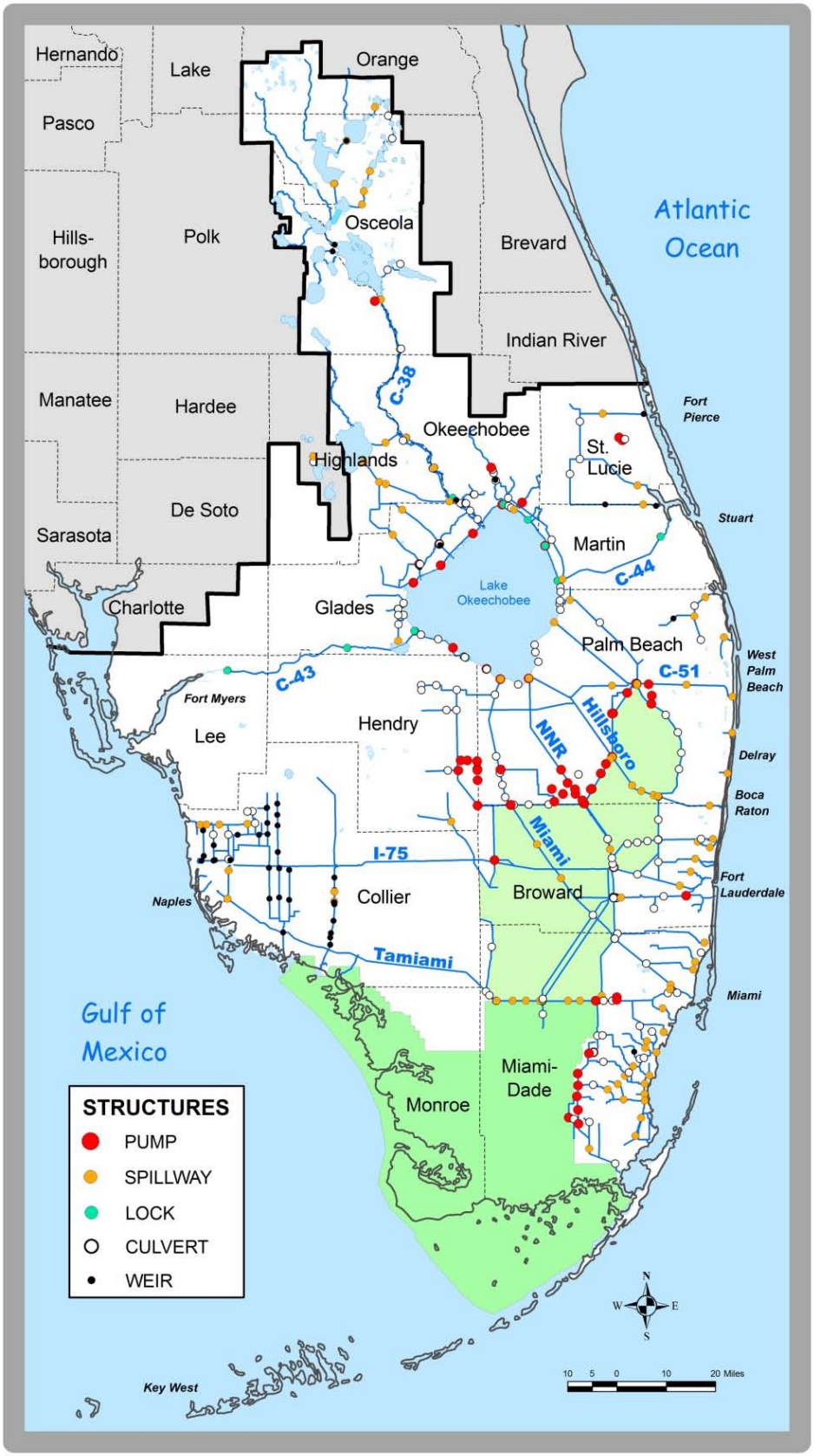


Figure 1 - SFWMD Structure Map

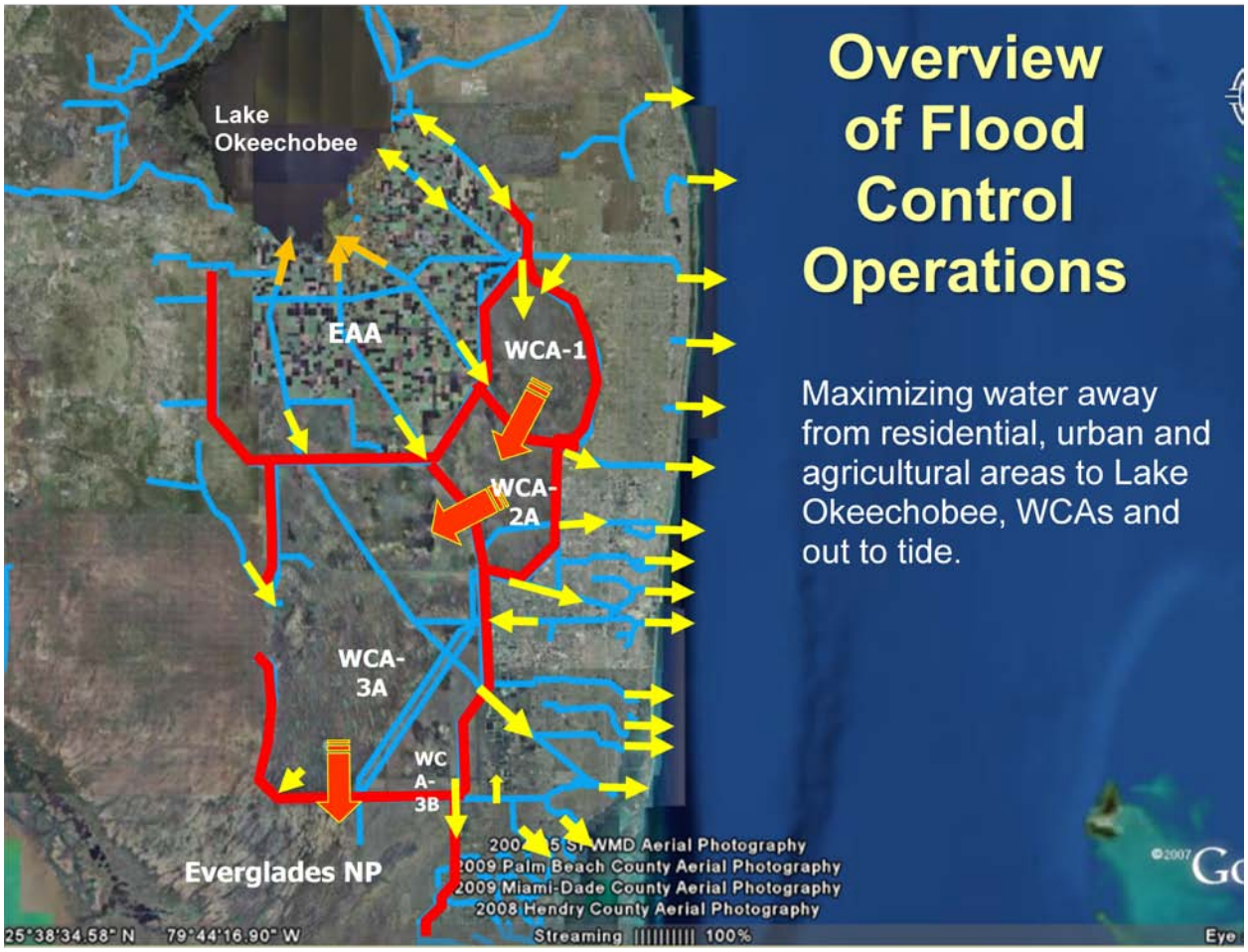


Figure 2 - Overview of Flood Control Operations during TS Isaac

BACKGROUND

The SFWMD operates and maintains the primary flood control and water supply network within its sixteen county area of jurisdiction. The major portion of that system includes the federally designed and constructed Central and Southern Florida Flood Control Project (C&SF Project). The SFWMD is responsible for the operation and maintenance of C&SF Project facilities, with the exception of certain facilities which remain under the jurisdiction of the U.S. Army Corps of Engineers (USACE). These USACE facilities are located on the perimeter of Lake Okeechobee which provides the primary outlet for the lake and the discharge structures for the three water conservation areas.

In addition to the C&SF Project, the SFWMD operates and maintains numerous other water control structures/facilities including:

1) Those canals, levees, and water control facilities located in eastern Hendry County, that are not part of the C&SF project, but provide for primary flood control within the C-139 Basin service area and

2) The Big Cypress Basin (BCB), a sub basin of the SFWMD, also operates and maintains a network of canals and water control structures that are not a part of the C&SF Project.
3) Various Stormwater Treatment Areas with associated pump stations and water control facilities.

This after-action assessment focuses only on the SFWMD's units responsible for carrying out the water control and field operations tasking. The units responsible for these tasks resides within the Operations, Maintenance & Construction Division (OMC Division) and are comprised of managers, supervisors, engineers, scientists, technicians, and administrators.

The Water Control Operations Control Bureau is an integral unit within the OMC Division and consists of an Operations Section which includes water managers and Meteorologists and an Operations Support Section which includes engineers working in support of the water managers and technicians assigned to monitor the system in the SFWMD's Operations Control Center. The Operations Control Center provides round the clock monitoring and control of the C&SF Project and other infrastructure totaling about 2,000 miles of canals and more than 2,000 miles of levees/berms. There are 645 water control structures, more than 700 culverts and 69 pump stations. In addition, there are nearly 3,500 hydrologic monitoring stations and more than 650 flow sites, including 200 rain gauges and 26 weather stations that are an integral part of the operation of the flood control system.

Monitoring and control of the primary flood control and water supply network requires coordination and decision making with the USACE and other SFWMD divisions and executives. The Water Control Operations Bureau also coordinates and liaisons with local, state and federal agencies, and other stakeholders. SFWMD Meteorologists provide weather forecast and storm tracking during an event. The Meteorologist responsibilities include:

1. Issuing Quantitative Precipitation Forecasts in graphical and text format as needed
2. Continuously monitoring storm movement and strength especially with regard to issuance of watches or warnings
3. Updating timetable for onset/offset of tropical storm force winds by county after each forecast is issued by the National Hurricane Center
4. Updating and briefing the Emergency Manager and EOC with changes in conditions
5. Collecting real-time data and disseminating rainfall reports
6. Providing weather briefings to 298 Districts and participating in local government conference calls
7. Ensuring reception and archival of meteorological data
8. Answering internal and external weather inquiries

The two Field Operations Bureaus (North and South) within the OMC Division are assigned the responsibility of carrying out daily field and pump station activities necessary for the operation and maintenance of the SFWMD's primary flood control and water supply networks. These critical field and pump station activities are the responsibility of eight Field Stations strategically located throughout the SFWMD.

Further critical functions within the OMC Division are provided by the Infrastructure Management Bureau, which includes a Supervisory Control and Data Acquisition (SCADA) Section and a Hydro Data Management Section. The SCADA Section provides the technical skills and support to ensure operational readiness of the SFWMD's communications and control system.

The Event

The developments leading up to TS Isaac required activation of the EOC and a high degree of coordination with the local 298 Districts and local government officials and staff. In addition, SFWMD Water Managers:

1. Analyzed the capabilities and operating criteria of the flood control system,
2. Assessed the rainfall threat,
3. Prepared for impact, and
4. Coordinated pre-storm and post-storm action plans.

A complete summary of the National Hurricane Center Forecast Track, the SFWMD qualitative Precipitation Forecast and the RAINDAR accumulated rainfall for the period from August 21 – 28, 2012 is contained in Attachment D.

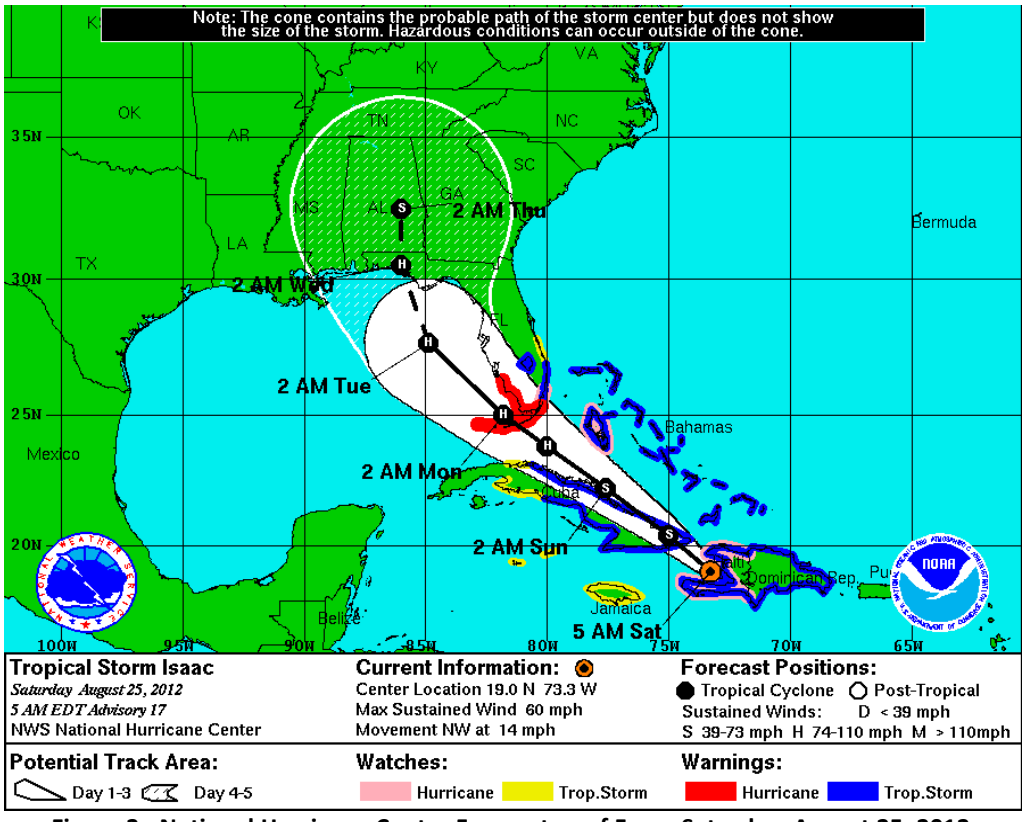


Figure 3 - National Hurricane Center Forecast as of 5 am, Saturday, August 25, 2012

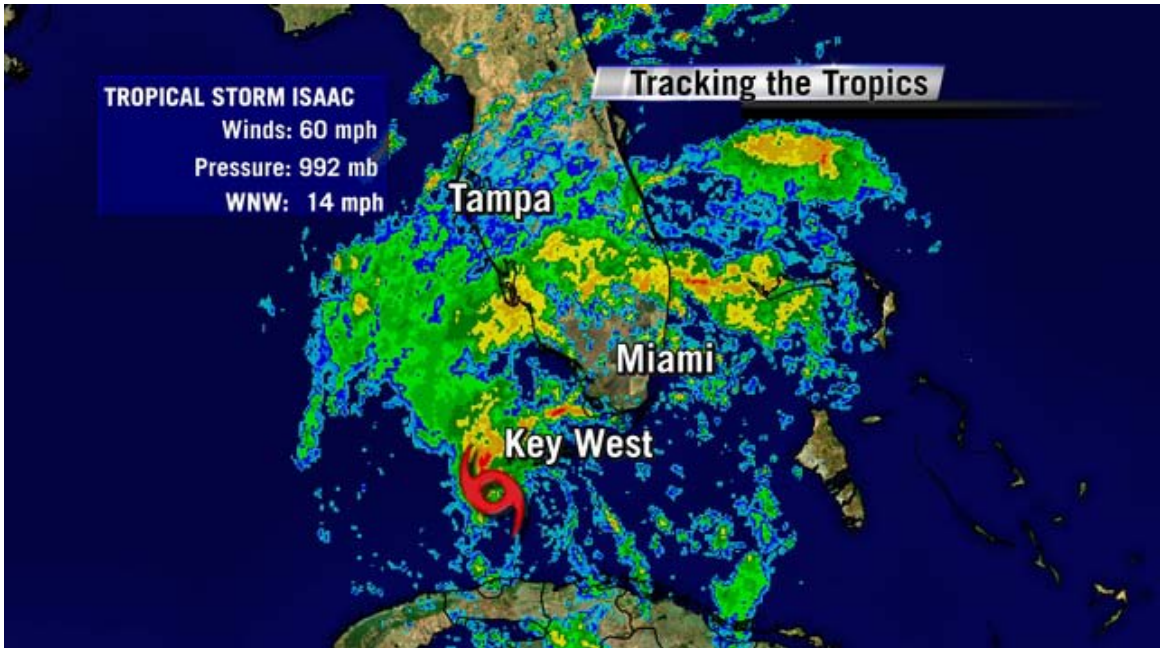


Figure 4 - Tracking the Tropics – TS Isaac

Rainfall

SFWMD wide average rainfall for the period from 8 am, 8/25 through 8 am, 8/28 was 4.8 inches. This covers the entire 16-county region served by the SFWMD and is calculated based on a weighted average of 240 rain gages. For perspective, a SFWMD wide average of 1 inch is an indicator that a significant rain event has occurred within the District. The 3-Day Rainfall Estimate in Figure 5 shows this graphically. Several of the basins in the Palm Beach County area indicate averages of up to 8+ inches of rain over that 3-day period with local maximums as much as 10 to 15 inches in these areas in about a 12-hour period.

A summary of some of the specific areas for this period are as follows:

- C-51 – 11.2”, 15” Max
- C-18 – 10.1”, 13” Max
- L-8 – 10.4”, 13” Max
- ACME – 11.4, 14” Max

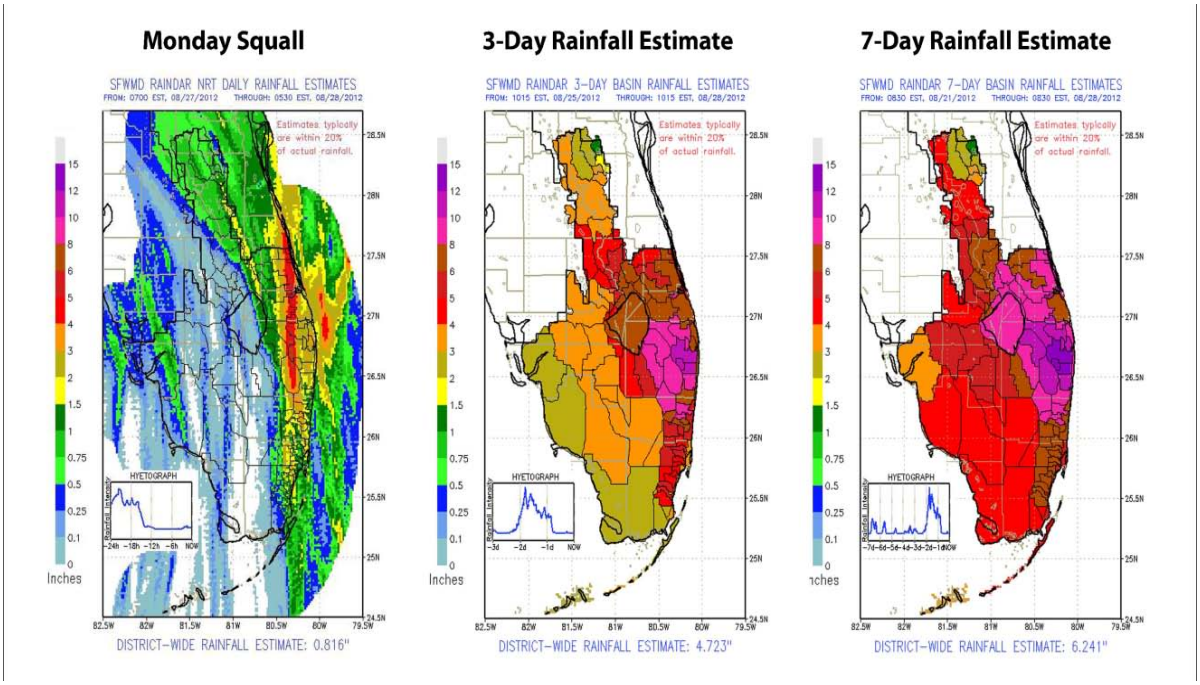


Figure 5:
A) Twenty-four hour (0700 on August 27, 2012 to 0700 on August 28, 2012) rainfall estimates from the SFMWD's RAINDAR
B) 3-day rainfall basin estimates from August 25 to 28, 2012
C) 7-day rainfall basin estimates from August 21 to 28, 2012

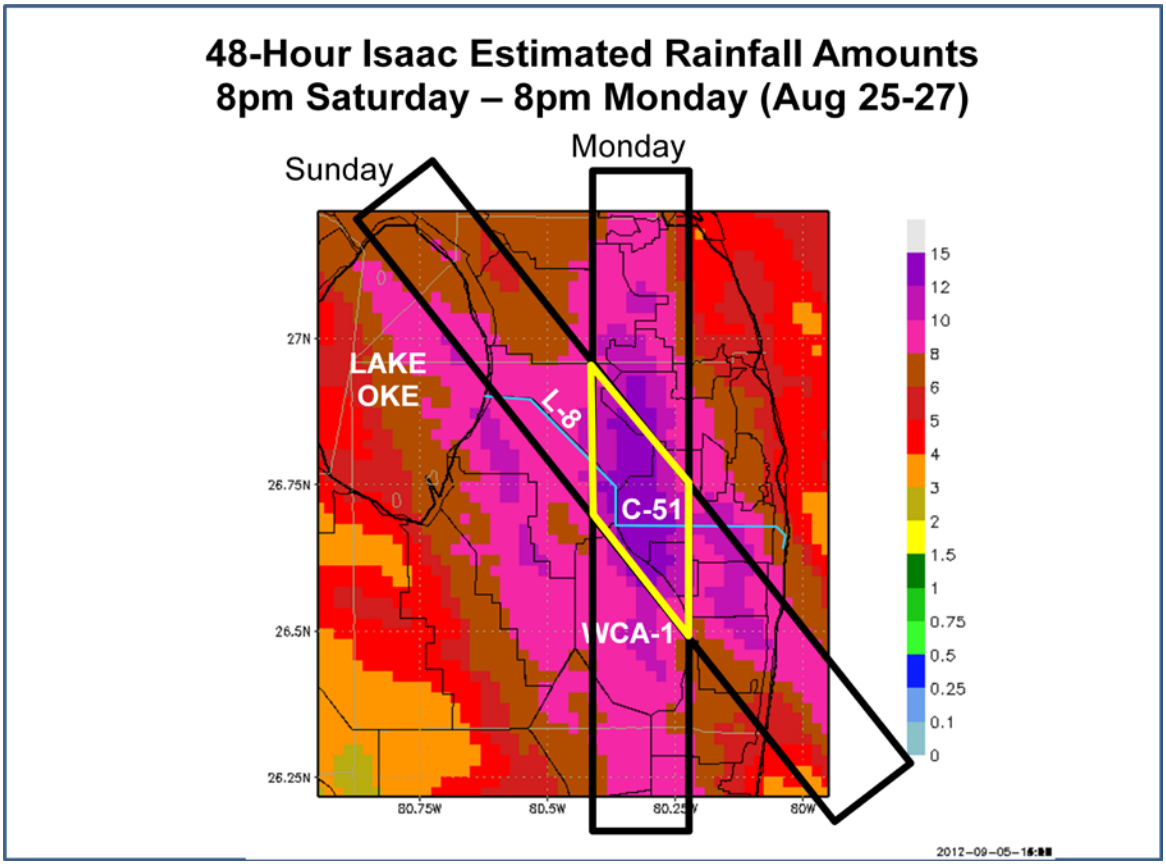


Figure 6 - TS Isaac 48-Hour Estimated Rainfall

Localized flooding conditions during and after the storm were observed in the following areas.

- Northern Broward County
- Palm Beach County
- Martin County
- St. Lucie County
- South East Okeechobee County

Although little structural flooding was noted, standing water in roads, swales and yards up to a few feet deep lingered in many of these areas for several days. In general, flooding conditions were resolved within a short period of time for the majority of the residential areas within these areas except for western Palm Beach County. These areas experienced extensive flooding of roads, swales and yards as evidenced in the following pictures. Actions to help alleviate the flooding were implemented immediately following the storm.

Village of Wellington

Village of Royal Palm Beach

60th Lane North just north of Lion Country Safari in Palm Beach County

Indian Trail Improvement District

Chronology of Forecasts

The SFWMD depends on information provided by the National Hurricane Center (NHC) in Miami, Florida regarding Tropical Weather systems. The following section contains a brief summary of those forecasts and actions the SFWMD took based on antecedent conditions due to recent rainfall and the forecast for rainfall from SFWMD meteorologist. Attachment D contains the NHC forecast graphics.

Tuesday, August 21, 2012

National Hurricane Center in Miami, Florida issued Tropical Depression discussion indicating that a large low pressure system that had been traversing the Tropical Atlantic had acquired enough deep convection to be classified as a Tropical Depression. Areas of the SFMWD had received local maximums between 1 to 3 inches of rainfall from an unassociated system. On August 21, 2012, the Miami-Dade area had been receiving above average rainfall since April 13, 2012, and a developing tropical depression presented a potential tropical storm or hurricane threat within 5 days. The SFMWD received afternoon and evening thunderstorms with local rainfall amounts up to 3 in. on August 21, 2012. This daily thunderstorm activity was being enhanced by some favorable upper level wind flow and was unrelated to TS Isaac. In the forecast issued on August 21, 2012, TS Isaac was not mentioned. TS Isaac was not mentioned in the text forecasts until August 23, 2012. TS Isaac was termed a "potential threat as early as Sunday" in the SFWMD tropical discussions August 21 and 22, 2012. TS Isaac was then expected to "begin affecting the SFMWD Sunday" in the SFWMD tropical discussions August, 23, 24, and 25, 2012.

In terms of relative wetness in Miami-Dade County on August 21, 2012, the area had been receiving a healthy amount of rainfall since April 13, 2012. Miami-Dade County had received 42.60 inches of rain between April 13 and August 21, 2012, which is 14.89 inches above the historical average. As of August 21, 2012, rainfall for the month was at 115% of the historical average with significant rainfall having fallen on August 3, 2012 (1.12 in.) and August 10-11, 2012 (2.29 in.).

Wednesday, August 22, 2012

Tropical disturbance was reported approximately 1,570 miles from Miami moving westward at 19 miles per hour (mph). This disturbance would later become TS Isaac. The SFWMD issued Emergency Bulletin #1 placing it in INCREASED READINESS CONDITION.

Thursday, August 23, 2012

TS Isaac was located approximately 1,272 miles from Miami moving west-northwestward at 15 mph. The SFWMD issued Emergency Bulletin #2 placing it in READINESS CONDITION 4. The Pre-storm action plan, such as testing of communication equipment; analyzing personnel status; and reviewing emergency action plans, was put into effect. The EOC status was level 3 – monitoring.

Friday, August 24, 2012

At 11:05 am, TS Isaac was located approximately 1,083 miles from Miami. The SFWMD issued Emergency Bulletin #3 and remained in READINESS CONDITION 4 and EOC was Level 3-monitoring.

At 6:02 pm, TS Isaac was moving toward the northwest at 16 mph with sustained winds at 65 mph. A THUNDERSTORM WATCH was issued for all of the Florida Keys, Dry Tortugas, Florida East Coast south of

Jupiter Inlet, Florida west Coast south of Bonita Beach, Florida Bay and Lake Okeechobee. The SFWMD issued Emergency Bulletin #4 and increased the READINESS CONDITION to 3 for Monroe, Miami-Dade, Palm Beach, Collier, Lee and Hendry Counties. CONDITION 4 was maintained for all other areas of the SFWMD. The EOC remained at LEVEL 3 – Monitoring.

Partial activation of the SFWMD's Citizen Information Line was implemented on Friday August 24, 2012. Staff received over 1,041 calls from concerned citizens.

Saturday, August 25, 2012

At 10:08 am, TS Isaac was located approximately 570 miles southwest of Miami moving northwest at 14 mph with wind speeds of 60 mph. The SFWMD issued Emergency Bulletin #5 and increased the READINESS CONDITION to 2 for Monroe, Miami-Dade, Broward, Palm Beach, Collier, Lee, Charlotte, and Hendry Counties. All other areas of the SFWMD were raised to CONDITION 3. A HURRICANE WARNING was issued for mainland Monroe, and south Miami-Dade and Collier Counties. A TROPICAL STORM WARNING and HURRICANE WATCH were issued for the remainder of Miami-Dade County. A TROPICAL STORM WARNING was also issued for Glades, Hendry, Broward, and Palm Beach Counties including Lake Okeechobee.

At 6:01 pm, TS Isaac was moving at 17 mph with winds at 60 mph, gradually strengthening into a hurricane approaching the Florida Keys. The SFWMD issued Emergency Bulletin #6 and remained in READINESS CONDITION 2 for Miami-Dade, Broward, Palm Beach, Collier, Lee, Charlotte, and Hendry Counties. All other areas within the SFWMD remained in READINESS CONDITION 3. A TROPICAL STORM WATCH was extended to the Florida East Coast north of Sebastian Inlet to Flagler Beach and on the West Coast north of Bonita Beach to Suwannee River. The EOC remained at LEVEL 3 – Monitoring.

At 8:00 pm, the SFWMD issued Emergency Bulletin #7 and increased the READINESS CONTION to 1 for Monroe, Miami-Dade, Broward, Palm Beach, and Collier Counties. Lee, Charlotte, Hendry, Glades, Highlands, Martin, and Okeechobee Counties were raised to READINESS CONDITION 2. St. Lucie, Osceola, Polk and Orange Counties remained in READINESS CONDITION 3. The EOC remained at LEVEL 3 – Monitoring.

Sunday, August 26, 2012.

At 07:20 am, TS Isaac was moving at 18 mph with maximum sustained winds of 65 mph. The main threat of the storm was the heavy to excessive forecasted rainfall of 2-6 inches on average with local rain falls forecasted to about 10 inches by Monday evening. The SFWMD issued Emergency Bulletin #8 with INCREASED READINESS CONDITION 0 for Monroe and Miami-Dade Counties. Broward, Palm Beach, and Collier Counties remained in READINESS CONDITION 1. Lee, Charlotte, Hendry, Glades, Highlands, Martin, and Okeechobee Counties were raised to READINESS CONDITION 1. St. Lucie, Osceola, Polk and Orange Counties were raised to READINESS CONDITION 2. At 11:05 am, the SFWMD issued Emergency Bulletin #9 with INCREASED READINESS CONDITION 0 for Monroe, Miami-Dade, Broward, Palm Beach, Collier Lee, Hendry, and Charlotte Counties. St. Lucie, Martin, Osceola, Polk, Glades, Highlands, Okeechobee and Orange Counties were designated at READINESS CONDITION 2. The EOC was elevated to LEVEL 1- Full Activation at 12:00 Noon.

SFWMD Pre-Storm Actions

In anticipation of the arrival of TS Isaac, the SFWMD initiated pre-storm drawdown of all canals in the coverage area. All 298 Districts and local governments for the entire SFWMD coverage area were contacted in the days prior to TS Isaac. They were given the forecast and advised to discharge down to their permitted low range water levels in preparation for the event. SFWMD Operations lowered the primary canals to allow for the additional discharge and maintained levels in the low range in anticipation of the storm. Pre-storm coordination conference calls began Friday, August 24, 2012 with 298 Districts and municipalities with areas of special concern. These calls were opportunities for their water resource managers to provide the District with information regarding any system problems or areas of concern.

Water Managers continuously and systematically monitored the system (North, Central and South Water Management Regions) and weather conditions. Gate adjustments were made as necessary in response to actual water levels, anticipated rainfall and as system issues warranted. Operators implemented adjustments as necessary based on changing site conditions. For example, when a bad sensor occurred during the event, Water Managers considered and determined the next best available point (if any), determined associated actions, and made system adjustments to mitigate the risk (open/close other gates, use alternate point, add 'no commands' tag to a gate). Priorities were also identified for issues that required site visits to resolve.

Prior to the arrival of TS Isaac, SFWMD Regulation Division staff confirmed contact information for entities with operable structures and participated in pre-storm local government teleconferences.

The following chronology of events describes the pre-storm actions taken by the SFWMD.

Tuesday, August 21 2012

- Started operation to lower stages in the C-4 Basin (S-25B headwater). All units of the S-25B Forward Pump Station were tested and were determined to be fully operational.
- The C-4 Emergency Impoundment was inspected and pump stations tested.
- The T-5 gauge on the C-4 Canal was at 3.16 ft, NGVD 29.

Wednesday, Aug 22, 2012

- The South Dade Conveyance System Pre-storm drawdown written request was transmitted to the USACE.
- Field Station Pumping crews were notified of storm event reporting assignment at all pump stations throughout the SFWMD.
- All range adjustments at coastal structures in Martin, Palm Beach and Broward Counties were assessed and all canals were within acceptable ranges and available for flood control. Adjustments were made as the storm progressed based on forecasted rainfall and tide cycles.
- Kissimmee Basin/Istokpoga: All lakes were at or near regulation schedule.
- Appropriate flow adjustments were made in order to be below schedule prior to the storm and then to increase releases in response to rainfall.

Thursday, August 23, 2012

- South Dade Conveyance System Pre-storm drawdown operations were initiated after approval was received from the USACE.

- Miami-Dade County / Homestead - Coastal canals were moved to the low range.
- Broward County - C11 Canal operational adjustments were made and the S9 Pump Station was staffed for pre-storm operations.
- G-54 and G-57 were placed in the low range.
- Pre-storm adjustments were made at manual structures by Field Stations per Water Managers orders (ex: G-103, S-135, G-33, G-34, test of backup controller G-93 and moved to low range etc.).
- Orders were given to lower stages at G-92 and G-160 in Palm Beach County, and the S-381 weir was lowered in Broward County.
- Continued assessment of the storm was made and canals were within acceptable range and available for flood control. Adjustments were made based upon the forecasted rainfall and tide cycle.
- Indian Trail Improvement District (ITID) requested and was given approval to move 200 cfs via Roach &/or 40th Street structures for Pre-Storm Releases to C-51E with SFWMD matching flows at S-155A.

Friday, August 24, 2012

- 298 Districts/Local Government - Conference calls were held to coordinate with the 298 Districts and local governments on water control operations. Initial calls took place on Friday Aug 24 and subsequent calls were made from Sunday Aug 25 through Thursday Aug 30.
- All SFWMD pump station crews were notified that the pump stations will be staffed round the clock beginning on Sunday morning.

SFWMD Storm Actions

Saturday, August 25, 2012

- Over the preceding 24 hours, the District wide rainfall was 0.43 inches. In the Homestead area, the C-111 & C-103 basins received a local maximum of 3.0 - 3.4 inches and local basin average of 2+ inches. The remainder of Miami-Dade County received 1.4 inch local max with basin averages of 1 inch. Eastern Palm Beach County received 2.9 inches local max with basin averages of 1.7 inch.
- Water Managers made system wide adjustments to deal with locally heavy rains in Miami-Dade/Homestead (Friday evening through Saturday morning). This rain took up some of the capacity gained from the pre-storm operations.
- SFWMD Order No. 2012-096-DAO was issued for Emergency Authorization for pumping and other measures to address flooding caused by TS Isaac.

Sunday, August 26, 2012 – TS Isaac Onslaught

- Areas of heavy rains over the past three days have taken up pre-storm capacity in the Miami-Dade & Homestead areas. Local maximums 4+ inches & basin averages of 3 inches in the C2 basin. Local maximums 3+ inches & basin averages 2+ inches in the rest of Miami-Dade County.
- Lake Okeechobee North Shore pump stations were manned and operating.
- ITID closed the Roach and 40th Street structures in accordance with its operation permit and on-peak discharges from the outfall into the ITID Upper and Lower M1 basins. Discharges were made through the L-8 borrow canal. For S-197, two gates were opened feet at about 5:30 pm, August 26, 2012 to achieve a discharge equivalent to the former structure discharge.

Monday, August 27, 2012 – TS Isaac moved into the Gulf of Mexico – Heavy rains continued on the East Coast

As TS Isaac moved into the Gulf of Mexico, a nearly stationary rainfall feeder band produced an average of 8.6 inches of rain with local maximums of 12.8 inches over the Lower East Coast from Broward County north to the Treasure Coast and west into Central Florida with a heavy focus on Palm Beach County.

- S-319 pumped all five units (4,500 cfs) and the headwater rose to 14.6 ft, NGVD 29 (5:30 pm).
- S-5A pumped all units and G-302 was maximizing flows into STA-1W.
- S-2 began flood control pumping at 6:30 am; moving water from the Everglades Agricultural Area into Lake Okeechobee for agricultural and residential flood control.
- S-3 began flood control pumping at 9:15 am; moving water from the Everglades Agricultural Area into Lake Okeechobee for agricultural and residential flood control.
- Beginning at approximately 4 pm, G-311 in STA-1E was opened. At the same time, G-300 and G-301 were opened. This operation allowed the S-319 pump station flows coming via STA-1E to pass through G-311 and be diverted directly into WCA-1.
- This also allowed the flows from the S-5A pump station, in excess of STA-1W capacity to move through G-300 and G-301 directly into WCA-1.
- In the C-18 Basin, water managers began taking water through G-92 (reverse flow) at the request of the South Indian River Water Control District to provide flood relief(Aug 27, 3 pm – Aug 30, 11:30 am).
- Along the NW shore of Lake Okeechobee, the Okeechobee Field Station installed temporary pumps at the S-127 structure (Glades County) to help deal with quickly rising water levels.

All actions were taken In accordance with requirements of the operating the Everglades Forever Act (EFA) and the National Pollutant Discharge Elimination System (NPDES) IWF permits, the District notified the Florida Department of Environmental Protection (FDEP or Department) of the diversion first via phone call on August 27, then via electronic mail on August 31, 2012. The District notified the Loxahatchee National Wildlife Refuge of the diversion via phone call on August 27, 2012, then via electronic mail on August 31, 2012 and followed up with subsequent updates via phone call throughout the event. The FDEP was also notified via phone call on September 3, 2012, that diversions had ceased.

SFWMD – Post Storm Recovery Operations/Actions

SFWMD post storm recovery operations included reviewing the state of the water control system, past and forecasted rainfall, making gate adjustments as required in response to canal/lake stages, and responding to control room calls regarding system conditions or site maintenance problems.

SFWMD began post storm recovery operations on Tuesday, August 28, 2012. Extensive flooding was reported in ITID, Village of Wellington (VOW), Village of Royal Palm Beach (VRPB), and City of Greenacres all in Palm Beach County, City of Okeechobee in Okeechobee County and the City of Lauderhill in Broward County.

SFWMD provided post-storm field reconnaissance and damage assessment services in response to various missions received from the SFWMD's EOC. The EOC's mission log identifies mission specific details. In general, field reconnaissance and damage assessment were provided for:

- Wellington – Documented flooding to support Village of Wellington's (VOW) request to operate Pump Stations 1 and 2 to pump directly into WCA-1.
- Deer Run/White Fences – Responded to reports and documented flooding to support the Home Owner Association's (HOA's) request for an Emergency Pump Order.
- Fox Trail – Documented failure of control structure and outfall culvert.
- Lion Country Safari – Investigated allegations of breach in perimeter berm.
- PB Aggregates – Investigated allegations of seepage causing elevated off-site water levels.
- Los Flores Ranches – Investigated flooding and corresponding perimeter elevations.
- ITID M-2 Basin – Investigated reports of a breach in the impoundment berm.
- Homeland – Investigated reports of dike over-topping.
- Corbett – Provided regulatory support to the OMC Division, FFWCC and ITID for emergency repairs to ITID's northern perimeter berm.
- Palm Beach Plantation – Documentation of flooding to support HOA's request for Emergency Pump Order.
- Delray Training Center – Responded to reports of flooding and breach in perimeter berm.
- Mission Bay/Boca Woods/Glades Road – Coordinated with county officials to remove unauthorized dam which was causing upstream flooding.

SFWMD Intergovernmental Representatives and Regulation Division staff participated in numerous additional outreach efforts to educate public regarding permitting, levels of flood protection, and proper operation and maintenance of Primary, Secondary and Tertiary Surface Water Management Systems (SWMS) in coordination with 298 Districts and local governments. Specific venues included Homeland, Deer Run, Wellington, Loxahatchee Groves, ITID, and Lake Worth Drainage District.

Tuesday, August 28, 2012

- Operations began moving water into the L-8 Reservoir for flood control.
- The VOW requested and was authorized to operate the pump at ACME 2 Pump Station to pump directly into WCA-1, based on rapidly rising water levels in neighborhoods and immediate flooding threats to homes.
- ITID was given approval to begin releasing 100 cfs into the M-1 Canal. The M-1 Canal passes through the VRPB and connects to the C-51 Canal. The Village staff monitored canal levels for possible downstream impacts. With approval from the SFWMD and the Village, ITID ramped up discharge to 250 cfs as quickly as possible.

Wednesday, August 29, 2012

- Recovery efforts were ongoing in the South Dade Conveyance System (SDCS) with pumping at S-331, S-332B, C, D, S-357, S-199, and S-200.
- Recovery efforts (night shift) were ongoing at S-2, S-4, G-372, G-370, S-7, S-8, S-319, S-362, S-5A, S-310, S-6, S-127, S-133, S-135, S-9, S-13, and S-331.
- Pumping operations were stopped at S-3 at 3 pm.

Thursday, August 30, 2012

- S-197 was closed at 9:30 am.
- Homestead structures S-165, S-167, S-21A, S-20F, and S-20 returned to normal operating levels.
- S-37A located in Broward County and G-93 located in Miami-Dade County was returned to normal operations.

Friday, August 31, 2012

- The Village of Wellington ACME 2 Pump Station was shut-off on August 31, 2012 at 8 am after pumping a total of 1,230 ac-ft of water.
- The SFWMD received and approved an Emergency Order from ITID at 2:45 pm to install additional temporary pumps at ITID Pump Station #2. The purpose of the additional temporary pumps was to move water south from the M-1 upper basin to the M-1 lower basin. Discharge was to the M-1 Canal in the VRPB. Three 24" diameter pumps rated at 20,000 gpm each were used for a total of 60,000 gallons per minute or 134 cfs.
- G-311 was closed towards the end of the day, terminating the diversion of STA-1E flows into WCA-1.

Saturday, September 1, 2012

- As pumping at S-5A flow reduced in response to the recovery at the S5A headwater and water levels in WCA-1 came up downstream of G-301 the automated gate control setting prevented reverse flow by closing the G-301 gate.
  G-301 closed to prevent backflow from the Loxahatchee NWR into the STA-1 inflow basin.

Monday, September 3, 2012

- Diversion at G-300 and G-301 to Loxahatchee NWR stopped by 2100 and 1600, respectively; gravity flow to the Loxahatchee NWR was no longer possible due to stage differentials across the structures. Flow continued to STA-1E and STA -1W treatment cells in response to decreased pumping at S5A and falling stages in STA-1E and STA-1W.
- The inflow culverts at the L-8 Reservoir were opened on 8/28/2012 and closed on 9/6/2012 after L-8 Canal levels fell to acceptable levels. This action helped lower levels in the L-8 Canal which facilitated Corbett and ITID to discharge to the L-8 Canal to relieve localized flooding.
- S-5AE was discharging at design capacity to help relieve high stages in the L-8 Canal. Pumping at S319 had been reduced to relieve high water levels in the treatment cells of the STA-1E central flow-way and flow through S155A had been declining.
- S-5AW was discharging (230 cfs) to help lower stages in the L-8 Canal. Stages had receded in the West Palm Beach Canal as had pumping at S5A.
- S-155A had both gates fully open and was discharging 944 cfs.
- S-155 was discharging 1,100 cfs.
- S-319 was pumping two units for a total of 1,716 cfs.
- G-341 had both gates open 1.0 foot with a HW of 12.7 feet, TW of 9.8 feet and was discharging 440 cfs.
- Martin County structures S-97, S-49, S-99 were returned to normal ranges.

Tuesday, September 4, 2012

- The S-2 pump station stopped flood control pumping operations at 2 pm.
- In response to higher than normal water levels in Water Conservation 3A, the plug in Old Tamiami Trail adjacent to the L67 extension (west of S-346) was removed to facilitate the

outflow from the WCAs into Everglades National Park. SFWMD coordinated the plug removal with FFWCC, USACE, DOI and Miccosukee Tribe.

Wednesday, September 5, 2012

- Adjustment of all water control structures continued as stages returned to normal.
- Coordination and adjustment of all STAs continued as stages returned to normal.
- Pumping was ongoing at S-4, G-372, G-370, S-7, S-8, S-319, S-362, S-5A, G-310, S-6, S-127, S-133, S-135, S-9, S-13, and G-355 through the night. S-5A and S-319 ended night shift operations on Sept 9.

Thursday, September 6 - Monday September 10, 2012

- The water managers continued moving the maximum amount of water from all three WCA's to tide via the coastal outlets, including S-39 / G-56, S-38/S-37A/S-37B, S-151 / S-31 / S-36, and S-338 / S-148 / S21.
- As recovery from TS Isaac and the additional rainfall in the South Dade area subsided, Operations began to move water from WCA-3A into the SDCS subject to favorable downstream conditions under IOP for Protection of CSSS.

Tuesday, September 11, 2012

- Focused on STA vegetation recovery by controlling stages in treatment cells affected by TS Isaac's inflows. Night shift pumping continued at S-362, G-310, G-335, and S-7
- Pumping (night shift) continued at Homestead S-331.
- The City of West Palm Beach requested to have water levels at Grassy Waters Preserve between elevations 18.5 and 18.75 ft, NGVD 29 by the end of the week. Attaining this level was feasible provided that there was no significant, additional rainfall. At the time of the request, levels at G-161 headwater were at 18.90 ft.
- Still dealing with run-off to the Grassy Waters Preserve - Releases at G-161 (about 150 cfs) were being made at the request of the City of West Palm Beach. G-160 was releasing about 500 cfs on average. G-92 was discharging 135 cfs and S-46 was discharging about 800 cfs to tide into the southwest fork of the Loxahatchee River.

Wednesday, September 12, 2012

SFWMD conducted an After-Action Roundtable with Palm Beach County, 298 Districts and local government officials:

- SFWMD officials presented an after-action summary to the attendees.
- Discussed how to improve access to real time information and operations data. It was proposed that a web-based Real Time Information Portal be implemented by the SFWMD with access provided to invited agencies.
- Discussed Corbett / ITID Berm Improvements.

Later on the same day, the SFWMD also gave a TS Isaac Presentation/Q&A at the ITID Board Meeting.

Tuesday, September 18, 2012

Water Managers conducted an ITID Public Information Workshop.

Thursday, October 4, 2012
Water Managers gave a TS Isaac Presentation/Q&A to the Broward League of Cities.

Friday, October 5, 2012
SFWMD conducted an After-Action Roundtable with the Everglades Agricultural Area Water Control Operations Group and discussed potential Bolles & Cross Canal and L13 levee refurbishments and/or improvements.

Summary of Actions Coordinated to alleviate flooding

1. WCA-1 Actions
   - Bypass of STA-1E and S-5A flows through structures G-300 and G-301.
   - S-319 was operated at full capacity as needed (4,500 cfs) to lower Western C-51 Canal stages.
   - VOW Pump Station ACME 2 (via G-94D) was operated.
2. Emergency Pumping Authorizations
   - SFWMD provided emergency pumping authorizations and local assistance by facilitating the installation of temporary pumps to alleviate flooding in communities whose secondary systems were overwhelmed.
   - SFWMD installed a pump at the intersection of the L-8 and M1 canal, the ITID reservoir outlet canal, in order to assist drainage from the ITID and Corbett. As of September 6th, 2012, these pumps moved approximately 7,000 ac-ft or 2.3 billion gallons of water.
   - Palm Beach County and the City of West Palm Beach also installed pumps and allowed additional flows to their systems.
3. Municipality Actions
   - Asked neighboring cities to hold back discharges whenever they were at safe levels. Also coordinated with cities to allow flows to pass through their systems to SFWMD canals.
   - The VRPB agreed to allow ITID pass flows through their M-1 canal, as long as the C-51 Canal could handle these flows and the stage in the M-1 canal remained below critical stages.
4. C-18 Basin Actions
   - Corbett C-18 area release to the L-8 borrow canal was stopped to allow increased capacity in the C-18 Canal. Culvert 10A was opened fully by the USACE to allow water to back flow into Lake Okeechobee.
   - Pump Station S-319 was pumped to allow the C-51 Canal to receive runoff from the L-8 borrow canal and ITID off-peak run-off. Primary purpose was for the C-51 basin run-off.
   - The L-8 Reservoir received about 10,000 ac-ft of water for flood control purposes.
   - Temporary pump on C-18W Weir.
   - Diversion of Corbett water to C-18W across Mecca property.

Summary of Actions Conducted during Recovery

The Operations Support Section and the Hydro Data Management Section provided Hydrology and Hydraulics expertise in the support of the post storm recovery, including:

- Coordination between Operations Control Center and Stream Gauging group.
- Deployment of stream gauging crews to critical sites for flow measurements.
- Data analysis for the SFWMDs Emergency Modeling Team.
- Computation of discharge volumes at more than 69 flow control structures and NEXRAD rain data at more than 45 watershed basins SFWMD wide.
- Hydro-meteorological data analysis and assessment of system operation.
- NEXRAD data extraction for eight Palm Beach County watershed basins.
- USGS data extraction of indexed velocity site on the L-8 borrow canal near C-10A.
- Analysis of the Corbett area ITID berm breach.

183 individual Missions were initiated, tracked and completed through the WebEOC incident management system. The missions resulted in the immediate deployment of SFWMD resources including staff, supplies and equipment needed to address emergency situations. This was done in support of the SFWMD overall mission of managing and protecting the water resources of South Florida by balancing and improving water quality, flood control, natural systems and water supply. The missions were broken down by area of responsibility as follows:

- West Palm Beach Field Station – 69 missions
- Okeechobee Field Station – 20 missions
- Clewiston Field Station – 13 missions
- Miami Field Station – 4 missions
- Ft. Lauderdale Field Station – 3 missions
- Homestead Field Station – 3 missions
- St. Cloud Field Station – 2 missions
- Big Cypress Basin Field Station – 1 mission
- Reconnaissance request for information – 32 missions
- Stream gauging – 36 missions

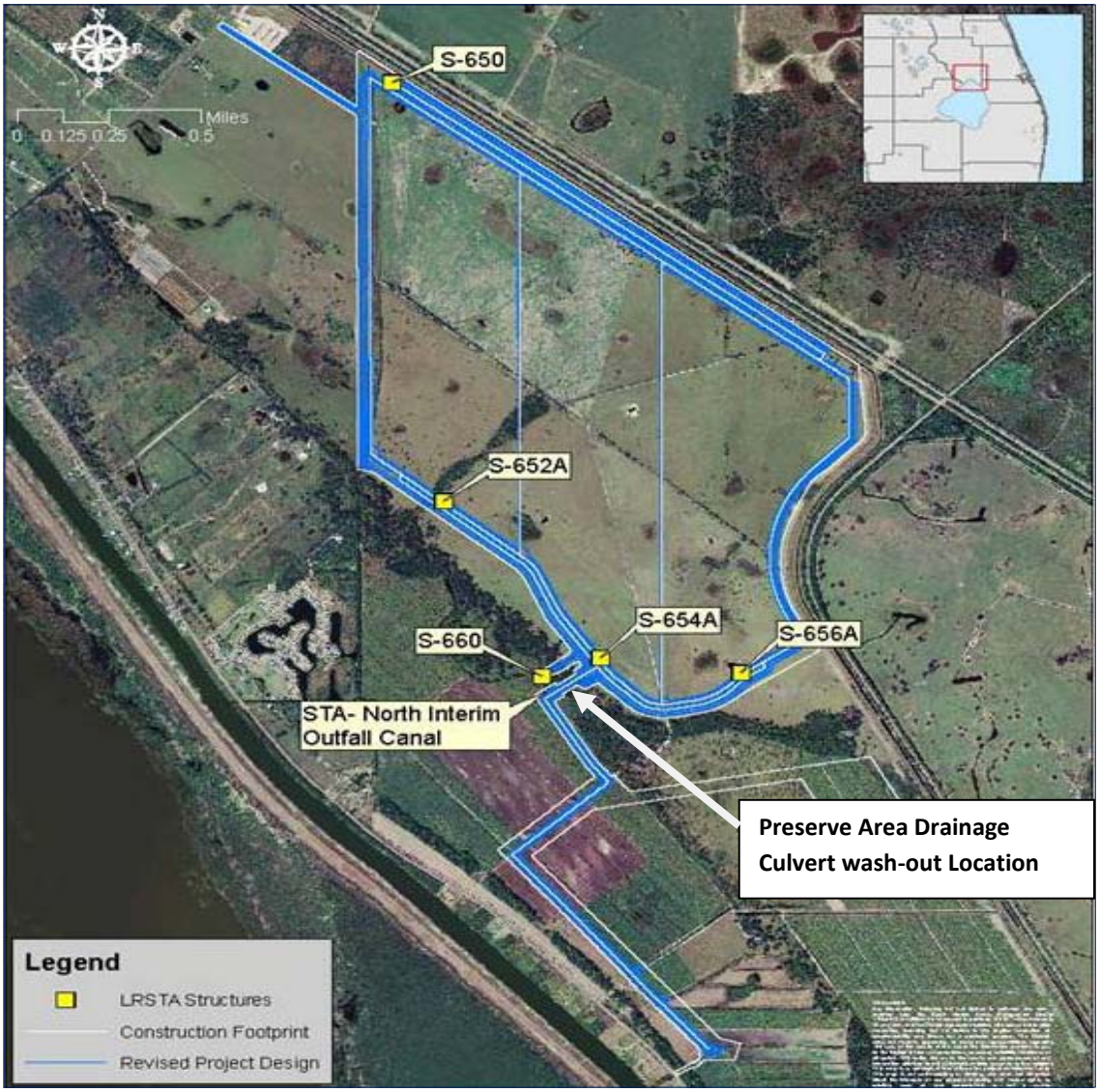
FINDINGS & OBSERVATIONS

Martin-St. Lucie County

TS Isaac had a significant impact on the SFWMD's infrastructure in Martin County, especially in the Lakeside Ranch STA. Structural damage, severe flooding, and erosion due to heavy rainfall from the storm event were observed at the STA.

Lakeside Ranch STA

Structural (culvert and levee road washout) and erosion damage was observed at Lakeside Ranch STA as a result of the heavy rains from TS Isaac. The washed-out culvert and levee roadway were part of the recently completed Lakeside Ranch STA project and this culvert provides needed drainage from the adjacent preserve land into the North Interim Outfall Canal within the STA. The damaged culvert did not impede operation of the STA.



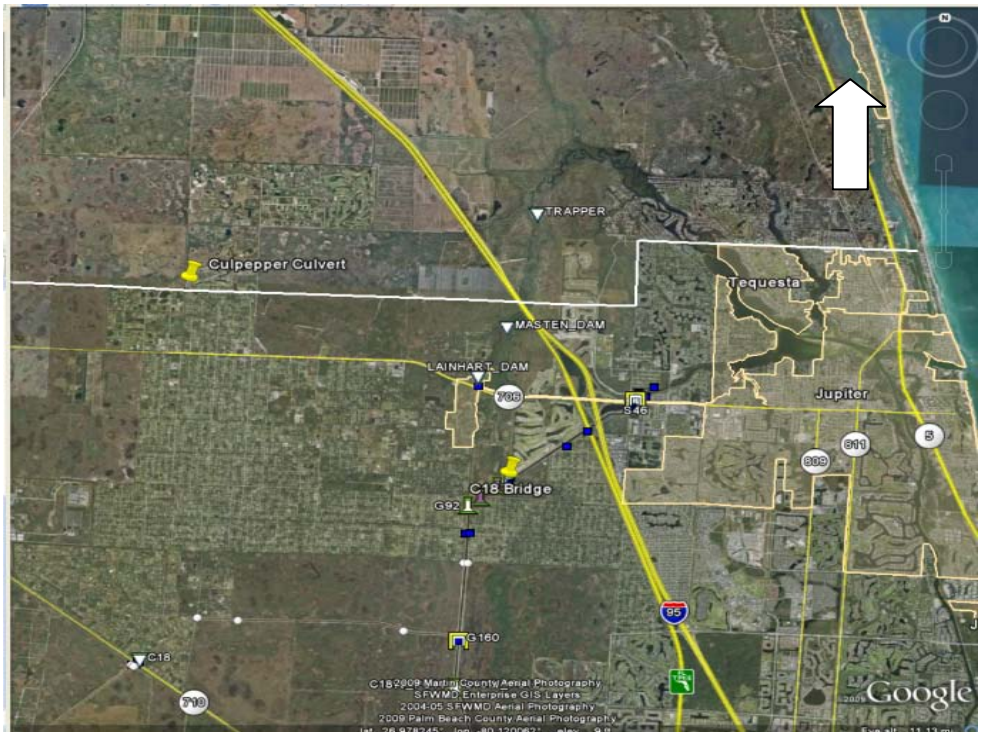
Lakeside Ranch STA Site Map

Preserve Area Drainage Culvert washout @ Lakeside Ranch STA

Preserve Area Drainage Culvert & Levee Road washout @ Lakeside Ranch STA

Culpepper Property Culvert

TS Isaac caused the collapse (erosion/washout) of the roadway accessing the Culpepper Property that is co-owned by the SFWMD and Martin County. The SFWMD deployed a crew to place fill, prevent full levee breach and avoid possible flooding of residential areas located downstream. As a result of continuing erosion and resulting roadway impacts, the SFWMD expedited the culvert replacement before the arrival of Hurricane Sandy October 2012. Construction was performed by Okeechobee Field Station crews, while Martin County paid for the materials.



Roadway Collapse resulting from erosion

Damaged Culvert

Okeechobee County

TS Isaac also had a significant impact in Okeechobee County both in the City of Okeechobee and on the SFWMD's infrastructure in the Taylor Creek and the Nubbin Slough STAs. Severe flooding and erosion due to heavy rainfall from the storm event was observed at the STAs.

The City of Okeechobee reported flooding conditions caused by TS Isaac in the south-west and north-west sections of the city during and several days after the storm; specifically, near: (1) Highway 78 and Lemkin Creek bridge, (2) bridge at the rim canal at Jaycee Park, and (3) areas drained by the "Whidden Ditch" drainage canal located along the west side of S.W. 7th Avenue.

The City of Okeechobee representative expressed concerns that the narrowness of the Herbert Hoover Dike (HHD) rim canal in the area of Jaycee Park may have contributed to flooding in the urban areas upstream from the HHD rim canal and the S-133 Pump Station may not have been operated correctly. Specifically, the concern was that water was not able to reach the pump station resulting in a backwater effect on areas draining to S-133. SFWMD analysis was not able to determine the conveyance of the HHD rim canal but was able to determine that S-133 Pump Station was operated in accordance with the USACE design and the approved Water Control Plan (see attachment C – Review of the operation of the S-133 Pump Station during TS Isaac).

Taylor Creek STA

In anticipation of high rainfall volumes, the Taylor Creek STA was shut down before the storm event and then put back online two (2) days after the storm. Severe flooding was observed at the Taylor Creek STA and surrounding areas. While there were no significant impacts on infrastructure or operations, TS Isaac caused flooding in the Taylor Creek Basin that rendered the WQ monitoring station at the inflow pump station (S-390) inaccessible (Photo 1). Flooding also triggered sheet flow into the Taylor Creek STA from the hammock located north of the pump station (Photo 2) and from the adjacent property located east of the STA (Photo 3).

Photo 1 – STA Intake Bay

Photo 2 – Sheet Flow from Hammock

Photo 3 – Overflowing

Nubbin Slough STA

TS Isaac brought significant rainfall that filled the S-385 inflow pump station storage pool. The swales that carry water from the seepage/discharge canal to Nubbin Slough were also at capacity. The storm also filled Cells 1 and 2 of the STA. No structural damage to the STA was observed, however erosion and bank sloughing was noted on the levees and surrounding areas sustained severe flooding. The STA was in start-up mode, but was shut down prior to the storm and remained offline due to the discovery of a remnant agricultural drainage pipe which was found to be conveying water from Cell 1 under the perimeter levee into the eastern perimeter seepage canal.

Further investigation revealed that the discovered drainage pipe was part of a 260-acre underdrain system from the prior dairy land use.

Nubbin Slough STA

S-385 In-flow Pump Station

Discharge Swale

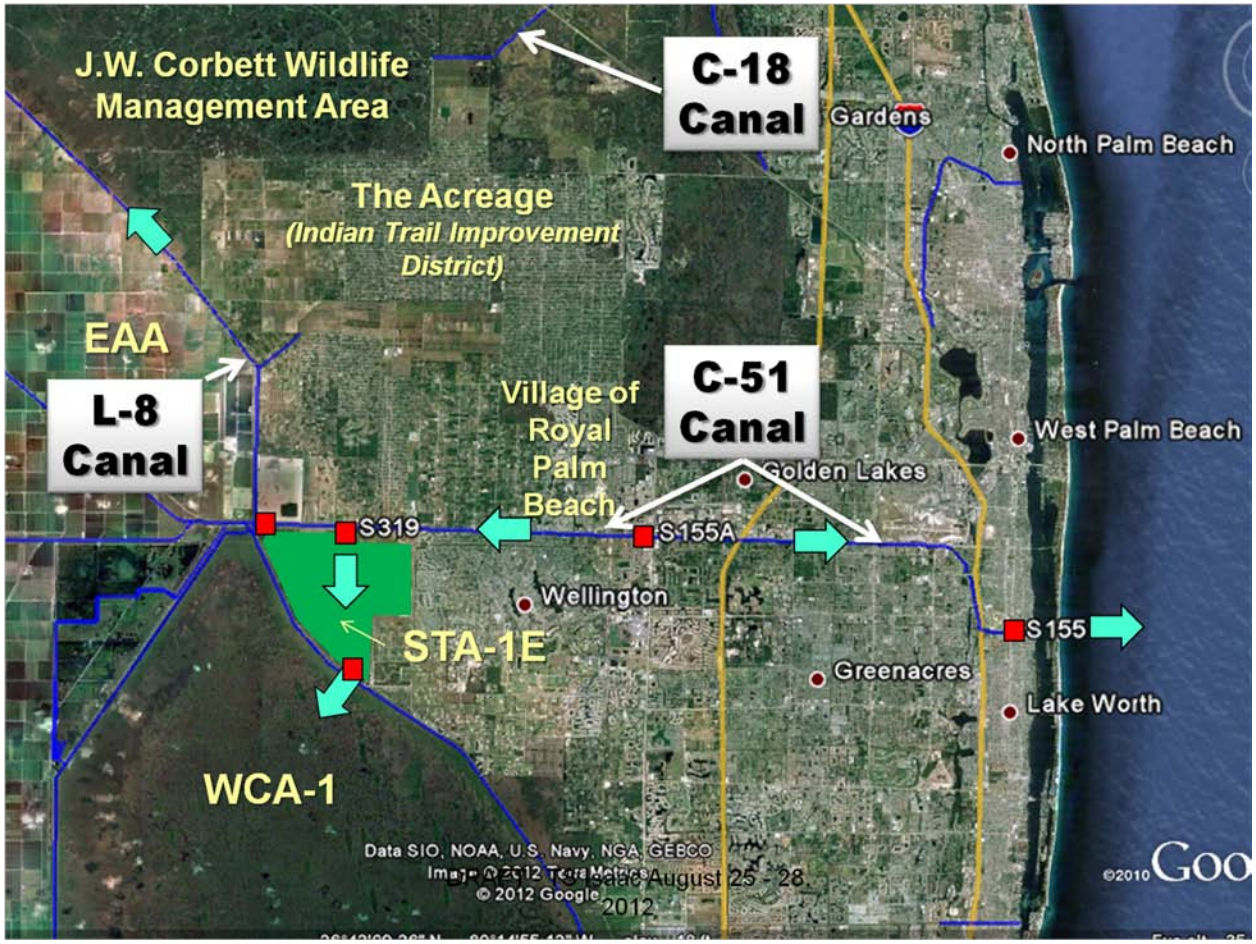
Cell 2

Cell 2

Palm Beach County & Everglades Agricultural Areas (EAA)

C-51 Basin

There were numerous questions regarding the operation of the Western C-51 Basin. TS Isaac was a significant rainfall event for South Florida. The C-51 Basin in western Palm Beach County was one of the hardest hit areas, where based on the radar calibrated rain data, 14.7 inches of rain fell between August 26 and 28, 2012. This rainfall amount for a 72-hour period is estimated to have a return period of 1 in 100 years. The 1 in 100 year flood has a one-percent chance of being equaled or exceeded during any given year. The majority of this rainfall fell as result of a nearly stationary feeder band that lingered over South Florida as the storm moved into the Gulf of Mexico on Monday, August 27, 2012. The National Weather Service reports that maximum rain amounts were both measured and estimated in the 15 to 20 inch range across the Village of Wellington and the Acreage communities.



TS Isaac had a significant impact on the SFWMD's infrastructure, especially in the STAs where high flows and increased water depths were experienced during and after the storm event. The C-51 basin received historic amounts of runoff and the use of the STA-1E inflow pump station, S-319, was maximized. S-319 ultimately helped alleviate flooding from the Western C-51 Basin communities by maintaining a lower elevation in the western C-51 Canal which allowed water to move through S-5AE to S-155A and to tide. This also allowed earlier discharge from the ITID basin to be passed through the VRPB, the C-51 and to tide via S155A and S155. SFWMD tow boats were dispatched to S-319 to assist

with mechanical vegetation removal. STA-1W inflow gates at G-302 were wide open in response to the S5A pumping STA-1E/STA-1W diversion structures (G-300/G-301) were also opened beginning on August 27th and after the storm and delivered approximately 28,000 ac-ft of water directly into WCA-1 around STA 1E and STA 1W until the storm passed. STA-1E and STA-1W received inflows of approximately 120,000 ac-ft over a two week period.

Responses to questions concerning the operation of the C-51 Basin have been included in the Attachment C of this After Action Assessment.

G-302 into STA-1W fully opened

Rollup of Submerged Aquatic Vegetation in STA-2 Cell 2

Damage assessment field surveys started immediately following the storm and continued weeks after the storm event. Impacts from this event, included vegetation stress caused by prolonged deep water conditions and resultant decreases in Total Phosphorous removal efficiency. There was no significant wind during this event. No structural damage was sustained within the STAs, however, some damage to aquatic vegetation was observed.

Indian Trail Improvement District

The lTID drainage system was designed to protect roads from 5.5 inches of rainfall occurring in one day and to protect building floor pads from about 17 inches of rain over the course of 3 days. Since 15 to 20 inches of rain fell during TS Isaac, roads would be expected to flood and there was even a chance that some building floors could have been flooded in areas receiving rainfall that exceeded 17 inches. Aside from the ITID western reservoir that discharges water to the L-8 borrow canal, the ITID system does not include a significant amount of basin storage. As designed, water is stored in the ITID canals and swales, on roads and in open areas such as yards, with only homes remaining above the flood waters. This is consistent with the Environmental Resource Permit issued for the ITID.

Over the years, in order to decrease extended flooding within ITID, there have been efforts to increase the amount of water that could be discharged from the area whenever possible and to lower the normal internal water levels during the wet season. These permit modifications were accomplished with the cooperation of the SFWMD. Although on-peak additional discharge has not been available, off-peak discharges to the C-51 Canal have been approved and used whenever possible. During TS Isaac, there

was close coordination between the SFWMD, ITID and the VRPB and conditions allowed for the discharge from the M1 canal to the C-51 to begin to make discharges on August 28, 2012 through the VRPB through the C-51W to tide via the S-155A and S-155. See section on System Operations above for more detailed description of these flood control releases. The lower wet season water control elevation has also helped to provide additional water storage in the internal ITID canal system. These efforts have helped to lessen flooding effects of some rainfall events but are insufficient to eliminate them during extreme rainfall events such as TS Isaac.

JW Corbett Wildlife Management Area (Non District Facility)

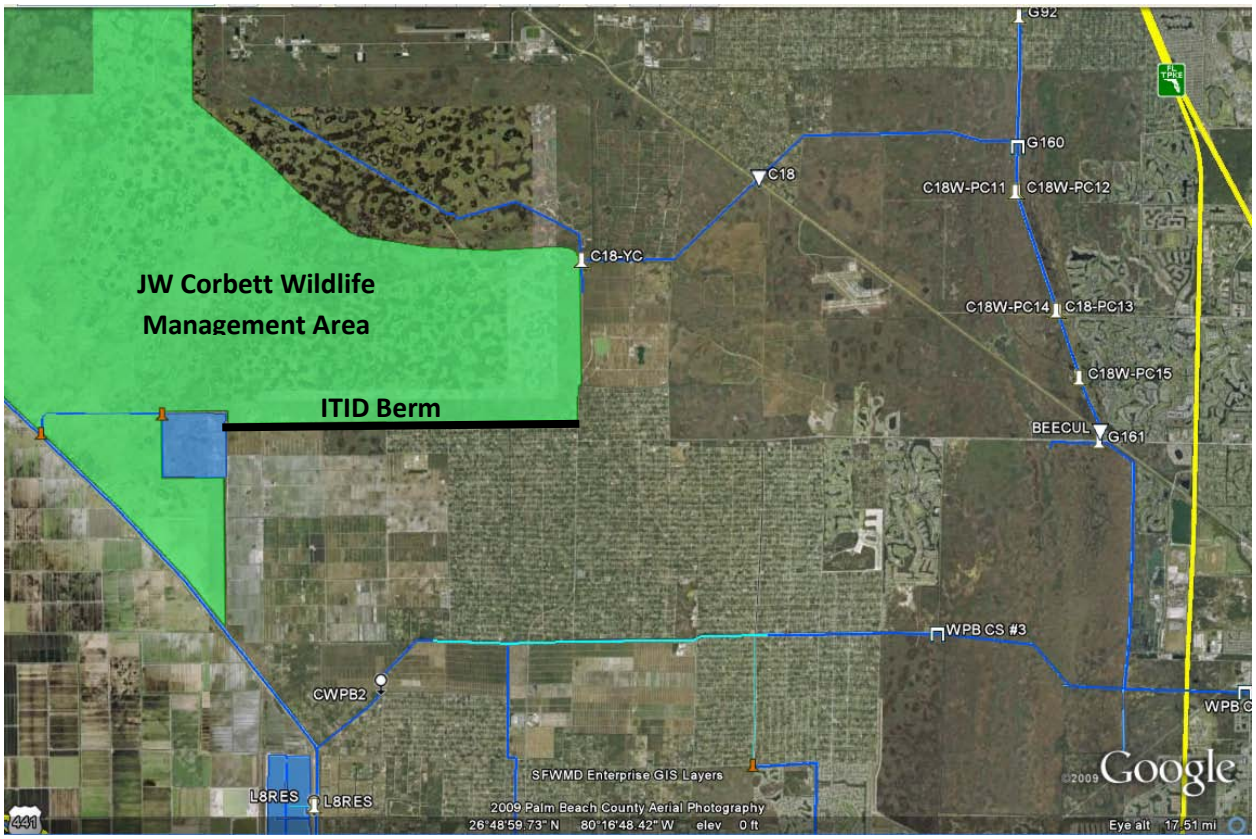
The SFWMD and ITID monitored the water levels continuously in the JW Corbett Wildlife Management Area (Corbett) area as a result of the high water levels experienced following TS Isaac. Although not a SFWMD facility, the SFWMD and ITID monitored the structural integrity of the ITID berm that separates Corbett from the 5,000 residential homes to the south, for signs of a potential breech in the berm.

The following actions were taken as a result of TS Isaac:

- Water levels were drawn down in the Corbett area as rapidly as possible
- Installation of temporary pumps to discharge water from Corbett into the L-8 borrow canal
- Installation of temporary pumps to discharge water from Corbett into the ITID M-O canal
- Prepositioned materials for immediate use in the event of a berm failure
- Continuous monitoring(every 4 hours) of the ITID berm for signs of breech initiation
- Temporary repair of slope failures at four locations along the berm with riprap material
- Temporary construction of a 140 feet emergency overflow weir to divert water from east end of Corbett into the Mecca Property canal system and subsequently into C-18 West Canal

While water levels were lowered in the Corbett area as a result of the above emergency actions, the SFWMD continued to observe deficiencies (slope failures and boils) with the ITID levee as result of the damage caused during TS Isaac.

Berm Slope Failures, longitudinal cracks and boils due to high water levels



JW Corbett Wildlife Management Area – Location Map

Repair of ITID Berm Embankment

Typical Repair of ITID Berm Embankment

Corbett Emergency Overflow Weir

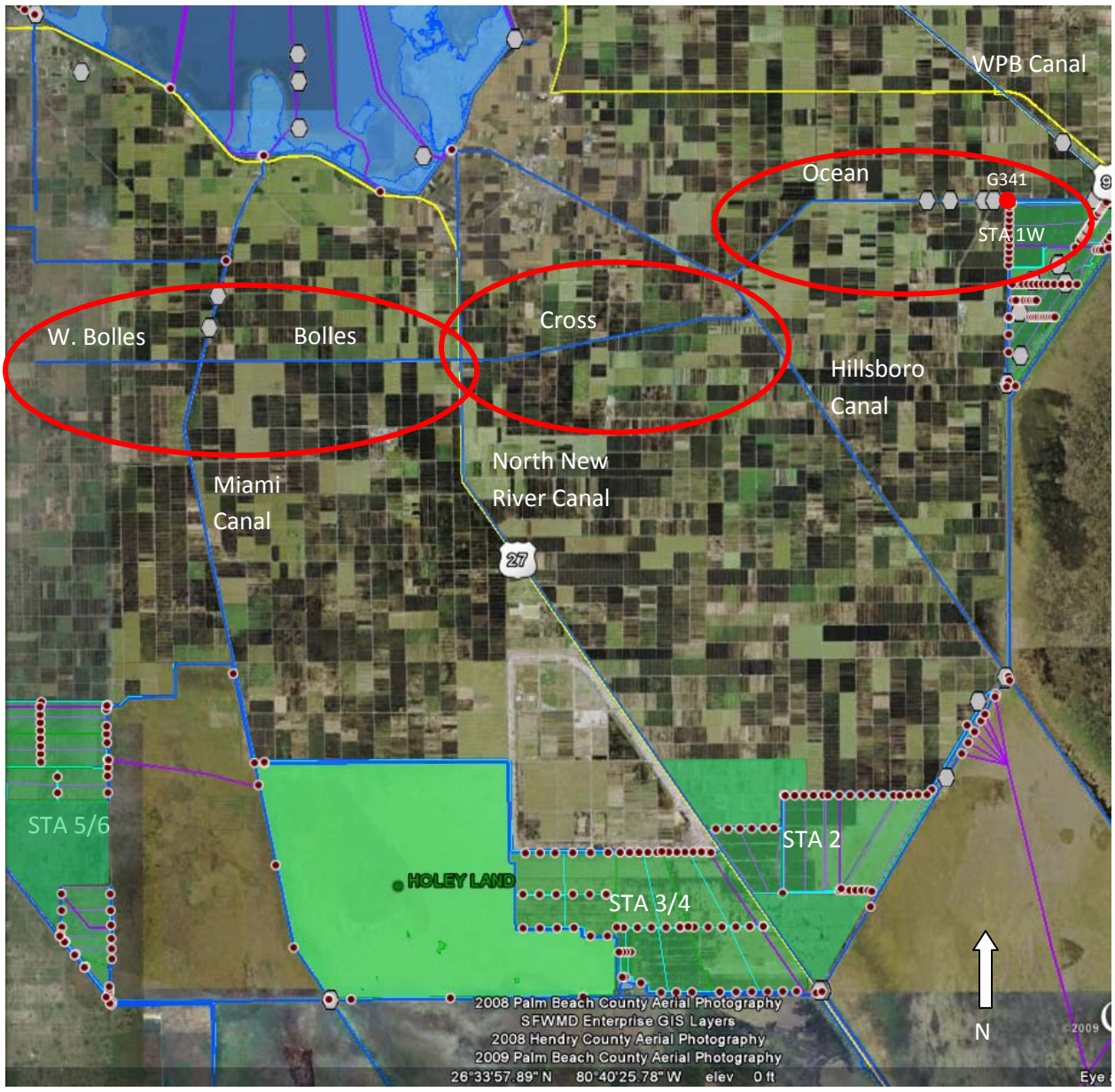
24" Pump from Corbett to M-O Canal extension

Failed section of rubble riprap

Ocean (L-13), Bolles (L-21) & Cross (L-16) Canals

The Ocean (L-13) Canal is comprised of a 12.8 mile reach of canal stretching between the West Palm Beach (L-12) Canal on the east and the Hillsboro (L-14) Canal on the west. This canal was widened and

improved in approximately 2000 from the G341 divide structure located at the northwestern corner of STA-1W to the western confluence with the Hillsboro Canal. Since the G-341 was intended to be a divide structure in the Ocean Canal, the eastern segment connecting to the West Palm Beach Canal was not widened or improved. At least two portions of the Ocean Canal east of the G-341 structure have reduced conveyance sections as compared to the existing canal section. The Ocean Canal did not overtop its banks/levees due to TS Isaac. It did, however, reach a peak stage of 14.29 ft, NGVD 29 west of the G-341 structure. This high stage impacted adjacent farming operations located north and south of the canal as seepage from the canal filled farm ditches which in turn overtopped farm roads and flooded farm fields (refer to Picture 1.)



EAA Region Canals and STAs

Flooding was also reported along the eastern end of the Cross (L-16) Canal. The Cross (L-16) Canal is comprised of a nine (9) mile reach of canal stretching between the Hillsboro Canal on the east and the North New River (NNR) Canal on the west. Flooding of the levee road on the north side (east end of the Cross Canal just west of the Hillsboro Canal) was reported to the Clewiston Field Station as a result of agricultural operations pumping into the canal. Two low areas of the levee were found to have overtopped and flowed over the levee road on the north side (refer to Picture 2). These two areas have been raised and improved by the Clewiston Field Station.

Picture 1: Hundley Farms ditch north of Ocean Canal

Picture 2: Levee road on North side of L16 repair work

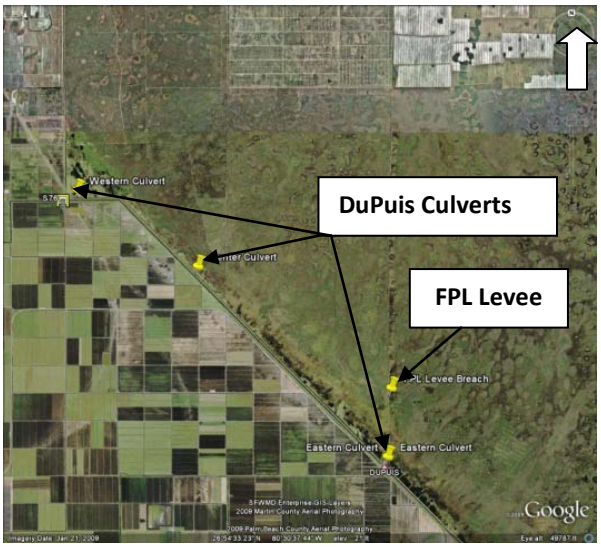
No reports of flooding along the Bolles (L-21) Canal were noted as a result of TS Isaac. The Bolles (L-21) Canal is comprised of a 7.8 mile reach of canal between the North New River (NNR) Canal on the east and the Miami Canal on the west. There is also a five (5) mile spur of the Bolles (L-26) Canal which exists west of the Miami Canal. The L-26 section of the Bolles Canal has a minimal cross section and currently provides marginal drainage and water supply for the adjacent agricultural operations. The Bolles (L-21) and Cross (L-16) Canals currently provide flood control and irrigation water supply conveyance for the adjacent agricultural operations. The existing conveyance capacity of these canals is small (~300 cfs) and any inter-basin flow conveyance that occurs is negligible.

The ability to move water westward away from STA-1E and -1W may have reduced the higher canal stages within the eastern EAA which would have reduced the duration or eliminated the agricultural flooding impacts described previously for the Ocean, Cross and Bolles Canals. Redirection of the excess stormwater to the west may have also taken advantage of existing storage capabilities in the western STAs (STA 5/6 complex). The overloaded conditions at STA-1E and -1W and the volume of flows that bypassed the STAs and directly discharged into WCA-1 may have been reduced thus improving the water quality in WCA-1.

DuPuis Management Area

TS Isaac had a significant impact on the DuPuis Management Area (DuPuis). The record setting rainfall flooded the adjacent Corbett area overtopping the FPL service road on the east side of DuPuis. The high water and turbulent discharge velocities caused the sand cement headwalls at the east and center culverts to collapse behind the drop inlet culverts. The western culvert did not fail but material loss was observed behind the headwall.

SFWMD Okeechobee Field Station staff placed rip rap behind the headwalls to stop further erosion and repaired the breach in the service road.



Location Map

Eastern Culvert Headwall Failure

Center Culvert Headwall Failure

Breach in FPL Service Road

RECOMMENDATIONS

Martin-St. Lucie County

Lakeside Ranch STA

The washed out or damaged culvert along with the portions of the levee access road that were damaged as a result of TS Isaac were temporarily stabilized and levee roadway blocked off. The washed-out culvert and levee roadway were part of the recently completed Lakeside Ranch STA project and this culvert provides needed drainage from the adjacent preserve land into the North Interim Outfall Canal within the STA.

Immediately following the incident, SFWMD field station staff removed the damaged concrete culverts and stabilized the washed out area with riprap in order to maintain continued flow from the adjacent preserve land into the Interim Outfall Canal within the STA. The levee roadway at this location was also blocked off to prevent access at this point.

The SFWMD has no immediate plans for providing a permanent fix due to resource constraints and other priorities. The temporary fix should result in sufficient drainage of the preserve and provide erosion protection of the Outfall Canal bank.

Temporary repairs @ Washed-out culvert location at Lakeside Ranch STA

Culpepper Property Culvert

Through the joint effort of the SFWMD and Martin County, the washed-out culvert and eroded roadway as a result of TS Isaac was immediately repaired to prevent the adjacent properties from flooding. The damaged culvert was removed and replaced with a new corrugated aluminum pipe and the eroded roadway restored. Work was performed by SFWMD Okeechobee Field Station staff, while Martin County paid for the materials. No further action required.

Installation of new Culvert Pipe by SFWMD Okeechobee Field Station Staff

Okeechobee County

Taylor Creek STA

While there were no significant impacts or damage to SFWMD infrastructure at Taylor Creek STA, TS Isaac caused flooding in Taylor Creek Basin that rendered the WQ monitoring station at the inflow station (S-390) inaccessible. The STA was put back in operation two (2) days after the storm and the WQ monitoring station became accessible once the water levels had receded. No further action is required.

Nubbin Slough STA

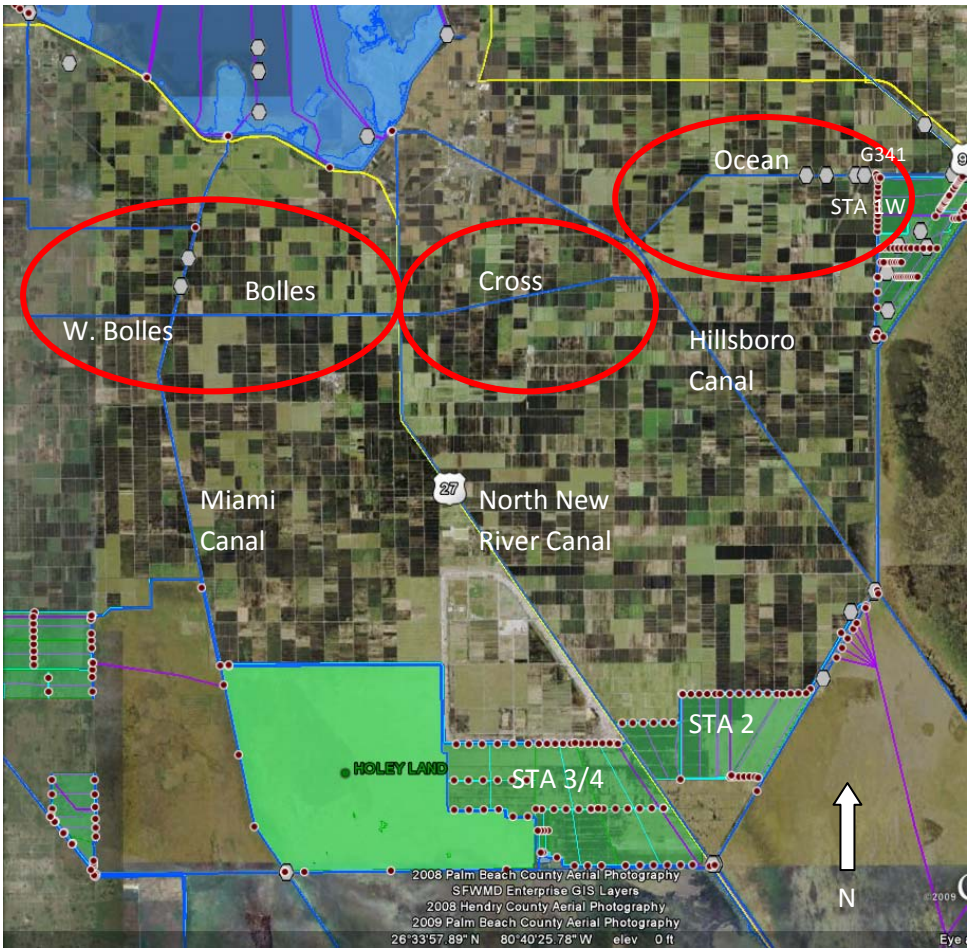
Due to the drainage pipe discovered within the STA, the STA had to be shutdown during the event. SFWMD investigated and determined that the pipe was part of a 260-acre underdrain system from the prior dairy land use. Since this STA was constructed and is still maintained by the USACE, SFWMD has advised the USACE that a thorough review of the old dairy farm site plans and USACE STA designs and construction documentation should be conducted to determine the extent and location of additional components of the drain system. The SFWMD also requested that the USACE develop a plan of action/remedy for repair of the STA.

Palm Beach County & Everglades Agricultural Areas (EAA)

Ocean, Bolles and Cross Canals Improvements

The Bolles and Cross Canals were slated to be improved as part of the EAA A1 Storage Reservoir Project, a component of the Comprehensive Everglades Restoration Plan (CERP). A hydraulic study was conducted in 2004 to determine the conveyance capacity improvements necessary for the Bolles, Cross, Miami and North NNR Canals to provide deliveries to the EAA A1 Reservoir. In addition to sizing the canals to provide deliveries to the reservoir, the study also examined the concept of improved flexibility in the primary C&SF System. The study confirmed that the canal improvements would allow better distribution of water between the Storm Water Treatment Areas (STAs). The study also found the expanded canals would provide improved water supply and flood protection for the areas served by the canals.

The preferred option of the investigation involves the development of optimized canal sections for the Bolles and Cross Canals that balances canal section excavation quantities and levee disposal requirements and maximizes conveyance capacity within the current right of way (ROW). This option assumed no additional real estate will be purchased to complete the canal improvements and that all improvements fall within the existing ROW.



The 2004 study included the following recommendations:

Bolles (L-21) Canal

- Conversion of existing dual 72" and single 48" corrugated metal culverts to triple 12' x 6' box culverts with inverts approximately located between elevation 1.15 and 1.35 ft, NGVD 29.
- The canal bottom needs to be dropped approximately 2.0 to 2.5 feet and reshaped into a trapezoid. This can be accomplished within the canal ROW if the existing side slopes are matched.
- The levees particularly on the south side of the canal need slight improvements to bring them up to SFWMD standards. A slight improvement of the levee includes the addition of two to three feet of height in some sections to simple reshaping of the levees in other areas.

Cross (L-16) Canal

- Replacement and enlargement of the hydraulic opening of the farm bridge located 7.57 miles from the Cross and Hillsboro Canal confluence.
- Replacement and enlargement of the hydraulic opening on the farm bridge located 7.31 miles west of the Cross and Hillsboro Canal confluence.
- Replacement and enlargement of the hydraulic opening of the secondary roadway bridge located 6.81 miles west of the Cross and Hillsboro Canal confluence.
- Replacement and enlargement of the hydraulic opening of the farm bridge located 1.76 miles west of the Cross and Hillsboro Canal confluence.
- Replacement of the existing culverts under Duda Road from dual 72" culverts to a bridge structure or a series of box culverts.
- The canal bottom needs to be dropped approximately 6.0 to 7.0 feet and reshaped into a trapezoid. The necessary flow capacity can be gained in the existing canal section if the side slopes of the channel are maintained as currently existing. However, the south side levee requires extensive expansion to meet SFWMD standards and will require at least 75 feet of additional ROW.

North New River

- The North New River Canal has a hump in its channel bottom that starts almost immediately downstream of the Bolles/Cross/North New River confluence. It was found that the conveyance capacity of the Bolles and Cross is improved if the hump is removed from this location.

Additional flexibility for the primary C&SF System was also examined during the development of the Restoration Strategies suite of alternatives. The objectives of this effort are to provide additional water quality treatment capabilities for flows entering the Water Conservation Areas and Everglades National Park. The additional flexibility gained from the Bolles (L-21) and Cross (L-16) Canal improvements would allow the diversion of flows from one area of the EAA to another in order to take advantage of available STA treatment capacity. Inflows into the EAA STAs (STA 1East and 1West, STA 2 and STA 3/4) could, therefore, be managed more advantageously – reducing high stages, enhancing vegetation growth and promoting optimized phosphorus reduction.

Still greater flexibility could be obtained in the C&SF System by the expansion and construction of the Bolles Canal (L-=26) westward to the L-1/L-2 Canal (refer to Figure 2). This would allow the connection of the STA 5/6 complex to the eastern EAA STAs. Based on initial investigations from the Restoration Strategies effort, 600 cfs capacity will be needed in this canal expansion and construction effort along with a 600 cfs pump station located at the confluence of the West Bolles (L-26) and the L-1/L-2 Canals. Additional field investigations (topography, geotechnical and hydrologic and hydraulic modeling) may show that additional pump stations, bridge replacements, facilities, capacities or other modifications will be necessary in the Ocean, Cross, Bolles, West Bolles, North New River, Hillsboro, Miami and L-1/L-2 Canals.

As part of the planning assessment for the Bolles and Cross Canal expansions, preliminary soil and sediment investigations (Phase 1 and 2) were conducted in the Bolles (L-21) Canal alignment and right of way. The data was analyzed and the results were evaluated to determine the potential use of the stockpiled canal sediments/soils and potential for human health and ecological risk. Nearly all the canal sediment and soil samples contain arsenic at concentrations that exceed the residential Soil Cleanup Target Levels (SCTLs), as identified in Chapter 62-777 of the Florida Administrative Code and many contain arsenic at concentrations exceeding the commercial/industrial SCTLs. The canal sediments also contain several pesticides and other metals that could present an unacceptable risk in either a terrestrial

or an aquatic ecosystem. Since the agricultural operations conducted by the landowners adjacent to the Ocean, Bolles and Cross Canals is in many ways similar to the Bolles (L-21) Canal, the same concerns regarding canal sediments and soils may be projected. The presence of arsenic and pesticides at these concentrations may limit or restrict the potential use of the canal sediments as future levee construction materials, such that the material may be buried within the levee, may be disposed of by burial adjacent to the levee or canal or require off-site disposal. Further study is warranted to define the canal sediment risk and use during project development and depending on the findings, additional construction costs may be identified.

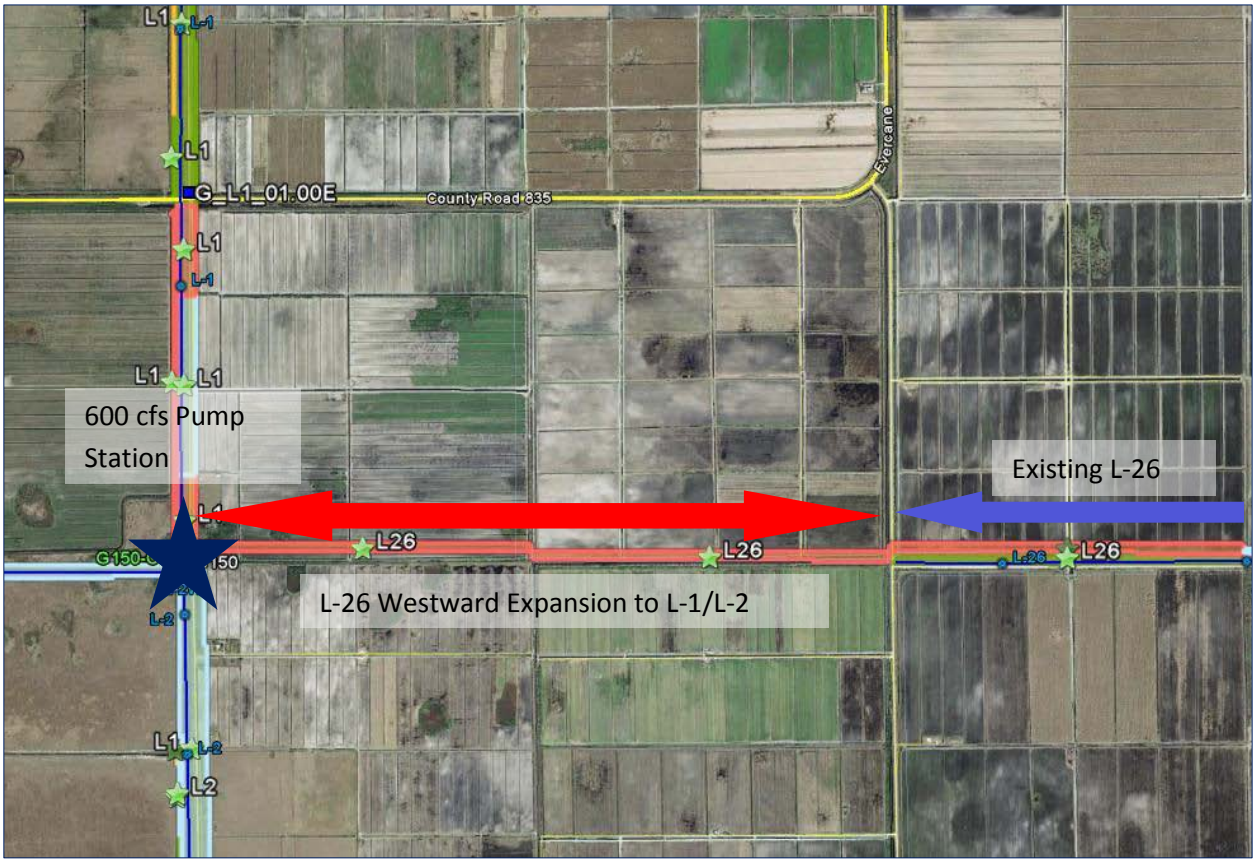


Figure 2: Westward Expansion of West Bolles (L26) to L1/L2 and 600 cfs Pump Station

Potential Phasing Approach by fiscal year:
It is recommended that the related improvements to the Ocean, Bolles and Cross canals be phased out over a 7 year period as outlined below pending availability of funding.

Years 1 & 2

- Remove conveyance constrictions in the Ocean Canal (L-13) – Field Station
- Perform updated modeling of the primary system in the EAA to determine if pumps, canal modifications or other facilities may be required to send additional flows south to the A1 Flow Equalization Basin and west to the STA 5/6 complex – in house modeling

- Coordinate with Right of Way to work out issues with permittees and structural modifications associated with proposed canal modifications and any additional right of way needed for project activities
- Request contribution/support from existing agricultural beneficiaries for improved flood protection and water supply resulting from canal improvements – this could consist of owner modifications/relocations of existing structures and facilities (culverts, roads, bridges and pump stations) to accommodate canal widening and construction activities

Years 2 & 3

- Final Design and Permitting of Bolles (L-21), Cross (L-16) and NNR Canals hydraulic improvements and levee repair
- Feasibility Study of Bolles (L-26) westward extension to L-2 and potential pump station at L-2 to pull water west and send south to STA 5/6

Years 4 & 5

- Construct Bolles (L-21) and Cross (L-16) Canals improvements and levees
- Remove hump in channel bottom of North New River (NNR) Canal downstream of the confluence of the Bolles/Cross/NNR Canals
- Design of Bolles (L26) westward extension to L-2 and pump station (if warranted)

Years 6 & 7

- Construct Bolles (L-26) westward extension to L-2 and potential pump station

JW Corbett Wildlife Management Area Improvements (Non District Facility)

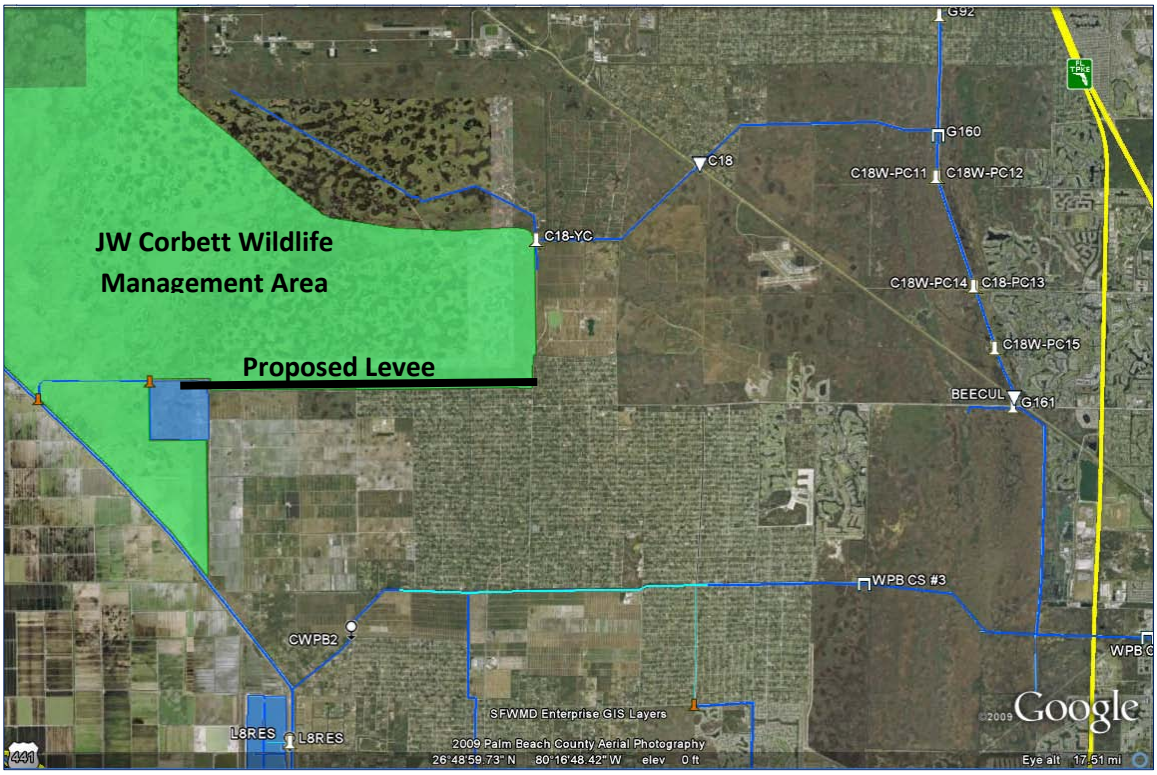
TS Isaac brought unprecedented rainfall to areas of central Palm Beach County, including communities served by the ITID. As part of the State of Florida's response to TS Isaac, the SFWMD took immediate action to respond to incidences of flooding in support to local relief efforts. SFWMD staff designed and constructed 140 feet overflow weir to drain the high water elevations to the east. The District also provided bypass pumping to the east and west of the system to help relieve flood waters and to minimize impacts to the ITID berm.

Interim repairs – Construction of 140 feet Overflow Weir

Interim Repairs to the ITID Berm

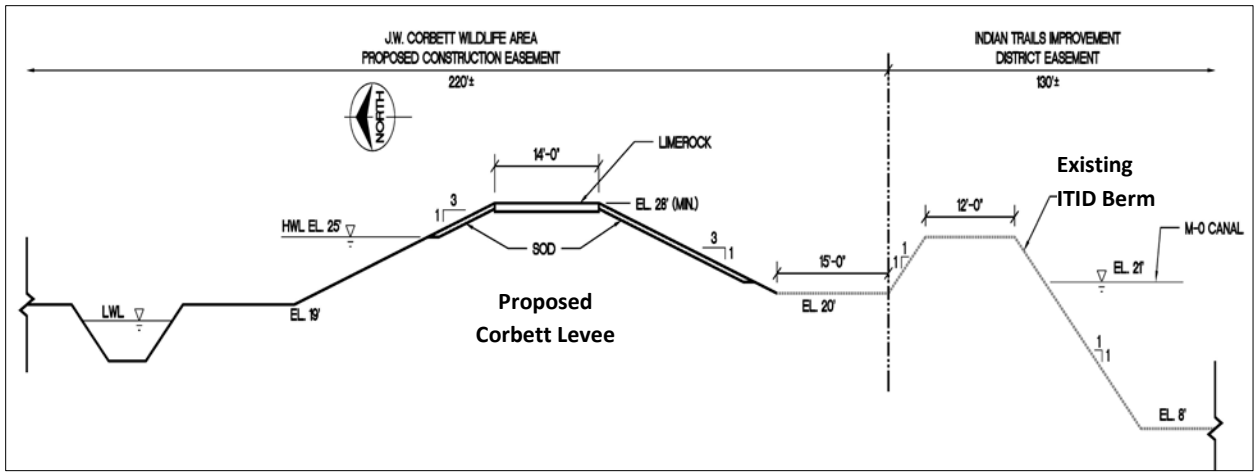
Also, in September 2012, SFWMD was directed by the Governor's Office to immediately convene a working group to determine a timely plan for strengthening the integrity of the levee.

Strengthening the integrity of the levee will improve the current berm by adding a levee just north of the existing berm that separates Corbett from the residential communities within ITID. This new levee is necessary to provide flood protection and safety to the residents of ITID due to deficiencies (slope failures and boils) with the ITID berm as result of the damage caused during TS Isaac.



Proposed Levee in Corbett – Location Map

The planned improvements will include the addition of approximately 5.7 miles of levee located on the north side of the M-O Canal between Pratt Whitney Road and ITID Pump Station #3. A draft cross section of the levee is shown in the figure below. The design of the Levee Improvement project will include the necessary details for the incorporation of survey, geotechnical investigations, hydrology and hydraulic modeling work and engineering services required to develop the design package. Data and results from surveys and geotechnical investigations and modeling shall be incorporated into a final design report. Conceptual drawings shall include a site plan and drawings for the Levee Improvement project including, embankments seepage system, inflow/outflow structures, and culverts. Initial preparation of permit applications shall be included.



Planned Improvements

Additionally, and if necessary, the planned improvements will evaluate and recommend revisions to procedures of the ITID and Corbett Operations and Management Plans.

DuPuis Management Area

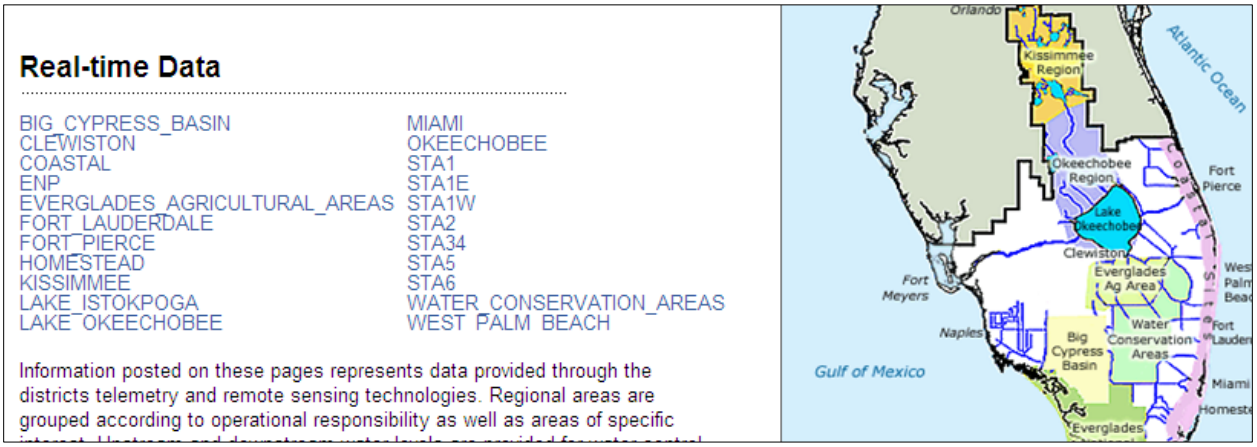
Immediately following the storm, SFWMD's West Palm Beach Field Station staff made temporary repairs to the eroded eastern culvert headwall by replacing the eroded fill material and stabilizing the structure. Also, repairs were made to the eroded sections of the FPL access levee road. A project identification sheet has been prepared that recommends the replacement of the three existing culverts to meet the current SFWMD standards.

Temporary Repairs - Eastern Culvert Headwall

FPL Service Road breach repaired

Operational Data Enhancements

From the After-Action Roundtable the SFWMD conducted with Palm Beach County, 298 Districts and local government officials, it was proposed that a web-based Real Time Information Portal be implemented by the SFWMD with access provided to invited agencies. A web portal has been created for external access to real time information and operations data and is in production, www.sfwmd.gov/realtime.



Refresh

Report generation started at 02/07/2013 14:01:35
Data for this report was last updated on 02/07/2013 13:51:21

STA1W

Click on a record below to view detailed Data.

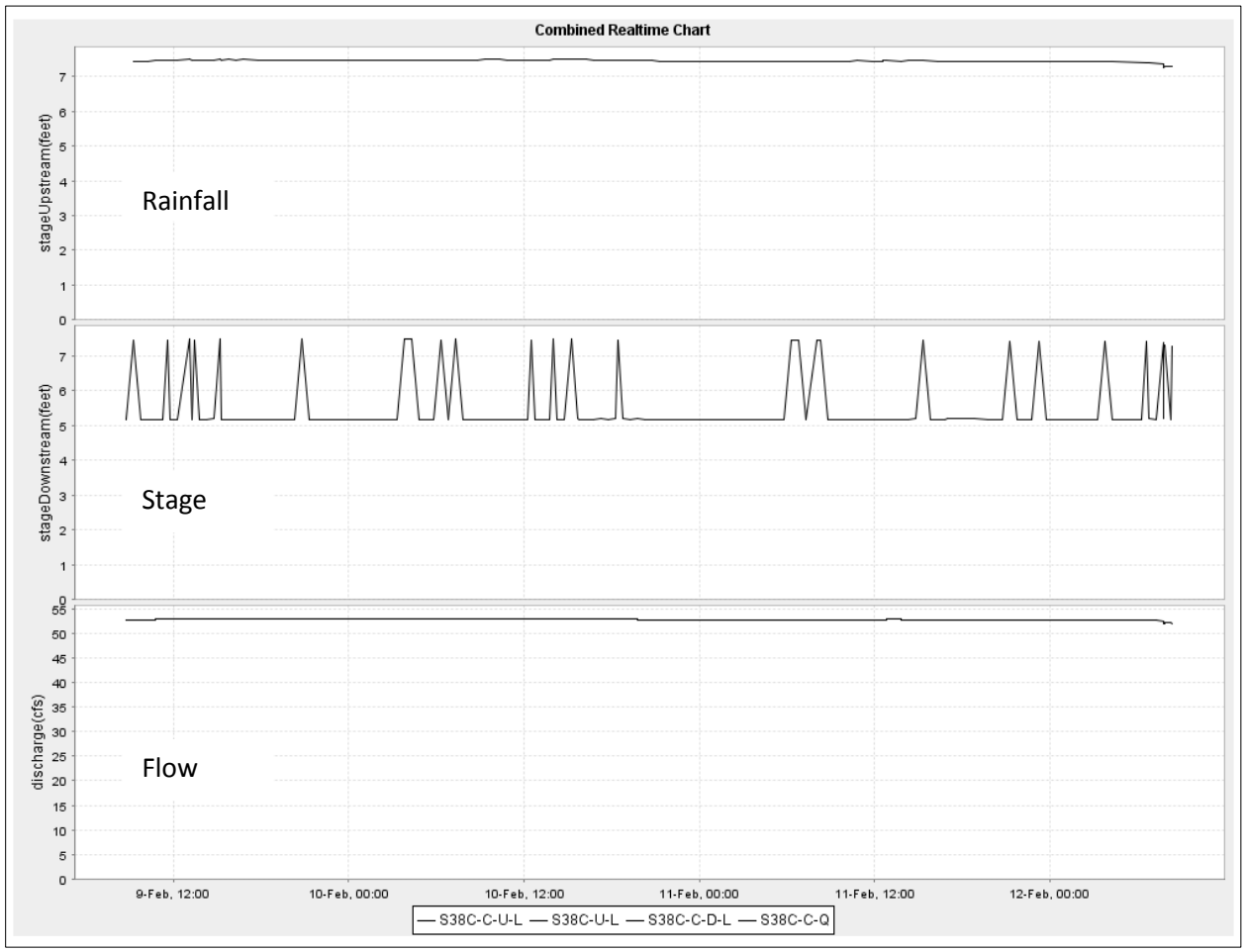
- "db" link is to DBHYDRO information
- "JN/SITE" locations can be a Junction (JN) or Site
- Hydraulic Element Set (HES) name suffix designate the control types of -C (Culvert), -P (Pump), -L (Lock), -S (Spillway), or -F (Flashboard).
- Upstream, Downstream, and Flow data are in black color if the value is recorded in last one hour. Purple if between 1 and 24 hours. Brown if more than 24 hours old.

Flow - (cfs) *Stage - (Feet, NGVD)*

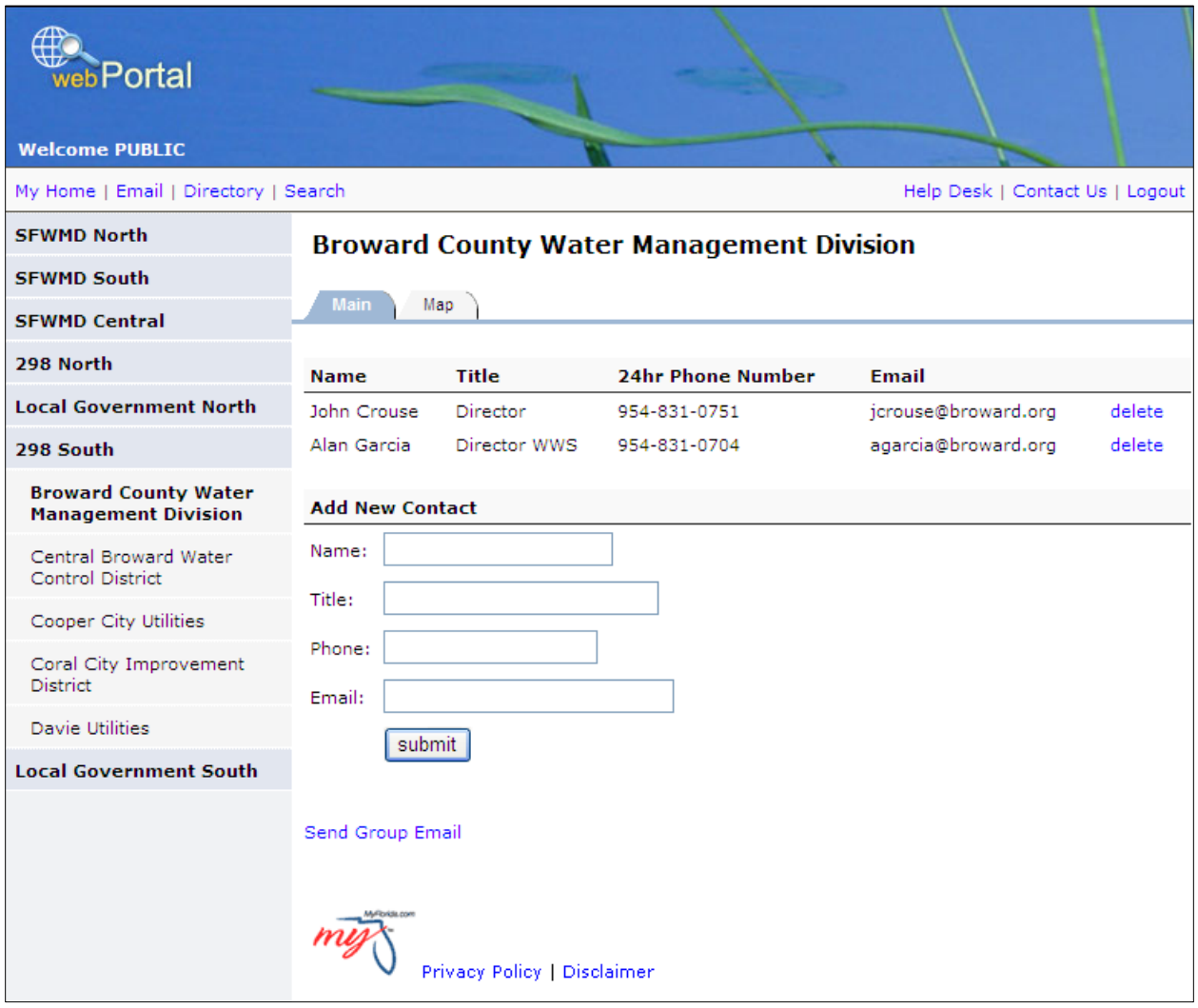
Gates - (Opening in Feet)
Weirs - (Crest Elev Feet, NGVD)
Pumps - (Revolutions per Minute)

db	JN/SITE	HES	UPSTREAM	DOWNSTREAM	Flow	STATE	1	2	3	4	5	6	7
	G250S	G250S-P	7.35	11.85	0	3 Pumps on	0	0	0				
	G251	G251-P	11.65	16.28	0	6 Pumps on	0	0	0	0	0	0	
	G255	G255-C	11.84	11.72	243	3 Gates open @4.49ft , Weir State Unavailable	Unavailable	4.48	Unavailable	4.50	Unavailable	4.49	
	G259	G259-C	11.65	9.75	0	All Gates Closed	.00						
		G308-S	11.58	9.69	0	All Gates Closed	.01						
	G303	G303-S	15.49	11.96	385	2 Gates Open @1ft	1.00	1.00					
	G310	G310-P	9.78	16.28	0	6 Pumps on	0	0	0	0	0	0	
	G327A	G327A-C	9.70	7.41	0	All Gates Closed	-.02						
	G327B	G327B-P	7.41	10.04	0	1 Pump on	0						

The next step in real time portal enhancements will include rainfall, stage and flow for structures. This is not in production yet. We estimate an April release timeframe.



A web portal for local governments and 298 Districts to input secondary system related information during a storm event is also in process and will be in production by April 2013.



ATTACHMENT A – Pumping Analysis

ATTACHMENT A – Pumping Analysis

PUMPING ANALYSIS FOR TROPICAL STORM ISAAC

1. INTRODUCTION

As shown on Figure 1, the spatial distribution of total rainfall within each hydrologic basin indicates that the eastern and southeastern areas to the Lake Okeechobee are the most affected areas by Tropical Storm (TS) Isaac, receiving the highest amounts of rainfall. The District's diesel and electric pump units, especially those located in the worst hit areas were operated to move flood water sequentially to prevent extensive flooding due to TS Isaac.

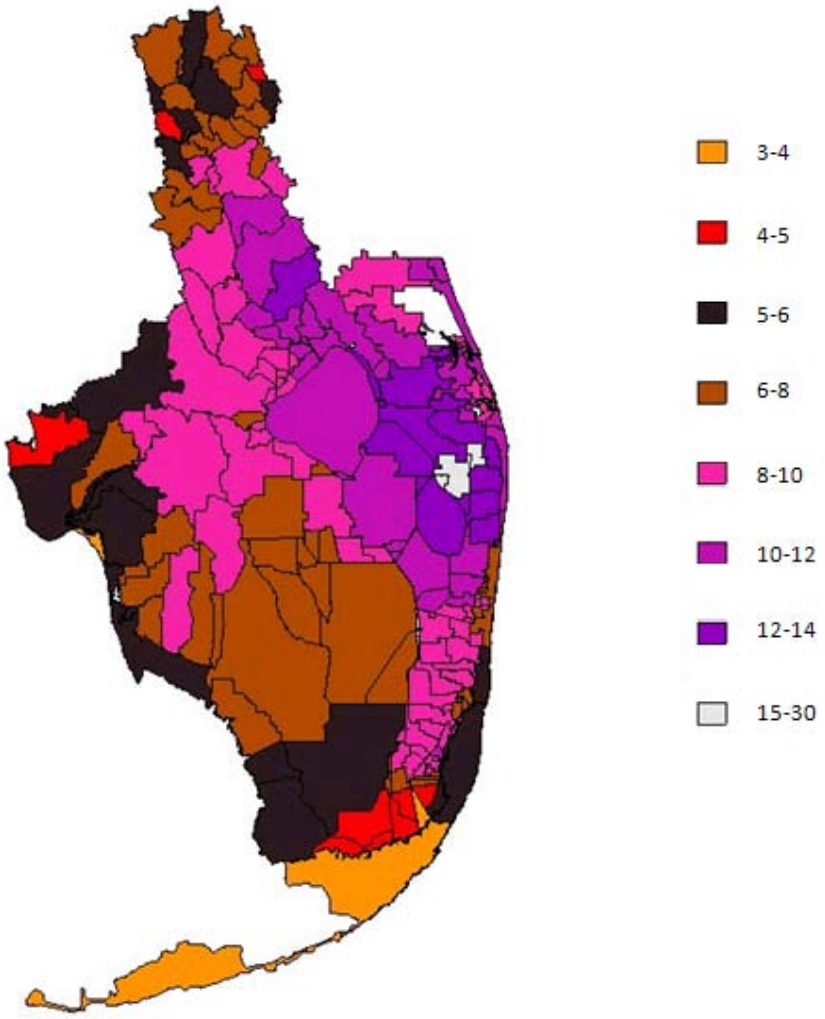


Figure 1. Rainfall (unit in inches) spatial distribution in TS Isaac (from 08/20/2012 to 9/10/2012)

A preliminary pumping analysis was conducted for the diesel and electric pump units operated in flood protection areas. **Table 1** lists the pump units of interest, used to move water along Miami Canal, Hillsboro Canal, Canal 51 West and etc. The pumping water volume and pumping duration were accounted for each pump unit based on the hydrologic and meteorological records in the District's DBHYDRO database. Comparing operation and rainfall data before, during, and after TS Isaac, an inflection point criterion was used for identifying the analysis period for each pump unit to show pumping related to TS Isaac. For simplification, the inflection point on the receding limb of each storm hydrograph (shown in **Appendix A**) was assumed as the end of pumping operation caused by TS Isaac. The locations of the selected pump units (shown in **Figure 2**) and identified analysis periods are also listed in **Table 1**.

Table 1. Pump units and locations

Station	Hydrological Basin	County	No. of Unit	Identified Analysis Period
S13_P	Canal 11 East basin	Broward	3 diesel units	8/20/2012~9/4/2012
S9_P	Conservation Area 3A basin	Broward	3 diesel units	8/20/2012~9/3/2012
G420_P	Canal 4 basin	Miami-Dade	3 diesel units	8/20/2012~9/3/2012
S127_P	S127 basin	Glades	5 diesel units	8/20/2012~9/5/2012
S129_P	S129 basin	Glades	3 diesel units	8/20/2012~9/4/2012
S131_P	S131 basin	Glades	2 diesel units	8/20/2012~9/3/2012
S135_P	S135 basin	Martin	4 diesel units	8/20/2012~9/3/2012
S133_P	S133 basin	Okeechobee	5 diesel units	8/20/2012~9/3/2012
G370_P	S2_6_G370 basin	Palm Beach	3 diesel units	8/20/2012~9/5/2012
G372_P	S3_G372 basin	Palm Beach	4 diesel units	8/20/2012~9/4/2012
S2_P	S2_6_G370 basin	Palm Beach	4 diesel units	8/20/2012~9/5/2012
S3_P	S3_G372 basin	Palm Beach	3 diesel units	8/20/2012~9/3/2012
S319_P	Canal 51 West basin	Palm Beach	5 diesel units	8/20/2012~9/5/2012
S5A_P	S5A basin	Palm Beach	6 diesel units	8/20/2012~9/5/2012
S6_P	S2_6_G370 basin	Palm Beach	3 diesel units	8/20/2012~9/5/2012
S7_P	Storm Treatment Area 3/4 basin	Palm Beach	3 diesel units	8/20/2012~9/6/2012
S8_P	Storm Treatment Area 3/4 basin	Palm Beach	4 diesel units	8/20/2012~9/5/2012
G310	Storm Treatment Area 1W basin	Palm Beach	6 diesel units	8/20/2012~9/7/2012
S362	Storm Treatment Area 1E basin	Palm Beach	7 diesel units	8/20/2012~9/3/2012
G335	Storm Treatment Area 2 basin	Palm Beach	6 diesel units	8/20/2012~9/6/2012
S25B_P	Canal 4 basin	Miami-Dade	3 electric units	8/20/2012~9/3/2012
S26_P	Canal 6 basin	Miami-Dade	3 electric units	8/20/2012~9/2/2012

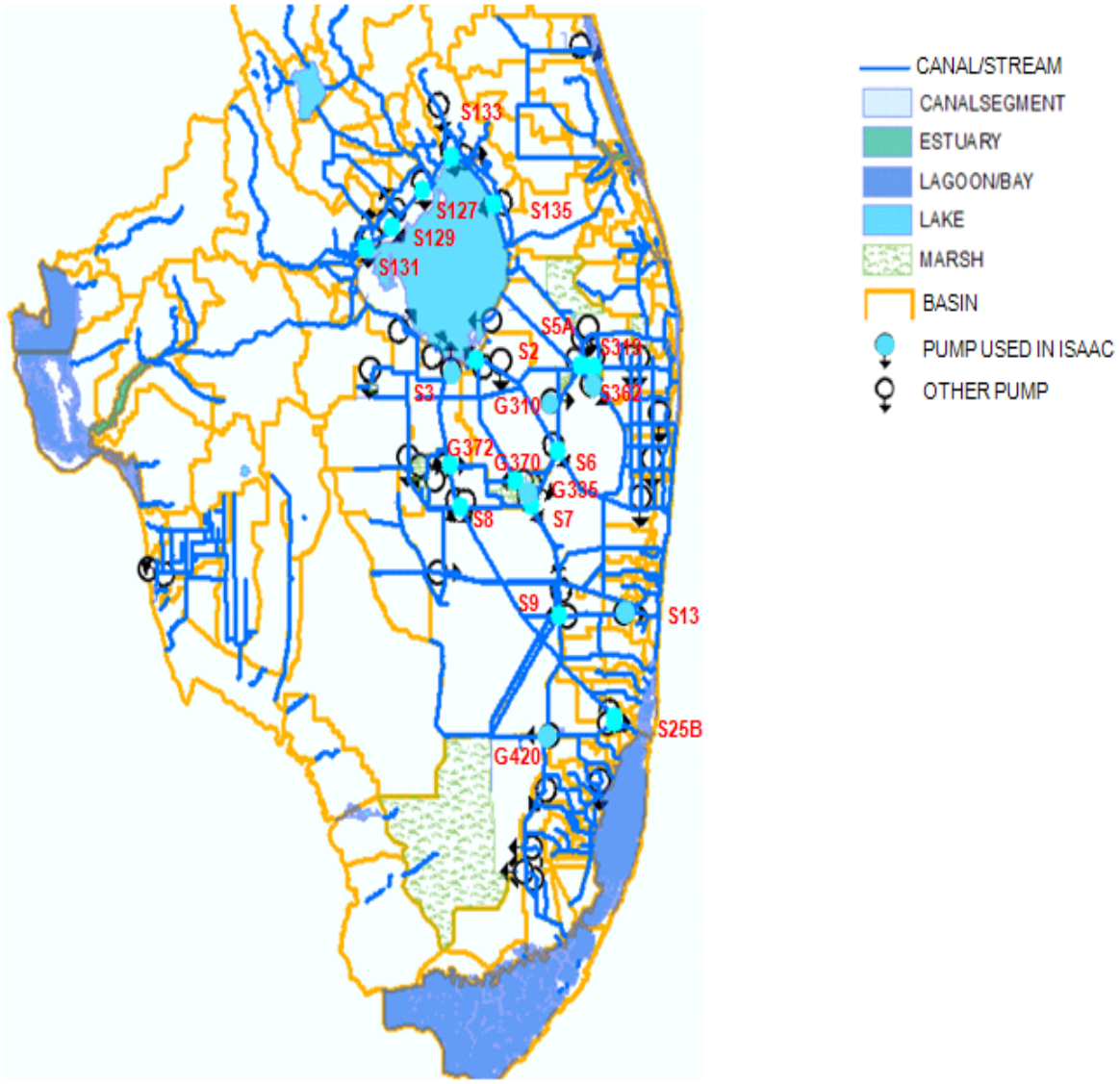


Figure 2. Locations of the District's pumps used in TS Isaac

2. PUMPING WATER VOLUME AND DAILY AREAL RAINFALL

The (total) pumping water volume and daily areal rainfall are accounted for each hydrological basin and listed in **Table 2**.

Table 2. Pumping water volume and daily areal rainfall within hydrological basin due to TS Isaac

Water/Rainfall	BASIN	Dissel Unit	No. of unit	Area (acre)	8/20/2012	8/21/2012	8/22/2012	8/23/2012	8/24/2012	8/25/2012	8/26/2012	8/27/2012	8/28/2012	8/29/2012	8/30/2012	8/31/2012
Water volume (ac-ft)	C11.E	diesel	3	16946.8	0	0	0	0	0	0	565	994	1037	833	816	766
Daily rainfall (inch)					0.000	0.035	0.000	0.000	0.220	0.626	3.141	2.532	0.017	0.000	0.000	0.000
Water volume (ac-ft)	CA3A	diesel	3	494137.4	388	849	433	681	727	1399	2432	4827	4414	3804	3371	2199
Daily rainfall (inch)					0.096	0.182	0.303	0.000	0.197	0.502	3.188	0.453	0.291	0.038	0.000	0.000
Water volume (ac-ft)	C4	diesel+electric	6	50527.0	0	0	2	16	6	161	70	694	158	59	20	0
Daily rainfall (inch)					0.000	0.411	0.081	0.000	0.680	1.234	2.546	1.933	0.063	0.010	0.000	0.000
Water volume (ac-ft)	S127	diesel	5	20797.9	0	0	0	7	0	0	315	1381	1226	1021	904	760
Daily rainfall (inch)					0.225	0.744	1.147	0.014	0.214	0.047	4.078	2.028	0.625	0.073	0.000	0.002
Water volume (ac-ft)	S129	diesel	3	11965.8	0	0	0	0	0	0	89	303	203	121	132	112
Daily rainfall (inch)					0.077	1.034	1.585	0.045	0.027	0.003	3.734	0.650	0.365	0.002	0.000	0.000
Water volume (ac-ft)	S131	diesel	5	7122.1	0	0	0	0	0	0	188	244	148	85	60	38
Daily rainfall (inch)					0.124	0.696	1.173	0.024	0.039	0.025	4.468	2.097	0.766	0.238	0.004	0.120
Water volume (ac-ft)	S135	diesel	4	17755.6	0	0	0	0	0	0	0	0	893	892	824	805
Daily rainfall (inch)					0.216	0.884	1.334	0.001	0.081	0.056	4.358	3.401	0.959	0.028	0.152	0.038
Water volume (ac-ft)	S133	diesel	5	25626.4	0	0	0	14	0	0	349	1407	1407	1423	1431	1047
Daily rainfall (inch)					0.422	0.785	0.623	0.000	0.357	0.138	3.807	3.312	0.355	0.378	0.000	0.425
Water volume (ac-ft)	S2_6_G370	diesel	10	267211.7	0	12	1451	1262	873	1146	5593	15110	16425	16192	14049	13271
Daily rainfall (inch)					0.164	0.570	0.119	0.061	0.146	0.013	4.583	2.583	0.608	0.007	0.000	0.380
Water volume (ac-ft)	S3_G372	diesel	7	117051.1	915	787	1526	856	497	489	5628	11741	14320	14581	15375	14202
Daily rainfall (inch)					0.002	0.102	0.312	0.000	0.290	1.510	2.134	0.091	0.001	0.000	0.000	0.000
Water volume (ac-ft)	C51W	diesel	5	51736.5	530	390	667	717	221	809	2866	8915	8979	8823	7178	5544
Daily rainfall (inch)					0.114	0.669	0.113	0.000	1.011	0.318	6.874	5.532	0.517	0.025	0.000	0.120
Water volume (ac-ft)	S5A	diesel	6	109194.6	0	0	1136	441	0	808	1635	7885	9291	9443	9357	9148
Daily rainfall (inch)					0.251	0.864	0.050	0.073	0.231	0.075	5.675	3.626	0.260	0.056	0.003	0.606
Water volume (ac-ft)	STA-3/4	diesel	7	18768.7	915	787	863	672	0	0	2658	6291	7946	8865	9319	9378
Daily rainfall (inch)					0.002	0.102	0.312	0.000	0.290	1.510	2.134	0.091	0.001	0.000	0.000	0.000
Water volume (ac-ft)	STA-1W	diesel+electric	6	7780.1	0	117	147	400	367	304	1609	3599	5067	5840	6274	6357
Daily rainfall (inch)					0.057	1.679	0.340	0.032	5.405	3.111	0.106	0.409	0.737	0.010	0.078	0.200
Water volume (ac-ft)	STA-1E	diesel+electric	7	6544.6	170	172	183	630	757	473	1465	4637	7188	8358	6913	5912
Daily rainfall (inch)					0.116	0.644	0.167	0.371	0.160	6.758	6.516	0.063	0.034	0.103	0.003	0.128
Water volume (ac-ft)	STA-2	diesel+electric	6	9975.8	414	405	264	433	636	414	2420	5196	5655	5686	5417	5479
Daily rainfall (inch)					0.260	0.203	0.476	0.324	0.170	5.142	2.971	1.199	0.009	0.200	0.116	0.054
Water volume (ac-ft)	C6	electric	3	43703.1	0	0	0	0	15	262	906	294	249	507	668	286
Daily rainfall (inch)					0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

~continued

Water/Rainfall	BASIN	Dissel Unit	No. of unit	Area (acre)	9/1/2012	9/2/2012	9/3/2012	9/4/2012	9/5/2012	9/6/2012	9/7/2012	9/8/2012	9/9/2012	9/10/2012	Total
Water volume (ac-ft)	C11.E	diesel	3	16946.8	716	689	680	0	0	0	0	0	0	N/A	7096
Daily rainfall (inch)					0.044	0.004	0.073	1.371	0.718	0.486	0.032	0.000	0.000	0.000	9.299
Water volume (ac-ft)	CA3A	diesel	3	494137.4	943	0	0	0	0	0	0	0	0	N/A	26467
Daily rainfall (inch)					0.035	0.610	0.306	0.277	0.090	0.021	0.031	0.000	0.385	0.385	7.390
Water volume (ac-ft)	C4	diesel+electric	6	50527.0	0	0	0	0	0	0	0	0	0	N/A	1186
Daily rainfall (inch)					0.045	0.088	0.410	0.495	0.270	0.105	0.169	0.000	0.087	0.087	8.714
Water volume (ac-ft)	S127	diesel	5	20797.9	544	481	396	0	0	0	0	0	0	N/A	7033
Daily rainfall (inch)					0.000	0.000	0.018	0.941	0.378	0.523	0.000	0.071	0.092	0.092	11.312
Water volume (ac-ft)	S129	diesel	3	11965.8	85	47	0	0	0	0	0	0	0	N/A	1093
Daily rainfall (inch)					0.000	0.000	0.001	1.893	0.886	0.725	0.000	0.083	0.214	0.214	11.538
Water volume (ac-ft)	S131	diesel	5	7122.1	32	0	0	0	0	0	0	0	0	N/A	796
Daily rainfall (inch)					0.000	0.019	0.308	1.141	0.426	0.133	0.055	0.016	0.139	0.139	12.150
Water volume (ac-ft)	S135	diesel	4	17755.6	298	298	0	0	0	0	0	0	0	N/A	4009
Daily rainfall (inch)					0.000	0.035	0.310	0.105	0.000	0.055	0.017	0.052	0.052	0.052	12.186
Water volume (ac-ft)	S133	diesel	5	25626.4	628	454	0	0	0	0	0	0	0	N/A	8160
Daily rainfall (inch)					0.000	0.000	0.172	0.160	0.054	0.355	0.000	0.021	0.044	0.044	11.452
Water volume (ac-ft)	S2_6_G370	diesel	10	267211.7	11608	9748	7589	7041	0	0	0	0	0	N/A	121371
Daily rainfall (inch)					0.000	0.010	0.501	0.500	0.665	0.004	0.022	0.000	0.192	0.192	11.320
Water volume (ac-ft)	S3_G372	diesel	7	117051.1	3303	2300	1226	311	0	0	0	0	0	0	54835
Daily rainfall (inch)					0.013	0.000	0.013	0.334	0.952	0.383	0.110	0.068	0.016	0.122	6.453
Water volume (ac-ft)	C51W	diesel	5	51736.5	4268	3043	2944	2498	2209	0	0	0	0	0	22040
Daily rainfall (inch)					0.019	0.000	0.255	0.214	0.644	0.274	0.002	0.011	0.000	0.226	12.247
Water volume (ac-ft)	S5A	diesel	6	109194.6	8642	8141	7142	5088	4302	0	0	0	0	0	118699
Daily rainfall (inch)					0.008	0.000	0.061	0.236	0.273	0.438	0.019	0.110	0.001	0.074	10.454
Water volume (ac-ft)	STA-3/4	diesel	7	18768.7	9391	9325	8989	7846	4895	3725	0	0	0	0	91866
Daily rainfall (inch)					0.208	0.159	0.133	0.340	0.319	0.158	0.041	0.026	0.000	0.081	5.907
Water volume (ac-ft)	STA-1W	diesel+electric	6	7780.1	6393	6303	6236	6201	6018	5317	4209				86317
Daily rainfall (inch)					0.224	0.001	0.020	0.122	0.000	0.000	0.000	0.000	0.000	0.000	15.660
Water volume (ac-ft)	STA-1E	diesel+electric	7	6544.6	4946	3853	3068	0	0	0	0	0	0	0	61010
Daily rainfall (inch)					0.014	0.583	0.060	0.396	0.000	0.000	0.000	0.000	0.000	0.000	12.823
Water volume (ac-ft)	STA-2	diesel+electric	6	9975.8	5411	5383	5362	5327	5336	5290	0	0	0	0	35298
Daily rainfall (inch)					0.050	0.050	0.023	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.186
Water volume (ac-ft)	C6	electric	3	43703.1	436	0	0	0	0	0	0	0	0	0	3623
Daily rainfall (inch)					0.025	0.052	0.037	0.203	0.722	0.295	0.268	0.250	0.000	0.090	1.942

Note: 1. the area of each hydrologic basin is determined from the navigation panel of the AHED Watershed layer of the NEXRAD, radar based rainfall data, only available on the District's intranet. 2. The areal rainfall data were retrieved from the NEXRAD database table for near real-time data based on different types of polygons (county or basin). The near real-time data spans the current day to several days in the past. 3. The relevant hydrographs of pumping water volume and daily areal rainfall are shown in **Appendix A**.

3. PUMPING DURATION AND AREAL RAINFALL

The pumping durations of each pump unit within hydrological basin are accounted and listed in **Table 3** for TS Isaac.

Table 3. Pumping duration of each pump unit during TS Isaac

Basin	Pump Unit	Pumping Duration		Basin	Pump Unit	Pumping Duration		Basin	Pump Unit	Pumping Duration	
		day	hour			day	hour			day	hour
C11.E	S13P-1	9.600	230.400	S133	S133P-1	4.776	114.633	C51W	S319P-1	4.922	118.133
	S13P-2	9.765	234.350		S133P-2	4.202	100.850		S319P-2	6.481	155.550
	S13P-3	9.765	234.350		S133P-3	6.309	151.417		S319P-3	8.422	202.117
	Subtotal	29.129	699.100		S133P-4	7.945	190.683		S319P-4	7.324	175.767
CA3A	S9P-1	5.997	143.933		S133P-5	8.523	204.550		S319P-5	5.495	131.883
	S9P-2	6.819	163.667		Subtotal	31.756	762.133		Subtotal	32.644	783.450
	S9P-3	3.230	77.517	S2_6_G370	G370P-1	8.989	215.733	S5A	S5AP-1	6.707	160.967
	Subtotal	16.047	385.117		G370P-2	5.436	130.467		S5AP-2	9.885	237.233
C4	S25BP-1	0.331	7.933		G370P-3	6.805	163.317		S5AP-3	10.572	253.733
	S25BP-2	0.327	7.850		S2P-1	2.790	66.967		S5AP-4	8.866	212.783
	S25BP-3	0.261	6.267		S2P-2	5.094	122.267		S5AP-5	10.547	253.117
	G420P-1	0.838	20.100		S2P-3	8.295	199.083		S5AP-6	8.058	193.400
	G420P-2	0.435	10.433		S2P-4	1.341	32.183		Subtotal	54.635	1311.233
	G420P-3	0.672	16.133		S6P-1	10.526	252.633	STA1W	G310P-1	11.394	273.467
	Subtotal	2.863	68.717		S6P-2	9.710	233.033		G310P-2	11.362	272.683
S127	S127P-1	6.047	145.133		S6P-3	11.913	285.900		G310P-3	11.744	281.867
	S127P-2	4.877	117.050		Subtotal	70.899	1701.583		G310P-4	12.361	296.667
	S127P-3	5.039	120.933	S3_G372	S3P-1	0.000	0.000		G310P-5	10.994	263.867
	S127P-4	5.111	122.667		S3P-2	1.325	31.800		G310P-6	8.081	193.950
	S127P-5	7.116	170.783		S3P-3	0.710	17.040		Subtotal	65.938	1582.500
	Subtotal	28.190	676.567		G372P-1	9.438	226.517	STA1E	S362P-1	4.578	109.867
S129	S129P-1	1.235	29.633		G372P-2	5.912	141.883		S362P-2	8.068	193.633
	S129P-2	1.459	35.017		G372P-3	4.814	115.533		S362P-3	7.197	172.733
	S129P-3	1.394	33.450		G372P-4	1.256	30.133		S362P-4	6.247	149.933
	Subtotal	4.088	98.100		Subtotal	23.454	562.907		S362P-5	3.535	84.850
S131	S131P-1	1.143	27.433	STA-3/4	S7P-1	10.606	254.550		S362P-6	7.077	169.850
	S131P-2	1.648	39.550		S7P-2	11.853	284.483		S362P-7	6.724	161.367
	Subtotal	2.791	66.983		S7P-3	11.965	287.167		Subtotal	43.426	1042.233
S135	S135P-1	2.513	60.300		S8P-1	1.782	42.767	STA2	G335P-1	5.917	142.000
	S135P-2	4.578	109.867		S8P-2	7.427	178.250		G335P-2	6.018	144.433
	S135P-3	5.168	124.033		S8P-3	9.469	227.267		G335P-3	7.431	178.350
	S135P-4	0.229	5.500		S8P-4	0.000	0.000		G335P-4	11.687	280.483
	Subtotal	12.488	299.700		Subtotal	53.103	1274.483		G335P-5	11.128	267.067
									G335P-6	5.996	143.900
									Subtotal	48.176	1156.233
								C6	S26P-1	2.917	70.000
									S26P-2	2.878	69.083
									S26P-3	2.835	68.033
									Subtotal	8.630	207.117
								Total		**528.257**	**12678.157**

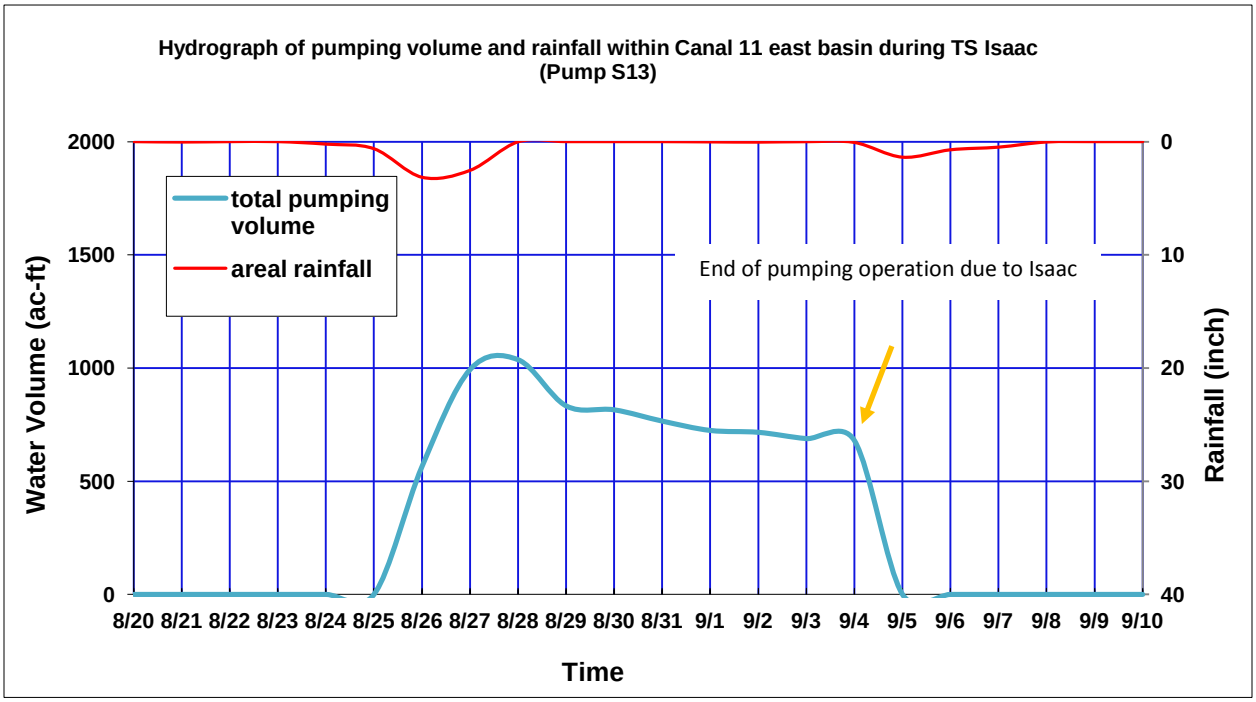
The relevant hydrographs of instantaneous pumping speed and 15-minute areal rainfall are shown in **Appendix B**.

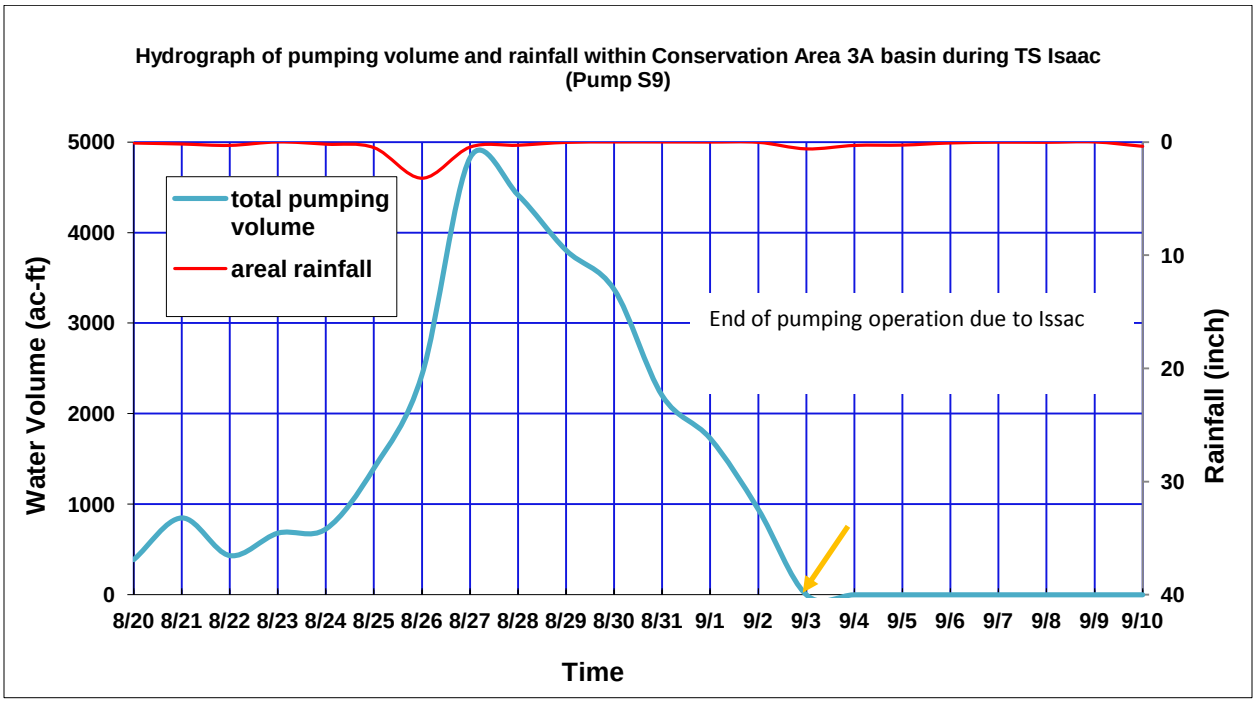
4. SUMMARY

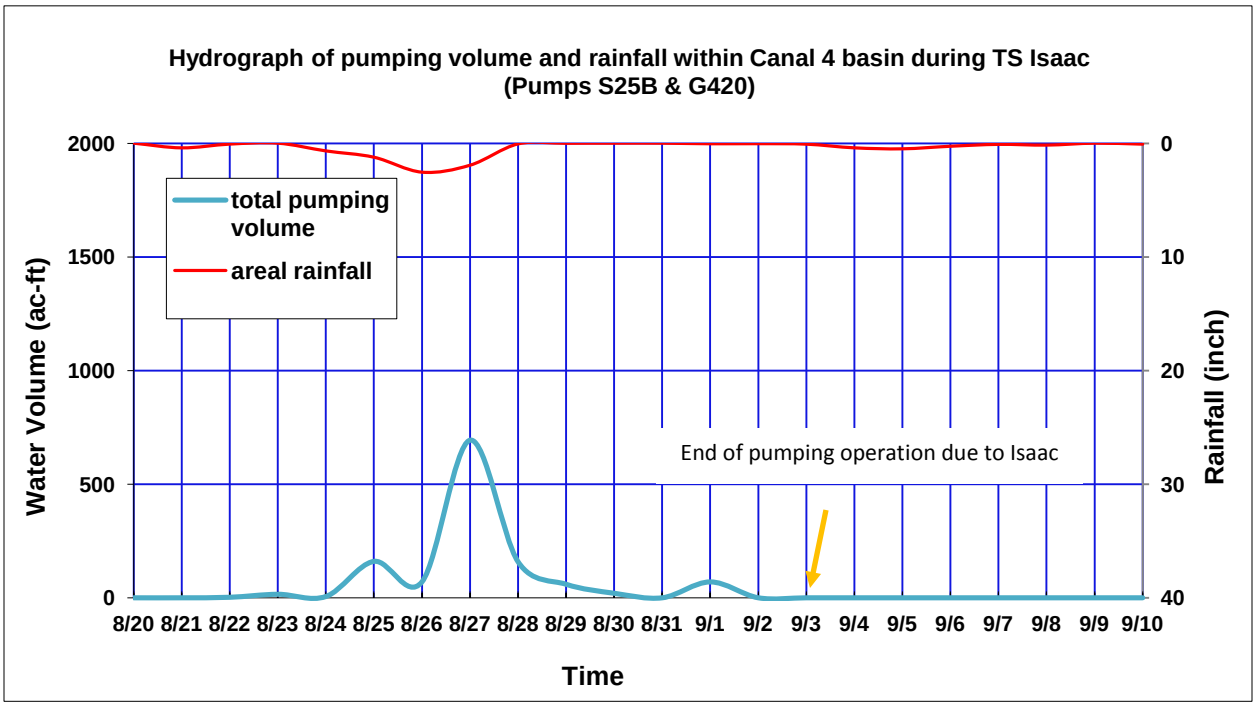
The total volume of pumped water is about **650,899 acre-feet (ac-ft)** mostly from S2_6_G370 basin (121,371 ac-ft, actual pumping date from 8/20/12 to 9/4/12), STA-3/4 basin (91,866 ac-ft, actual pumping date from 8/20/12 to 9/5/12), S5A basin (118,699 ac-ft, actual pumping date from 8/20/12 to 9/5/12), Canal 51 West basin (22,040 ac-ft, actual pumping date from 8/20/12 to 9/5/12), S3_G372 basin (54,835 ac-ft, actual pumping date from 8/20/12 to 9/4/12), STA1W basin (86,317 ac-ft, actual pumping date from 8/20/12 to 9/7/12), STA1E basin (61,010 ac-ft, actual pumping date from 8/20/12 to 9/3/12), STA2 basin (32,198 ac-ft, actual pumping date 8/20/12 to 9/6/12). The total combined duration corresponding to all pumping units operated was about 12,678 hours (the equivalent of 528 days) during TS Isaac. Palm Beach County was the most impacted area where the pumping volume was about 590,955 ac-ft, about 90.0% of the total amount (see Attachment C – Pumping Analysis).

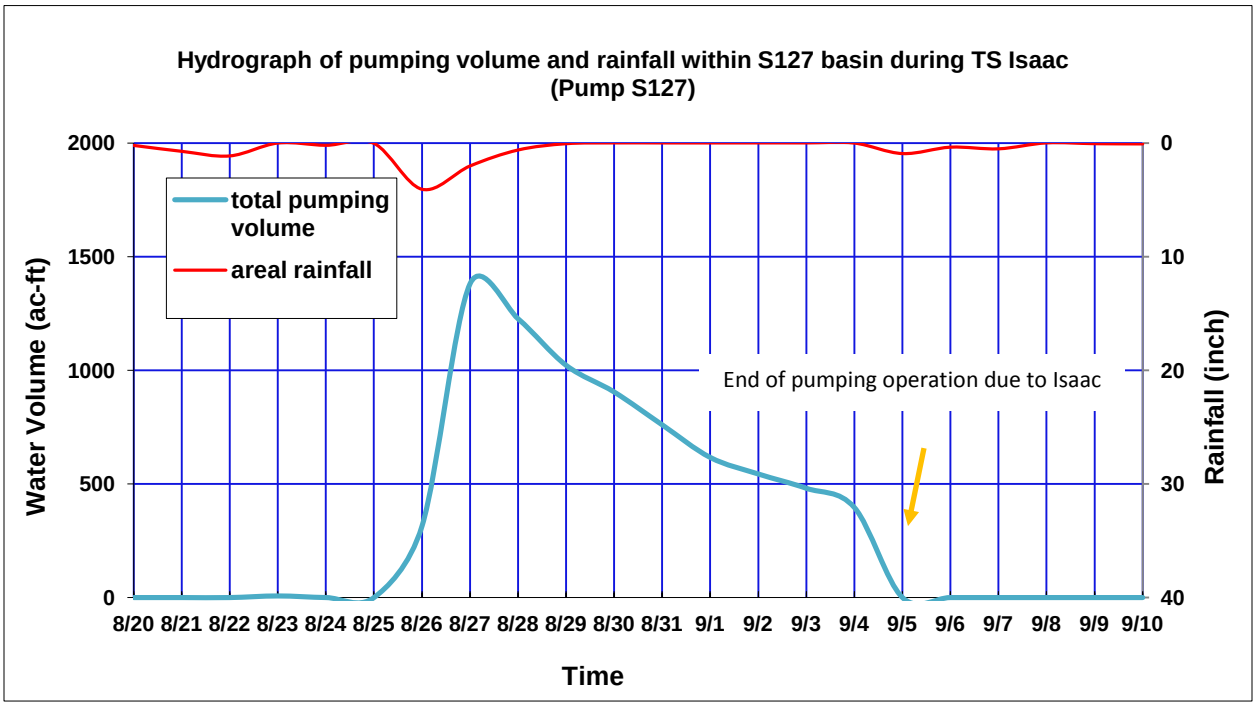
APPENDIX A

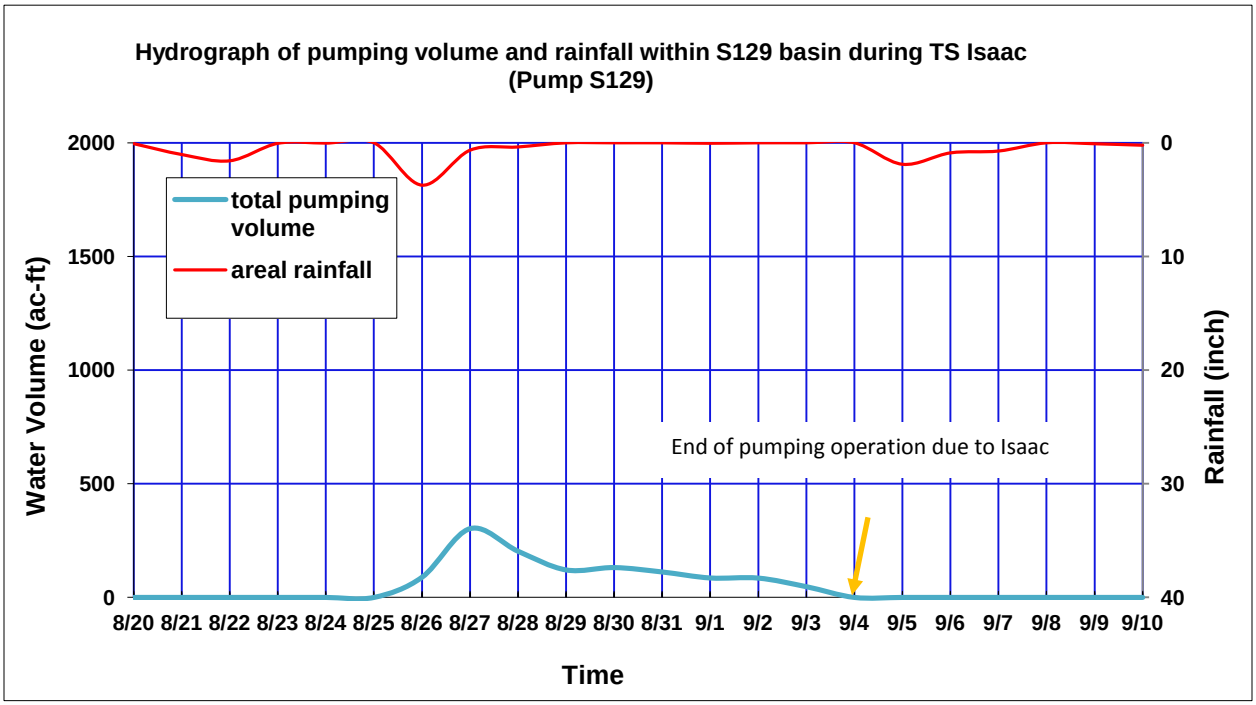
Hydrographs of pumping water volume and daily areal rainfall within hydrological basin

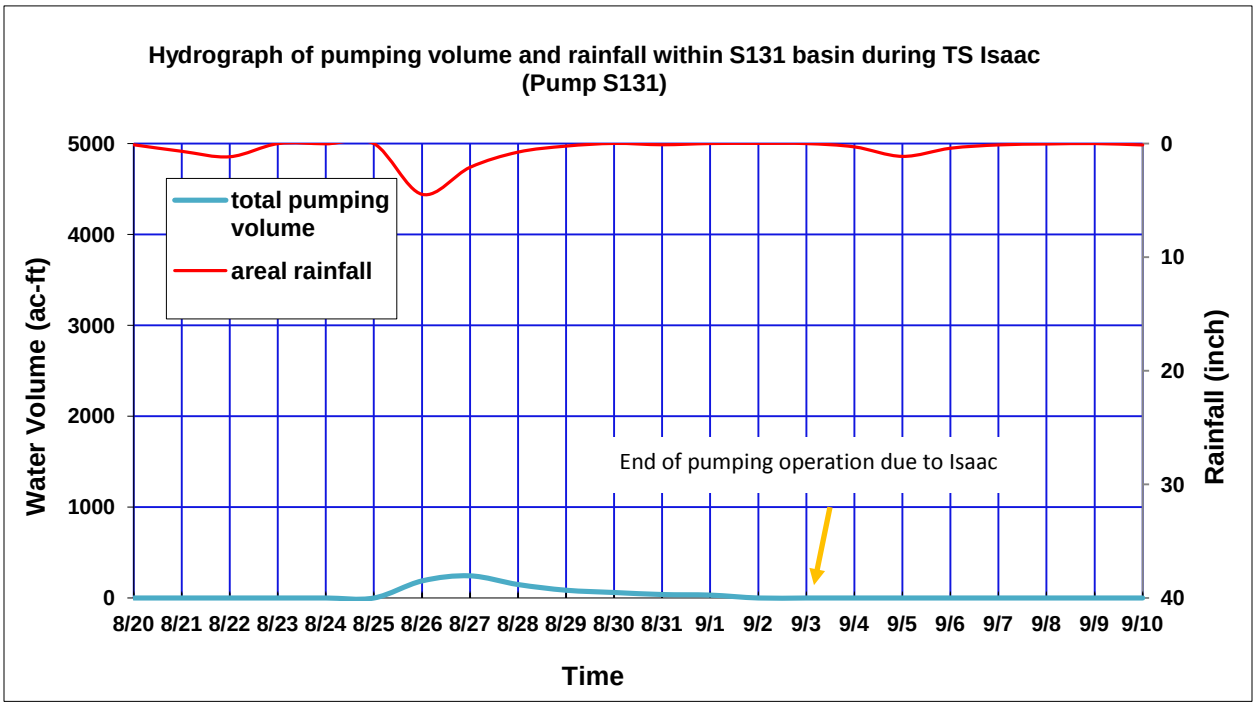


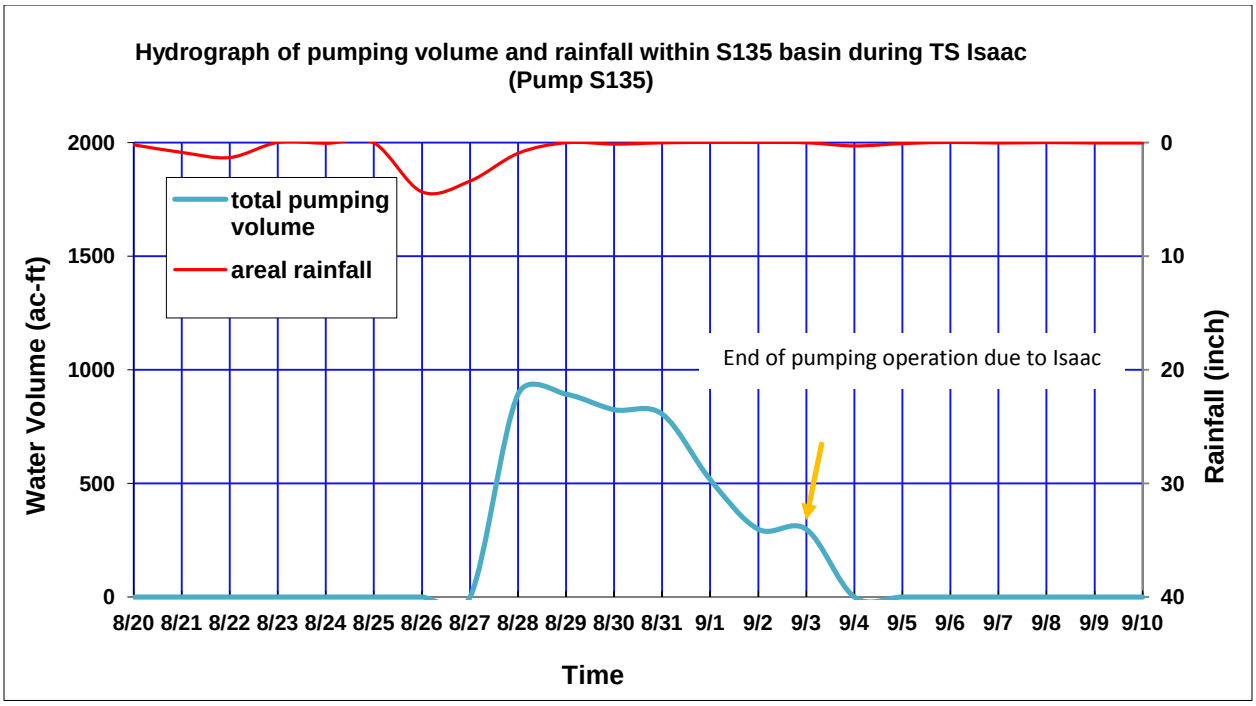


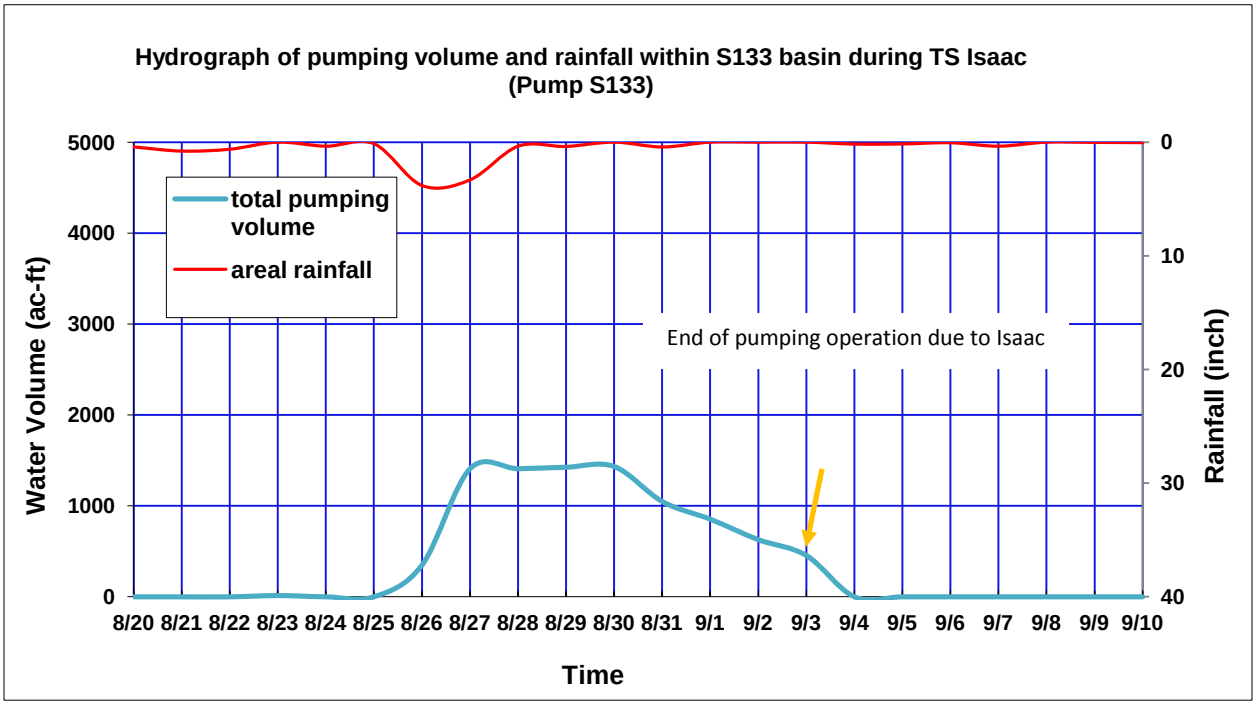

Hydrograph of pumping volume and rainfall within Canal 4 basin during TS Isaac
(Pumps S25B & G420)
Water Volume (ac-ft)
Rainfall (inch)
total pumping volume
areal rainfall
End of pumping operation due to Isaac
2000
1500
1000
500
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

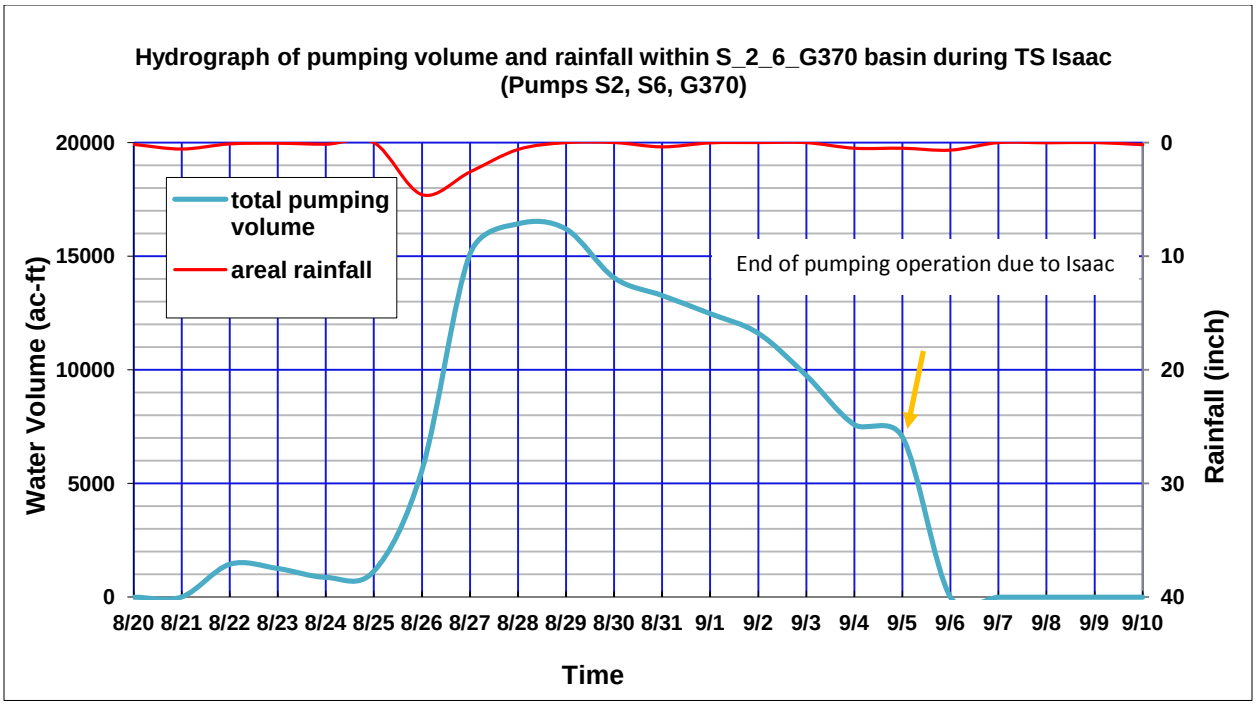

Hydrograph of pumping volume and rainfall within S127 basin during TS Isaac
(Pump S127)
Water Volume (ac-ft)
Rainfall (inch)
total pumping volume
areal rainfall
End of pumping operation due to Isaac
2000
1500
1000
500
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

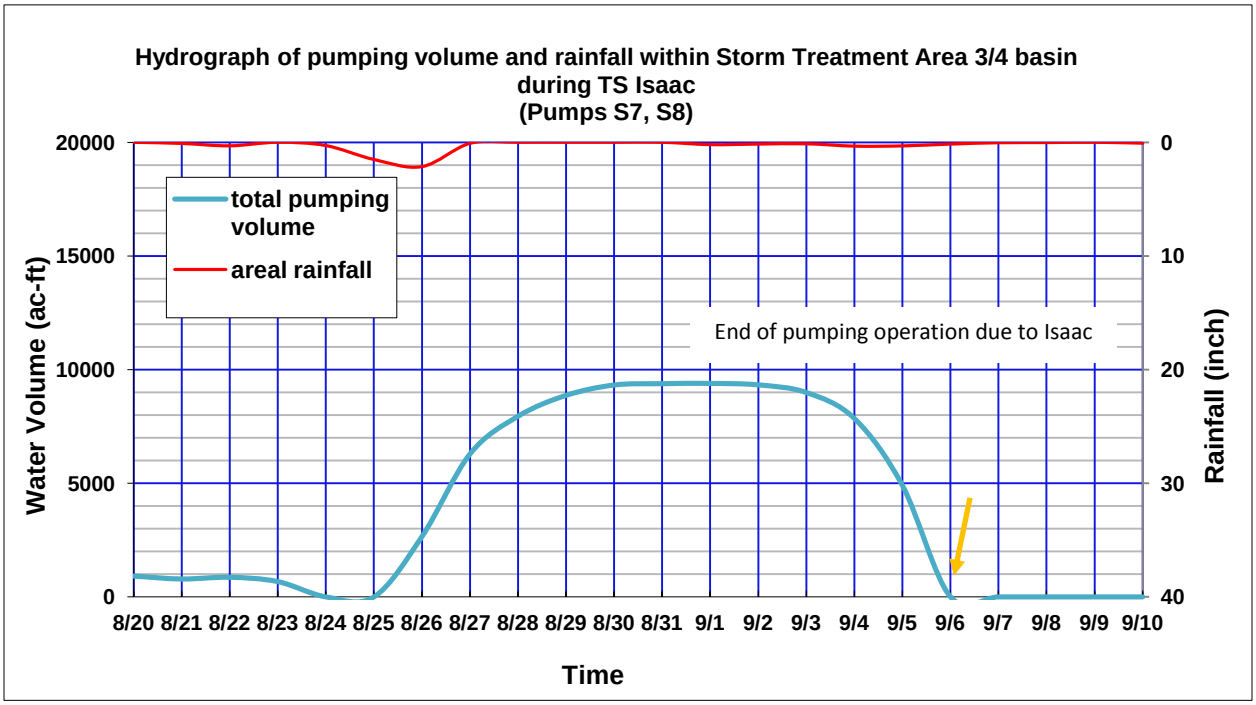

Hydrograph of pumping volume and rainfall within S129 basin during TS Isaac
(Pump S129)
Water Volume (ac-ft)
Rainfall (inch)
total pumping volume
areal rainfall
End of pumping operation due to Isaac
2000
1500
1000
500
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

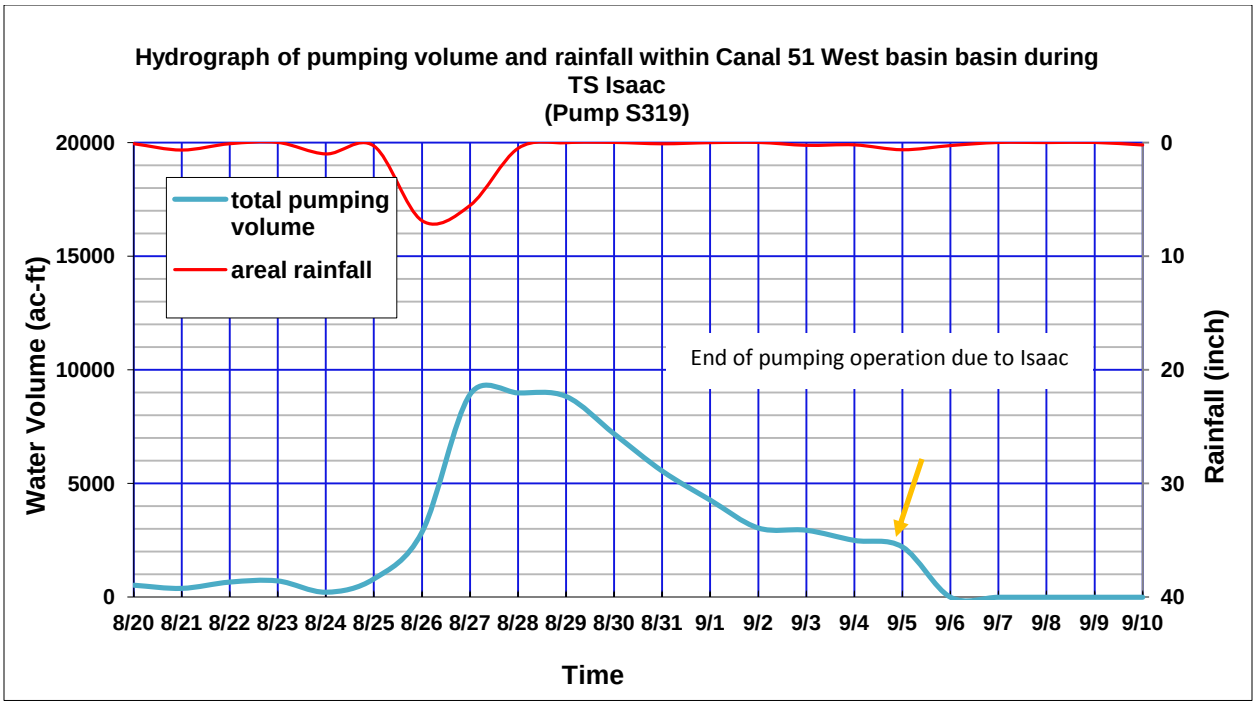

Hydrograph of pumping volume and rainfall within S131 basin during TS Isaac
(Pump S131)
Water Volume (ac-ft)
Rainfall (inch)
total pumping volume
areal rainfall
End of pumping operation due to Isaac
5000
4000
3000
2000
1000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

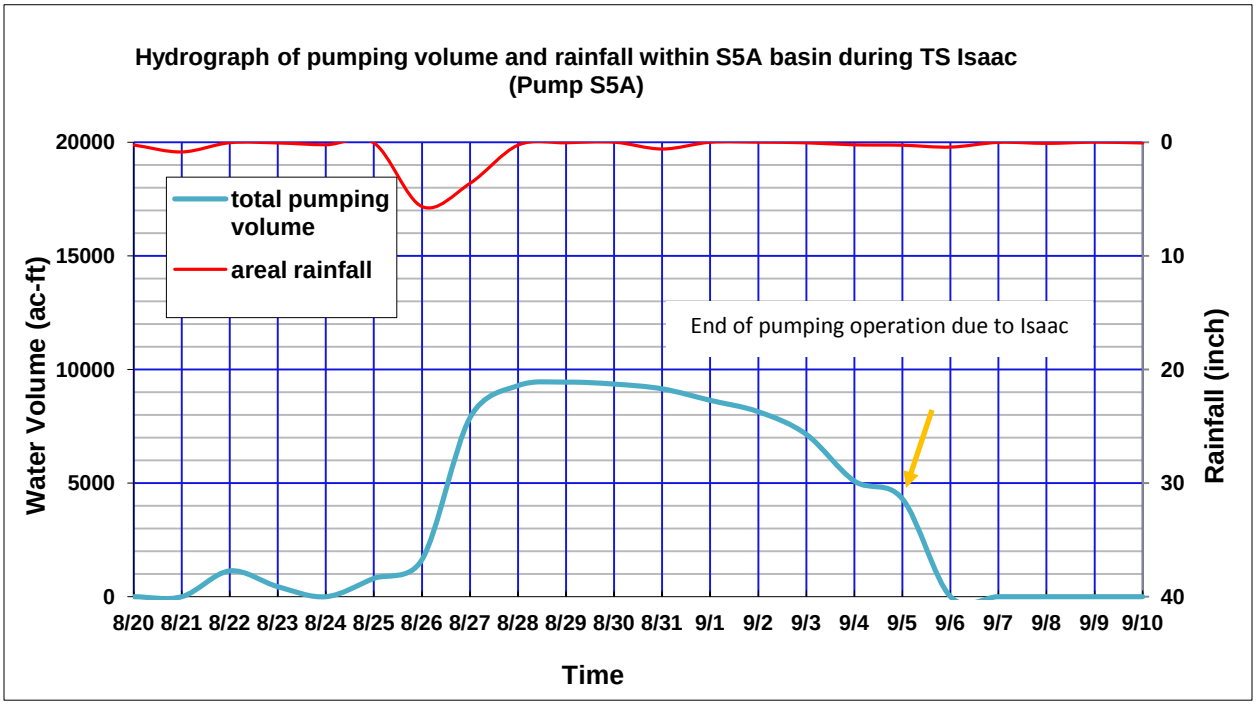

Hydrograph of pumping volume and rainfall within S135 basin during TS Isaac
(Pump S135)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
2000
1500
1000
500
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

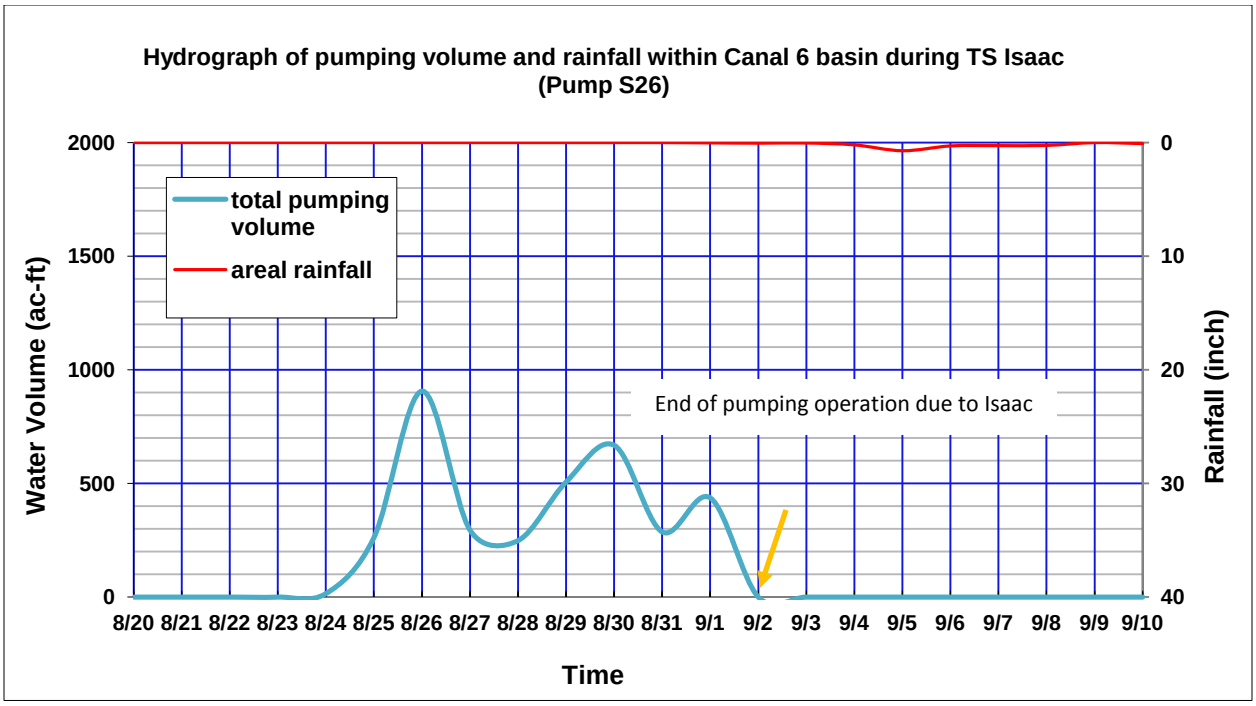

Hydrograph of pumping volume and rainfall within S133 basin during TS Isaac
(Pump S133)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
5000
4000
3000
2000
1000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

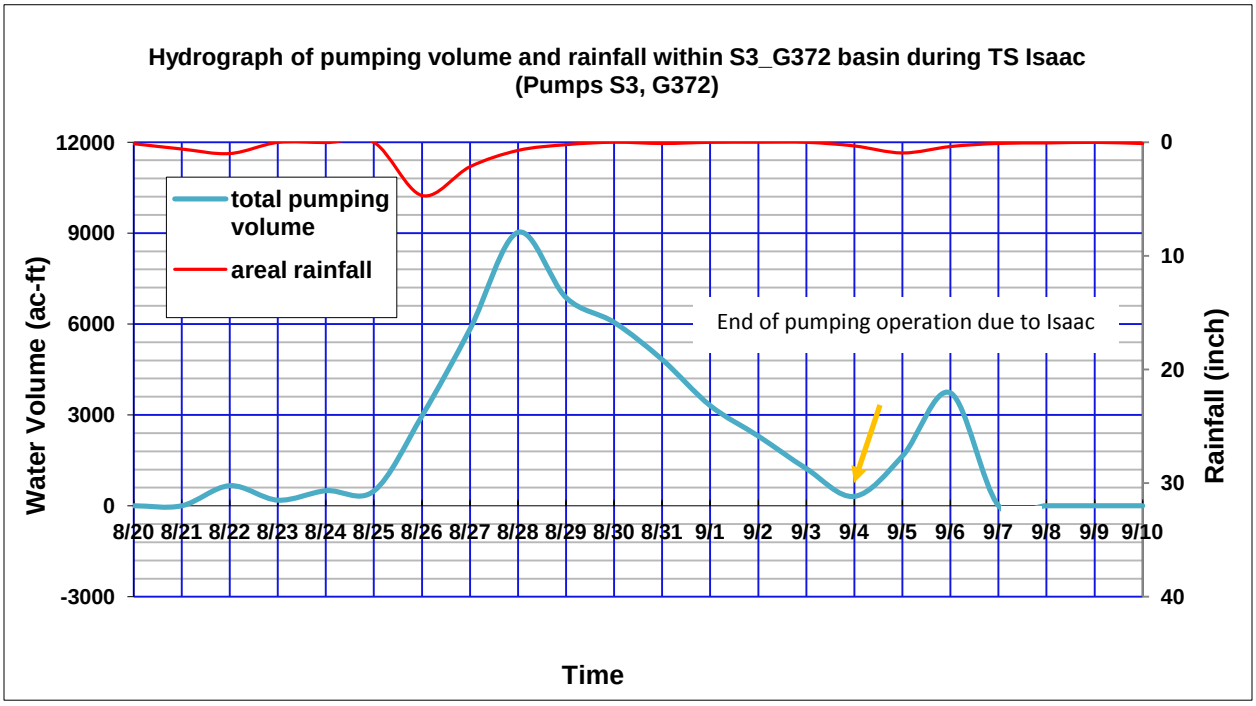

Hydrograph of pumping volume and rainfall within S_2_6_G370 basin during TS Isaac
(Pumps S2, S6, G370)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
20000
15000
10000
5000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

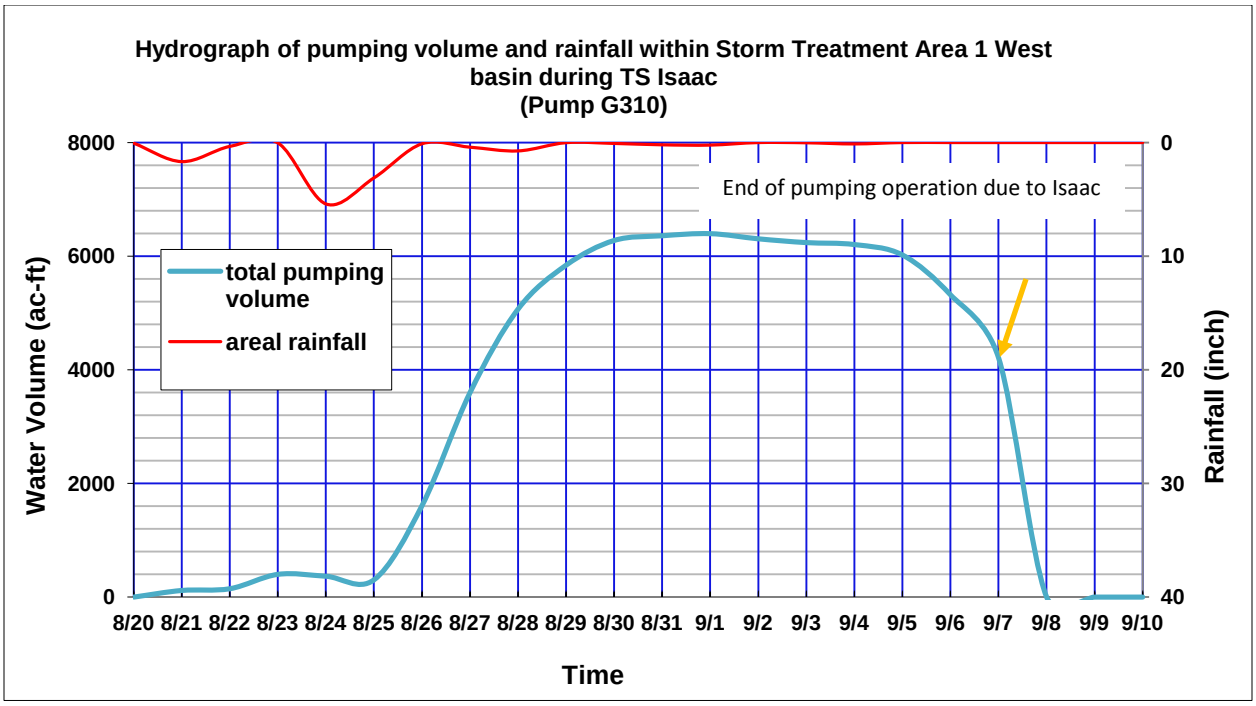

Hydrograph of pumping volume and rainfall within Storm Treatment Area 3/4 basin during TS Isaac
(Pumps S7, S8)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
20000
15000
10000
5000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

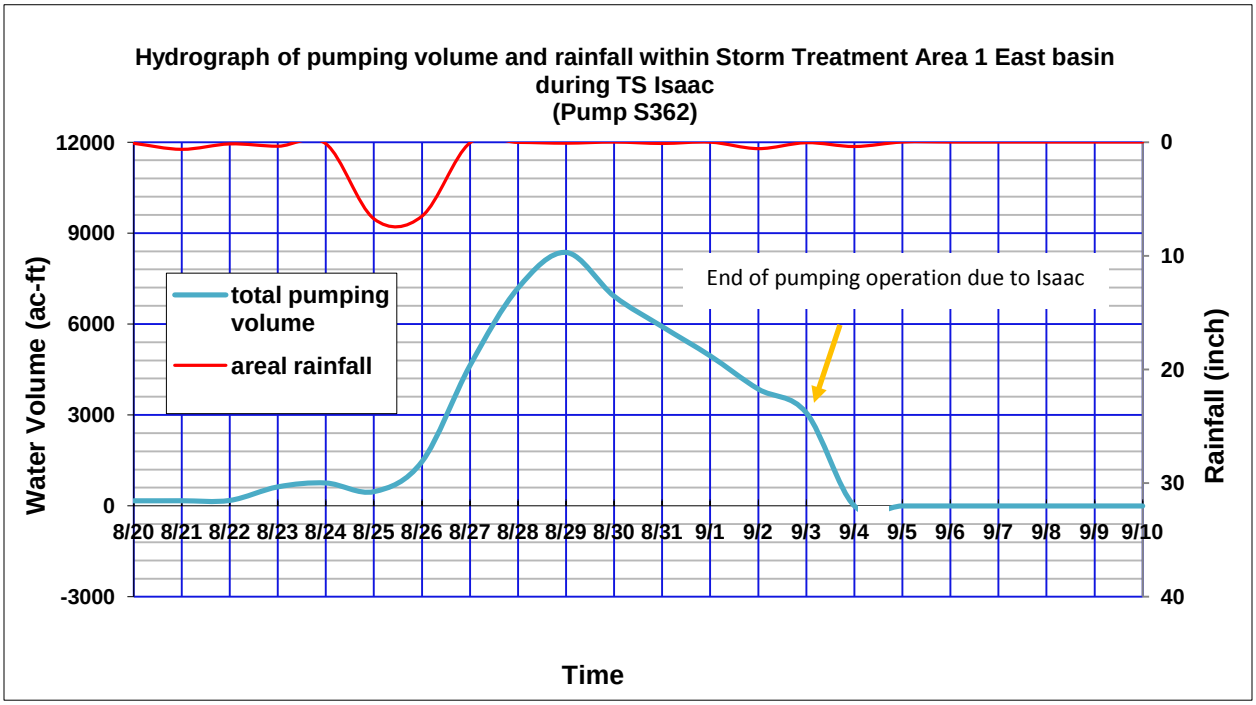

Hydrograph of pumping volume and rainfall within Canal 51 West basin basin during TS Isaac
(Pump S319)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
20000
15000
10000
5000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

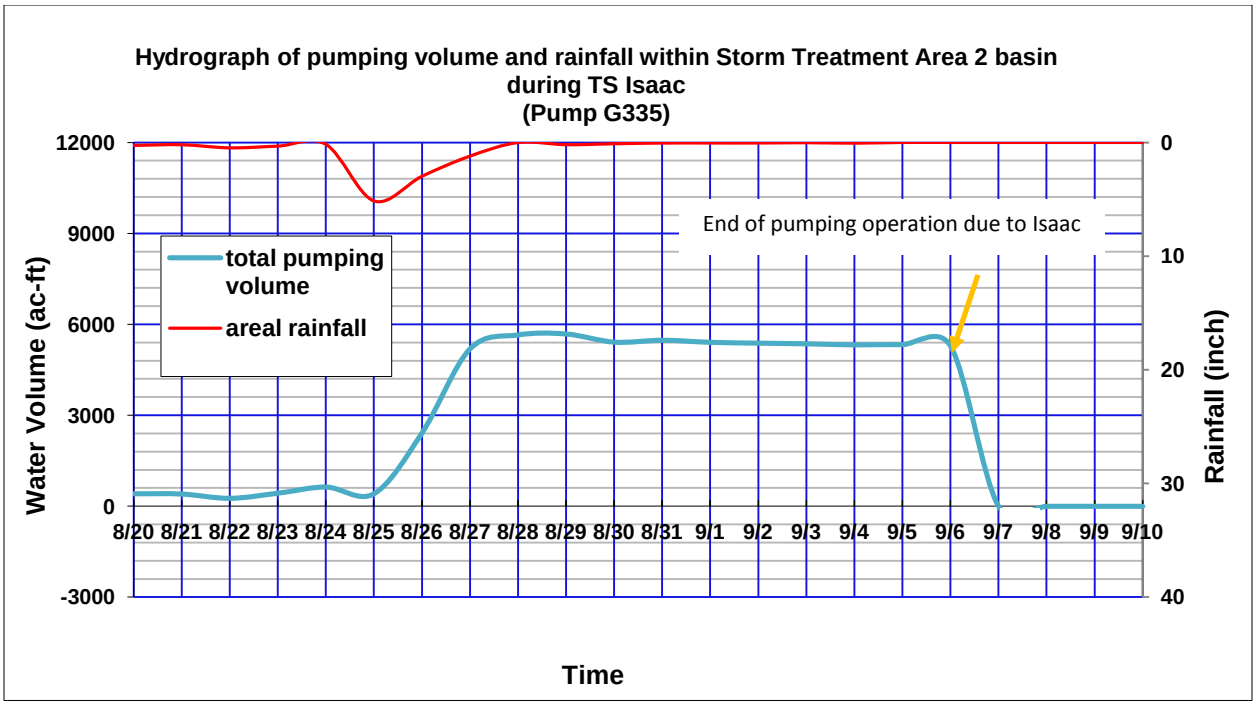

Hydrograph of pumping volume and rainfall within S5A basin during TS Isaac
(Pump S5A)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
20000
15000
10000
5000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10


Hydrograph of pumping volume and rainfall within Canal 6 basin during TS Isaac
(Pump S26)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
2000
1500
1000
500
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10


Hydrograph of pumping volume and rainfall within S3_G372 basin during TS Isaac
(Pumps S3, G372)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
12000
9000
6000
3000
0
-3000
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

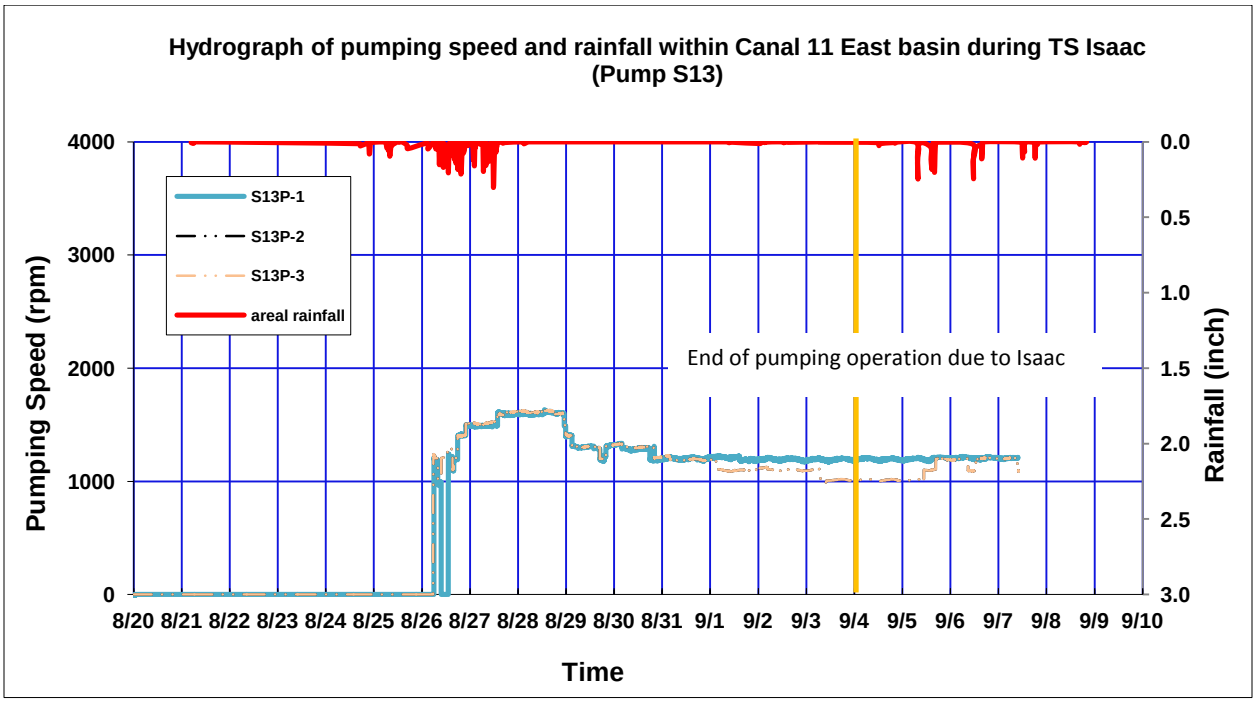

Hydrograph of pumping volume and rainfall within Storm Treatment Area 1 West basin during TS Isaac
(Pump G310)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
8000
6000
4000
2000
0
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

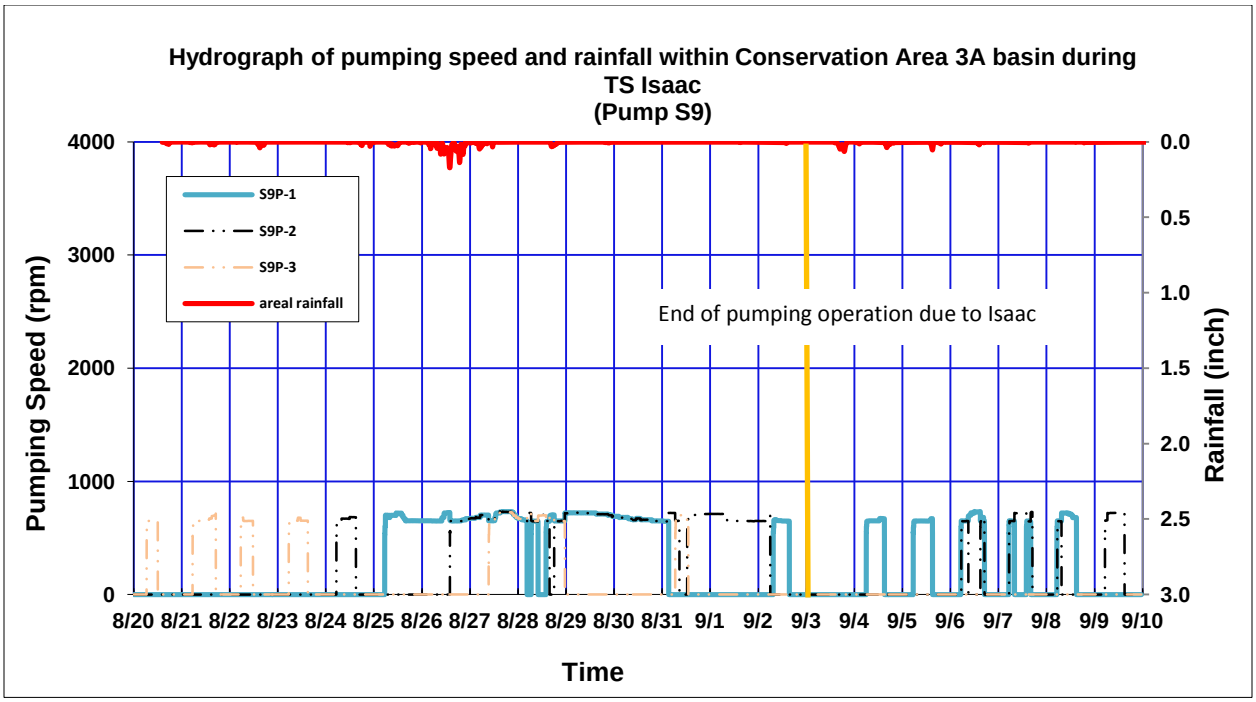

Hydrograph of pumping volume and rainfall within Storm Treatment Area 1 East basin during TS Isaac
(Pump S362)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
12000
9000
6000
3000
0
-3000
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

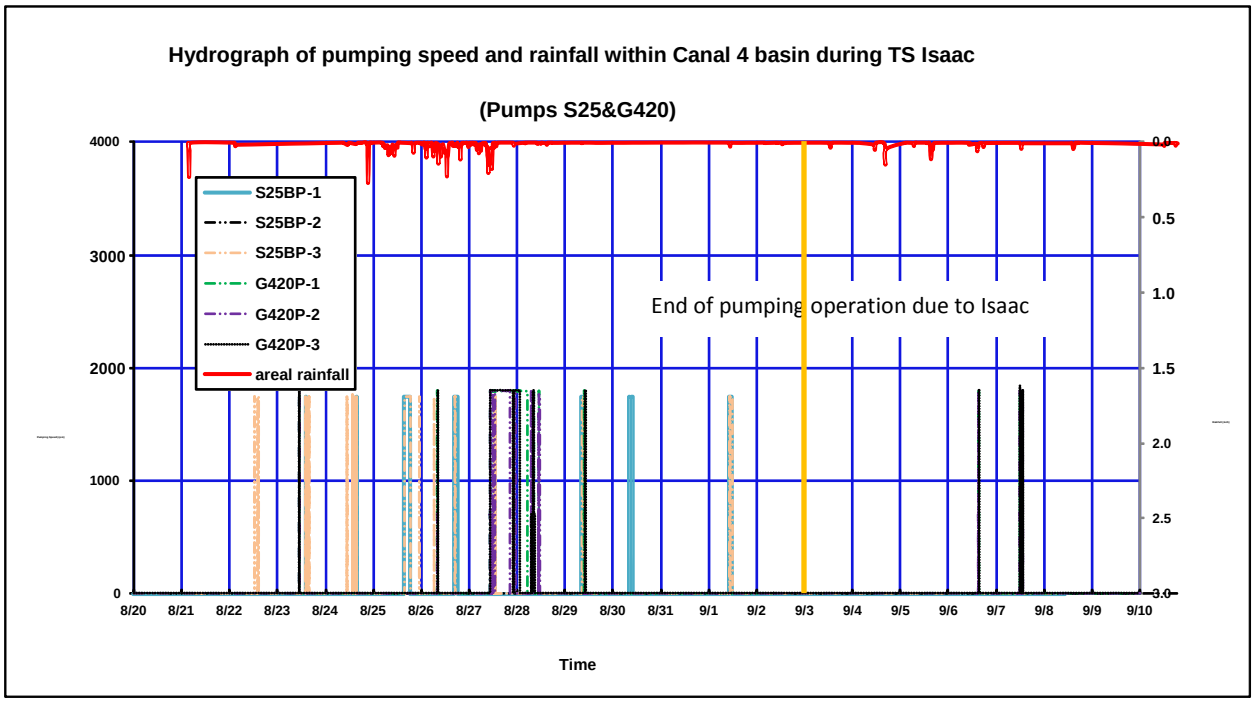

Hydrograph of pumping volume and rainfall within Storm Treatment Area 2 basin during TS Isaac (Pump G335)
Water Volume (ac-ft)
Rainfall (inch)
Time
total pumping volume
areal rainfall
End of pumping operation due to Isaac
12000
9000
6000
3000
0
-3000
0
10
20
30
40
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

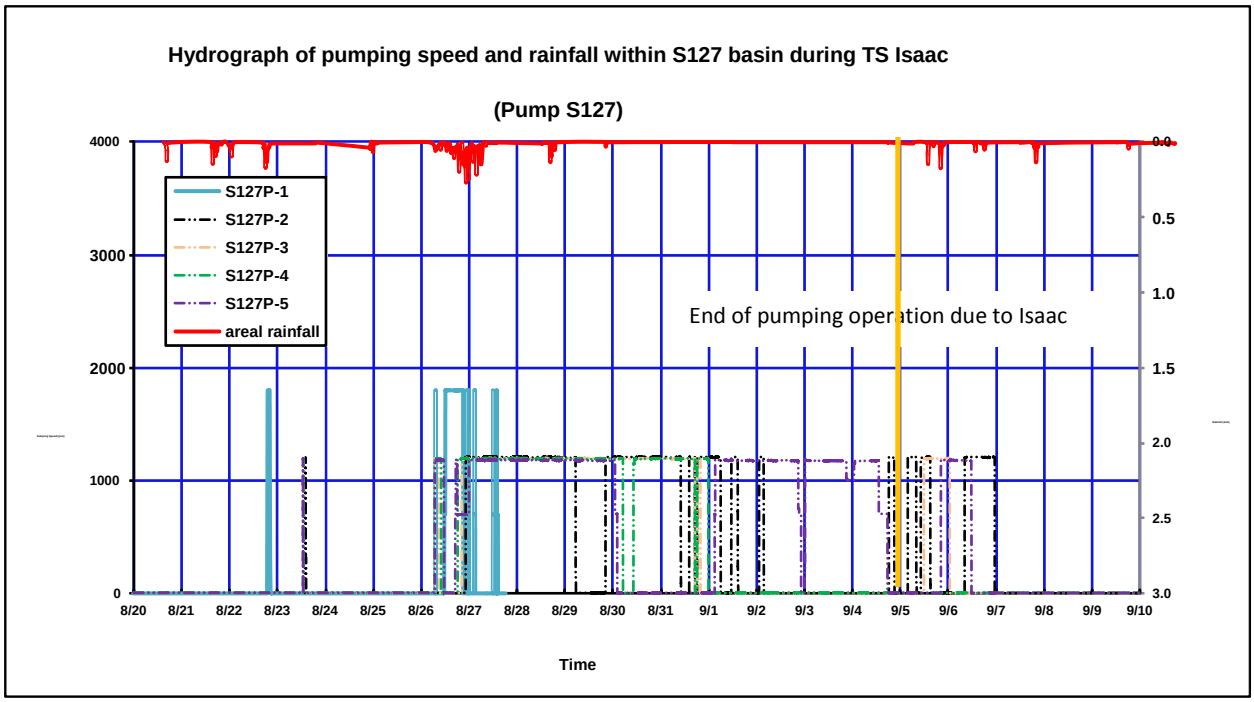
APPENDIX B The end of pumping operation due to TS Isaac was determined by the inflection point on the receding limb of each storm hydrograph in **Appendix A**. Whenever the pumping speed is not zero, the pumping minutes of each pump unit within the same hydrological basin are summed up to a total value (listed in Table 3).

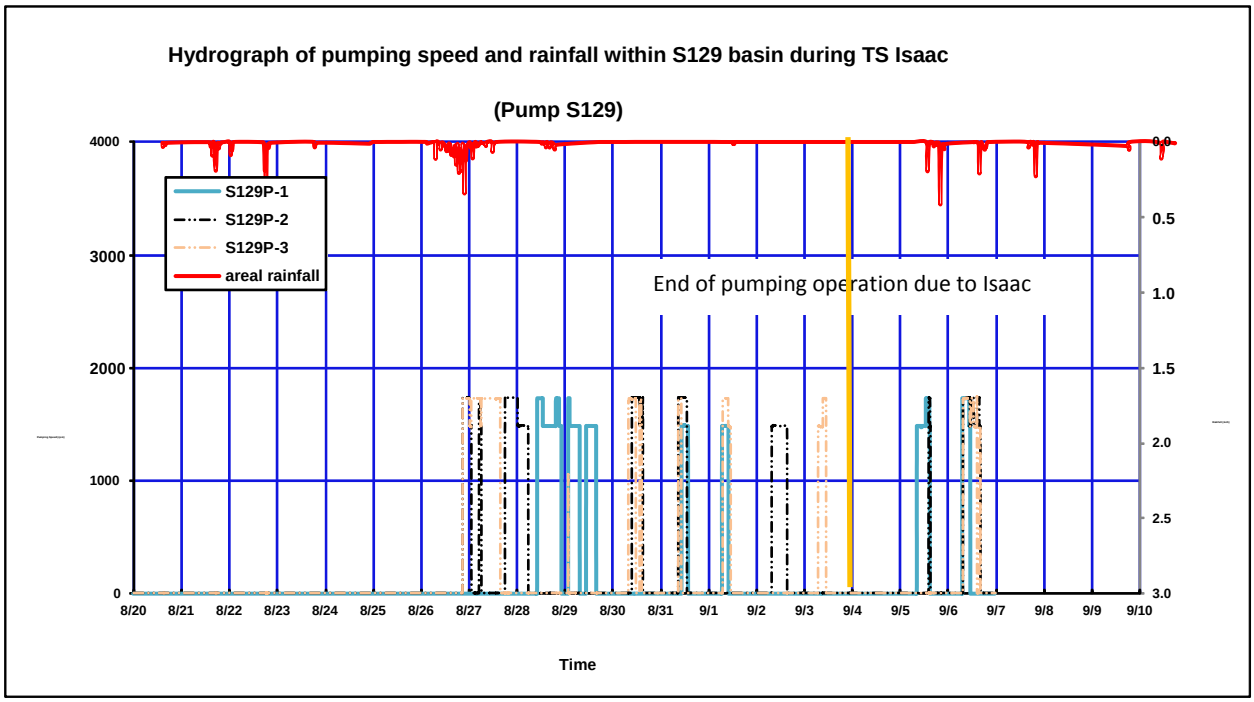
Hydrographs of instantaneous pumping speed (duration) and 15-minute areal rainfall within hydrological basin

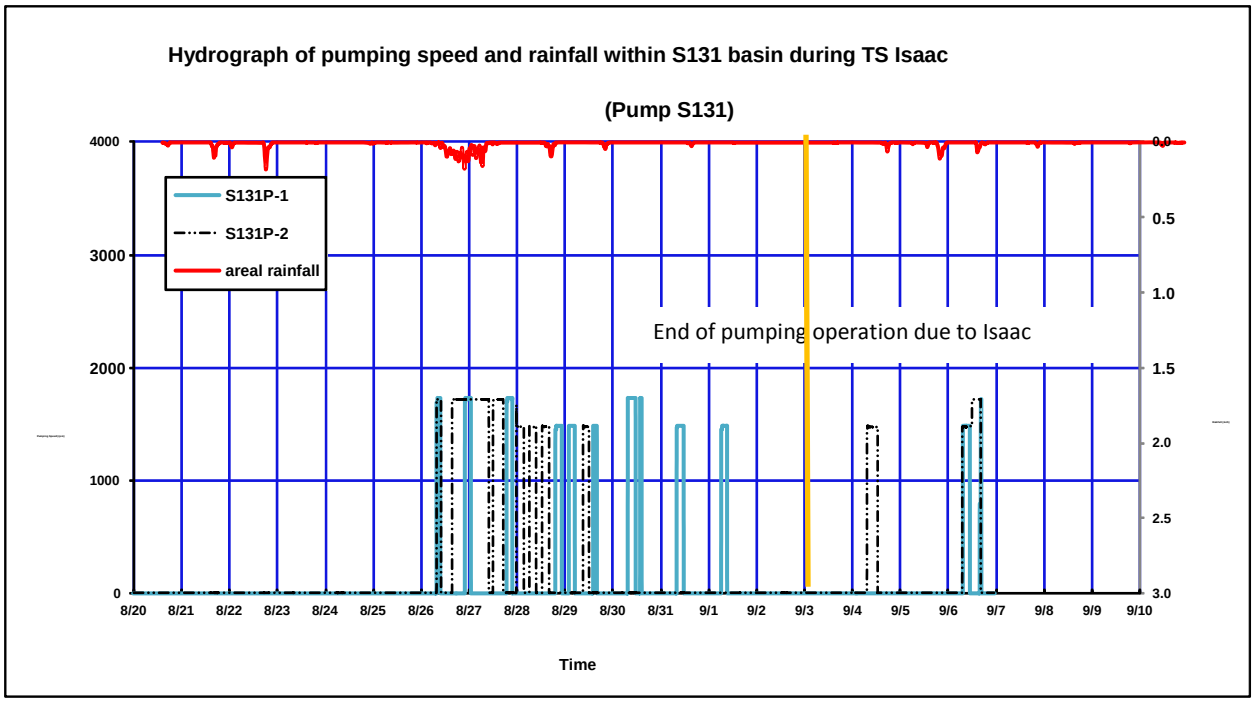


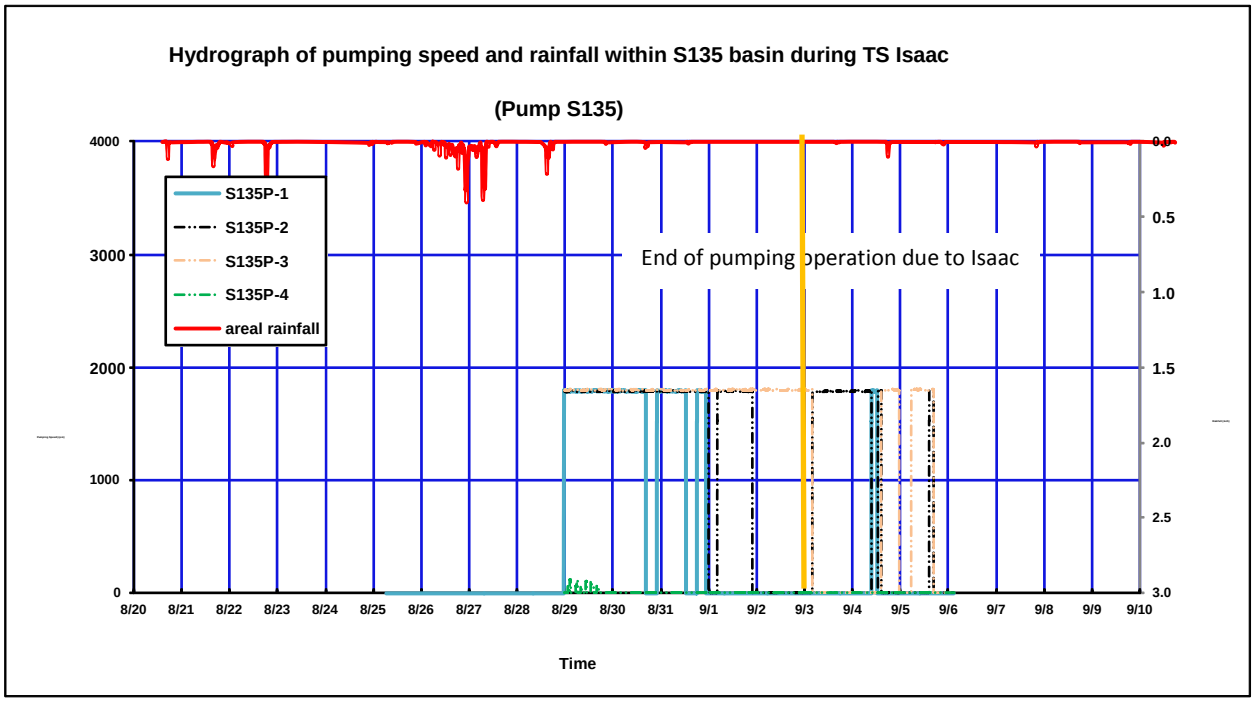

Hydrograph of pumping speed and rainfall within Conservation Area 3A basin during TS Isaac
(Pump S9)
Pumping Speed (rpm)
Rainfall (inch)
S9P-1
S9P-2
S9P-3
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

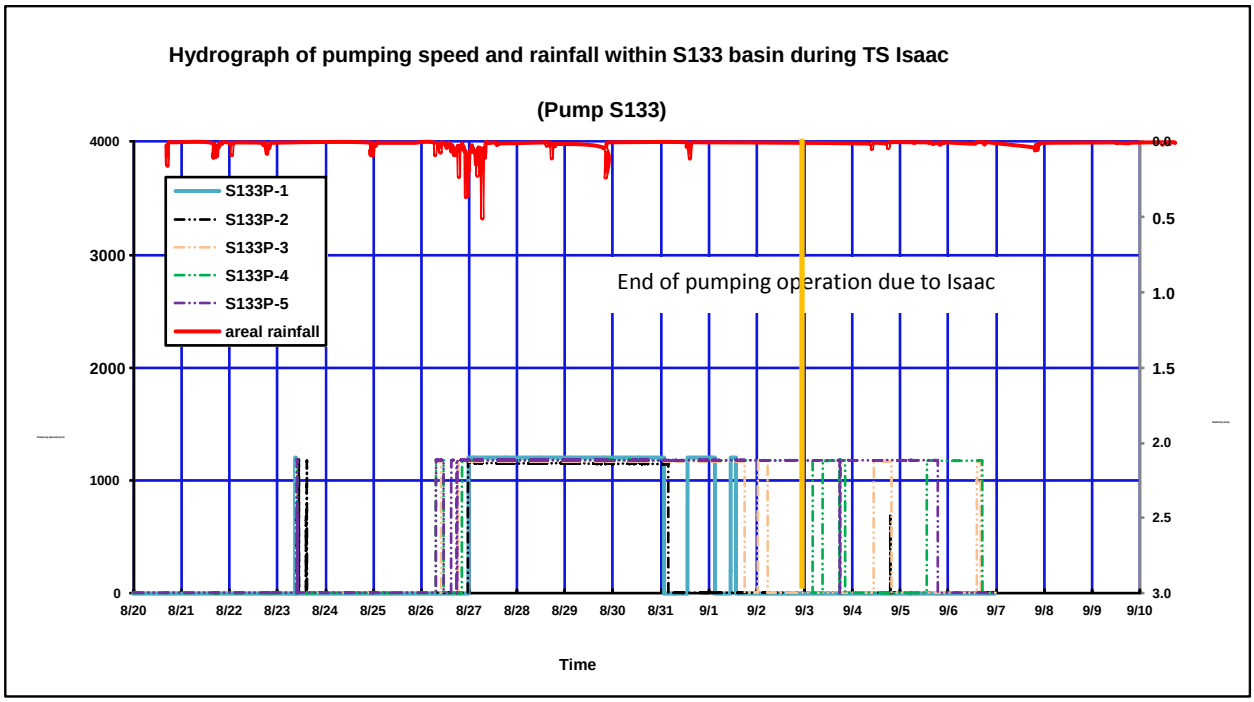

Hydrograph of pumping speed and rainfall within Canal 4 basin during TS Isaac
(Pumps S25&G420)
S25BP-1
S25BP-2
S25BP-3
G420P-1
G420P-2
G420P-3
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

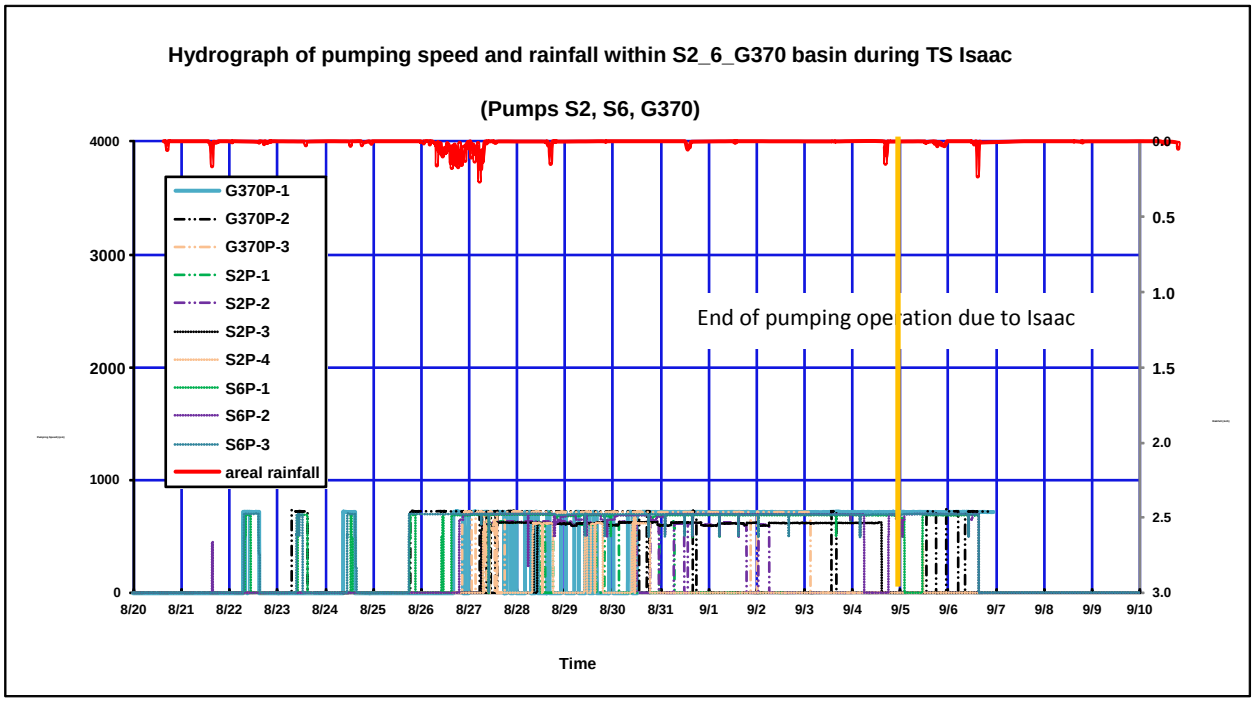

Hydrograph of pumping speed and rainfall within S127 basin during TS Isaac
(Pump S127)
S127P-1
S127P-2
S127P-3
S127P-4
S127P-5
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20
8/21
8/22
8/23
8/24
8/25
8/26
8/27
8/28
8/29
8/30
8/31
9/1
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
Time

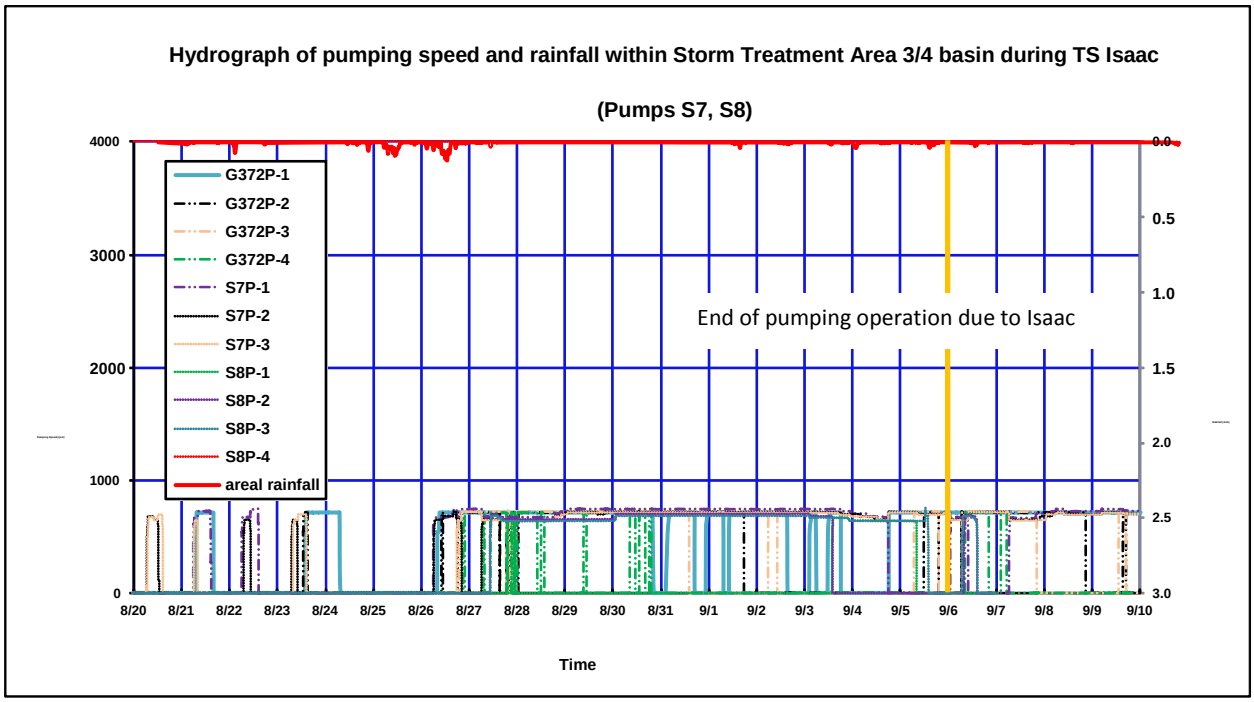

Hydrograph of pumping speed and rainfall within S129 basin during TS Isaac
(Pump S129)
S129P-1
S129P-2
S129P-3
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20
8/21
8/22
8/23
8/24
8/25
8/26
8/27
8/28
8/29
8/30
8/31
9/1
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
Time

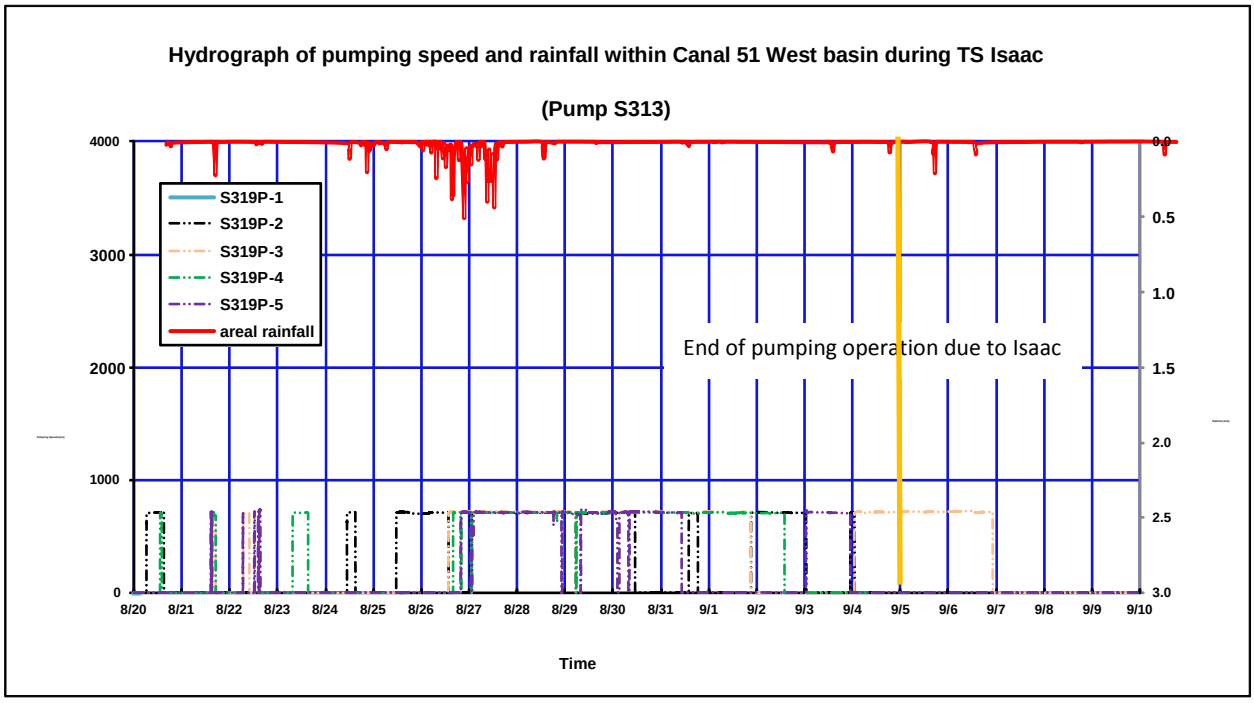

Hydrograph of pumping speed and rainfall within S131 basin during TS Isaac
(Pump S131)
S131P-1
S131P-2
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20
8/21
8/22
8/23
8/24
8/25
8/26
8/27
8/28
8/29
8/30
8/31
9/1
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
Time

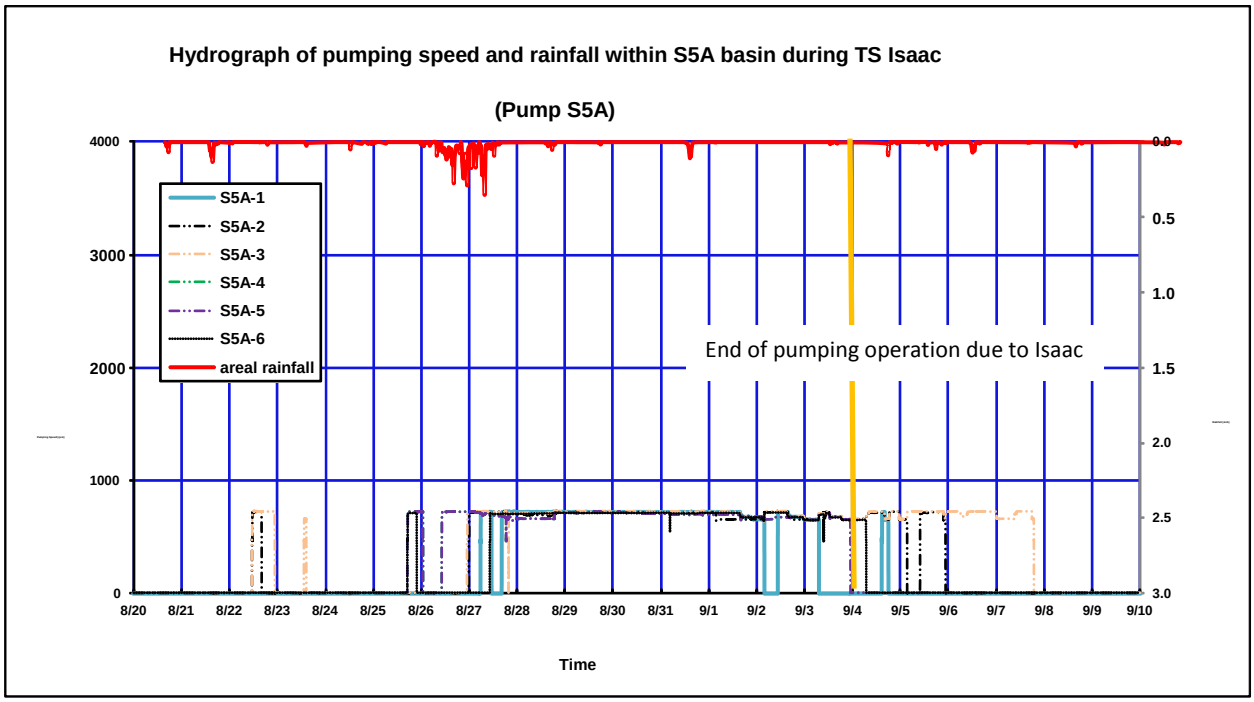

Hydrograph of pumping speed and rainfall within S135 basin during TS Isaac
(Pump S135)
S135P-1
S135P-2
S135P-3
S135P-4
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20
8/21
8/22
8/23
8/24
8/25
8/26
8/27
8/28
8/29
8/30
8/31
9/1
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
Time

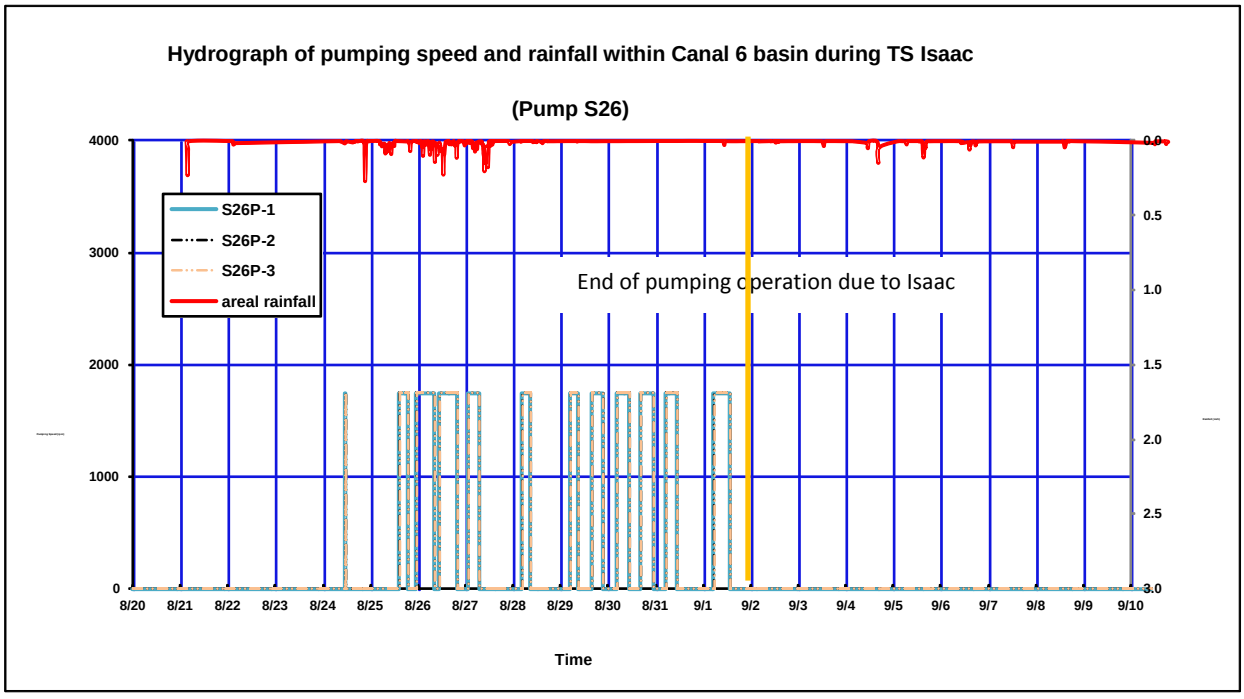

Hydrograph of pumping speed and rainfall within S133 basin during TS Isaac
(Pump S133)
S133P-1
S133P-2
S133P-3
S133P-4
S133P-5
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

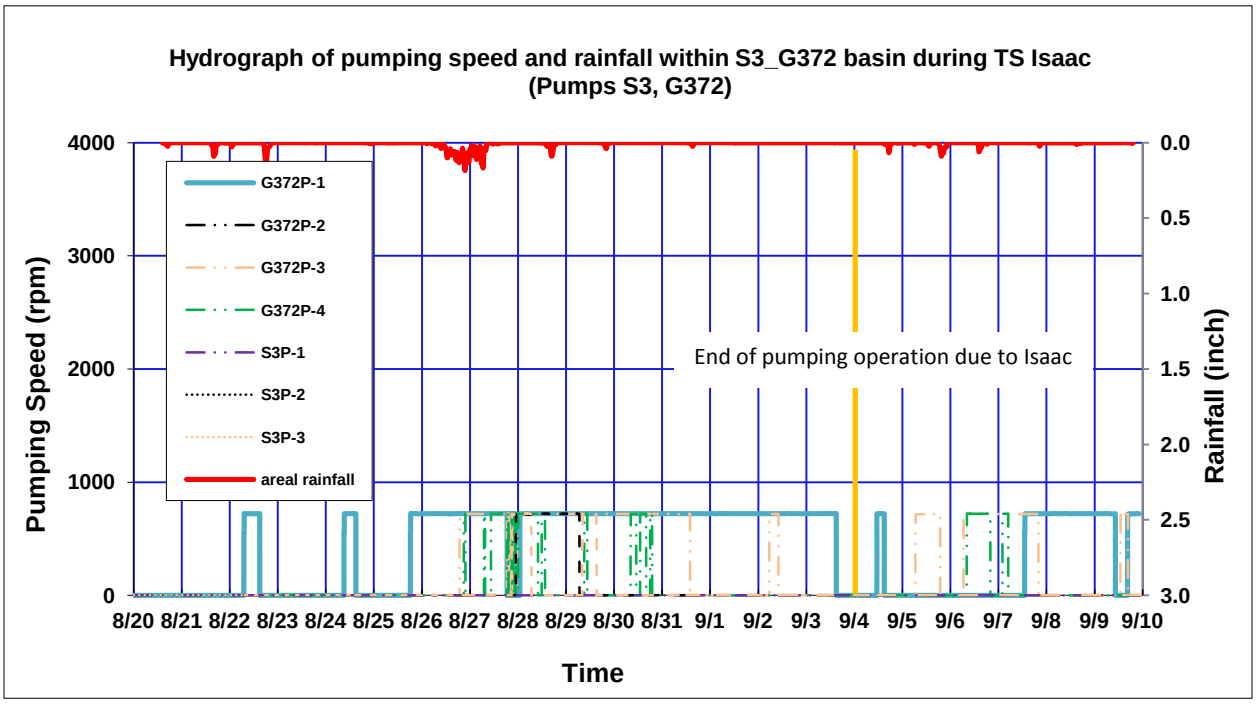

Hydrograph of pumping speed and rainfall within S2_6_G370 basin during TS Isaac
(Pumps S2, S6, G370)
G370P-1
G370P-2
G370P-3
S2P-1
S2P-2
S2P-3
S2P-4
S6P-1
S6P-2
S6P-3
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time

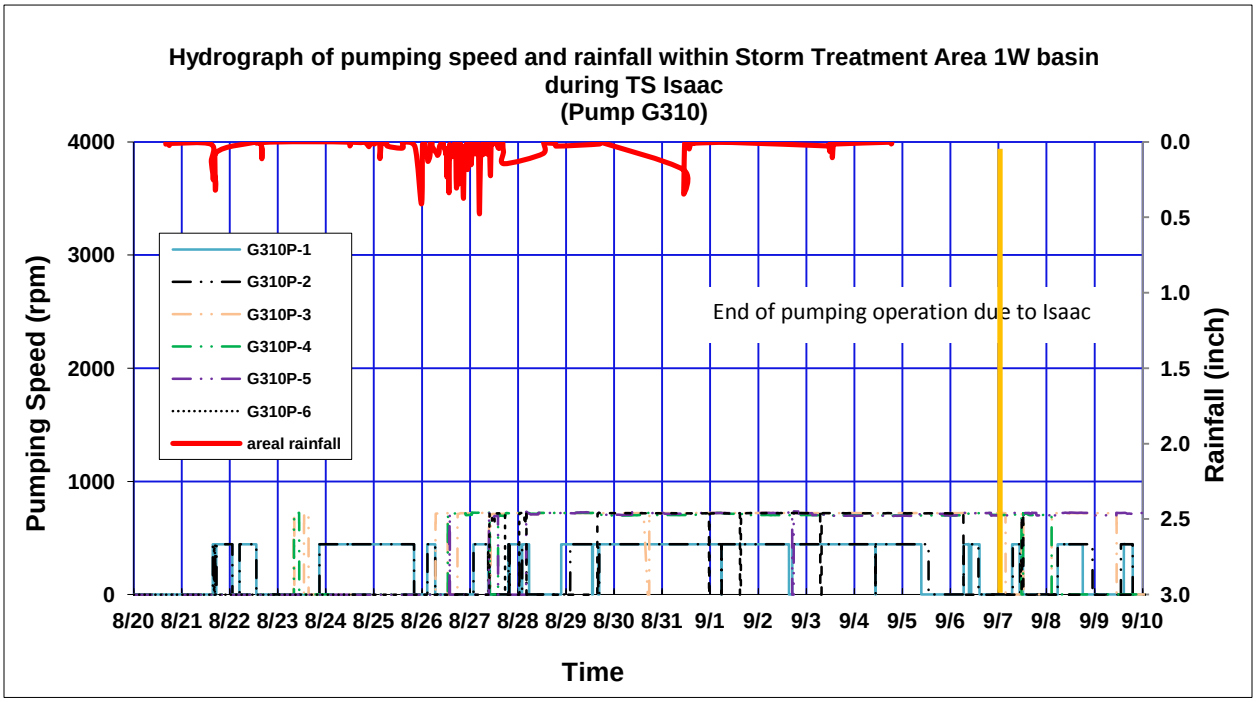

Hydrograph of pumping speed and rainfall within Storm Treatment Area 3/4 basin during TS Isaac
(Pumps S7, S8)
G372P-1
G372P-2
G372P-3
G372P-4
S7P-1
S7P-2
S7P-3
S8P-1
S8P-2
S8P-3
S8P-4
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20
8/21
8/22
8/23
8/24
8/25
8/26
8/27
8/28
8/29
8/30
8/31
9/1
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
Time

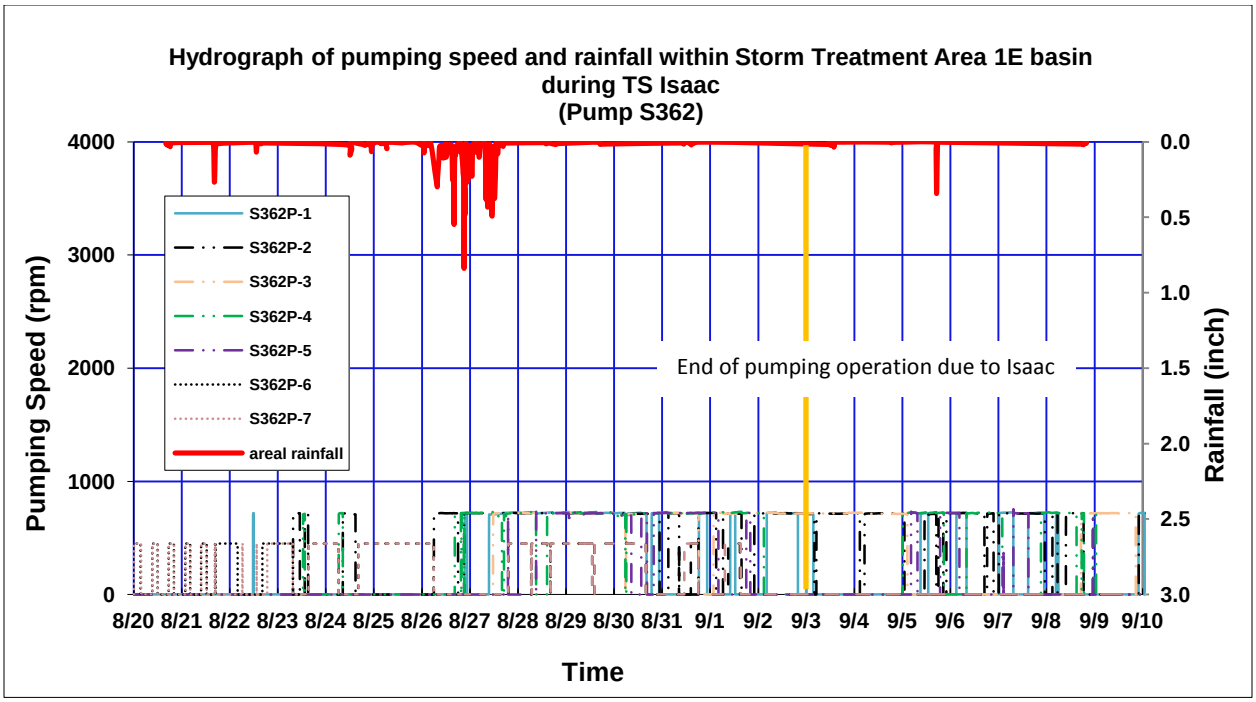

Hydrograph of pumping speed and rainfall within Canal 51 West basin during TS Isaac
(Pump S313)
S319P-1
S319P-2
S319P-3
S319P-4
S319P-5
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20
8/21
8/22
8/23
8/24
8/25
8/26
8/27
8/28
8/29
8/30
8/31
9/1
9/2
9/3
9/4
9/5
9/6
9/7
9/8
9/9
9/10
Time

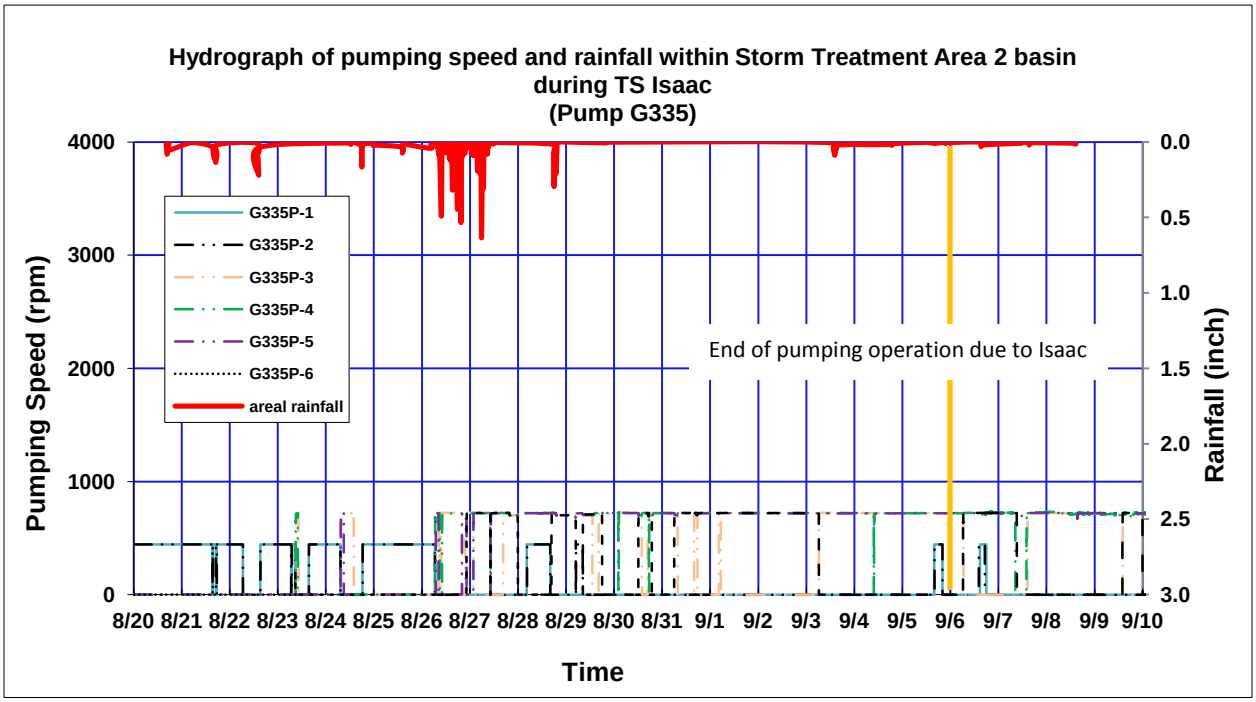

Hydrograph of pumping speed and rainfall within S5A basin during TS Isaac
(Pump S5A)
S5A-1
S5A-2
S5A-3
S5A-4
S5A-5
S5A-6
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time


Hydrograph of pumping speed and rainfall within Canal 6 basin during TS Isaac
(Pump S26)
S26P-1
S26P-2
S26P-3
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10
Time


Hydrograph of pumping speed and rainfall within S3_G372 basin during TS Isaac
(Pumps S3, G372)
Pumping Speed (rpm)
Rainfall (inch)
Time
G372P-1
G372P-2
G372P-3
G372P-4
S3P-1
S3P-2
S3P-3
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10


Hydrograph of pumping speed and rainfall within Storm Treatment Area 1W basin
during TS Isaac
(Pump G310)
Pumping Speed (rpm)
Rainfall (inch)
Time
G310P-1
G310P-2
G310P-3
G310P-4
G310P-5
G310P-6
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10


Hydrograph of pumping speed and rainfall within Storm Treatment Area 1E basin during TS Isaac (Pump S362)
Pumping Speed (rpm)
Rainfall (inch)
Time
S362P-1
S362P-2
S362P-3
S362P-4
S362P-5
S362P-6
S362P-7
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10


Hydrograph of pumping speed and rainfall within Storm Treatment Area 2 basin during TS Isaac (Pump G335)
Pumping Speed (rpm)
Rainfall (inch)
Time
G335P-1
G335P-2
G335P-3
G335P-4
G335P-5
G335P-6
areal rainfall
End of pumping operation due to Isaac
4000
3000
2000
1000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
8/20 8/21 8/22 8/23 8/24 8/25 8/26 8/27 8/28 8/29 8/30 8/31 9/1 9/2 9/3 9/4 9/5 9/6 9/7 9/8 9/9 9/10

APPENDIX C

Pumping water volume and areal rainfall within administrative county due to TS Isaac

Diesel Unit	County	No. of Unit	8/20/2012	8/21/2012	8/22/2012	8/23/2012	8/24/2012	8/25/2012	8/26/2012	8/27/2012	8/28/2012	8/29/2012	8/30/2012	8/31/2012
Water volume (ac-ft)	Broward	8	547	1054	647	709	850	1483	2998	5820	5451	4637	4187	2964
Daily rainfall (inch)			0.111	0.190	0.299	0.000	0.249	0.374	3.600	1.619	0.307	0.042	0.001	0.000
Water volume (ac-ft)	Miami-Dade	9	0	0	2	16	21	423	976	988	407	566	688	286
Daily rainfall (inch)			0.005	0.120	0.217	0.000	0.473	1.267	2.444	0.650	0.017	0.002	0.000	0.000
Water volume (ac-ft)	Glades	10	0	0	0	7	0	0	592	1928	1578	1228	1096	910
Daily rainfall (inch)			0.090	0.769	1.126	0.104	0.107	0.014	3.631	0.470	0.290	0.100	0.000	0.009
Water volume (ac-ft)	Martin	4	0	0	0	0	0	0	0	0	893	892	824	805
Daily rainfall (inch)			0.324	0.512	0.520	0.229	0.150	0.361	3.576	4.007	0.675	0.042	0.074	0.020
Water volume (ac-ft)	Okeechobee	5	0	0	0	14	0	0	349	1407	1407	1423	1431	1047
Daily rainfall (inch)			0.277	1.021	0.468	0.000	0.107	0.218	3.125	3.245	0.665	0.165	0.004	0.095
Water volume (ac-ft)	Palm Beach	54	2029	1884	5374	4739	3351	4442	21216	57472	69582	70076	64564	59912
Daily rainfall (inch)			0.185	0.453	0.290	0.021	0.614	0.168	4.958	3.111	0.591	0.067	0.000	0.149

~continued

Diesel Unit	County	No. of Unit	9/1/2012	9/2/2012	9/3/2012	9/4/2012	9/5/2012	9/6/2012	9/7/2012	9/8/2012	9/9/2012	9/10/2012	Total
Water volume (ac-ft)	Broward	8	2450	1659	1328	926	0	0	0	0	0	0	37710
Daily rainfall (inch)			0.024	0.015	0.283	0.310	0.570	0.319	0.132	0.065	0.000	0.161	8.671
Water volume (ac-ft)	Miami-Dade	9	506	0	0	0	0	0	0	0	0	0	4880
Daily rainfall (inch)			0.119	0.155	0.294	0.268	0.294	0.142	0.078	0.045	0.000	0.179	6.769
Water volume (ac-ft)	Glades	10	734	629	528	396	0	0	0	0	0	0	9624
Daily rainfall (inch)			0.015	0.000	0.000	0.448	1.344	0.933	0.147	0.007	0.017	0.288	9.909
Water volume (ac-ft)	Martin	4	516	298	298	0	0	0	0	0	0	0	4526
Daily rainfall (inch)			0.001	0.000	0.092	0.339	0.189	0.418	0.114	0.031	0.064	0.139	11.877
Water volume (ac-ft)	Okeechobee	5	853	628	454	0	0	0	0	0	0	0	9012
Daily rainfall (inch)			0.000	0.000	0.000	0.127	0.453	0.640	0.539	0.006	0.034	0.132	11.321
Water volume (ac-ft)	Palm Beach	54	54826	49956	44715	34860	27143	10607	4209	0	0	0	590955
Daily rainfall (inch)			0.024	0.001	0.089	0.344	0.557	0.573	0.129	0.049	0.007	0.167	12.547

ATTACHMENT B – Rapid Response Streamgaging Team Summaries

Missions for 8/31/2012 update @ 15:00

Reqst. No	Mission	Crew	Findings/Provisional Data
8935	Streamgauging needed at G308 and G309 in STA1W	Leader Giles Rhoades [EAS] **561-914-0208**	G308 At ~ 13:30-14:00 -- @ 150' ds of structure Q=613 +/- 97 cfs; H=12.72' ; T=10.06' --- G309 **In Progress**
8938	Streamgauge at canals flowing into ITID. (1) along 130th Ave N (2) ~ 650 west of N 121St Tr	Mario Mayes and Tom Brown **561-723-9073**	(1) At Canal along 130th Ave N Meas. Time: ~10:00 to 10:20 Q=156+/-1.3 cfs; H=16.89', T=14.45' with water stage ~5 ft below levee top ----- (2) At canal running S ~ 650 ft west of N 121St Tr Meas. Time: ~11:53 to 12:10 Q=485 cfs with water stage ~5 ft below levee top
8940	Streamgauging at S319 P (STA1E)	John Goodson & Joe Buzard **772-214-5986**	Meas. Time: ~12:08 to 14:01 Q=1,996+/-82 cfs HW=11.4', TW=19.2', P1, P2 & P5 not pumping. P3=P4 ≈718 rpm
8940	Streamgauging at S375C in STA1E	Orlin Kellman and Dan Bachand **561-312-5446**	Meas. Time: 11:00 to 11:30 Q=685+/-13.7 cfs, H=19.38', T=18.74'; G1=G2=G3=7.5'
8943	Streamgauging outflow Structure ITID - C51W-S	Orlin Kellman and Dan Bachand **561-312-5446**	Meas. Time: 12:00 to 13:30 On S side of structure ~ 150 ft from SR80 Q=694+/-21 cfs, H≈14.06'; T=11.1'

Missions for 8/30/2012 17:00 update

Request No	Mission	Crew	Findings/Provisional Data
8304	Streamgauging needed at PBA Inflow/L8RES	Asif Mohamed & Anier Sosa	On 8/29 access for measurement was not possible with RiverBoat ADCP due to high flow stages in the L8 canal. ---- Crew measure flow on 8/30/2012 with our ADCP-RoboBoat system At ~ 10:00 Q=584cfs; H=18.45' [from staff gage; value on data depo was about 13']; Tailwater flowing free.
8711	S155A and S155	Mario Mayes and Tom Brown	S155A At 15:30 with Two gates at 7.5' [out of water] Meas Time: 10.50 to 11:10 Q=1,102 cfs, H=11.7', T=10.41' S155 Mission has been postponed.
8719	Streamgauging at S319 P (STA1E)	John Goodson, Jesús Zamora & Ligia Jurado	Meas Time: ~13:55 to 15:30 Q=3000+/-320 cfs HW=11.15-1141', TW=19.65', P1 & P2 not pumping. P3=P4=P5=720 rpm
8720	Streamgauging at S154_C for two settings	Andrew Kelly (SUTRON)	(1) Meas Time: 10:56 to 11:10 Q=50 cfs, H = 15.84', T =13.88' G1=G2=6' ---- (2) Meas Time: 12:17 to 12:30 Q=52 cfs, H = 15.80', T =13.77' G1=G2=6.2'
8763	ADCP sounding of shoaling on C51 ~¾ of Mi E of 319	John Goodson, Jesús Zamora & Ligia Jurado	**In Progress**
8816	Streamgauging at S5AE	Asif Mohamed & Anier Sosa	Measurement with ADCP–RoboBoat System (1) Two gates at 2.38 ft Meas Time: 10.40 to 10.50 Q=733 cfs, H=18.23', T=11.01' --- (2) Two gates at 2.50 ft Meas Time: 10.50 to 11:10 Q=795 cfs, H=18.21', T=10.98'

Rapid Response Streamgaging Team (RRST) Summaries

Summary of RRST deployments of 8/29/2012 with findings/provisional data (as of 14:10) information for requests highlighted in yellow.

Request No	Mission	Crew	Findings/Provisional Data
8303	Streamgauging at ACME Pump Station 2	Orlin Kellman, Dan Bachand, Kevin Zhu	Provisional: Meas Time: 13:12 to 13:46 Q=186 cfs; H=12.90 ft; T=18.15 ft
8304	Streamgauging needed at PBA Inflow/L8RES	Asif Mohamed & Anier Sosa	Access for measurement was not possible with RiverBoat ADCP due to high flow stages in the L8 canal. ---- The crew has been scheduled to measure tomorrow morning with our ADCP-RoboBoat system.
8306	Streamgauging at S154, 3 mi ds of S65E on N bank of C-38	Andrew Kelly (SUTRON)	In Progress
8307	Streamgauging at C10A Culvert, at junction of L8 and LO	Andrew Kelly (SUTRON)	In Progress
8424	Streamgauging at ITID - C51W-S	Asif Mohamed & Anier Sosa	Provisional: Meas Time: 12:30 to 13:00 Q=1,256 cfs, There is no stage information available
8425	Streamgauge at canals flowing into ITID. (1) along 130th Ave N (2) ~ 650 west of N 121St Tr	Rodrigo Musalem & Tom Brown	Provisional: Meas Time: ~11:30 to 14:30 (1) At Canal along 130th Ave N Q=200 cfs with water stage ~1 ft below levee top and receding ----- (2) At canal running S ~ 650 ft west of N 121St Tr Q=600 cfs with water stage ~4 ft below levee top and receding
8422	G711 and C139S3 (C139 Basin)	Joe Buzard & Jesús Zamora	In Progress G711: Meas Time: ~13:53 to 14:10 H = 20.4', T =15.45', Head over boards ~ 6" C139S3:
8431	G370P (STA3/4)	Giles Rhoads (EAS)	In Progress
8412	S190, L28IN and canal station 1 Mi ds of S190	Mario Mayes, Jack Zeng, and Ceyda Polatel	In Progress

Summary of RRST work with Findings and Prov Data for 8/28/2012

Request No	Mission	Crew	Findings/Provisional Data
7539 & 7499	C6 and C8 culverts (flowing into N and NNW shore of Lake O)	Orlin Kellman, Dan Bachand, Kevin Zhu	C8 Provisional: Meas Time: 12:30 to 13:00 Q=283cfs, Staff gauges are unreadable. C6 Provisional: Meas Time: 14:05 to 14:24 Q=122 cfs, HW Staff=14.90, TW=no staff
7960 & 7971	G300 and G311 (STA1E)	Rodrigo Musalem & Jesús Zamora	G300 Provisional: Meas Time: ~14:15 to 15:15 Q=1200 to 1500 cfs (pulsing and unsteady), HW=18.35, TW=18.1, G1=7.0', G2=7.0' Setting up for G311 measurement
7982 & 7984	G301 and G319 (STA1E)	Joe Buzard & Anier Sosa	G301 Provisional: Meas Time: ~11:34 to 12:15 Q=946 cfs HW=18.11, TW=17.97, G1=4.4', G2=4.1' G319 Provisional: Meas Time: ~13:55 to 14:05 Q=3163 cfs HW=12.94, TW=20.39, P1=716 rpm, P2=717 rpm, P3=720 rpm, P4=718 rpm, P5=714 rpm.
7994	S127 (NW shore of LO)	Andrew Kelly (SUTRON)	S127 Pump Provisional: Meas Time: 12:31 to ~13:15 Q=420cfs, HW=13.40, TW=14.90, P1=OFF, P2,3,4,5=ON
7996	G331E (STA2)	Giles Rhoads (EAS)	ADFM sensor and cable installed in the culvert have separated. No additional equipment on hand. Contractor will call when he reaches their office.
7920	S190 & L28IN	Mario Mayes and Tibebe Dessalegne	S190 both Gate 1 and Gate2 is slipping closed. Closed Gate1 and trying to keep Gate 2 open to 3.0 feet with Control Rooms help. S190 Provisional: Meas Time: 14:15 to 15:15, Q=708cfs, HW= 14.38, TW=11.56, G1=0, G2~2.7 to 3.0'

Rapid Response Streamgaging Team (RRST) Summaries

Summary of RRST work with Findings and Prov Data for 8/27/2012

Request No	Mission	Crew	Findings/Provisional Data
7490	Streamgauging at S197 (Homestead)	Orlin Kellman, Dan Bachand, Kevin Zhu	Q≈798 cfs; H~2.64 ft; T~1.33 ft; G3=G4=5 ft; All other gates closed
7502	C2 Extension near FL TPK & NW 25 St (Miami-Dade)	Mario Mayes, Tom Brown, and Jack Zeng	At ~ 15:00, Q ≈ 30 ± 3.3 cfs Water stage ~ 3 ft below bankfull level
7610	Streamgauging at S374 (STA 1E)	Giles Rhoads	Measurement was not possible at S374 due to ADFM mounting problems. Attempted to measure at S372, but there was no power to momentarily close gate to allow mounting ADFM.
7615	Streamgauging at S376 & S361 (STA1E)	Joe Buzard and Tibebe Dessalegne-Agaze.	At S376: Q ~ 40 cfs; H~14.55 ft; T~14.3 ft; G1=G2=4 ft; At S361; No measurement due to time limitations due to rainy conditions

ATTACHMENT C – Review of the Operation of the S-133 Pump Station during TS Isaac

S-133 Basin - General Description

The S-133 basin is located immediately north of Lake Okeechobee in Okeechobee County. It is bounded by the Herbert Hoover Dike (HHD) (L-D4 section) on the south, the L-62 levee on the north, the L-63N levee on the east, and the C-38 canal on the west. The City of Okeechobee is located within the S-133 basin. Drainage for the basin is provided by pump station S-133 and/or by gravity through culverts located in the HHD.

Pump Station S-133 was designed and built by the United States Army Corps of Engineers (USACE) in the 1960's. The USACE original design for S-133 indicated that the pump station would have a capacity of 625 cfs to remove 0.75 inches per day of runoff from a drainage area of 19,180 acres. The removal rate of 0.75 inches per day was the standard design value used by the USACE for agricultural areas in the Central and Southern Florida (C&SF) Project. At the time this analysis was performed, the City of Okeechobee represented a small localized area of the basin. (USACE C&SF Project, Detail Design Memorandum, Part IV Supplement 25).

The SFWMD maintains and operates S-133 in accordance with the guidance provided by the USACE in the Central & Southern Florida (C&SF) Master Water Control Manual, Volume 3. Normally, pumping is initiated when the S-133 headwater elevation reaches 14.0 feet, NGVD 29 and terminated when the headwater level falls to 13.5 ft, NGVD 29. Pumping to as low as 13.0 ft, NGVD 29 may be initiated if heavy rainfall is predicted which is expected to raise the headwater stage above 14.0 ft, NGVD 29. The pump station is staffed by the SFWMD Okeechobee Field Station and experience has shown that pumping below 12.5 ft, NGVD 29 should be avoided due to potential impeller cavitations and to avoid de-stabilizing private retaining walls in the area. For practical proposes, a safety factor of 0.3 ft is highly recommended to account for rapid stage changes which translates to a minimum pumping stage of 12.8 ft, NGVD 29.

Gravity drainage of the S-133 basin is currently provided by Culvert 6 and Culvert 8. Drainage through these culverts is limited to periods when the water levels in the HHD rim canal at the headwater of Culvert 6 and Culvert 8 are higher than the water level on the lake side. Culvert 6 is comprised of one 10 ft diameter barrel and the discharge is controlled by the USACE by means of a manually operated slide gate on the downstream side of the culvert (south side). Culvert 8 is comprised of three 10 ft diameter barrels with flap gates on the lake side. A sheet pile weir with an elevation of 13.0 ft, NGVD 29 is located upstream of Culvert 8 and functions to restrict the flows and retain more water for local stakeholders during low lake periods and address residents retaining-wall stability concerns.

The USACE Master Water Control Manual suggests that the lock structure S-193, which replaced the Hurricane Gate Structure 6 (HGS 6) in 1973, may also be utilized to provide gravity drainage for the basin under conditions when the water level in the rim canal is higher than the water level on the Lake Okeechobee side of the structure. However, neither the Master Water Control Manual nor the detail design memorandum for lock S-193 provides any guidelines for flood control operations of the lock

(typically lock structures are not design for flood control purposes). In addition, prior to and during tropical storms, structures that pass through the HHD are closed to avoid flooding that could be induced by wind driven storm surge in the lake. Therefore, only culverts with flap gates and pump stations can then be relied on for flood control until after the storm has passed.

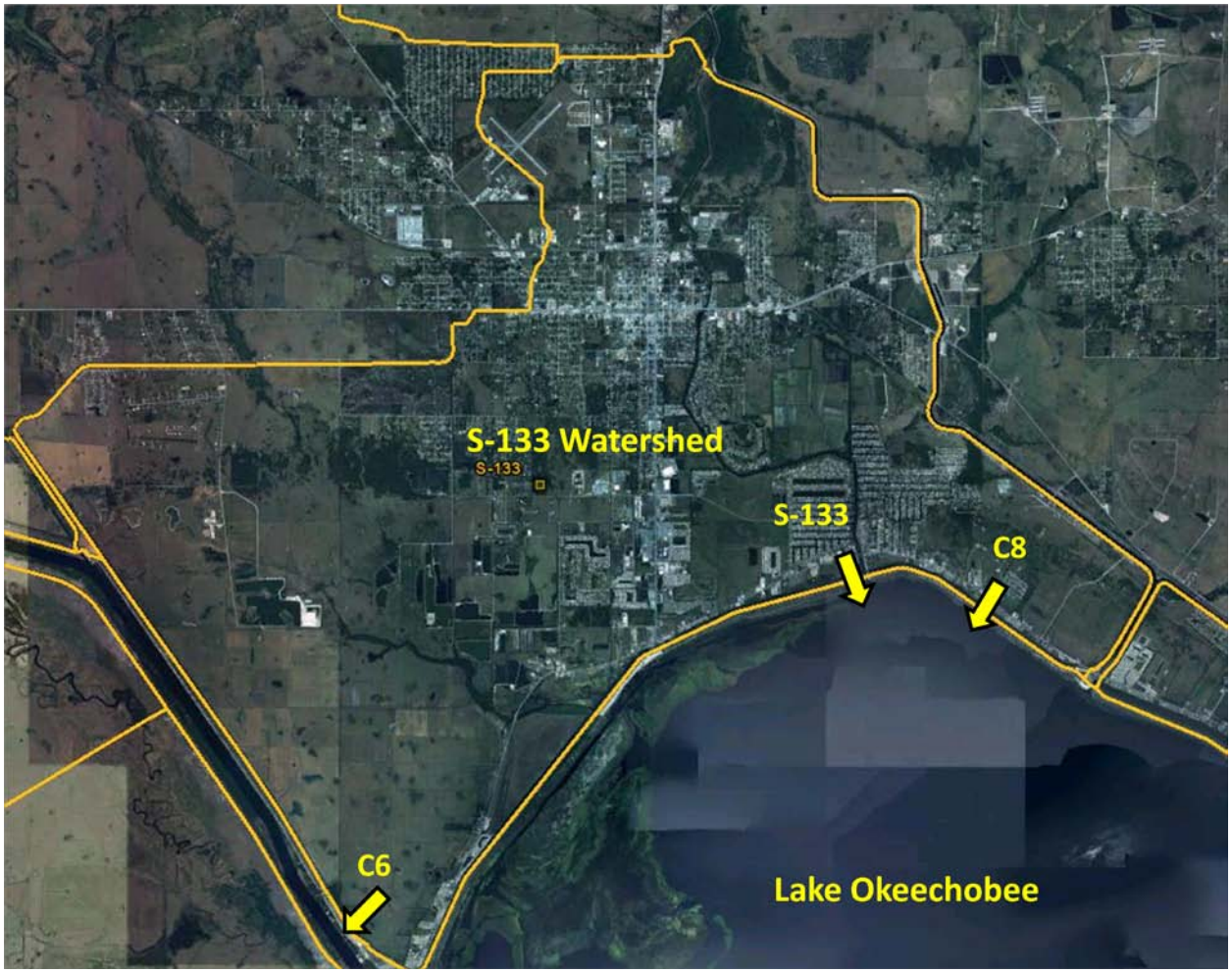


Figure 1: Flood control structure location map in the S-133 basin.

Tropical Storm Isaac – Rain Summary and Operation Evaluation

S-133 basin is located within the area most affected by TS Isaac and the heavy rainfall covered the entire basin (Figure 1). During TS Isaac the rain gauge located at S-133 pump station recorded 7.8 inches of rain in two days (August 26th - 27th). Frequency analysis suggests events of this magnitude have a return period of about 8.5 years (Figure 2). Furthermore, Table A highlights the magnitude of TS Isaac in the S-133 basin which, since 1997, is superseded only by TS Fay in 2008 with a return period of approximately 17 years.

Prior to the storm, the basin was relatively dry and the S-133 headwater was maintained at 13.5 ft, NGVD 29 by gravity via HHD Culvert 8. In preparation for the storm, S-133 pump station was staffed and the water level was brought down to 13.25 ft, NGVD 29. But as can be seen in Figure 3, even with all

units running at 1200 rpm (equivalent to a flow discharge of 720 cfs calculated at 1200 rpm under headwater tailwater conditions experienced), heavy rainfall resulted in the headwater rising rapidly to 15.0 ft, NGVD 29 in less than 17 hours. The station continued to operate at maximum capacity for 96 hours and by day 4, August 31st, the canal stage upstream of S-133 reached the pre-storm level of 13.25ft, NGVD 29 and pumping rates were reduced to avoid potential damage to the pumps. Thereafter, pumping was done on as-need basis in order to maintain the canal stage of 13.25 ft, NGVD 29.

Since Lake Okeechobee stages were below 13.5 ft, NGVD 29, Culvert 8 maintained positive gravity drainage throughout the storm. In addition, on August 27 the SFWMD asked the USACE to open the manual gate at Culvert 6. On August 28 streamgaging crews were deployed and measured flows at Culverts 6 and 8 of 120 cfs and 280 cfs respectively.

Since S-193 boat lock was out of service due to a major refurbishment project, the SFWMD had developed a contingency plan under a potential extraordinary flood condition to have the contractor lower the sheetpile to allow for gravity drainage if needed. However, the pump station was able to prevent the canal level (measured at the headwater of S-133) from exceeding 15.0 ft, NGVD 29 and had returned the canal level to 14.0 ft, NGVD 29 by day 2 and to 13.25 ft, NGVD 29 by day 4. The headwater at S-133 and Lake Okeechobee water level as measured at the tailwater of S-133 were both at 13.5 ft, NGVD 29 by the end of the third day.

Summary

During TS Isaac the SFWMD operated S-133 pump station according to standard operating procedures established by the USACE. These operations restored water levels in the rim canal to the pre-storm levels within a period of 4-days post-storm. City officials indicated that flood water remained in localized areas up to 14 days post storm. This suggests potential drainage issues in the upstream areas and or conditions preventing the water from reaching the rim canal and pump station.

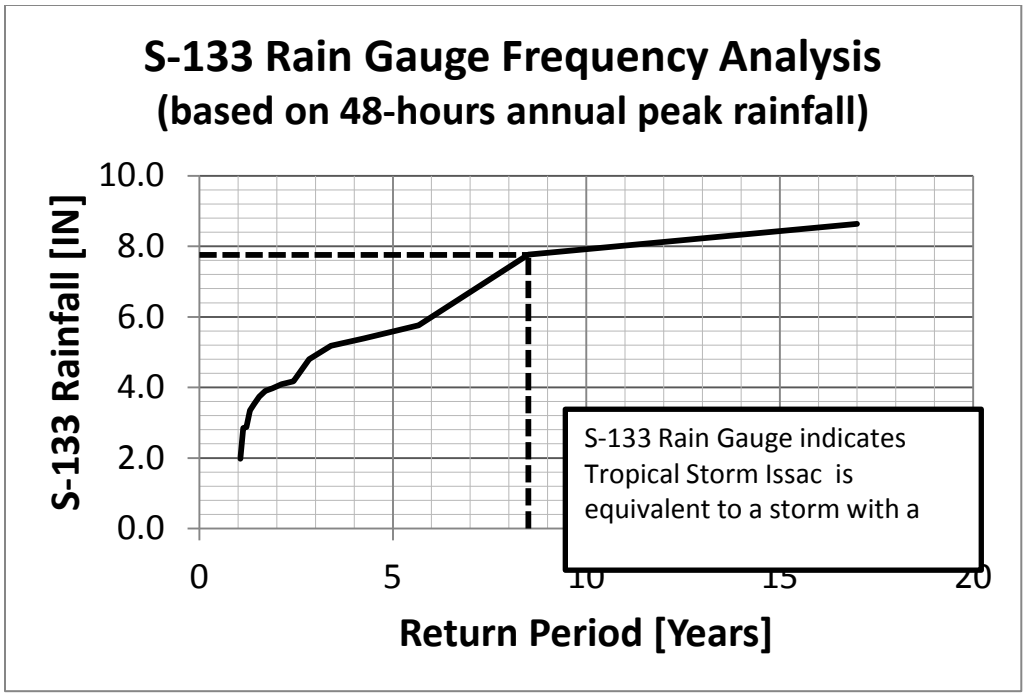


Figure 2: Frequency analysis of rain at S-133 rain gauge since 1997.

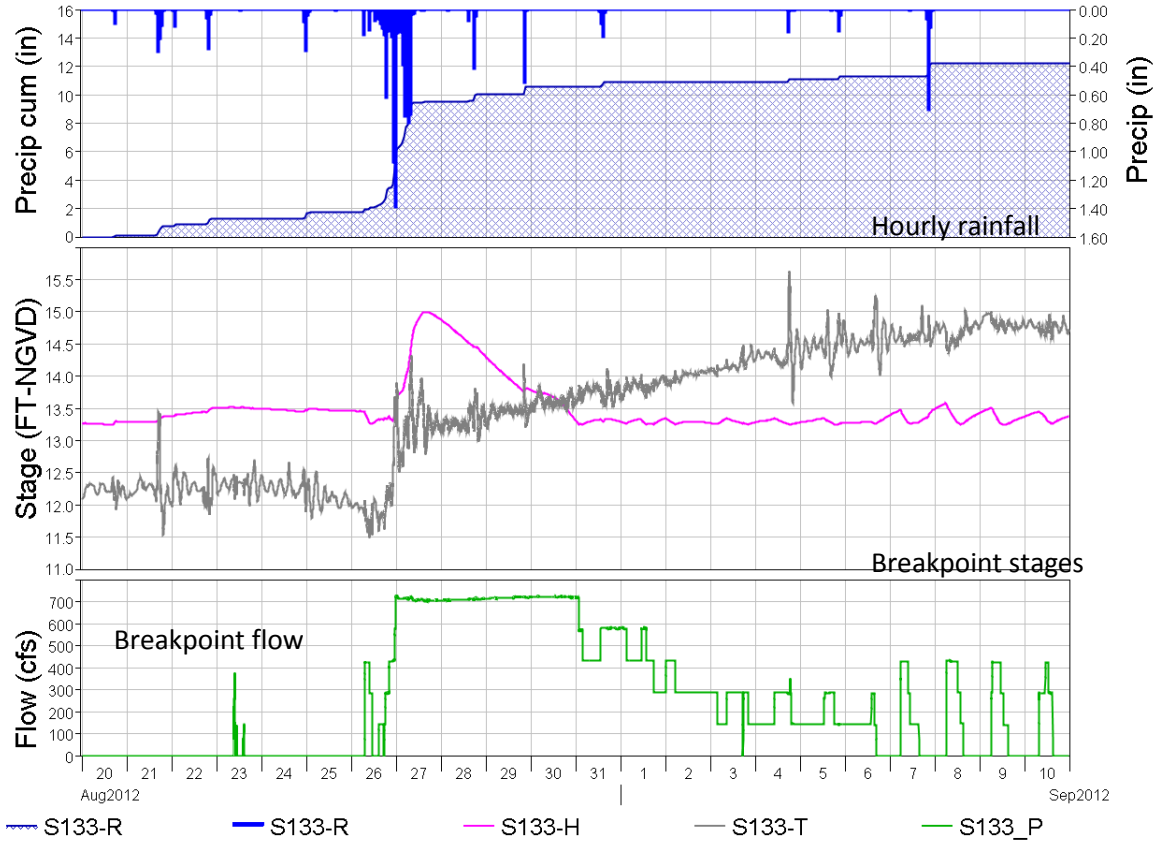


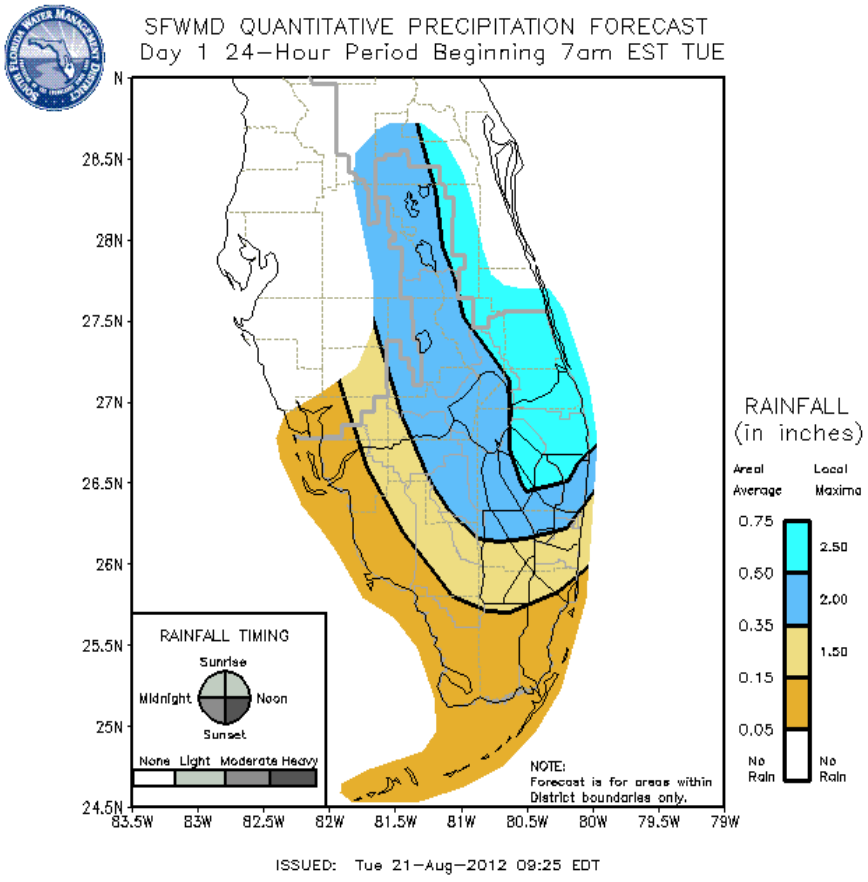
Figure 3: Headwater and tailwater stages, pumping and rain gauge data at S-133 pump station during TS Isaac.

Table A: Storm events at the S-133 rainfall gauge since 1997 – data arranged by rain accumulation in 48 hrs.

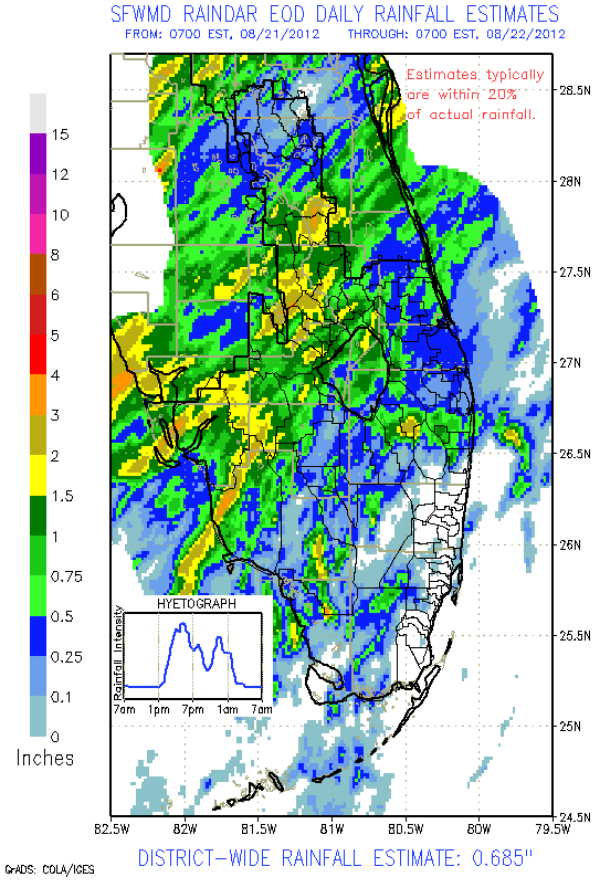
Order	Probability	Return Period [years]	Rain [inches]	Year
1	0.06	17.0	8.43	2008
2	0.12	8.5	7.76	2012
3	0.18	5.7	5.51	1999
4	0.24	4.3	4.53	2000
5	0.29	3.4	4.17	1998
6	0.35	2.8	3.96	1997
7	0.41	2.4	3.76	2011
8	0.47	2.1	3.62	2005
9	0.53	1.9	3.23	2001
10	0.59	1.7	3.18	2010
11	0.65	1.5	3.17	2007
12	0.71	1.4	2.88	2006
13	0.76	1.3	2.53	2009
14	0.82	1.2	2.51	2004
15	0.88	1.1	2.44	2003
16	0.94	1.1	1.98	2002

ATTACHMENT D – National Hurricane Center Forecast Track, SFWMD Qualitative Precipitation Forecast and RAINDAR

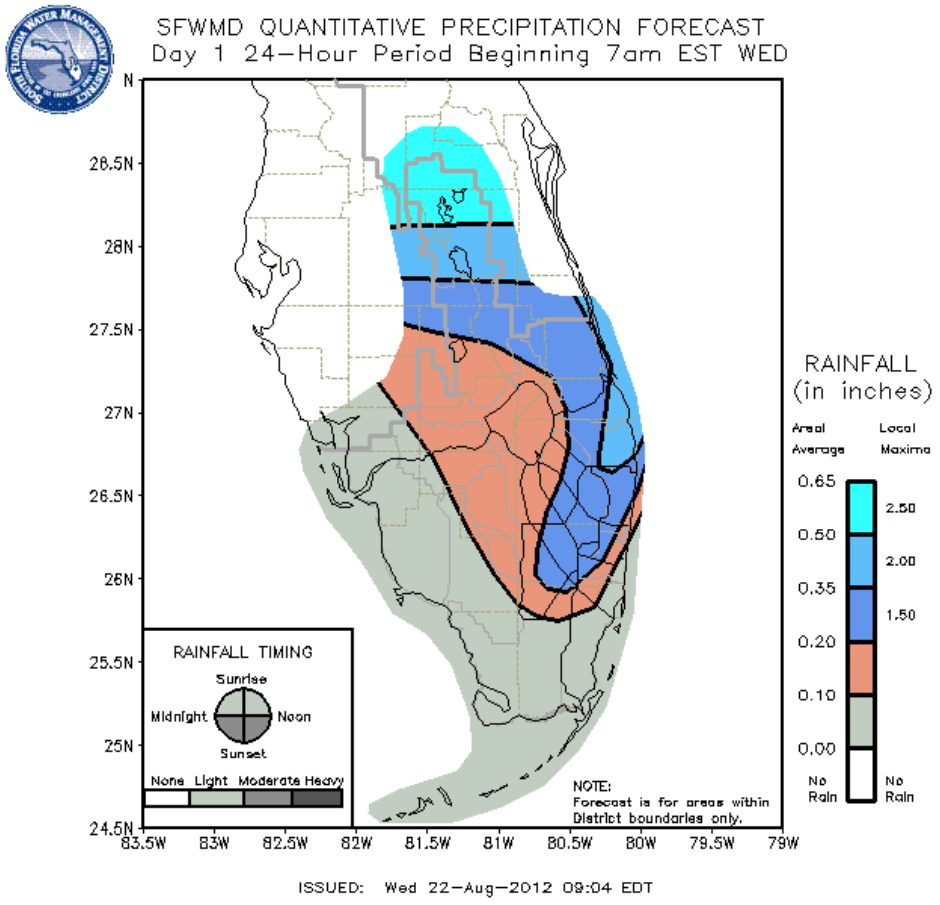
Forecast – Tuesday, August 21



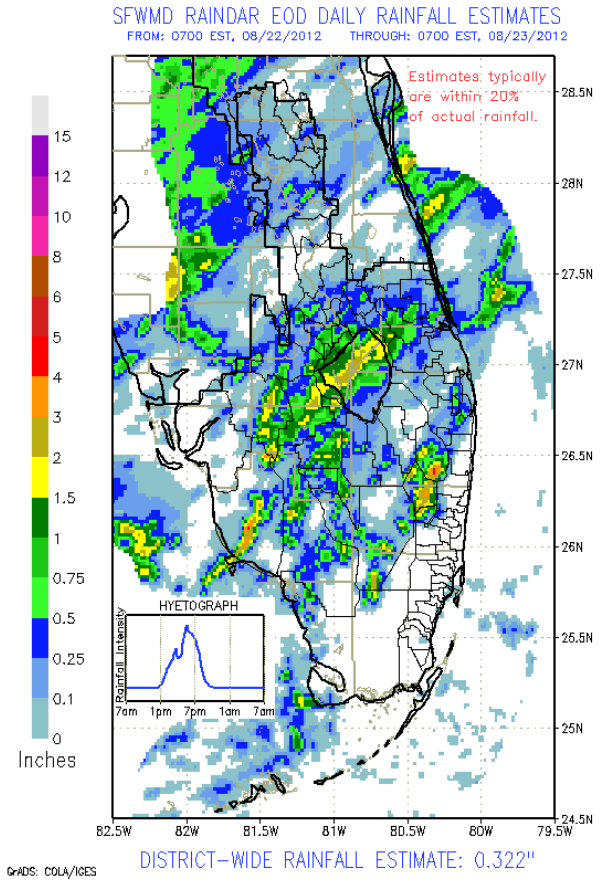
Observed – Tuesday, August 21



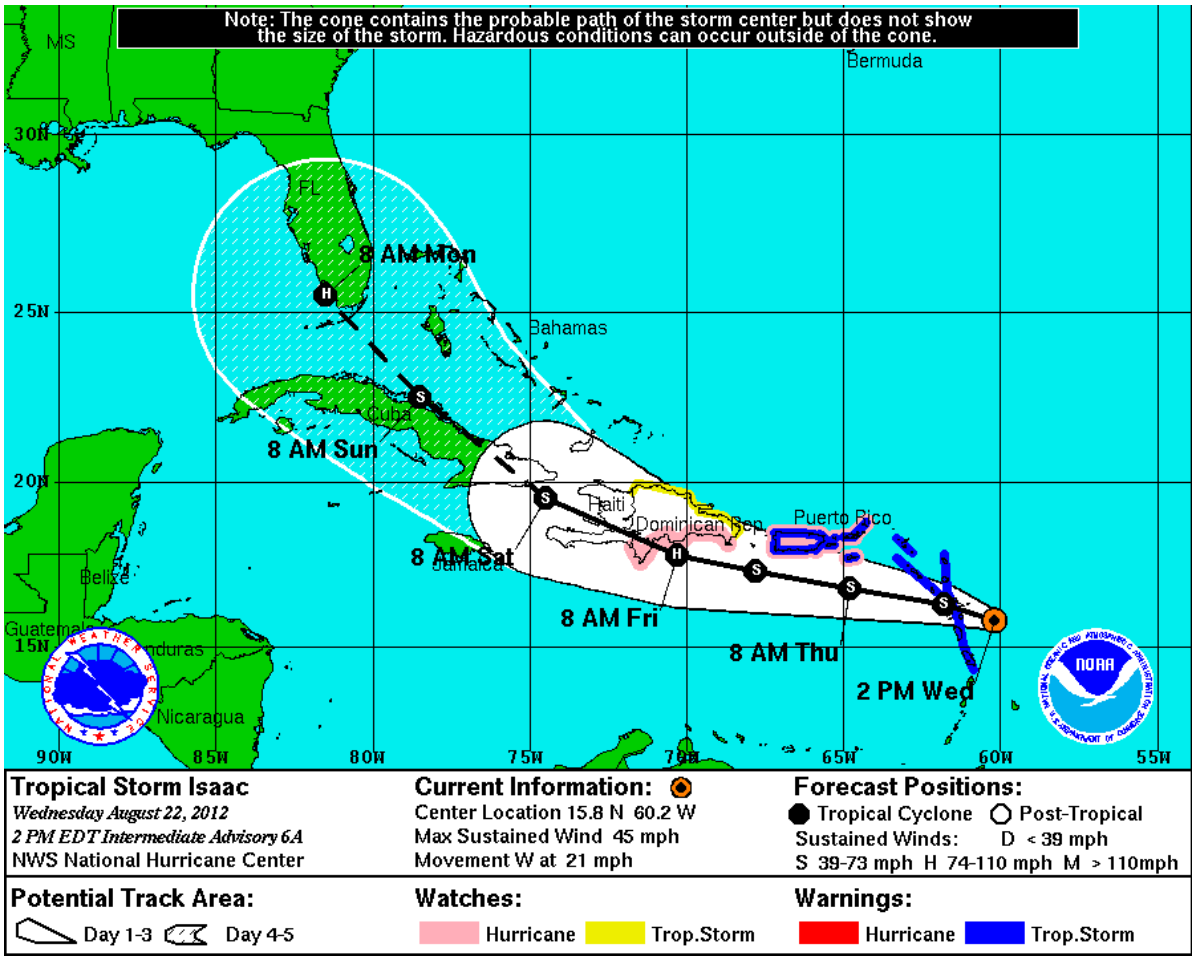
Forecast – Wednesday, August 22



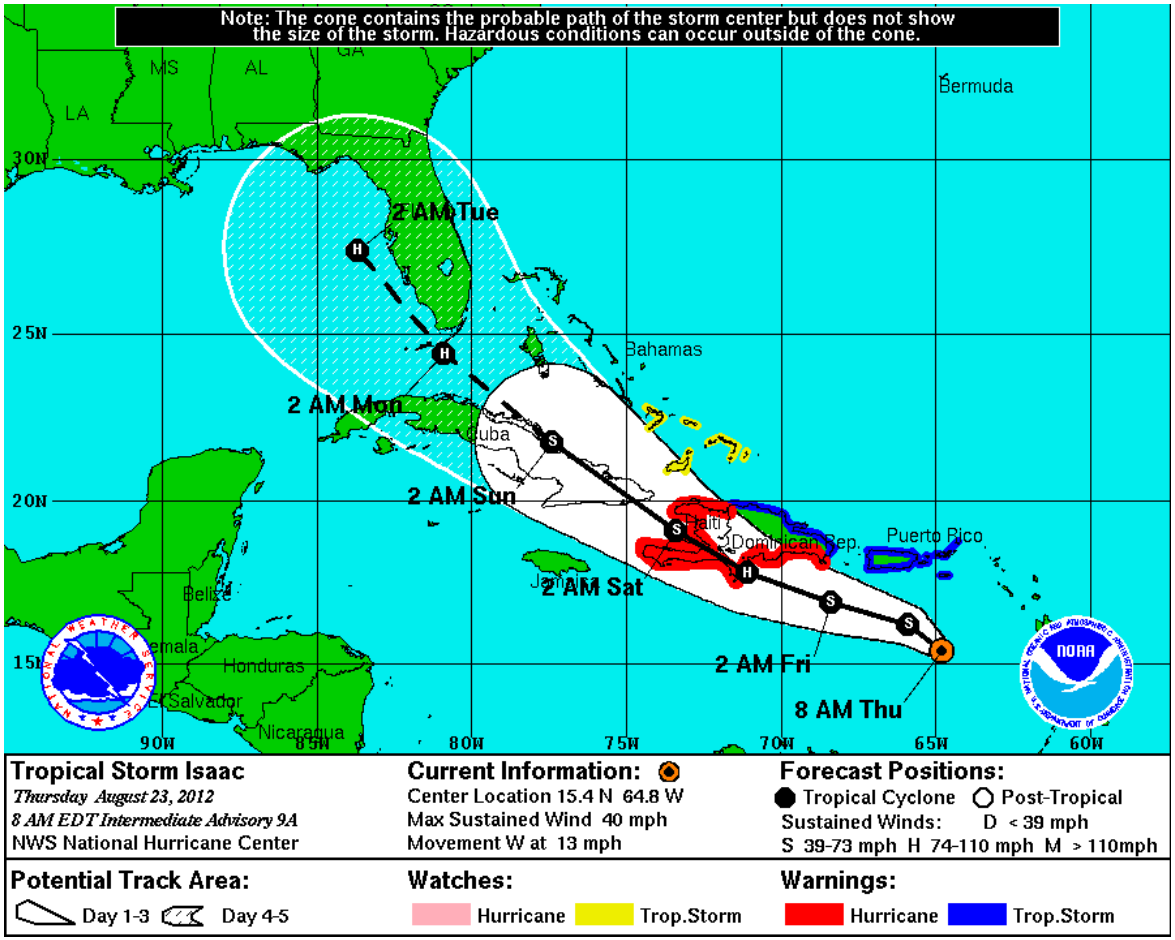
Observed – Wednesday, August 22



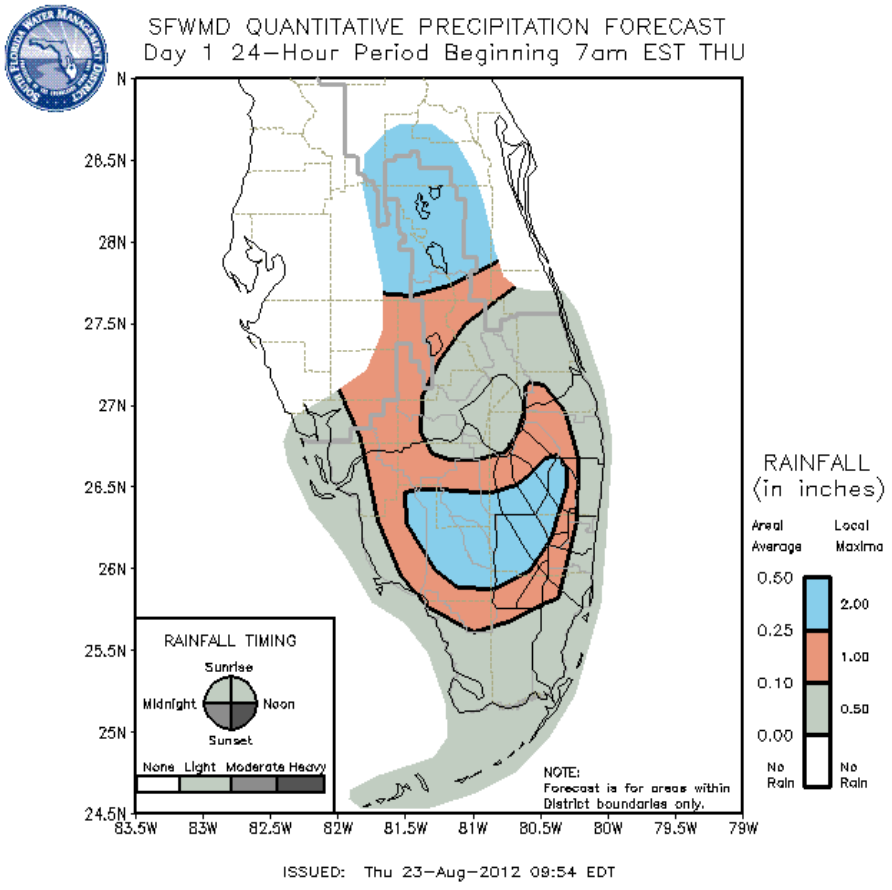
NHC 2pm Forecast Track Wednesday, August 22



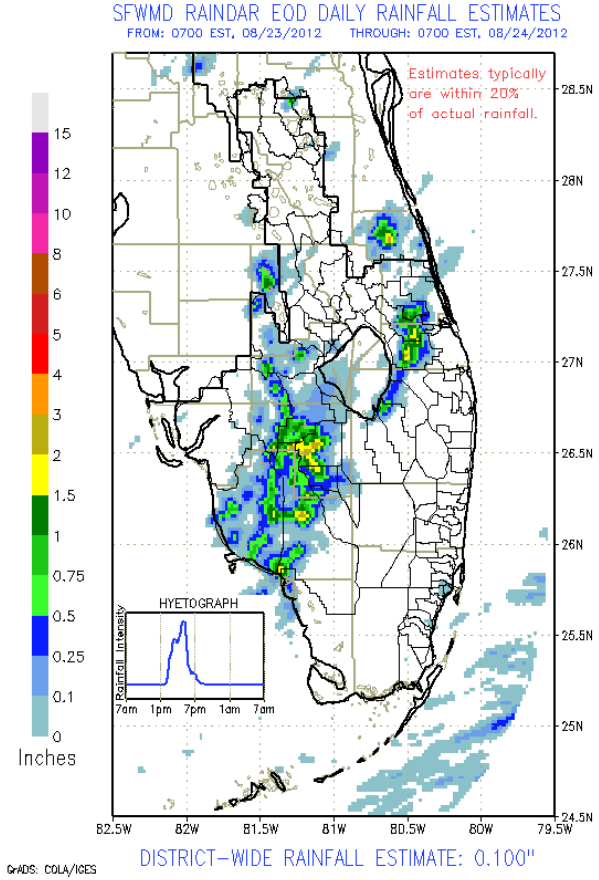
NHC 8 am Forecast Track
Thursday, August 23



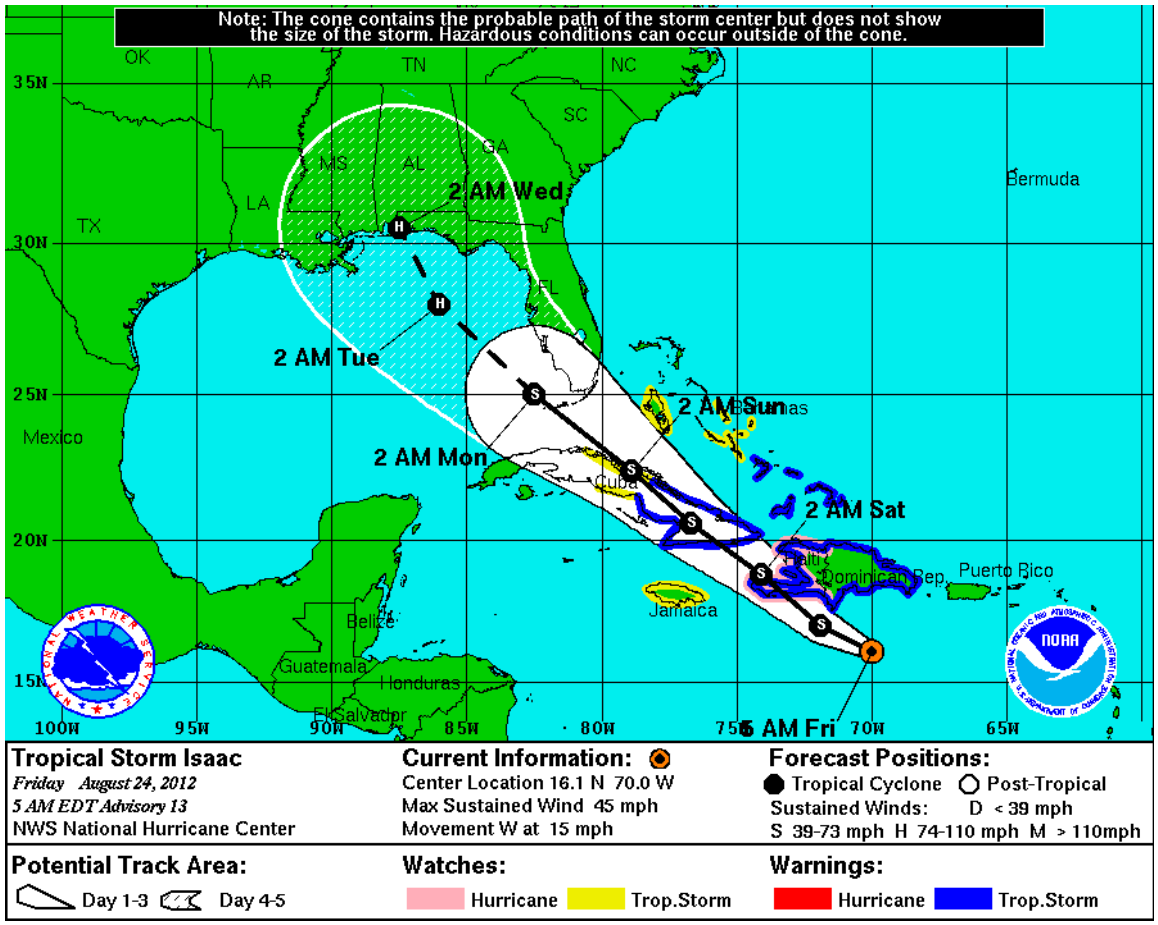
Forecast – Thursday, August 23



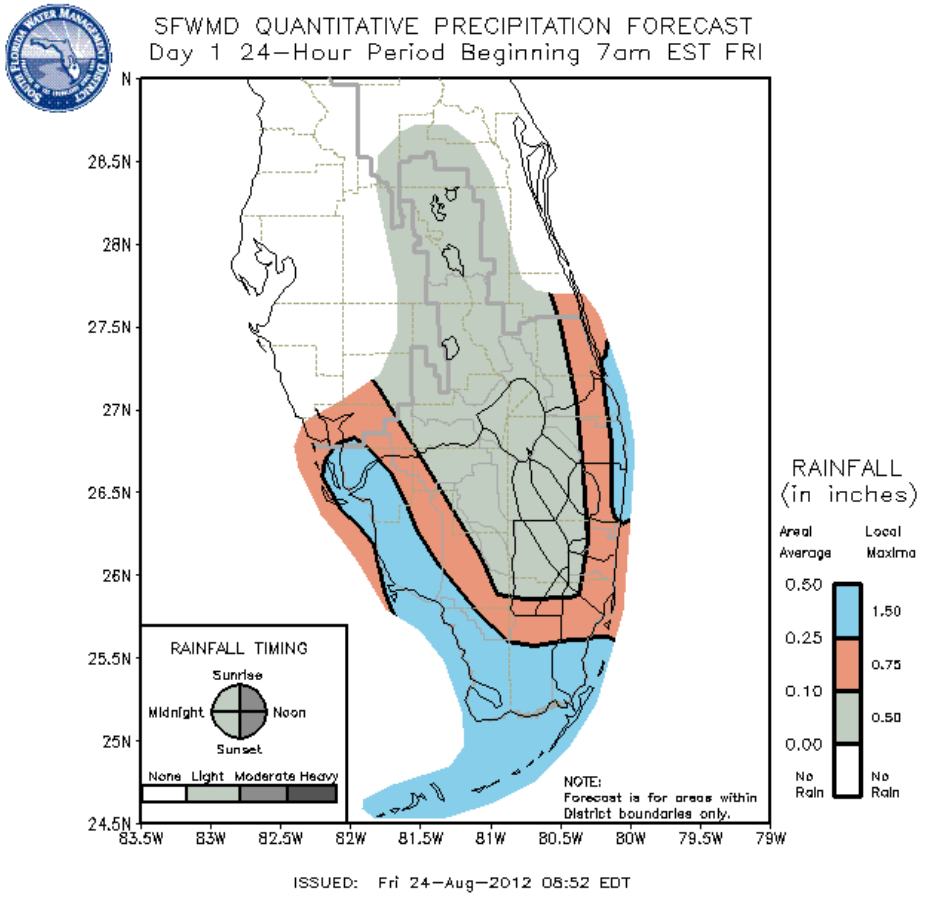
Observed – Thursday, August 23



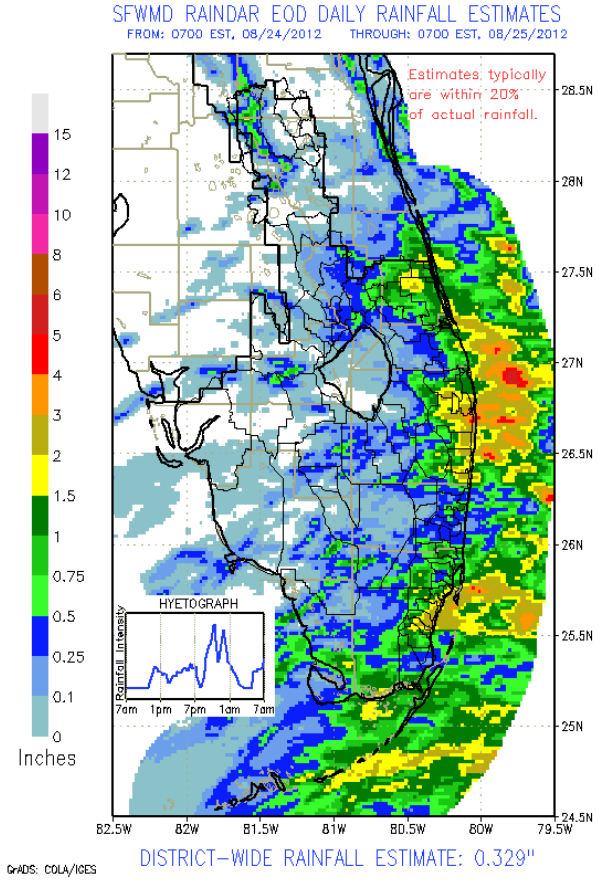
NHC 5 am Forecast Track
Friday, August 24



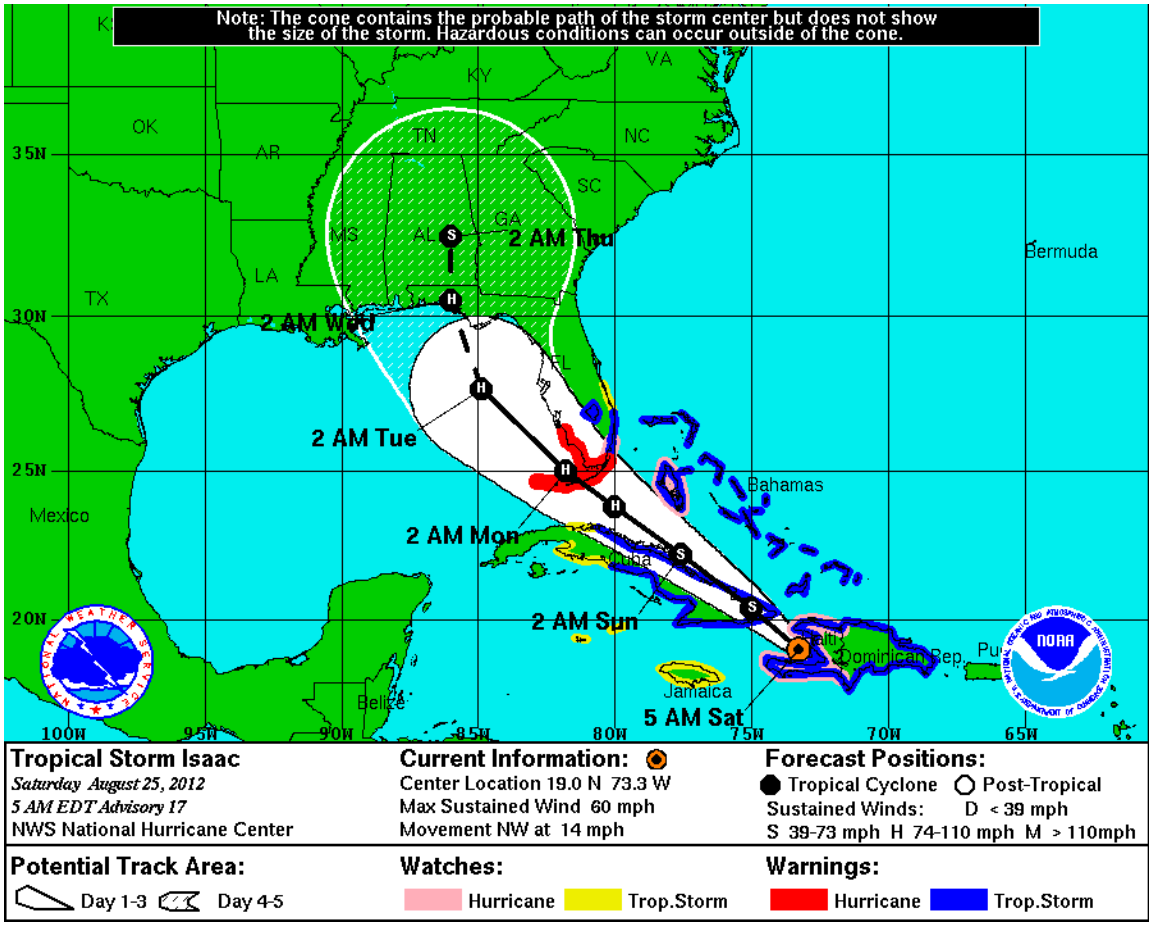
Forecast – Friday, August 24



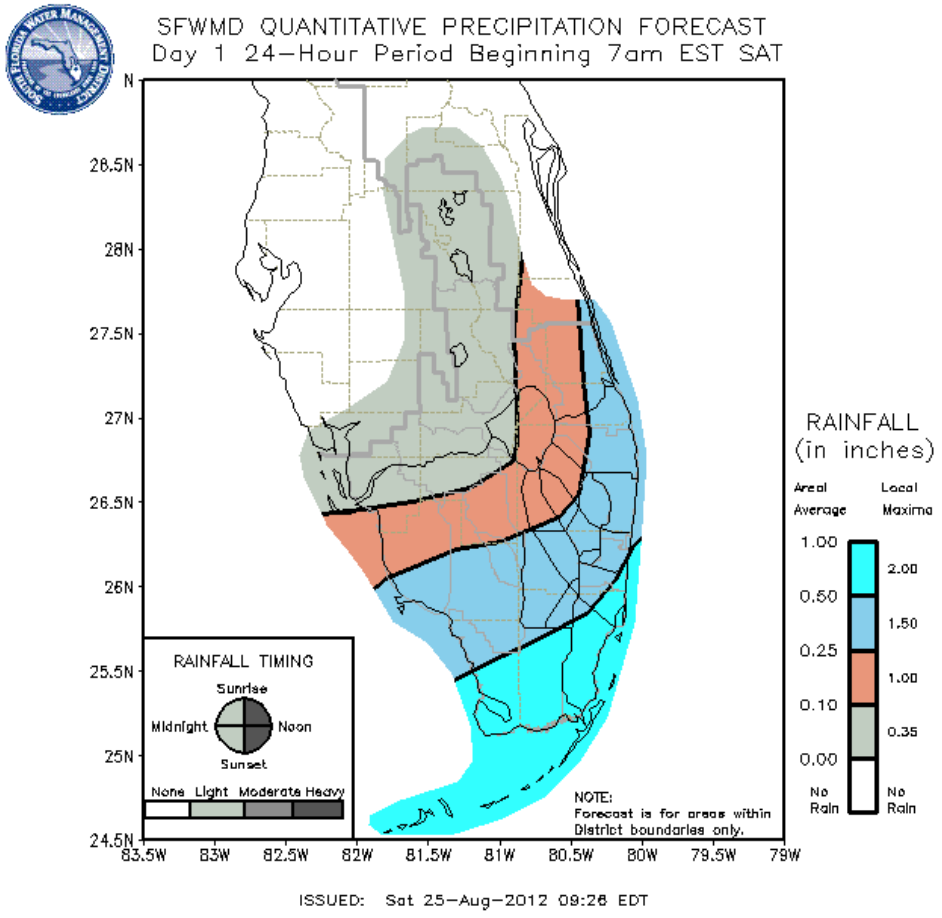
Observed – Friday, August 24



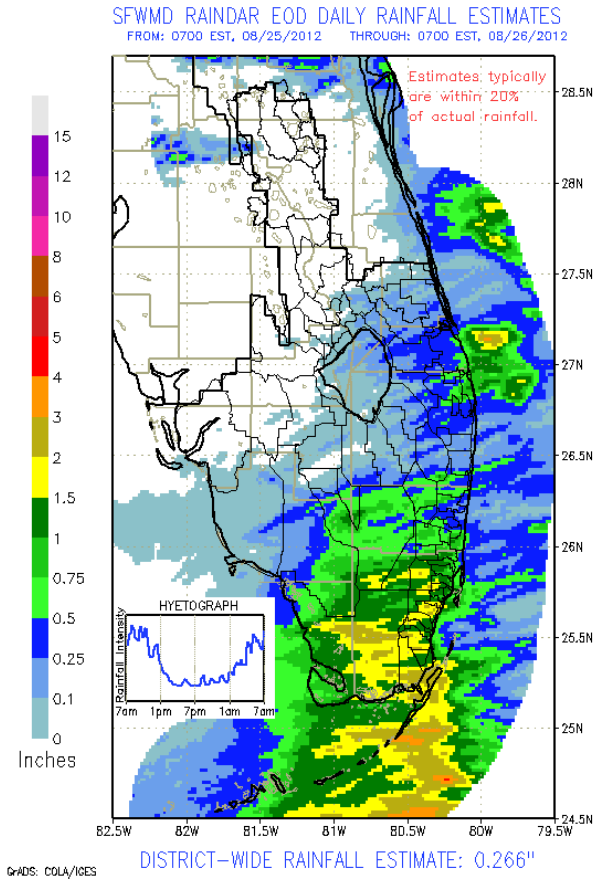
NHC 5 am Forecast Track
Saturday, August 25



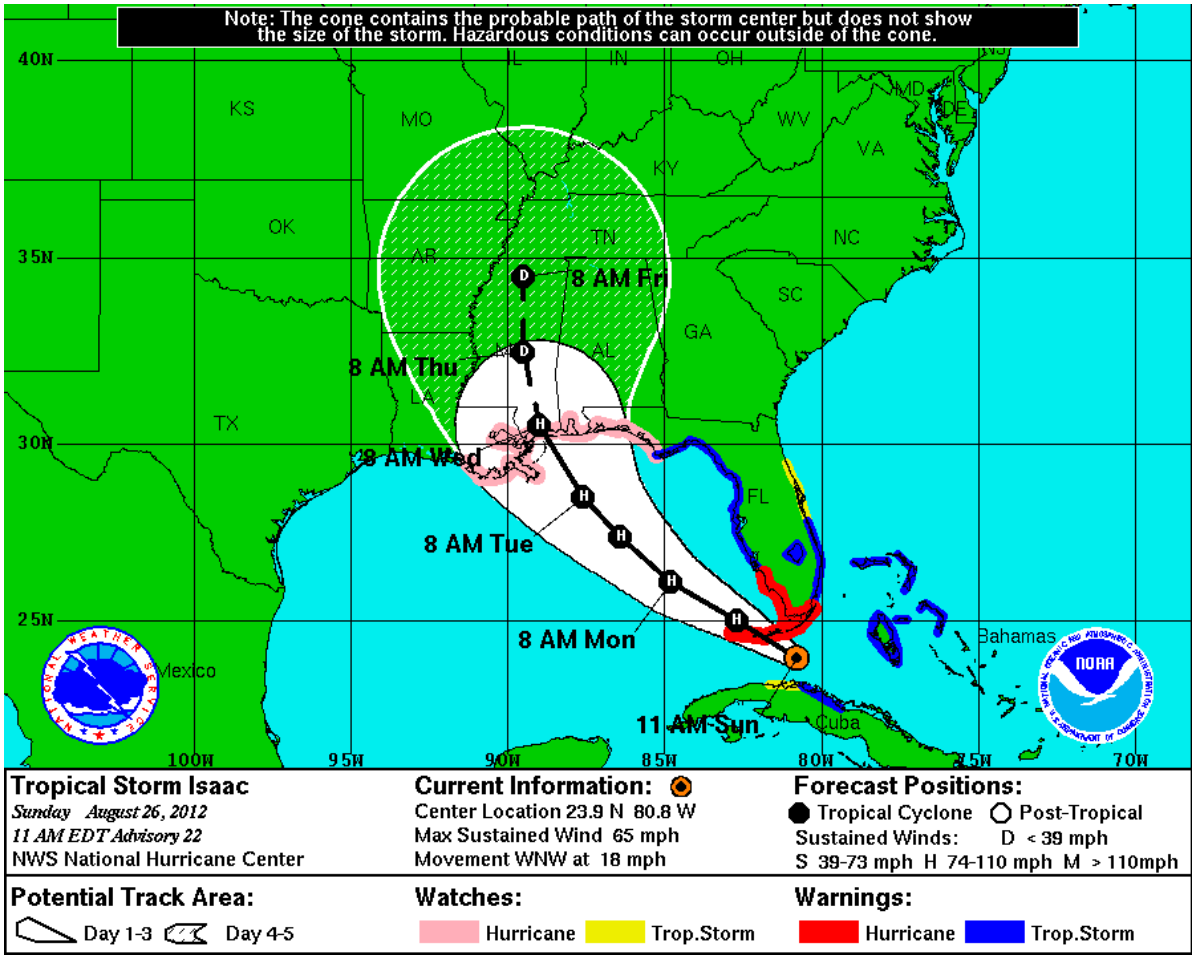
Forecast – Saturday, August 25



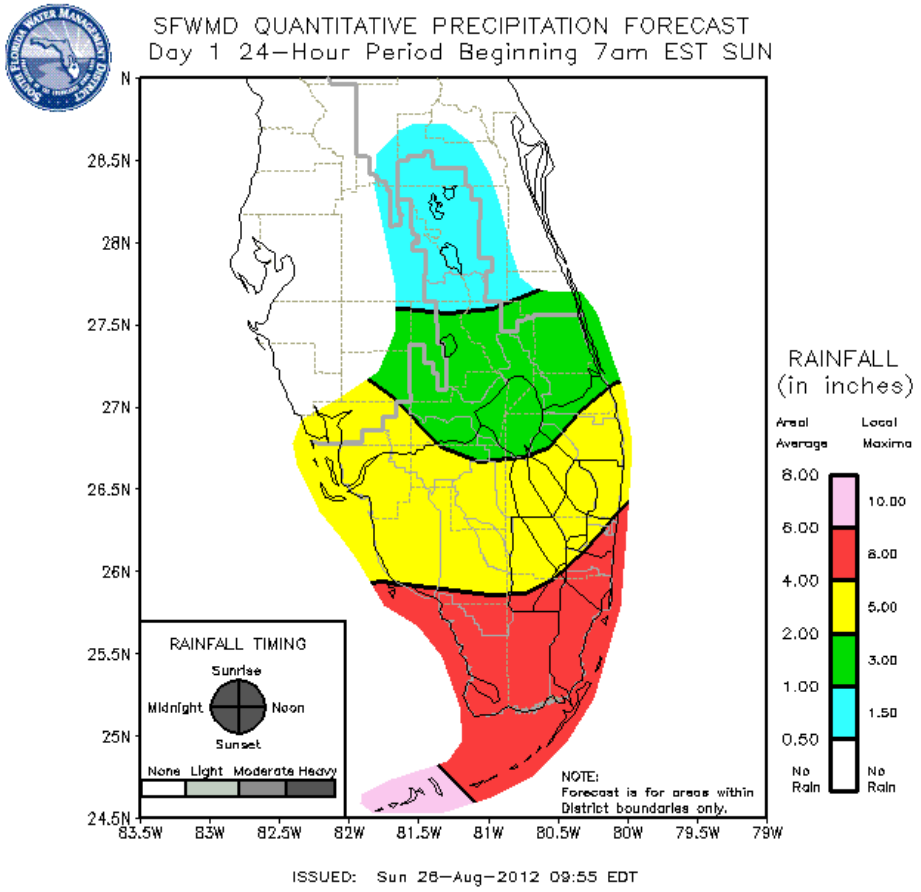
Observed – Saturday, August 25



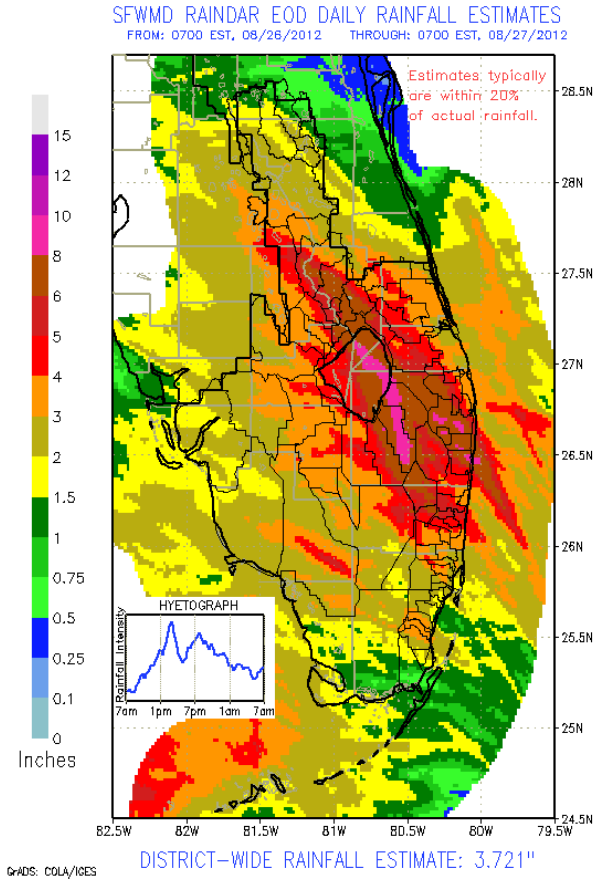
NHC 11 am Forecast Track
Sunday, August 26



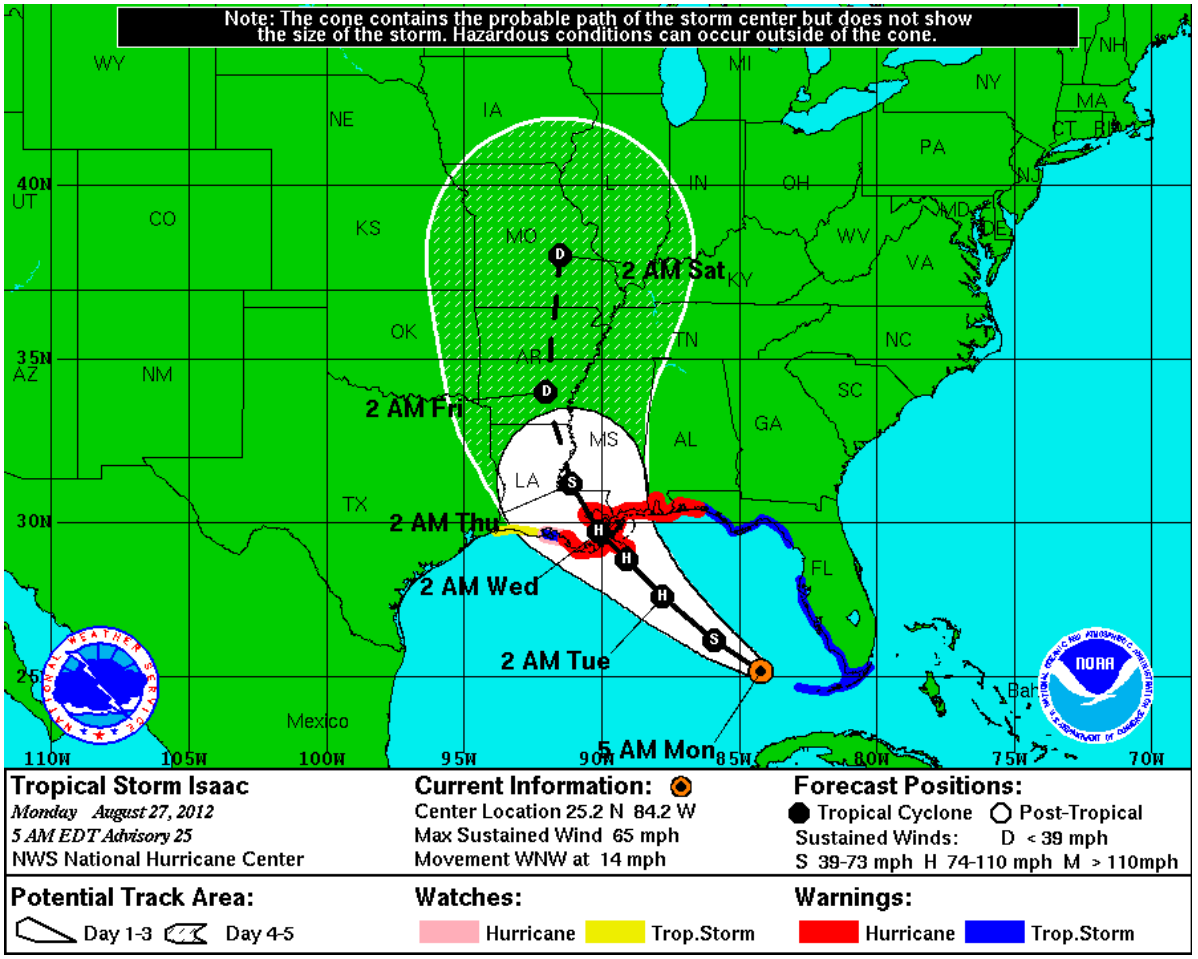
Forecast – Sunday, August 26



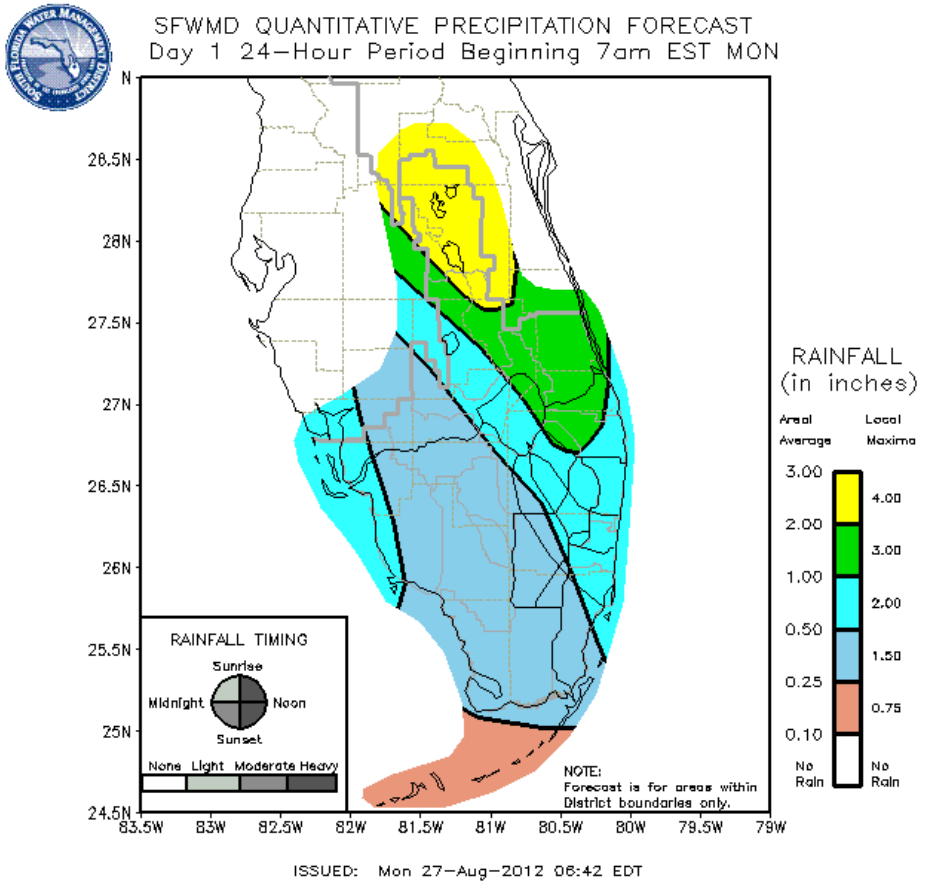
Observed – Sunday, August 26



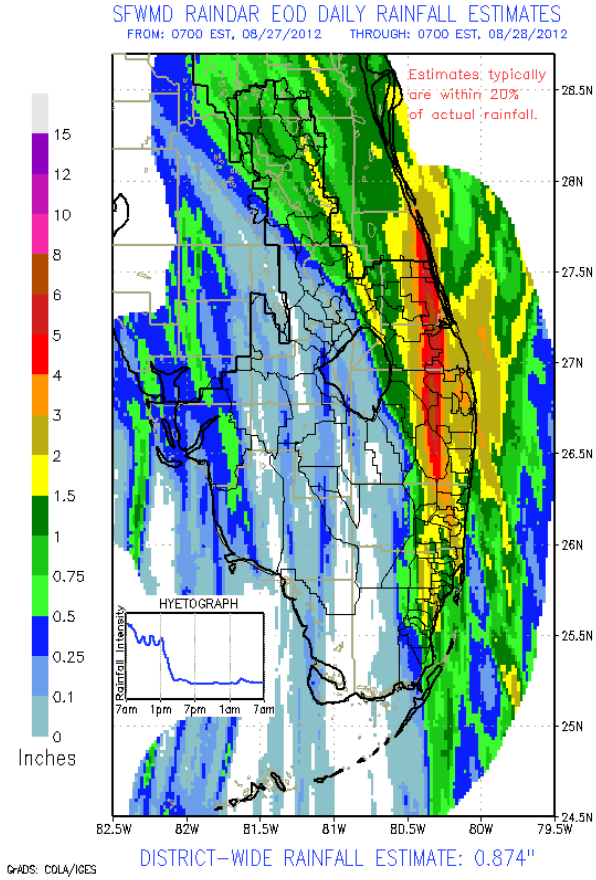
NHC 5 am Forecast Track
Monday, August 27



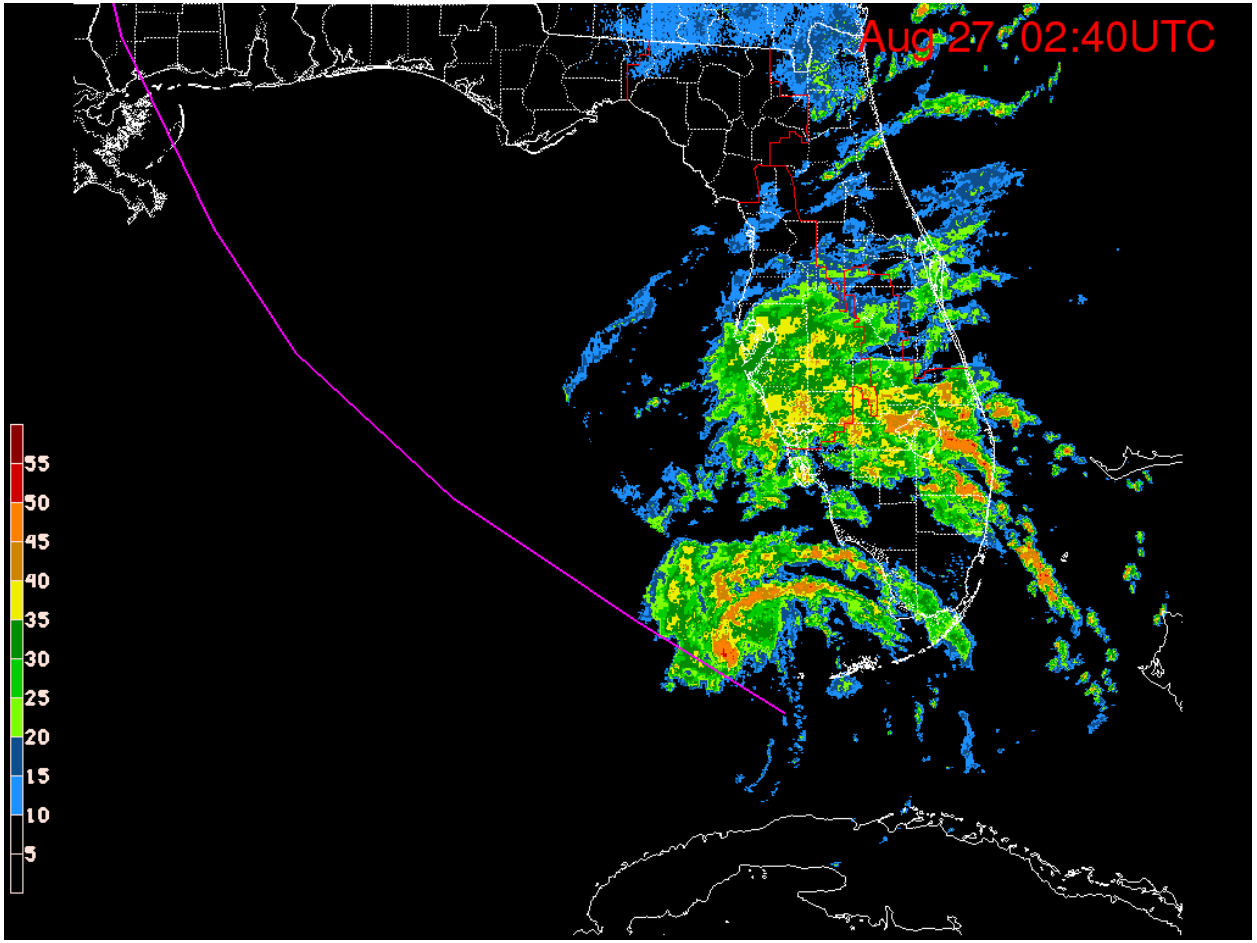
Forecast – Monday, August 27



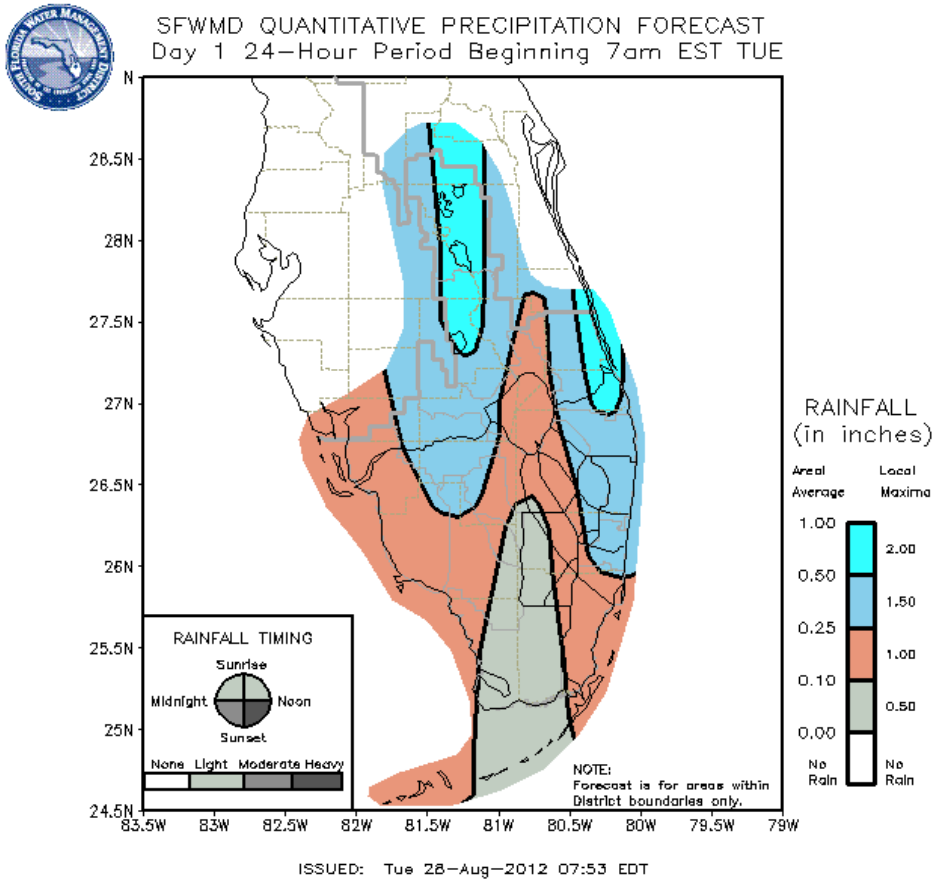
Observed – Monday, August 27



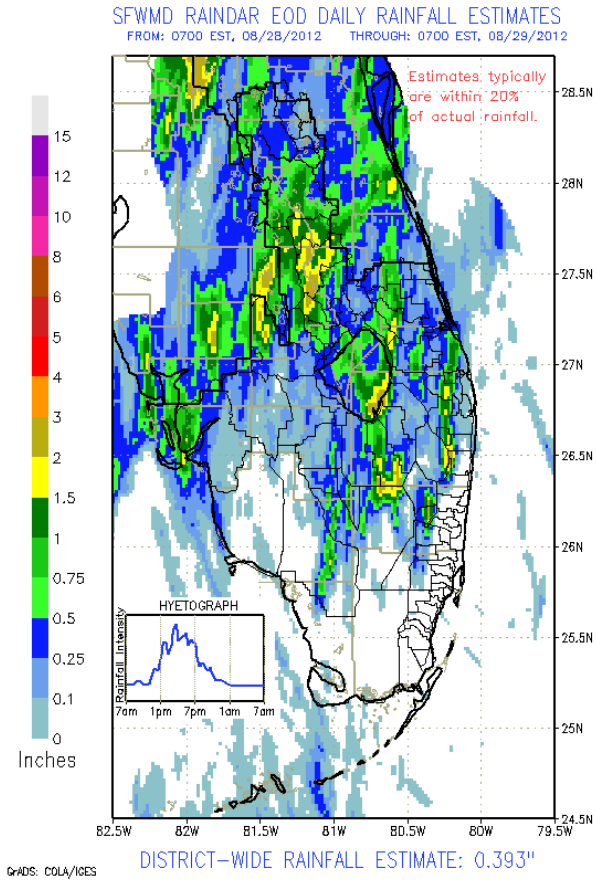
Radar with track at 10 pm Monday, August 27

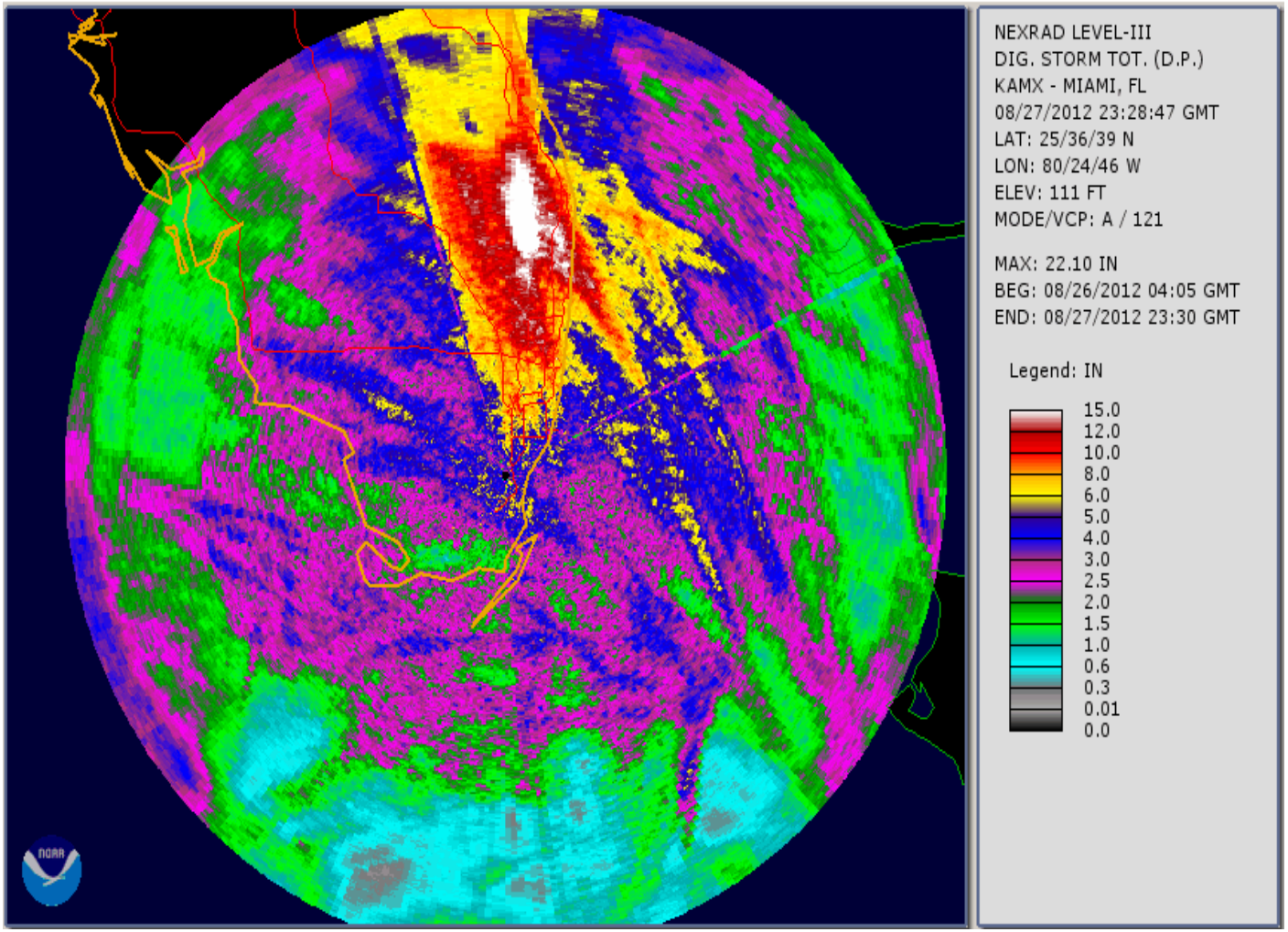


Forecast – Tuesday, August 28



Observed – Tuesday, August 28





For a more detailed report on Isaac, visit the following page: http://www.srh.noaa.gov/mfl/?n=isaac

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