Increasing the Safety of Hays County Citizens and First Responders through Hydrologic Data, Flood Cameras and Low Water Crossing Monitoring

Written by: Justin McInnis
Interim Director
Hays County Office of Emergency Services
justin.mcinnis@co.hays.tx.us
512-393-7300

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List of Acronyms

USGS United States Geological Survey

NWS National Weather Service

TDMA Time-division multiple access

ALERT2 Automated Local Evaluation in Real Time

SDI12 Serial Digital Interface at 1200 baud

TWDB Texas Water Development Board

EOC Emergency Operations Center

TPZ Tilt/Pan/Zoom

Introduction

From a meteorological/hydrologic standpoint, 2015 was a historical year for Hays County, Texas. Hays County witnessed two historical flooding events within five months of each other with each event wiping out critical County infrastructure, damaging the auxiliary spillways of our flood protection dams, and sweeping away homes leaving many displaced and causing loss of life.

During these events, Hays County and other jurisdictions relied heavily on United States Geological Survey (USGS) gages, County owned low water crossing system, and reports from citizens in order to grasp the true scope of the floods. However, USGS gages washed away and the low water crossing system failed to provide and fulfill the data needs for Emergency Managers and those responding.

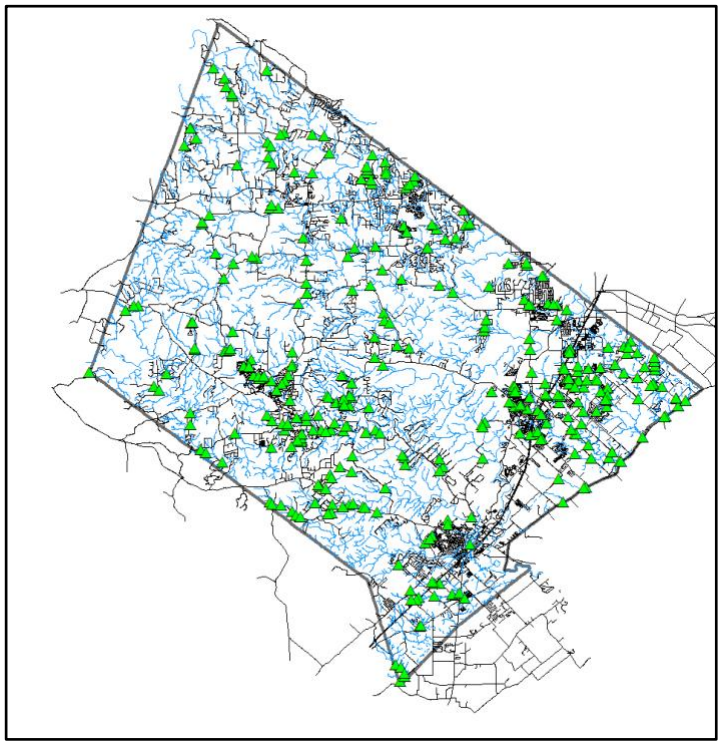

Figure 1. Hays County Low Water Crossings

The tragic events in 2015 changed the way Hays County viewed the hydrologic data collection process and the dissemination platforms. These events gave Hays County a unique opportunity to look for new and improved ways to provide officials and responders with more effective and efficient hydrologic/meteorological public safety data.

Scope

After the devastating floods of 2015, Hays County took an in-depth look at current flood warning and hydrologic data capabilities within the County to come up with a better way to monitor flood events and subsequently warn citizens. This assessment was an iterative process that included meeting with subject matter experts, reviewing studies, and assessing the needs of the community. Through this internal assessment, three key findings were identified:

- The current flood warning system lacked the ability to monitor stream conditions in the upper Blanco basin as well as throughout the County and its ephemeral streams;
- The current flood warning system ineffectively monitored the low water crossings and failed to provide usable hydrologic data and as well as gather important reservoir conditions in the five detention basins that surround the City of San Marcos and;
- Gaps in the precipitation-monitoring infrastructure, which feeds back into the National Weather Service.

Based on the internal assessment and review of the Hays County After Action Report on the floods of 2015, Hays County went out for bid to find a vendor that would implement a new flood warning system and low water crossing network.

In 2017, Hays County received a grant award from the Texas Water Development Board to take the first steps in creating a county-wide system. This new system implemented multiple technologies and monitoring systems, which included; automated alerts, inundation maps, automated road closures, precipitation gages, and dam gages. The system has proven to be an effective and reliable system through some of the most severe rain storms.

Overview

Hays County is unique in that we are one of the fastest growing counties in the United States, while also residing within Flash Flood Alley. Residing within Flash Flood Alley presents a multitude of issues, concerns, and challenges that make proper flood monitoring so important.

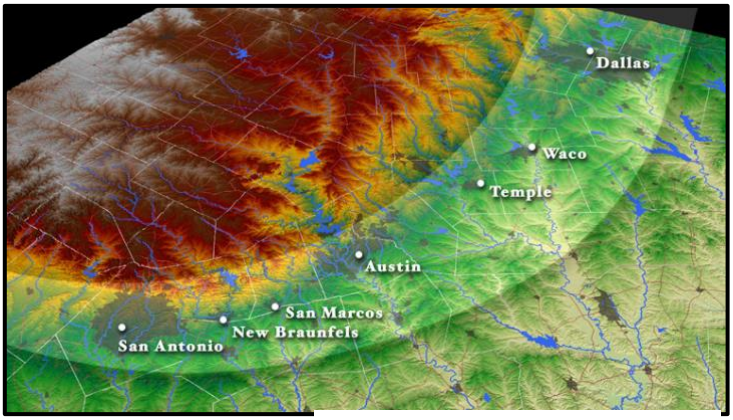

Figure 2. Flash Flood Alley

The County is cognizant of the rapid rate of development in the unincorporated parts of the County and the subsequent increase in traffic counts along our roads, including the large amount of those who are visiting the Hill Country.

Hays County received funding through the Flood Planning Protection grant program in FY2016 to develop and implement a comprehensive flood monitoring system. During that funding cycle, sites for precipitation gages, dam gages, and

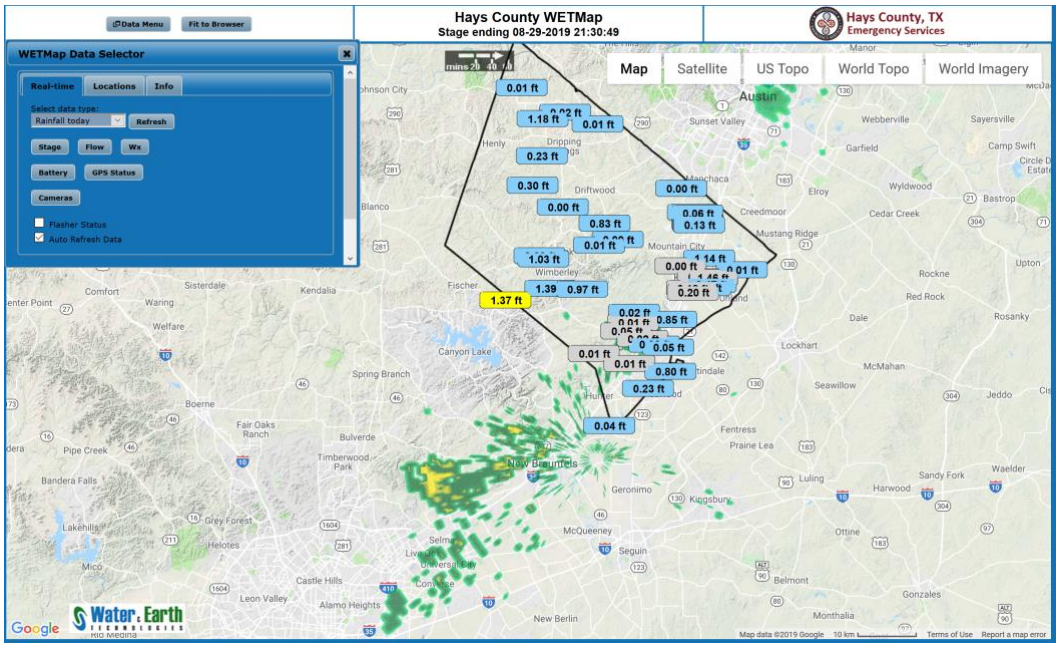

Figure 3. Hays County Low Water Crossing Monitors and dam gages

cameras were identified. Due to the timeline and funding limits, not all sites were able to be improved/added. Through this round of grant funding, Hays County was able to add those additional gages and cameras to the sites that had not been addressed yet. To determine which sites were to be monitored, the metrics examined were frequency of inundation, traffic counts, access issues, rescues, frequency of accidents, hydrologic/meteorological data gaps, current monitoring locations, input from the first responder community, and predicted future growth. Most of this data was found in our *Hays County Low Water Crossing Urgency Rating* study. A complete list of what gages and cameras that were installed can be found in Appendix A, B and C.

To address the gap within the precipitation monitoring/warning infrastructure, collaboration with the National Weather Service (NWS) was necessary to assess where exactly the gaps were and identify locations that would benefit from improved precipitation monitoring. From this assessment and other factors, five key locations were identified for precipitation monitoring. Originally, we planned on installing only five precipitation gages but ended up installing 11 total new precipitation gages without going over budget. In doing this, we were able to add even more visibility in our flood prone areas. These data are now being served up to NWS to aid in making decisions on flood conditions. A list of all eleven precipitation sites can be found in Appendix C.

There are a multitude of dam structures throughout Hays County. With Hays County's unprecedented growth, especially around the dams, during this latest phase of monitor installs we chose five sites within the Plum Creek Conservation District to monitor. These five sites were picked based on their proximity to critical infrastructure, impacts to the community, and population density. Each site has a pressure transducer installed on the primary spillway, which

allows Hays County officials to monitor the amount of water behind the dam. Specific elevations have been surveyed in and are now tied into the elevation of the transducer. These specific elevations allow for better interpretation of the hydrograph and aid in critical decision making.

To add more depth to our system, we decided to implement four new live streamed Tilt/Pan/Zoom (PTZ) cameras (See Fig. 4). We wanted to be able to have visual on sites that were inaccessible during extreme flood events, monitor rescue operations, provide invaluable intel for scene size up, and the ability to monitor critical infrastructure during major floods. The list of the four sites chosen are in Appendix B.

Figure 4. Hays County Flood Cameras at night

Equipment

After the floods in 2015, Hays County saw the benefit/necessity of having two-way communications with field monitoring sites. There is a large tactical advantage of being able to interrogate the system remotely from an EOC or office. Hays County's goal was to implement an entire system, which was non-proprietary, to allow for shorter down times, fewer equipment

manufacturing shortages, and the ability to quickly train individuals to maintain/repair our system.

Hays County went out for bid~~,~~ for a two-way flood warning system that implemented the Time Division Multiple Access (TDMA) ALERT2 protocols. This system allows Hays County to manage the transmission of data and communicate with the field sites by turning flashers off or on from the office.

For the camera system, we decided to use cell modems connected to the FirstNet system to provide reliable imagery back to the EOC, Dispatch Center, and to other critical partners.

Conclusion

Flood Early Warning Systems are a necessity and an integral part of responding to, and recovering from, flood disasters, especially if your jurisdiction lies within the Flash Flood Alley of Texas. Unfortunately, due to how costly these systems are, it is out of reach for many jurisdictions that may need the situational awareness a flood early warning system provides. From a data standpoint, Hays County is now able to share a mass amount of hydrologic and meteorological data to many of its surrounding partners and partner agencies to help make informed decisions. In addition, the data can be shared internally so all departments within the County are provided the same operational picture during a flooding event. The data is now provided to our first responder community to help enhance ~~in~~ their operations and for pre-planning decisions. Engineers and owners of public infrastructure are also provided the hydrologic data to aid them in engineered designs and to help them understand inundation frequencies. The data is utilized as a supplement and helps ground truth radar data with the National Weather Service. Lastly, the data now helps groundwater and surface water authorities understand what is going on in their basins both hydrologically and meteorologically.

Hays County plans on adding more low water crossing systems each year as well as more precipitation monitors. The County is now collecting hydrologic data that has never been collected before, taking us into new possibilities/capabilities. The data will be utilized to create flood models and inundation maps to help with pre-planning purposes as well as the creation of rating curves. These maps will also be available to our first responder organizations, Emergency Management, and Transportation departments.

Lessons Learned

During this latest round of installs, we were able to apply the lessons learned from the last time we underwent a major revamp of our system. Installation, permissions, and completion of the project went more smoothly. That said, we did learn a lesson regarding the usage of cameras. Cameras are data intensive systems, but the intel gathered from them is invaluable. Hays County inevitably had to buy a server specifically for hosting camera imagery. The imagery being served on the server is accessed by a small group of entities that require a reliable connection that also archives days' worth of imagery/videos. We looked into free software and imagery services, but we were asking too much of our system and a free service could not handle what was being required of it. The best and most reliable solution was to get a new server for the imagery and videos being captured in the field.

Acknowledgments

Thank you to our sponsors and those involved in such an impactful project:

Texas Water Development Board
National Weather Service
Texas Department of Transportation
Plum Creek Conservation District
Upper San Marcos Watershed District

Appendices

Appendix A: List of Monitored Sites

- Plum Creek Conservation District Dam 1
- Plum Creek Conservation District Dam 2
- Plum Creek Conservation District Dam 3
- Plum Creek Conservation District Dam 5
- Plum Creek Conservation District Dam 6

The following list is the sites that were addressed with the funding from the FY2016

- Bell Springs Rd (Cr 169) At Barton Creek
- Chaparral Rd At Little Bear Creek
- Creek Rd (Cr 190) & Mt Gainer Rd (Cr 220) At Onion Creek
- Cr 1492 At Blanco River
- Elder Hill Rd (Cr 170) At South Gatlin Creek
- Fitzhugh Rd (Cr 101) At Fitzhugh Creek
- Hilliard Rd (Cr 222) At Sink Creek Tributary
- Lime Kiln Rd At Sink Creek
- Jacobs Well Rd (Cr 220) At Cypress Creek
- Little Arkansas Rd (Cr 174) At Blanco River
- Mt Gainor Rd (Cr 220) At South Onion Creek
- Old Bastrop Hwy (Cr 266) At San Marcos River
- Post Rd (Cr 140) At Blanco River • Ranch Road 150 At York Creek
- Ranch Road 150 Double Crossing At Onion Creek
- Raeford Crossing At Pedernales Tributary
- Rohde Rd (Cr 126) At Brushy Creek
- Trautwein Rd (Cr 185) At Barton Creek
- Uhland Rd (Cr 161) At York Creek
- Wayside Dr (Cr 179) At Blanco River
- Windy Hill Rd (Cr 131) At Andrews Branch
- York Creek Rd (Cr 262) At York Creek

Appendix B: Camera Sites

- Onion Creek at FM 150 Double Crossing
- Blanco River at Post Road
- Upper San Marcos River District Dam 4
- Upper San Marcos River District Dam 5

Appendix C: Precipitation Sites

- Blue Hole Park at Wimberley
- Hug Road
- Woodacre Drive
- Upper San Marcos River District Dam 1
- Upper San Marcos River District Dam 3
- Upper San Marcos River District Dam 5
- Plum Creek Conservation District Dam 1
- Plum Creek Conservation District Dam 2
- Plum Creek Conservation District Dam 3
- Plum Creek Conservation District Dam 5
- Plum Creek Conservation District Dam 6

Below is the list of sites that were address with the funding in FY2016

- Chaparral Rd At Little Bear Creek
- Creek Rd (Cr 190) & Mt Gainer Rd (Cr 220) At Onion Creek
- Cr 1492 At Blanco River
- Hilliard Rd (Cr 222) At Sink Creek Tributary
- Little Arkansas Rd (Cr 174) At Blanco River
- NRCS Dam 4
- Post Rd (Cr 140) At Blanco River
- Rohde Rd (Cr 126) At Brushy Creek
- Uhland Rd (Cr 161) At York Creek
- Wayside Dr (Cr 179) At Blanco River

Appendix D

Site Installation Coordinates

Site	Latitude	Longitude	Camera	Reservoir	Precipitation
PCCD DAM 1	30° 1'9.67"N	97°52'44.53"W		x	x
PCCD DAM 2	29°59'3.09"N	97°51'26.40"W		x	x
PCCD DAM 3	29°58'43.5"N	97°51'25.5"W		x	x
PCCD DAM 5	30°00'08.9"N	97°50'21.8"W		x	x
PCCD DAM 6	30°00'06.5"N	97°49'19.3"W		x	x
NRCS DAM 4	29°53'5.93"N	98° 1'54.96"W	x		
NRCS DAM 5	29°52'7.87"N	97°58'9.68"W	x		x
POST RD (CR 140) AT BLANCO RIVER	29°56'16.46"N	97°53'39.45"W	x		
RANCH ROAD 150 DOUBLE CROSSING AT ONION CREEK	30° 5'8.25"N	98° 0'51.10"W	x		
BLUE HOLE	30°00'11.8"N	98°05'20.4"W			x
HUGO ROAD	29°54'20.2"N	98°05'38.5"W			x
NRCS DAM 1	29°55'10.46"N	97°58'27.16"W			x
NRCS DAM 3	29°54'24.53"N	97°56'43.32"W			x
WOODACRE DRIVE AT CYPRESS CREEK	30°02'00.3"N	98°07'41.6"W			x

Appendix E: Site Locations

Water & Earth TECHNOLOGIES	Designed: EEC Drawn: EEC Checked: MLR Edit: 8-14-2019	Title: NRCS DAM 4 CAMERA STATION STATION DETAILS #2	Scale: NOT TO SCALE Copy: AS BUILT	Project No: HC001 Drawing: 3
		Filepath: C:\WET-Folders\Water & Earth Technologies\WET Folders - Documents\Clients\Hays County TX\AutoCAD\AS BUILT\CAMERAS\NRCS DAM 4 CAMERA\NRCS DAM 4 CAMERA.dwg		

Appendix F:

Texas Water Development Board Comments

ATTACHMENT 1

Hays County Flood Early Warning System
Hays County
Contract #1800012310
Texas Water Development Board Comments to Draft Report

REQUIRED CHANGES

General Draft Report Comments:

In general, the study follows standard methodologies and practice. Mitigation alternatives identified may be eligible for funding under the Texas Water Development Board's financial assistance programs. Application requirements and eligibility criteria are identified by Texas Water Development Board rules specified in Section 363 of the Texas Administrative Code (TAC). The report would be appropriate for use in support of an application to the Board for financing the proposed improvements. All additional information required by Board rules, 31 TAC 363.401-404, as well as necessary information to make legal findings as required by Texas Water Code chapter 17.771-776, would be required at the time of loan application.

Please conduct a final edit of the document for grammar, spelling, typographical errors, and inconsistent usage of acronyms, and abbreviations. Please spell out all acronyms, with the acronym in parentheses, the first time they are used. Please include a list of acronyms used in the report after the Table of Contents.

Specific Draft Report Comments:

1. Page 7 – Scope of Work says there would be six precipitation gauges, but the Report states that there were five. Please clarify if there were five or six gauges. If there were only five gauges installed, please state why the sixth one was not installed.
2. Page 7-8 – Please provide coordinates for Monitored, Camera, and Precipitation sites.
3. Entire Report – Please use consistent font throughout document.
4. Entire Report – Please use consistent spelling of "Gauges/Gages".

Exhibits and Tables Comments:

None.

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