

WALTER P MOORE



UNIVERSITY OF
TEXAS
ARLINGTON

PROPOSAL

FLOOD WARNING-FORECASTING SYSTEM

PHASE 3

CITY OF GRAND PRAIRIE

February 5, 2019



WALTER P MOORE

February 5, 2019

Ms. Stephanie W. Griffin, P.E., CFM
Stormwater Utility Manager and Floodplain Administrator
City of Grand Prairie
Stormwater Department
206 W. Church St.
Grand Prairie, TX 75053

Subject: Proposal for City of Grand Prairie Flood Warning-Forecasting System Phase 3

Dear Ms. Griffin,

Walter P. Moore and Associates, Inc. is pleased to submit our proposal for Phase 3 of the City of Grand Prairie Flood Warning-Forecasting System. Walter P Moore has provided Water Resources Engineering since 1983 with a focus on floodplain management, storm water services, and water supply. Relevant to this project, our experience includes multiple Flood Warning Systems for public agencies and private clients.

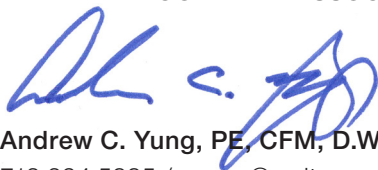
As with Phase 1 & 2, Walter P Moore has teamed with the University of Texas at Arlington for the third phase of the project. Our team provides complementary and overlapping capabilities to ensure additional manpower and expertise to help develop a better, more cost effective solution.

This proposal includes only those tasks and associated budgets that cover the services necessary to expand the City of Grand Prairie's Phase 1 & 2 flood warning/forecasting project. This proposal is designed to make the best use of available funding to provide the City with a product that is most beneficial and useful to City staff during flood emergency operations. It is recognized that much of the scope and budget are reflective of Walter P Moore's assumptions about the direction of the project, which may be altered following the meeting with City staff. Ultimately, it is our goal to serve the City's needs in the most efficient and cost effective manner possible.

We appreciate the opportunity to present our credentials. Should you have any questions, please contact me.

Sincerely,

WALTER P. MOORE AND ASSOCIATES, INC.



Andrew C. Yung, PE, CFM, D.WRE / Principal
713.394.5885 / ayung@walterpmoore.com



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Walter P. Moore and Associates, Inc.

Walter P Moore's water resources engineering services provide innovative engineering solutions for floodplain and watershed management. The results are cost-effective, environmentally responsible, and optimally designed to meet long-term needs. We create solutions for floodplain management, storm water management, erosion and scour mitigation, and flood protection. They result from our collaboration with owners and other stakeholders, including the design team, citizens, agency representatives, and others.

Our engineering is combined with current technologies—geographic information systems; steady and unsteady state modeling of surface, channel and pipe flow, and radar-derived rainfall data—to offer effective solutions to challenging drainage issues.

Our tools and technology include:

- › Computer Aided Engineering Analysis, Design (e.g., XP-SWMM, MOUSE, EPA-SWM, EPANET, InfoWorks)
- › H&H Modeling Software (e.g., HEC-RAS, HEC-HMS)
- › Specialized Applications of Geographic Information Systems (GIS) (e.g., ArcHydro Data Model, HEC-GeoRAS)

Our designs have been recognized at the national level for conserving resources, improving water quality, and making other environmental improvements.

Floodplain Management

Sound floodplain management strategies are essential for responsible urban development in flood prone areas. We collaborate with public agencies and private clients to identify areas of flood risk, develop floodplain or inundation maps, take measurements to protect human lives and structures, and prevent adverse impacts to flood levels resulting from construction activities. Our floodplain management projects are based on our engineer's solid hydrologic and hydraulic concepts and their good judgment combined with state of the art modeling and mapping tools with consideration of the regulatory requirements and policies. Together all of these elements define a unique skill set we use every day to mitigate flood problems and protect our communities.

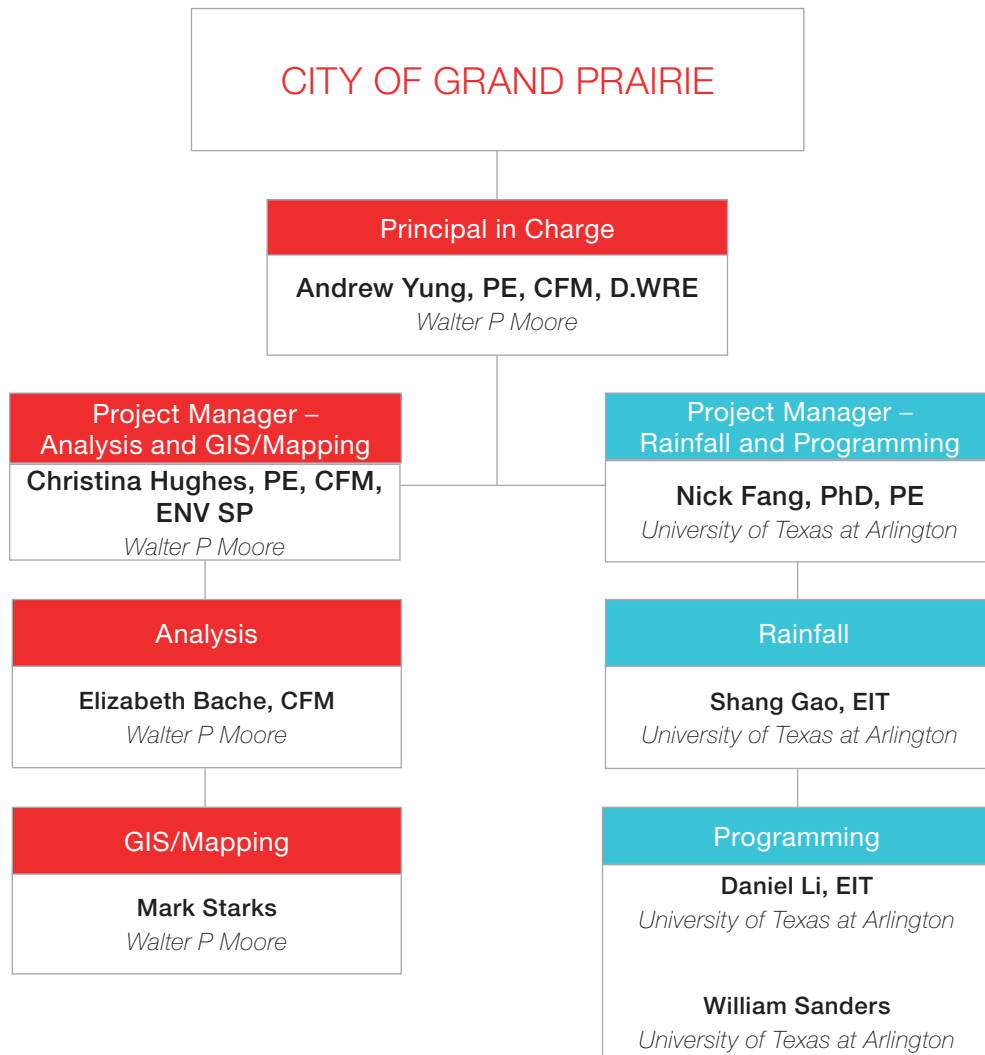
Flood Warning Systems

We gather information in real time about rainfall events to produce warnings and estimated water levels in streams and water crossings. We then produce models to create awareness for flood related risks in real time.

University of Texas at Arlington

The University of Texas at Arlington (UTA) is a major comprehensive research, teaching, and public service institution located in the heart of the Dallas/Fort Worth metropolitan area. UTA is more than 100 years old and is the second-largest component of The University of Texas System. With an enrollment of approximately 35,000 students, UTA ranks among the finest institutions of higher learning in the state, attracting scholars of international stature to its faculty. Emphasis on graduate education has resulted in a Graduate School population numbering more than 25% of the total student body.

The Fang Water Resources Group has approximately 1,400 SF of lab space that is connected to the campus backbone network. This provides research fellows/students access to main frame computers and allows them to communicate and transfer data with collaborators at other universities. The group is well equipped with the state of the art computing facilities including the following industrial software: ESRI ArcGIS, HEC-HMS, HEC-RAS, XP-SWMM, Vflo, HEC-ResSim, etc. Two external hard disks are also available for data storage and backup. The university high-performance computing (HPC) system is also available, which currently consists of 840 processors with more than 90 Terabytes of aggregate storage. The UT System Research Infrastructure (UTRC) facility is also available for this project. The new Lonestar supercomputing system of UTRC enables parallel computing applications, large shared memory applications, high throughput computing, and remote visualization of large scale data. Lonestar is a national TeraGrid resource and is one of the most powerful, productive, and comprehensive academic systems in the US, and its availability within UTRC presents a scientific advantage to us. The high bandwidth network connectivity (10 Gbps) enables high-speed data sharing and transferring.



Andrew Yung, PE, CFM, D.WRE
Principal in Charge / Chief Hydrologist
23 Years with **Walter P Moore**

Andy Yung has more than 30 years of experience as an engineer, planner, and hydrologist. He has managed a wide range of engineering projects involving hydrology, hydraulics, master drainage studies, channel modification and hydraulic structure designs, watershed impact analyses, detention facility designs, and dam safety analyses. He served as the team leader for Independent Technical Review (ITR) for several federal projects currently under construction in Houston. He is very familiar with HEC-HMS/HEC-1, HEC-RAS/HEC-2, HEC-DSS, and HEC-SSP and provides technical support and training to users of these programs.

EDUCATION

Bachelor of Civil Engineering, Georgia Institute of Technology, 1987

REGISTRATIONS

Licensed Professional Engineer

Texas 79810

Additional Registrations

Certified Floodplain Manager 0103-98N

Diplomate, Water Resources Engineer

PROFESSIONAL AFFILIATIONS

Association of State Floodplain Managers

Texas Floodplain Managers Association

Association of State Dam Safety Officials

National Hydrologic Warning Council

RELEVANT PROJECT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Provided oversight and technical support/guidance for this Phase 1 & 2 project for Technical Services in support of a flood-warning program for the City of Grand Prairie. The Phase 1 & 2 products present advance notification of roadway inundation at 11 sites throughout the City.
- › **Harris County Flood Control District (HCFCD) FWS Gauge Ratings**, Harris County, TX – Developed preliminary elevation vs. discharge rating curves for 87 stream gaging stations monitored by HCFCD as part of their Flood Warning System (FWS). As storm events occur, HCFCD will use stream flow measuring equipment to confirm/modify these ratings. These were coupled with ratings from 45 USGS gaging stations to cover nearly all gaging locations across the county, omitting rainfall-only gauges and coastal gauges.
- › **HCFCD Flood Warning System (Phases 1, 2, & 3)**, Harris County, TX - Development of a comprehensive automated system to ingest radar-based rainfall data into a HEC-HMS modeling system in order to provide HCFCD with forecasted estimates of flood timing and flood peak along three major streams in Harris County. The system is currently running with one watershed, with the two additional watersheds currently being worked on to be inserted into the overall system. This effort includes the calibration of the system to eight historical flood events in each watershed.
- › **HCFCD Cypress Creek Watershed Study and Physical Map Revision**, Harris County, TX – Revision to the floodplain delineation of the main stem of Cypress Creek based on recalibration of existing hydrologic and hydraulic models to three historical flood events. The effort included redefining the rating curve at a critical USGS location based on understanding of downstream conditions, USGS observed field measurements, and historical high water marks. The USGS utilized the revised data to assist in reestablishing the rating for this gauge location.
- › **Confidential Flood Warning System**, Harris County, TX – Provided technical support to a major corporation by creating a flood warning product that would be simplistic and useful in determining the potential for flooding and which could be used by non-technical personnel onsite during a flood emergency. The product required an understanding of the interaction of two local stream gauges in order to forecast flooding.
- › **East End Crossing Flood Investigation**, Louisville, KY – Performed a forensic analysis of several minor flooding events on the Ohio River. The effort required several flood frequency analyses of the USGS gauge on the river and a thorough understanding of the non-typical rating procedure developed by the USGS to identify flows at that location.
- › **White Oak Bayou Flood Investigation**, Harris County, TX – Performed a forensic analysis related to flooding along White Oak Bayou resulting from several flood events. This effort included investigating the reasonableness of rating data at two USGS gauges along the stream. Once confirmed, the flood event analyses were calibrated to these two gauges.

Christina Hughes, PE, CFM, ENV SP
 Project Manager- Analysis and GIS/Mapping
 4 Years with **Walter P Moore**

Christina Hughes is project manager with experience in diversified aspects of water resources engineering analysis and design. She is proficient in the use of HEC-HMS, HEC-RAS, Vflo, ArcGIS, MODFLOW, MT3D/RT3D (Groundwater Vistas), AutoCAD.

EDUCATION

Master of Science, Environmental Engineering, Rice University, 2015

Bachelor of Science, Civil and Environmental Engineering, Rice University, 2013

REGISTRATIONS

Certified Floodplain Manager 2993-16N

Envision Sustainability Professional

PROFESSIONAL AFFILIATIONS

Texas Floodplain Management Association

Phi Beta Kappa

RELEVANT PROJECT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Provided project management, development, and analysis for this Phase 1 & 2 project for Technical Services in support of a flood-warning program for the City of Grand Prairie. The Phase 1 & 2 products present advance notification of roadway inundation at 11 sites throughout the City.
- › **Harris County Flood Control District (HCFCD) FWS Gauge Ratings**, Harris County, TX – Developed preliminary elevation vs. discharge rating curves for 87 stream gaging stations monitored by HCFCD as part of their Flood Warning System (FWS). As storm events occur, HCFCD will use stream flow measuring equipment to confirm/modify these ratings. These were coupled with ratings from 45 USGS gaging stations to cover nearly all gaging locations across the county, omitting rainfall-only gauges and coastal gauges.
- › **East End Crossing Flood Investigation**, Louisville, KY – Performed a forensic analysis of several minor flooding events on the Ohio River. The effort required several flood frequency analyses of the USGS gauge on the river and a thorough understanding of the non-typical rating procedure developed by the USGS to identify flows at that location.
- › **May 2015 Flood Analysis of Brays Bayou**, Houston, TX – Walter P Moore was engaged to analyze the Memorial Day Weekend storm to compare pre-Project Brays conditions (effective hydraulic model) with post-Project Brays conditions (high water marks). This effort included calibration of radar-based rainfall to ALERT system rainfall gauges for this event, inserting the calibrated rainfall into the hydrologic model for the Brays Bayou watershed, using the results of the hydrologic analysis as input into the effective hydraulic model, and comparing the results of the hydraulic model with observed high water marks. To confirm the analysis, floodplains based on the pre-Project Brays model and the post-Project Brays high water marks were developed. The post-Project Brays floodplain was also compared with FEMA “Quick Claims” for the City of Houston.
- › **Merritt Lake Dam Retrofit**, Fort Leavenworth, KS – This project involved the analysis of a flood event that caused overtopping of the dam embankment. An analysis was performed using the HEC-HMS hydrologic model and included the evaluation of radar-based rainfall for the storm event for comparison of intensities frequency-based design storms. In addition, the effort included designing a retrofit of the existing dam spillway to provide additional capacity and reducing the risk of dam overtopping from future events.
- › **Country Creek Detention Preliminary Design**, Houston, TX – Walter P Moore was engaged by Tax Increment Reinvestment Zone No. 20 to develop a plan for regional detention on a 13+ acre site along Brays Bayou. This site was evaluated as a dual use facility to address flood mitigation caused by increased runoff from City of Houston capital improvement projects, as well as recreational space to serve local neighborhoods. For flood mitigation purposes, this regional detention site was analyzed using unsteady flow HEC-RAS modeling routines, which ultimately identified significant benefits along Brays Bayou that could be used to offset the increased runoff.

Elizabeth Bache, EIT

Analysis/ Graduate Engineer

1 Year with **Walter P Moore**

Elizabeth Bache is a graduate engineer with experience in diversified aspects of civil engineering analysis and design. She is proficient in the use of ArcGIS, XPSWMM, HEC-RAS, HEC-HMS, HEC-GeoRAS, and HY-8. She joined Walter P Moore in 2018 and is a resident of Houston, Texas.

EDUCATION

Bachelor of Science, Civil and Environmental Engineering, Rice University, 2015

REGISTRATIONS

Engineer in Training, Texas 56410

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

RELEVANT EXPERIENCE

- › **265-Acre Tract Willis Waukegan Road**, Cut and Shoot, TX – Completing a drainage impact analysis for a large lot development located east of Conroe in the unincorporated area of Montgomery County.
- › **City of Carrollton Citywide Flood Study**, Carrollton, TX – Walter P Moore is currently updating the hydrologic and hydraulic models of four major watersheds (Dudley Branch, Furneaux Creek, Hutton Branch, and Indian Creek) in the City of Carrollton to include completed projects, channel improvements, and other development changes that have occurred since the previous study in 2006. New floodplain mapping will be delineated for the 1% and 0.2% annual chance events along with the regulatory floodway. The results of the watershed study will include a Physical Map Revision (PMR) submittal to FEMA and identification of flood and erosion risks. An initial assessment of potential grant funding opportunities for flood mitigation projects will also be performed. Finally, a simplified Flood Warning System will be developed including the siting and implementation of a stream and rain gage network.
- › **Harris County Flood Control District Technical Assistance to Harris County in Response to Atlas 14 Update**, Harris County, TX – As a subconsultant to HDR, performed flood frequency analysis for all USGS stream gages in Harris County.
- › **Harris County Flood Control District Flood Forecasting System**, Harris County, TX – Walter P Moore is developing a program of flood forecasting to assist HCFCD in determining areas of potential flood risk during flood emergencies. As part of this overall county-wide program, Walter P Moore developed a pilot flood forecasting system for the Brays Bayou watershed that forecasts flood levels and timing. The system uses HEC-RTS and an HEC-HMS model with rating curves to determine flood stages at 15 gauge locations along Brays Bayou and its tributaries.
- › **City of Carrollton Citywide Flood Study**, Carrollton, TX – Walter P Moore is updating the hydrologic and hydraulic models of four major watersheds (Dudley Branch, Furneaux Creek, Hutton Branch, and Indian Creek) in the City of Carrollton to include completed projects, channel improvements, and other development changes that have occurred since the previous study in 2006. The project will include updated floodplain mapping for the City.
- › **Hurricane Harvey Forensic Analysis**, Brazoria County, TX – Performed a forensic analysis of Hurricane Harvey flooding. Utilized radar-based rainfall and combined 1D/2D HEC-RAS modeling to determine impacts of the storm over an extensive geographic area.
- › **City of Arlington Watershed Studies**, Arlington, TX – Walter P Moore is completing a stream geomorphology assessment focusing on erosion hazards using the Bank Erosion Hazard Index (BEHI) method for six small watersheds. Walter P Moore is also performing an independent technical review of the hydrology and hydraulic modeling, floodplain mapping, and FEMA deliverables.

Mark Starks

GIS/Mapping / Senior GIS Specialist
32 Years with **Walter P Moore**

Mark Starks is a Senior GIS Specialist with more than 30 years of experience in graphics creation and support for water resources planning and design. He has managed all CAD/GIS related efforts in the many projects performed at Walter P Moore. His support graphics include: floodplain management studies and Federal Emergency Management Agency submittals, transportation related drainage analyses, major hydrologic and hydraulic studies, channel improvements projects, master drainage studies, drainage criteria manual development, and watershed impact analyses.

EDUCATION

Bachelor of Science, Engineering Technology, University of Houston, 1986

RELEVANT PROJECT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Provided mapping and GIS/graphical support for this Phase 1 & 2 project for Technical Services in support of a flood-warning program for the City of Grand Prairie. The Phase 1 & 2 products present advance notification of roadway inundation at 11 sites throughout the City.
- › **Harris County Flood Control District (HCFCD) FWS Gauge Ratings**, Harris County, TX – Developed preliminary elevation vs. discharge rating curves for 87 stream gaging stations monitored by HCFCD as part of their Flood Warning System (FWS). As storm events occur, HCFCD will use stream flow measuring equipment to confirm/modify these ratings. These were coupled with ratings from 45 USGS gaging stations to cover nearly all gaging locations across the county, omitting rainfall-only gauges and coastal gauges.
- › **HCFCD Flood Event Modeling Program**, Harris County, TX – Developed a comprehensive computer program to ingest radar-based rainfall data into a modeling system in order to provide HCFCD with flood inundation mapping in real-time. Buffalo Bayou and White Oak Bayou served as the two pilot studies for the system development. This effort included the calibration of the system to real-time stage (HCFCD FWS) and flow (USGS) data.
- › **May 2015 Flood Analysis of Brays Bayou**, Houston, TX – Walter P Moore analyzed the Memorial Day Weekend storm to compare pre-Project Brays conditions (effective hydraulic model) with post-Project Brays conditions (high water marks). This effort included calibration of radar-based rainfall to ALERT system rainfall gauges for this event, inserting the calibrated rainfall into the hydrologic model for the Brays Bayou watershed, using the results of the hydrologic analysis as input into the effective hydraulic model, and comparing the results of the hydraulic model with observed high water marks. To confirm the analysis, floodplains based on the pre-Project Brays model and the post-Project Brays high water marks were developed. The post-Project Brays floodplain was also compared with FEMA “Quick Claims” for the City of Houston.
- › **Confidential Flood Warning System**, Harris County, TX – Provided technical support to a major corporation by creating a flood warning product that would be simplistic and useful in determining the potential for flooding and which could be used by non-technical personnel onsite during a flood emergency. The product required an understanding of the interaction of two local stream gauges in order to forecast flooding.
- › **HCFCD Sims Bayou RiskMAP**, Harris County, TX – The emphasis of this project is to streamline the process associated with obtaining a Physical Map Revision (PMR) for Sims Bayou that reflects the construction of the Sims Bayou Federal Flood Damage Reduction Project. Phase 1 of this project involves public interaction and gathering information from the public in order to adequately define risks to the public. Phase 2 will include the actual remapping of the floodplains based on the benefits derived from the Federal Project and will be submittal to FEMA for review.
- › **Cumberland Oil Field Flood Investigation**, Bryan and Marshall Counties, OK – Walter P Moore investigated the reasons for flooding of the oilfield area during consecutive flood events in southern Oklahoma in 2015. Considerations were given to river flooding along the Washita River, failure of a levee protecting the oilfield, and localized rainfall events that contributed significant runoff directly to the site. This evaluation included USGS stream gauge analysis, the hydraulic effects of Lake Texoma, and the development of gauge-adjusted radar-based rainfall for the entire Washita River watershed.

Nick Fang, PhD, PE

Project Manager – Rainfall and Programming /
Senior Project Manager
5 Years with **University of Texas at Arlington**

Nick Fang is an assistant professor of civil engineering at the University of Texas at Arlington. Dr. Fang has worked on surface water and groundwater issues for more than ten years. His experience includes floodplain studies, hydrologic/hydraulic modeling, reservoir operation and management, water treatment, hydrodynamic simulation, storm water management modeling, and water quality assessment for a number of watersheds and municipalities. Dr. Fang has actively worked in the area of hydrologic/hydraulic analysis for flood prediction and warning in real time. He has enhanced a radar-based flood warning system to achieve more accurate and timely flood forecasts. Dr. Fang also possesses in-depth knowledge of hydrologic, hydraulic, and groundwater packages including HEC-HMS, HEC-RAS, GW-Vistas, XP-SWMM, Visual MODFLOW, and ArcGIS.

EDUCATION

Doctor of Philosophy, Civil and Environmental Engineering,
Rice University, 2008

Master of Science, Chemical Engineering, Lamar University,
2003

Bachelor of Science, Environmental Engineering, Zhejiang
University, 1998

REGISTRATIONS

Licensed Professional Engineer

Texas 109861

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers

American Water Resources Association

American Geophysical Union

RELEVANT PROJECT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Provided project management for rainfall analysis and programming in this Phase 1 & 2 project for Technical Services in support of a flood-warning program for the City of Grand Prairie. The Phase 1 & 2 products present advance notification of roadway inundation at 11 sites throughout the City.
- › **TxDOT SH 288 Real-time Flood Warning System**, Houston, TX – Developed a real-time flood warning system for the SH 288 junction over Brays Bayou using calibrated hydrologic/hydraulic models and real-time NEXRAD rainfall data. The recently developed hydraulic prediction tool (FPML) is also being incorporated into this flood warning system to visualize floodplain in near real time.
- › **TxDOT Real-time Radar-Based Flood Warning System for Two Flood-prone Locations**, Houston, TX – Designed and developed a real-time radar-based flood warning system for Mandell Street near US 59 and Tellepsen Road near IH 45. Calibrated the SWMM models for both locations and developed rainfall – water surface elevation correlations with a detailed hydrologic/hydraulic study in order to provide flood warning information in real-time based on radar rainfall information.
- › **City of Sugar Land Real-time Flood Warning System for Oyster Creek Cross Sections**, Sugar Land, TX – Designing and developing a real-time flood warning system for several cross sections over Oyster Creek. The flood alert system is based on real-time NEXRAD radar rainfall data, a well-calibrated hydrologic model, and an operational data transfer platform.
- › **Texas Medical Center Re-evaluation of the Storm Water System in Harris Gully**, Houston, TX – Re-evaluating the storm water system in Harris Gully with updated drainage information, hydrologic and hydraulic models, land use information, and recently-installed flood control facilities.
- › **Clear Lake City Water Authority (CLCWA) Analysis of Inland Flooding and Storm Surge Risk**, Harris County, TX – Performing an analysis of inland flooding and storm surge risk using information collected during Hurricane Ike and hydrologic and hydraulic models. The research results will be used to inform local residents and governmental agencies how to deal with floods and hurricane induced storm surge; funding for local infrastructural improvements will also be allocated based upon these research results.
- › **Shell Sustainability Center Pilot Project**, Harris County, TX – Performing a pilot project that integrates a comprehensive coastal flood warning system with a “lifeline” evacuation analysis of the roadways and bridges in the Clear Lake area.
- › **Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) Center**, Houston, TX – With funding from Houston Endowment, coordinating major research universities and other public and private entities in the collaboration and exchange of technical information about inland flooding induced by severe storms.
- › **SSPEED Center Study of Storm Surge Impacts on the Houston Ship Channel**, Houston, TX – Performing a study of storm surge impacts on the Houston Ship Channel using collected Hurricane Ike storm surge information, the results from Advanced Circulation Model (ADCIRC), and a 2-D MIKE-FLOOD model.

Shang Gao, EIT

Rainfall / UTA Student

6 Years with **University of Texas at Arlington**

Shang Gao is a PhD student in Civil Engineering at the University of Texas at Arlington. His main research topic is modeling the spatial and temporal dynamics of rainfall. He is proficient in processing and analyzing large amount of data with the use of various scripting languages, e.g., Matlab and Python. He also has extensive experience in hydrologic and hydraulic modeling using HEC-HMS, HEC-RAS, ArcGIS, Vflo, et al.

EDUCATION

Master of Science, Environmental Engineering, University of California, Irvine, 2013

Bachelor of Science, Environmental Science, Nankai University, Tianjin, China, 2011

REGISTRATIONS

Engineer-in-Training, Texas 151149

PROFESSIONAL AFFILIATIONS

American Geophysical Union

RELEVANT PROJECT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Developed filtering algorithm to transform raw rain gauge data into error-free hyetographs. The system is an online real-time flood warning website not only displaying sensing (rainfall) and warning (predicted stream stages) information, but also delineating flood extent based on a library of floodplain maps.
- › **Evaluation of Urbanization and Infiltration for the Fort Worth Floodway**, TX – Conducted extensive software scripting 1) to generate thousands of synthetic storms (Standard Project Storm and frequency storms) by integrating and automating software, like HMR52, HEC-MetVue, HEC-HMS, DSS-UTL; 2) to automatically calibrate HEC-HMS models of the Upper Trinity River Basin (UTRB) using long-term rainfall and USGS streamflow data; 3) to compare design storms with deterministically and stochastically transposed historical storms using Python scripting. Also developed a Dynamic Moving Storm (DMS) generator to incorporate spatiotemporal characteristics of rainfall into traditional Probable Maximum Precipitation (PMP) design.
- › **Hydrologic and Hydraulic Analysis for Brays Bayou during Memorial Day Flood 2015**, Houston, TX – Performed sensitivity analysis to evaluate the hydrologic impacts from moving storms by shifting the center mass of the Memorial Day storm at various levels in relative to the Texas Medical Center area. The outcome of this task has enhanced the decision making process for emerging storms with rapidly varied movements.
- › **Floodplain Delineation for Brays Bayou during Hurricane Harvey 2017**, Houston, TX – Simulated the flood inundation in Brays Bayou using HEC-HMS and HEC-RAS (1-D) as the hydrologic and hydraulic models, respectively. Also processed radar rainfall data (both QPE and QPF) into DSS format for all the subcatchments in Harris County, which provides other inundation-mapping teams with rainfall input on a daily basis.

Daniel Li, EIT

Programming / UTA Student

5 Years with **University of Texas at Arlington**

Daniel Li is a PhD student in Water Resource Engineering at the University of Texas at Arlington. He has hands on hydrologic and hydraulic modeling, flood warning system design and deploying, and reservoir operation modeling experience. He is proficient in the use of Python, Java, R, Apache server, MySQL, Linux shell, Spring framework, JavaScript, GitHub/Git Cloud service (AWS EC2, Google cloud), HEC-HMS, HEC-RAS, HEC-ResSim, Riverware.

EDUCATION

Master of Science, Environmental Engineering, University of California, Irvine, 2015

REGISTRATIONS

Engineer-in-Training, Texas 58321

RELEVANT PROJECT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Managed the building of the website and database (Warning Interface) integrated with google map and the backend based on Spring framework, with Git version control. Also managed the deploying of the web interface system through Amazon Web Service Beanstalk, which is integrated AWS's EC2 and RDS.
- › **Deep Learning in Water Resource** – To apply the latest deep learning techniques in water resource. Using Recurrent Neural Network to forecast hydrologic inflow for water supply reservoirs. Deployed custom deep learning networks in TensorFlow.
- › **Georgia Water Rights Modeling**, GA – Simulated the outflow from Lake Seminole in the Chattahoochee River under different water use conditions in HEC-ResSim. Compared the different simulation results from HEC-ResSim, Matlab model, USGS Precipitation-Runoff Modeling System for Georgia water supply reservoir system.
- › **Hydrologic Analysis of Urbanization and Infiltration for Fort Worth Floodway**, TX – Scripted in Python environment to automate the CDC upper Trinity River HEC-HMS model calibration process. (More than 50 sub basins and 20 events). Studied the urbanization impacts on the hydrologic performance of the Upper Trinity watersheds.

William Sanders

Programming / UTA Student

7 Years with **University of Texas at Arlington**

William Sanders is a PhD student in Water Resource Engineering at the University of Texas at Arlington. He has hands on hydrologic and hydraulic modeling, and flood warning system design and deployment. He is proficient in the use of Python, Java, R, SQL, HTML, CSS, C/C++, Linux/Unix, JavaScript, GitHub/Git Cloud service (AWS EC2, Google cloud), ArcGIS, and Wordpress.

EDUCATION

Master of Civil Engineering, University of Texas at Arlington, 2018

Bachelor of Science, Civil Engineering, University of Texas at Arlington, 2016

RELEVANT EXPERIENCE

- › **Grand Prairie Flood Warning System (Phase 1 & 2)**, Grand Prairie, TX – Developed flood warning system front-end/back-end programming, database management, and server administration.
- › **Carrollton Flood Warning System**, Carrollton, TX – Developing ongoing flood warning system front-end/back-end programming, database management, and server administration.
- › **North Texas Regional Housing Assessment**, Dallas, TX – Crafted ArcGIS solutions as part of the data team for HUD research funded by the City of Dallas. Automated team processes to manage research in a timely fashion.
- › **Chi Epsilon National Headquarters**, Arlington, TX – Performed data cleaning/fusion on existing member database using publicly available information.

03 | AVAILABILITY



We propose to staff the project with a core team of individuals. We have reviewed other commitments of our key team members and confirmed that each individual is available to participate in the project to the level indicated herein.

Each member of our team understands their role in integrating our services with those of the overall project team. Each individual is eager and currently available to work on the project, and will remain on the project from start to finish.

Meeting project schedules has always been a priority for Walter P Moore. We work closely with clients to establish aggressive and effective project schedules and then track our progress closely to maintain the commitment. Our team members have complementary and overlapping capabilities, which further enhances our ability to meet schedules.



Scope for Developing a Flood Warning System for Grand Prairie, Texas

Andy Yung, PE, CFM *Walter P. Moore and Associates, Inc.*
Nick Z. Fang, PhD, PE *The University of Texas at Arlington*

February 2019

This proposal includes only those tasks and associated budgets that cover the services Walter P Moore and Associates and the University of Texas at Arlington (UTA) believe necessary to expand the City of Grand Prairie's Phase 1 & 2 flood warning/forecasting system. This proposal is designed to make the best use of available funding to provide the City with a product that is most beneficial and useful to City staff during flood emergency operations. It is recognized that much of the scope and budget are reflective of Walter P Moore/UTA's assumptions about the direction of the project, which may be altered following the meeting with City staff. Ultimately, it is the goal of Walter P Moore and UTA to serve the City's needs in the most efficient and cost effective manner possible.

Objective

To provide a flood warning/forecasting system that will permit the City's Stormwater, Public Works and Office of Emergency Management departments to identify areas of inundation and allow the timely dispatch of first responders to these areas to close roads, evacuate, shelter-in-place, and/or begin rescue operations.

For Phase 3, the City will include the following items:

1. Research gauge-adjusted radar-rainfall (GARR) options.
2. Test Fish Creek and Cottonwood Creek with GARR data.
3. Add new gauge at Jefferson to system.
4. Add in the September 2018 and October 2018 storms for validation/calibration.
5. Ongoing monitoring of flood warning system - including post-event analysis and updates.

In addition, the City operates and maintains several other rainfall/stream gauges and has identified additional locations for future installation of gauging systems. As more station locations come online, consideration can be given to expanding this scope of work. However, this present scope will focus only on the five items identified above and included in the tasks below.

Task 1: Meetings with City Staff and Project Coordination

- › Walter P Moore/UTA will meet with City staff (including primary users, as needed) to kickoff Phase 3, to provide updates, to determine what improvements may be necessary for the overall Flood Warning system moving forward, and to update staff on adjustments to the current system. This task assumes up to four meetings may be required by the City.
- › Walter P Moore/UTA will provide overall project coordination for the various project subtasks.

Task 2: Data Collection

- › Walter P Moore/UTA will collect available information related to available topographic data, radar data, model data, storm data, GIS data, etc. This information will then be used to address the GARR research, the GARR testing, the addition of the new gauge at Jefferson, the addition of historical storms to validate/calibrate the system, and ongoing monitoring of the flood warning system.
- › Specific to the GARR research, Walter P Moore/UTA will investigate the methods used by third-party GARR providers for accuracy/precision/delivery/response time as well as costs associated with obtaining the GARR data product. Included in this effort will be research into the use of multi-radar multi-sensor (MRMS) data.
- › This task will also include any necessary field reconnaissance.

Task 3: Testing of GARR

- › Based on information from the data collection task, Walter P Moore/UTA will utilize sample GARR datasets from third-party providers to test the Fish Creek and Cottonwood Creek sites against the current system based on gauge-only data. *Please note that any cost associated with acquiring sample GARR datasets is not included in this proposal.*
- › This effort will include comparing watershed weighted rainfall in HEC-HMS to data assumed from the rain gauges-only, as well as watershed weighted intensity against the current nomograph-based system.
- › Walter P Moore/UTA will coordinate with the City to determine the best option for GARR data to support the City in flood warning efforts.

Task 4: Review of Flooding Along Jefferson

- › Walter P Moore/ UTA will investigate the source of flooding at the low spot on eastbound Jefferson and at the mobile home park along Jefferson near Mountain Creek. Using the topographic information or an existing HEC-RAS 2D model (if available) along with rain gauge data from a historic storm where flooding was noted, Walter P Moore/UTA will create a simplified 2D-only rain-on-grid analysis to try to define the flooding source.
- › Once identified, a recommendation will be made related to modifications of the thresholds for the current Jefferson watch point or how to tie the new Jefferson gauge location to the existing watch point.

Task 5: Updates to Current System

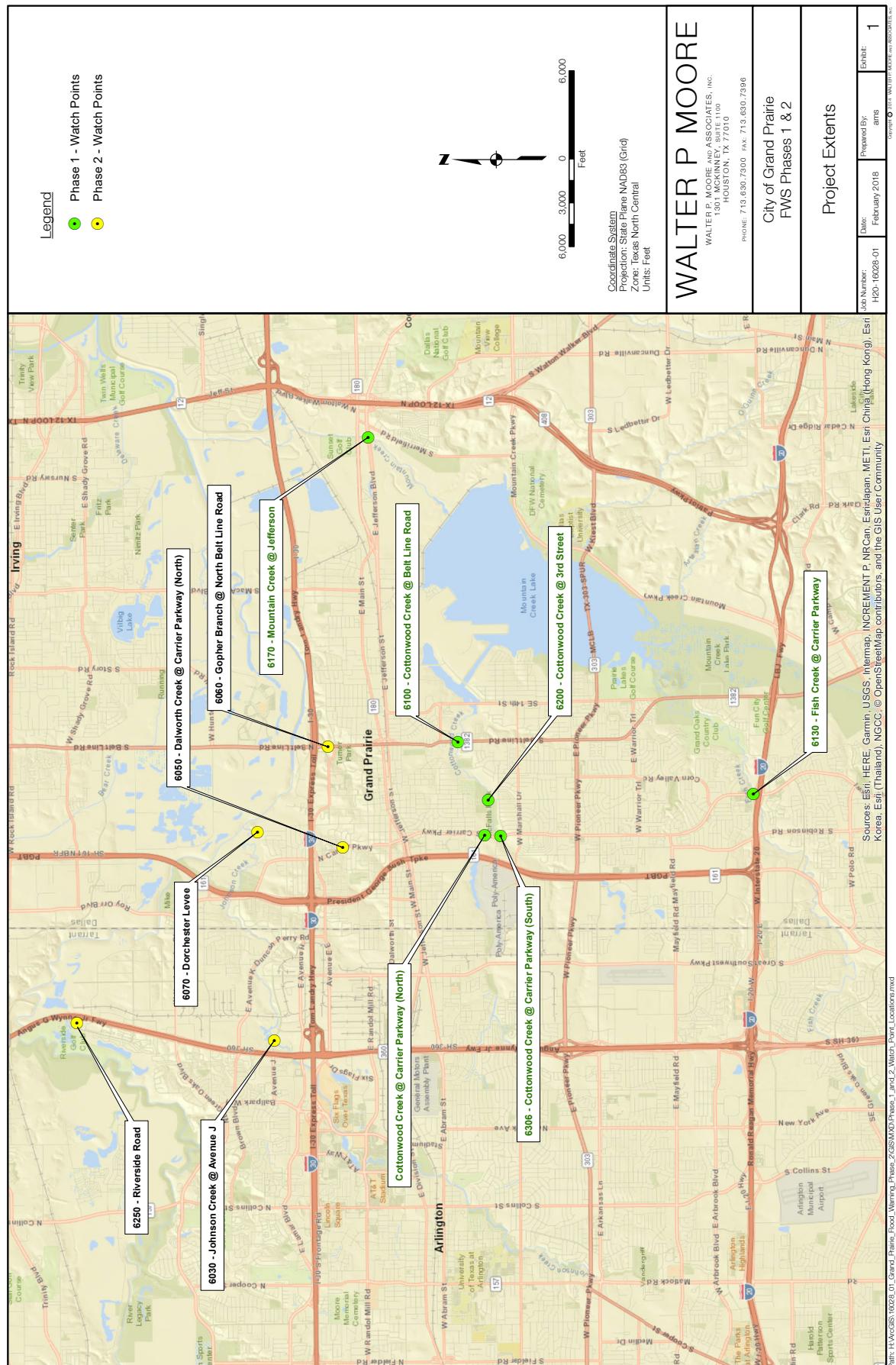
- › Walter P Moore/UTA will update the current system to add in consideration the flooding review at Jefferson noted in the previous task.
- › In addition, the nomographs for the existing watch points in the current system will be updated (recalibrated/verified) to include data from the September 2018 and October 2018 storm events.

Task 6: Documentation/ Optimization/ Maintenance-of-Systems

- › Walter P Moore/UTA will document assumptions, procedures, and findings from Tasks 3, 4, and 5 above. This documentation will be in the form of memoranda

complete with any tables, figures, and/or exhibits necessary to convey the pertinent information.

- › Walter P Moore/UTA will continue to monitor the flood warning system as storm events occur and will provide documentation related to post-event analysis and updates to the system in the form of memoranda to the City.



Budget and Project Duration

To complete the aforementioned tasks, a budget of \$150,000 is needed. As stated above, this budget is subject to change in direction following meetings with City staff, and it is further noted that based on Walter P Moore/UTA assumptions, the Phase 3 outcome will be a useful and beneficial product.

This budget is considered lump sum, but is based on hours assigned to various tasks and the following hourly rates:

Task	WPM Chief Hydrologist	UTA Senior Project Manager	WPM Project Manager	WPM Graduate Engineer	UTA Student	WPM Senior GIS Specialist	Budget
Task 1: Meet with City Staff and Project Coordination							
1 Prepare/Meet/Follow-up Documentation	16	16	16	16	24	8	
2 Project Coordination	8	16	16	0	0	0	
Subtotal	24	32	32	16	24	8	\$ 23,700.00
Task 2: Data Collection							
1 Obtain Data (topographic, radar, model, storm, GIS, etc.)	2	8	8	8	24	16	
2 GARR Research	4	16	12	16	48	12	
3 Field Reconnaissance	8	8	8	8	24	4	
Subtotal	14	32	28	32	96	32	\$ 33,300.00
Task 3: Testing of GARR							
1 Obtain Sample Datasets of GARR	2	8	4	4	32	4	
2 Fish Creek HEC-HMS Test	1	2	4	24	0	8	
3 Fish Creek Watershed Weighted Intensity Test	1	8	2	0	32	0	
4 Cottonwood Creek HEC-HMS Test	1	2	4	24	0	8	
5 Cottonwood Creek Watershed Weighted Intensity Test	1	8	2	0	32	0	
Subtotal	6	28	16	52	96	20	\$ 29,000.00
Task 4: Review of Flooding Along Jefferson							
1 Prepare 2D Rain-on-Grid Model	4	2	8	40	8	8	
2 Run Model/Make Recommendations about Thresholds	4	4	4	8	8	4	
Subtotal	8	6	12	48	16	12	\$ 14,700.00
Task 5: Updates to Current System							
1 Update Threshold Data at Jefferson	1	8	4	0	40	0	
2 Add September 2018 and October 2018 Storms for Calibration/Verification	1	8	8	20	80	0	
Subtotal	2	16	12	20	120	0	\$ 19,500.00
Task 6: Optimization/Maintenance of System							
1 Documentation of Tasks 3, 4, and 5	8	16	16	32	32	16	
2 Monitor Live Storm Events/Document Post-Event Analysis and Updates	4	16	8	4	32	16	
Subtotal	12	32	24	36	64	32	\$ 29,800.00
Total Hours	66	146	124	204	416	104	
TOTAL BUDGET							\$ 150,000.00

Category	Rate
Walter P. Moore- Principal	\$260
Walter P. Moore- Chief Hydrologist	\$225
University of Texas at Arlington- Senior Project Manager	\$225
Walter P. Moore- Project Manager	\$175
Walter P. Moore- Senior GIS Specialist	\$170
Walter P. Moore- Graduate Engineer	\$125
UTA Student	\$90

WHO WE ARE

Walter P Moore is an international company of engineers, innovators, and creative people who solve some of the world's most complex structural and infrastructural challenges. Providing structural, diagnostics, civil, traffic, transportation engineering, and parking consulting services, we engineer solutions that are resource-efficient, forward-thinking, and help support and shape our communities. Founded in 1931, we are headquartered in Houston, Texas and have more than 600 professionals working across 16 U.S. offices and 5 international locations.

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