Amendment No. 2
to
Contract No. 6300 NA160000103
for
Hydrologic Forecast Modeling and Mapping
Solution for the Flood Early Warning System
between
Vieux & Associates, Inc.
and the
City of Austin

1.0 The City hereby exercises this extension option for the subject contract. This extension option will be May 19, 2019 through May 18, 2020. One (1) option will remain.

2.0 The total contract amount is increased by $247,127.00 by this extension period. The total contract authorization is recapped below:

Action	Action Amount	Total Contract Amount
Initial Term: 05/19/2016 – 05/18/2018	$435,254.00	$435,254.00
Amendment No. 1: Option 1 – Extension 05/19/2018 – 05/18/2019 BLS Index Replaced with PCU5182105182104 04/13/2018	$247,127.00	$682,381.00
Amendment No. 2: Option 2 – Extension 05/19/2019 – 05/18/2020	$247,127.00	$929,508.00

3.0 MBE/WBE goals do not apply to this contract.

4.0 By signing this Amendment the Contractor certifies that the vendor and its principals are not currently suspended or debarred from doing business with the Federal Government, as indicated by the GSA List of Parties Excluded from Federal Procurement and Non-Procurement Programs, the State of Texas, or the City of Austin.

5.0 All other terms and conditions remain the same.

BY THE SIGNATURES affixed below, this amendment is hereby incorporated into and made a part of the above-referenced contract.

Sign/Date: Jean E Vieux 5/23/2019

Printed Name: Jean E Vieux
Authorized Representative

Vieux & Associates, Inc.
301 David L. Boren Blvd., Ste. 3050
Norman, Oklahoma 73072

Sign/Date: 5/24/19

Printed Name: Ken Bragdon
Authorized Representative

City of Austin
Purchasing Office
124 W. 8th Street, Ste. 310
Austin, Texas 78701

Elisa Tolles
5/24/19

Amendment No. 1
to
Contract No. NA160000103
for
Hydrologic Forecast Modeling and Mapping
Solution for the Flood Early Warning System
between
Vieux & Associates, Inc.
and the
City of Austin

1.0 The above referenced contract is hereby amended as follows:

1.1 Section 0400.9.D.iii. Bureau of Labor Statistics Series ID CUUR0000SEE is superseded and replaced with PCU5182105182104.

2.0 The City hereby exercises this extension option for the subject contract. This extension option will be May 19, 2018 through May 18, 2019. Two options will remain.

3.0 The total contract amount is increased by $247,127.00 for this extension period. The total contract authorization is recapped below:

Action	Action Amount	Total Contract Amount
Initial Term: 05/19/2016 – 05/18/2018	$435,254.00	$435,254.00
Amendment No. 1: Option 1 – Extension 05/19/2018 – 05/18/2019 BLS Index Replaced with PCU5182105182104 04/13/2018	$247,127.00	$682,381.00

4.0 MBE/WBE goals do not apply to this contract.

5.0 By signing this Amendment the Contractor certifies that the vendor and its principals are not currently suspended or debarred from doing business with the Federal Government, as indicated by the GSA List of Parties Excluded from Federal Procurement and Non-Procurement Programs, the State of Texas, or the City of Austin.

6.0 All other terms and conditions remain the same.

BY THE SIGNATURES affixed below, this amendment is hereby incorporated into and made a part of the above-referenced contract.

Sign/Date: Jean E Vieux 4/30/2018

Printed Name: Jean E Vieux
Authorized Representative

Vieux & Associates, Inc.
301 David L. Boren Blvd., Suite 3050
Norman, Oklahoma 73072
(405) 325-1818
jv@vieuxicn.com

Sign/Date: Cyrenthia Ellis 5/3/2018

Cyrenthia Ellis
Procurement Manager

City of Austin
Purchasing Office
124 W. 8th Street, Ste. 310
Austin, Texas 78701

City of Austin
Purchasing Office, Financial Services Department
P.O. Box 1088, Austin, TX 78767

5/19/2016

Vieux & Associates, Inc.
Jean E. Vieux
350 David L. Boren Blvd, Suite 2500
Norman, OK 73072
Jean.vieux@vieuxinc.com

Dear Ms. Vieux:

The Austin City Council approved the execution of a contract with your company for Hydrologic forecast modeling and mapping solution for the Flood Early Warning System in accordance with the referenced solicitation.

Responsible Department:	Watershed Protection Department
Department Contact Person:	Donna Lee Bliss
Department Contact Email Address:	Donna-lee.bliss@austintexas.gov
Department Contact Telephone:	512-974-2530
Project Name:	Hydrologic forecast modeling and mapping solution for the Flood Early Warning System
Contractor Name:	Vieux & Associates, Inc.
Contract Number:	MA 6300 NA160000103
Contract Period:	5/19/2016 – 5/18/2018
Dollar Amount	$435,254
Extension Options:	3 x 12 month options ($247,121 each)
Requisition Number:	15012100144
Solicitation Type & Number:	RFP SMW0127
Agenda Item Number:	20
Council Approval Date:	5/19/2016

Thank you for your interest in doing business with the City of Austin. If you have any questions regarding this contract, please contact the person referenced under Department Contact Person.

Sincerely,

Georgia L. Billela
Senior Buyer
City of Austin
Purchasing Office

cc: Donna Lee Bliss
Kevin Shunk
Susan Janek

CONTRACT BETWEEN THE CITY OF AUSTIN ("City")
AND
VIEUX & ASSOCIATES, INC. ("Contractor")
FOR
HYDROLOGIC FORECAST MODELING AND MAPPING SOLUTION FOR THE FLOOD EARLY WARNING SYSTEM

CONTRACT NUMBER: MA 6300 NA160000103

The City accepts the Contractor's Offer (as referenced in Section 1.1.3 below) for the above requirement and enters into the following Contract.

This Contract is between Vieux & Associates, Inc. having offices at 301 David L. Boren Blvd. Suite 3050, Norman, OK 73072 and the City, a home-rule municipality incorporated by the State of Texas, and is effective as of the date executed by the City ("Effective Date").

Capitalized terms used but not defined herein have the meanings given them in Solicitation Number SMW0127.

1.1 **This Contract is composed of the following documents:**

1.1.1 This Contract

1.1.2 The City's Solicitation, RFP, SMW0127 including all documents incorporated by reference

1.1.3 Vieux & Associates, Inc. Offer, dated March 26, 2015, including subsequent clarifications

1.2 **Order of Precedence.** Any inconsistency or conflict in the Contract documents shall be resolved by giving precedence in the following order:

1.2.1 This Contract

1.2.2 The City's Solicitation as referenced in Section 1.1.2, including all documents incorporated by reference

1.2.3 The Contractor's Offer as referenced in Section 1.1.3, including subsequent clarifications.

1.3 **Term of Contract.** The Contract will be in effect on the date executed by the City (Effective Date) for an initial term of 24 months and may be extended thereafter for up to 3 additional 12 month extension option(s), subject to the approval of the Contractor and the City Purchasing Officer or his designee. See the Term of Contract provision in Section 0400 for additional Contract requirements.

1.4 **Compensation.** The Contractor shall be paid a total Not-to-Exceed amount of $435,254 for the initial Contract term, $247,121 for extension option 1, $247,121 for extension option 2, and $247,121 for extension option 3, for a total contract amount not to exceed $1,176,617 as indicated in the Bid Sheet, IFB Section 0600. Payment shall be made upon successful completion of services or delivery of goods as outlined in each individual Delivery Order.

1.5 **Quantity of Work.** There is no guaranteed quantity of work for the period of the Contract and there are no minimum order quantities. Work will be on an as needed basis as specified by the City for each Delivery Order

1.6 **Clarifications and Additional Agreements.** The following are incorporated into the Contract.

1.6.1 Limitation of Liability

In recognition of the relative risks and benefits of the Project to both the Client and the Consultant, the risks have been allocated such that the Client agrees, to the fullest extent permitted by law and excepting Consultant's indemnification obligations, to limit the liability of the Consultant and Consultants officers, directors, partners, employees, shareholders, owners and subconsultants for any and all claims, losses, costs, damages of any nature whatsoever or claims expenses from any cause or causes, including attorney's fees and costs and expert-witness fees and costs, so that the total aggregate liability of the Consultant and Consultants officers, directors, partners, employees, shareholders, owners and subconsultants shall not exceed $250,000, or the Consultant's total annual fee for services rendered on this Project, whichever is greater. It is intended that this limitation apply to any and all liability or cause of action however alleged or arising, unless otherwise prohibited by law.

1.6.2 Cost Proposal

Revisions to SMW0127 Mapping/Modeling

		Initial Contract Term		Total for Initial Term	Year 3 Option	Year 4 Option	Year 5 Option	TOTAL CONTRACT NTE	NOTES
	Description	Year 1	Year 2						
1	Vflo Model Licen	$ 7,995.00	$ 3,597.00	$ 11,592.00	$ 3,597.00	$ 3,597.00	$ 3,597.00	$ 22,383.00	
7	Real-time continuous simulations	$ 73,388.00	$ 68,388.00	$ 141,776.00	$ 68,388.00	$ 68,388.00	$ 68,388.00	$ 346,940.00	
8	Setup: mapping forecast model outpus & post-processed products	$ 12,500.00	$ 12,500.00	$ 25,000.00	$ -	$ -	$ -	$ 25,000.00	
9	Map Display & Hosting	$ 45,750.00	$ 40,750.00	$ 86,500.00	$ 40,750.00	$ 40,750.00	$ 40,750.00	$ 208,750.00	Vieux Data Services are fixed for FFMMS
10	Data Archiving & User Retrieval	$ 17,500.00	$ 17,500.00	$ 35,000.00	$ 17,500.00	$ 17,500.00	$ 17,500.00	$ 87,500.00	
11	Model Results Prep in Open Format	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$25K eliminated as VAI has both contracts
12	Maps of Output Forecast Maps	$ 12,000.00	$ 12,000.00	$ 24,000.00	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 60,000.00	
13	Training Costs	$ 6,500.00	$ 6,500.00	$ 13,000.00	$ 6,500.00	$ 6,500.00	$ 6,500.00	$ 32,500.00	
	Radar Rainfall (begins when current MA #NS10*33 expires)	$ -	$ 98,386.00	$ 98,386.00	$ 98,386.00	$ 98,386.00	$ 98,386.00	$ 393,544.00	for Radar Rainfall Services starting after end of current contract MA #NS10*33 expires
Total Contract Costs		$ 175,633.00	$ 259,621.00	**$435,254.00**	$ 247,121.00	$ 247,121.00	$ 247,121.00	**$ 1,176,617.00**	

This Contract (including any Exhibits) constitutes the entire agreement of the parties regarding the subject matter of this Contract and supersedes all prior and contemporaneous agreements and understandings, whether written or oral, relating to such subject matter. This Contract may be altered, amended, or modified only by a written instrument signed by the duly authorized representatives of both parties.

In witness whereof, the parties have caused a duly authorized representative to execute this Contract on the date set forth below.

VIEUX & ASSOCIATES, INC.	**CITY OF AUSTIN**
Jean E. Vieux	Elisa Folco
Printed Name of Authorized Person	Printed Name of Authorized Person
Jean E Vieux	Elisa Folco
Signature	Signature
CEO/President	Corporate Contract Administrator
Title:	Title:
May 5, 2016	May 19, 2016
Date:	Date:

CITY OF AUSTIN, TEXAS

Purchasing Office

REQUEST FOR PROPOSAL (RFP)

OFFER SHEET

SOLICITATION NO: RFP SMW0127

DATE ISSUED: January 26, 2015

REQUISITION NO.: RQM 15012100144

COMMODITY CODE: 20811

FOR CONTRACTUAL AND TECHNICAL ISSUES CONTACT THE FOLLOWING AUTHORIZED CONTACT PERSON:

Ms. Shawn M. Willett
Corporate Contract Compliance Manager

Phone: (512) 974-2274
E-Mail: Shawn.Willett

COMMODITY/SERVICE DESCRIPTION: Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software

PRE-PROPOSAL CONFERENCE TIME AND DATE: N/A

LOCATION: N/A

PROPOSAL DUE PRIOR TO: 3:00 PM on March 12, 2015

PROPOSAL CLOSING TIME AND DATE: 3:00 PM on March 12, 2015

LOCATION: MUNICIPAL BUILDING, 124 W 8th STREET RM 308, AUSTIN, TEXAS 78701

When submitting a sealed Offer and/or Compliance Plan, use the proper address for the type of service desired, as shown below:

P.O. Address for US Mail	Street Address for Hand Delivery or Courier Service
City of Austin	City of Austin, Municipal Building
Purchasing Office-Response Enclosed	Purchasing Office-Response Enclosed
P.O. Box 1088	124 W 8th Street, Rm 310
Austin, Texas 78767-8845	Austin, Texas 78701
	Reception Phone: (512) 974-2500

To ensure prompt delivery, all packages SHALL BE CLEARLY MARKED ON THE OUTSIDE "Purchasing Office-Response Enclosed" along with the offeror's name & address, solicitation number and due date and time. See Section 0200 Solicitation Instructions for more details.

All Offers (including Compliance Plans) that are not submitted in a sealed envelope or container will not be considered.

SUBMIT 1 ORIGINAL, 5 COPIES, AND 1 ELECTRONIC COPY (CD or FLASH DRIVE) OF YOUR RESPONSE

*****SIGNATURE FOR SUBMITTAL REQUIRED ON PAGE 3 OF THIS DOCUMENT*****

This solicitation is comprised of the following required sections. Please ensure to carefully read each section including those incorporated by reference. By signing this document, you are agreeing to all the items contained herein and will be bound to all terms.

SECTION NO.	TITLE	PAGES
0100	STANDARD PURCHASE DEFINITIONS	*
0200	STANDARD SOLICITATION INSTRUCTIONS	*
0300	STANDARD PURCHASE TERMS AND CONDITIONS	*
0400	SUPPLEMENTAL PURCHASE PROVISIONS	7
0500	SCOPE OF WORK	2
0600	PROPOSAL PREPARATION INSTRUCTIONS & EVALUATION FACTORS	6
0605	LOCAL BUSINESS PRESENCE IDENTIFICATION FORM – Complete and return	1
0700	REFERENCE SHEET – Complete and return if required	2
0800	NON-DISCRIMINATION CERTIFICATION	*
0805	NON-SUSPENSION OR DEBARMENT CERTIFICATION	*
0810	NON-COLLUSION, NON-CONFLICT OF INTEREST, AND ANTI-LOBBYING CERTIFICATION	*
0815	LIVING WAGES AND BENEFITS CONTRACTOR CERTIFICATION–Complete and return	1
0835	NONRESIDENT BIDDER PROVISIONS – Complete and return	1

*** Documents are hereby incorporated into this Solicitation by reference, with the same force and effect as if they were incorporated in full text. The full text versions of these Sections are available, on the Internet at the following online address:**

http://www.austintexas.gov/financeonline/vendor_connection/index.cfm#STANDARDBIDDOCUMENTS

If you do not have access to the Internet, you may obtain a copy of these Sections from the City of Austin Purchasing Office located in the Municipal Building, 124 West 8th Street, Room #308 Austin, Texas 78701; phone (512) 974-2500. Please have the Solicitation number available so that the staff can select the proper documents. These documents can be mailed, expressed mailed, or faxed to you.

I agree to abide by the City's MBE/WBE Procurement Program Ordinance and Rules. In cases where the City has established that there are no M/WBE subcontracting goals for a solicitation, I agree that by submitting this offer my firm is completing all the work for the project and not subcontracting any portion. If any service is needed to perform the contract that my firm does not perform with its own workforce or supplies, I agree to contact the Small and Minority Business Resources Department (SMBR) at (512) 974-7600 to obtain a list of MBE and WBE firms available to perform the service and am including the completed No Goals Utilization Plan with my submittal. This form can be found Under the Standard Bid Document Tab on the Vendor Connection Website:

http://www.austintexas.gov/financeonline/vendor_connection/index.cfm#STANDARDBIDDOCUMENTS

If I am awarded the contract I agree to continue complying with the City's MBE/WBE Procurement Program Ordinance and Rules including contacting SMBR if any subcontracting is later identified.

The undersigned, by his/her signature, represents that he/she is submitting a binding offer and is authorized to bind the respondent to fully comply with the solicitation document contained herein. The Respondent, by submitting and signing below, acknowledges that he/she has received and read the entire document packet sections defined above including all documents incorporated by reference, and agrees to be bound by the terms therein.

Company Name: Vieux & Associates, Inc.

Company Address: 350 David L Boren Blvd, Suite 2500

City, State, Zip: Norman, OK 73072

Federal Tax ID No. [redacted]

Printed Name of Officer or Authorized Representative: Jean E. Vieux

Title: President

Signature of Officer or Authorized Representative:

Date: 3/23/2015

Email Address: jean.vieux@vieuxinc.com

Phone Number: 405.325.1818

*** Proposal response must be submitted with this Offer sheet to be considered for award**

Our fixed-price offer for FFMMS Services is $75,000 one-time, $467,788 for the first 24-month period, and annually at $215,569 for 12-month extensions (3), thereafter.

RECEIVED
2015 MAR 26 AM 9 43
PURCHASING OFFICE
CITY OF AUSTIN, TEXAS

CITY OF AUSTIN
PURCHASING OFFICE
STANDARD PURCHASE TERMS AND CONDITIONS

By submitting an Offer in response to the Solicitation, the Contractor agrees that the Contract shall be governed by the following terms and conditions. Unless otherwise specified in the Contract, Sections 3, 4, 5, 6, 7, 8, 20, 21, and 36 shall apply only to a Solicitation to purchase Goods, and Sections 9, 10, 11 and 22 shall apply only to a Solicitation to purchase Services to be performed principally at the City's premises or on public rights-of-way.

1. **CONTRACTOR'S OBLIGATIONS**. The Contractor shall fully and timely provide all Deliverables described in the Solicitation and in the Contractor's Offer in strict accordance with the terms, covenants, and conditions of the Contract and all applicable Federal, State, and local laws, rules, and regulations.

2. **EFFECTIVE DATE/TERM**. Unless otherwise specified in the Solicitation, this Contract shall be effective as of the date the contract is signed by the City, and shall continue in effect until all obligations are performed in accordance with the Contract.

3. **CONTRACTOR TO PACKAGE DELIVERABLES**: The Contractor will package Deliverables in accordance with good commercial practice and shall include a packing list showing the description of each item, the quantity and unit price Unless otherwise provided in the Specifications or Supplemental Terms and Conditions, each shipping container shall be clearly and permanently marked as follows: (a) The Contractor's name and address, (b) the City's name, address and purchase order or purchase release number and the price agreement number if applicable, (c) Container number and total number of containers, e.g. box 1 of 4 boxes, and (d) the number of the container bearing the packing list. The Contractor shall bear cost of packaging. Deliverables shall be suitably packed to secure lowest transportation costs and to conform with requirements of common carriers and any applicable specifications. The City's count or weight shall be final and conclusive on shipments not accompanied by packing lists.

4. **SHIPMENT UNDER RESERVATION PROHIBITED**: The Contractor is not authorized to ship the Deliverables under reservation and no tender of a bill of lading will operate as a tender of Deliverables.

5. **TITLE & RISK OF LOSS**: Title to and risk of loss of the Deliverables shall pass to the City only when the City actually receives and accepts the Deliverables.

6. **DELIVERY TERMS AND TRANSPORTATION CHARGES**: Deliverables shall be shipped F.O.B. point of delivery unless otherwise specified in the Supplemental Terms and Conditions. Unless otherwise stated in the Offer, the Contractor's price shall be deemed to include all delivery and transportation charges. The City shall have the right to designate what method of transportation shall be used to ship the Deliverables. The place of delivery shall be that set forth in the block of the purchase order or purchase release entitled "Receiving Agency".

7. **RIGHT OF INSPECTION AND REJECTION**: The City expressly reserves all rights under law, including, but not limited to the Uniform Commercial Code, to inspect the Deliverables at delivery before accepting them, and to reject defective or non-conforming Deliverables. If the City has the right to inspect the Contractor's, or the Contractor's Subcontractor's, facilities, or the Deliverables at the Contractor's, or the Contractor's Subcontractor's, premises, the Contractor shall furnish, or cause to be furnished, without additional charge, all reasonable facilities and assistance to the City to facilitate such inspection.

8. **NO REPLACEMENT OF DEFECTIVE TENDER**: Every tender or delivery of Deliverables must fully comply with all provisions of the Contract as to time of delivery, quality, and quantity. Any non-complying tender shall constitute a breach and the Contractor shall not have the right to substitute a conforming tender; provided, where the time for performance has not yet expired, the Contractor may notify the City of the intention to cure and may then make a conforming tender within the time allotted in the contract.

9. **PLACE AND CONDITION OF WORK**: The City shall provide the Contractor access to the sites where the Contractor is to perform the services as required in order for the Contractor to perform the services in a timely and efficient manner, in accordance with and subject to the applicable security laws, rules, and regulations. The Contractor acknowledges that it has satisfied itself as to the nature of the City's service requirements and specifications, the location and essential characteristics of the work sites, the quality and quantity of materials, equipment, labor and facilities necessary to perform the services, and any other condition or state of fact which could in any way affect performance of the Contractor's obligations under the contract. The Contractor hereby

releases and holds the City harmless from and against any liability or claim for damages of any kind or nature if the actual site or service conditions differ from expected conditions.

10. **WORKFORCE**

A. The Contractor shall employ only orderly and competent workers, skilled in the performance of the services which they will perform under the Contract.

B. The Contractor, its employees, subcontractors, and subcontractor's employees may not while engaged in participating or responding to a solicitation or while in the course and scope of delivering goods or services under a City of Austin contract or on the City's property .

i. use or possess a firearm, including a concealed handgun that is licensed under state law, except as required by the terms of the contract; or
ii. use or possess alcoholic or other intoxicating beverages, illegal drugs or controlled substances, nor may such workers be intoxicated, or under the influence of alcohol or drugs, on the job.

C. If the City or the City's representative notifies the Contractor that any worker is incompetent, disorderly or disobedient, has knowingly or repeatedly violated safety regulations, has possessed any firearms, or has possessed or was under the influence of alcohol or drugs on the job, the Contractor shall immediately remove such worker from Contract services, and may not employ such worker again on Contract services without the City's prior written consent.

11. **COMPLIANCE WITH HEALTH, SAFETY, AND ENVIRONMENTAL REGULATIONS**: The Contractor, its Subcontractors, and their respective employees, shall comply fully with all applicable federal, state, and local health, safety, and environmental laws, ordinances, rules and regulations in the performance of the services, including but not limited to those promulgated by the City and by the Occupational Safety and Health Administration (OSHA). In case of conflict, the most stringent safety requirement shall govern. The Contractor shall indemnify and hold the City harmless from and against all claims, demands, suits, actions, judgments, fines, penalties and liability of every kind arising from the breach of the Contractor's obligations under this paragraph.

12. **INVOICES**:

A. The Contractor shall submit separate invoices in duplicate on each purchase order or purchase release after each delivery. If partial shipments or deliveries are authorized by the City, a separate invoice must be sent for each shipment or delivery made.

B. **Proper Invoices must include a unique invoice number, the purchase order or delivery order number and the master agreement number if applicable, the Department's Name, and the name of the point of contact for the Department**. Invoices shall be itemized and transportation charges, if any, shall be listed separately. A copy of the bill of lading and the freight waybill, when applicable, shall be attached to the invoice. The Contractor's name and, if applicable, the tax identification number on the invoice must exactly match the information in the Vendor's registration with the City. Unless otherwise instructed in writing, the City may rely on the remittance address specified on the Contractor's invoice.

C. Invoices for labor shall include a copy of all time-sheets with trade labor rate and Deliverables order number clearly identified. Invoices shall also include a tabulation of work-hours at the appropriate rates and grouped by work order number. Time billed for labor shall be limited to hours actually worked at the work site.

D. Unless otherwise expressly authorized in the Contract, the Contractor shall pass through all Subcontract and other authorized expenses at actual cost without markup.

E. Federal excise taxes, State taxes, or City sales taxes must not be included in the invoiced amount. The City will furnish a tax exemption certificate upon request.

13. **PAYMENT**:

A. All proper invoices received by the City will be paid within thirty (30) calendar days of the City's receipt of the Deliverables or of the invoice, whichever is later.

B. **If payment is not timely made, (per paragraph A), interest shall accrue on the unpaid balance at the lesser of the rate specified in Texas Government Code Section 2251.025 or the maximum lawful rate; except, if payment is not timely made for a reason for which the City may withhold payment hereunder, interest shall not accrue until ten (10) calendar days after the grounds for withholding payment have been resolved.**

C. If partial shipments or deliveries are authorized by the City, the Contractor will be paid for the partial shipment or delivery, as stated above, provided that the invoice matches the shipment or delivery.

D. The City may withhold or set off the entire payment or part of any payment otherwise due the Contractor to such extent as may be necessary on account of:

i. delivery of defective or non-conforming Deliverables by the Contractor;
ii. third party claims, which are not covered by the insurance which the Contractor is required to provide, are filed or reasonable evidence indicating probable filing of such claims;
iii. failure of the Contractor to pay Subcontractors, or for labor, materials or equipment;
iv. damage to the property of the City or the City's agents, employees or contractors, which is not covered by insurance required to be provided by the Contractor;
v. reasonable evidence that the Contractor's obligations will not be completed within the time specified in the Contract, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;
vi. failure of the Contractor to submit proper invoices with all required attachments and supporting documentation; or
vii. failure of the Contractor to comply with any material provision of the Contract Documents.

E. Notice is hereby given of Article VIII, Section 1 of the Austin City Charter which prohibits the payment of any money to any person, firm or corporation who is in arrears to the City for taxes, and of §2-8-3 of the Austin City Code concerning the right of the City to offset indebtedness owed the City.

F. Payment will be made by check unless the parties mutually agree to payment by credit card or electronic transfer of funds. The Contractor agrees that there shall be no additional charges, surcharges, or penalties to the City for payments made by credit card or electronic funds transfer.

G. The awarding or continuation of this contract is dependent upon the availability of funding. The City's payment obligations are payable only and solely from funds Appropriated and available for this contract. The absence of Appropriated or other lawfully available funds shall render the Contract null and void to the extent funds are not Appropriated or available and any Deliverables delivered but unpaid shall be returned to the Contractor. The City shall provide the Contractor written notice of the failure of the City to make an adequate Appropriation for any fiscal year to pay the amounts due under the Contract, or the reduction of any Appropriation to an amount insufficient to permit the City to pay its obligations under the Contract. In the event of non or inadequate appropriation of funds, there will be no penalty nor removal fees charged to the City.

14. **TRAVEL EXPENSES**: All travel, lodging and per diem expenses in connection with the Contract for which reimbursement may be claimed by the Contractor under the terms of the Solicitation will be reviewed against the City's Travel Policy as published and maintained by the City's Controller's Office and the Current United States General Services Administration Domestic Per Diem Rates (the "Rates") as published and maintained on the Internet at:

http://www.gsa.gov/portal/category/21287

No amounts in excess of the Travel Policy or Rates shall be paid. All invoices must be accompanied by copies of detailed itemized receipts (e.g. hotel bills, airline tickets). No reimbursement will be made for expenses not actually incurred. Airline fares in excess of coach or economy will not be reimbursed. Mileage charges may not exceed the amount permitted as a deduction in any year under the Internal Revenue Code or Regulations.

15. **FINAL PAYMENT AND CLOSE-OUT**:

A. If an MBE/WBE Program Compliance Plan is required by the Solicitation, and the Contractor has identified Subcontractors, the Contractor is required to submit a Contract Close-Out MBE/WBE Compliance Report to the Project manager or Contract manager no later than the 15th calendar day after completion of all work under the contract. Final payment, retainage, or both may be withheld if the Contractor is not in compliance with the requirements of the Compliance Plan as accepted by the City.

B. The making and acceptance of final payment will constitute:

i. a waiver of all claims by the City against the Contractor, except claims (1) which have been previously asserted in writing and not yet settled, (2) arising from defective work appearing after final inspection, (3) arising from failure of the Contractor to comply with the Contract or the terms of any warranty specified herein, (4) arising from the Contractor's continuing obligations under the Contract, including but not limited to indemnity and warranty obligations, or (5) arising under the City's right to audit; and

ii. a waiver of all claims by the Contractor against the City other than those previously asserted in writing and not yet settled.

16. **SPECIAL TOOLS & TEST EQUIPMENT**: If the price stated on the Offer includes the cost of any special tooling or special test equipment fabricated or required by the Contractor for the purpose of filling this order, such special tooling equipment and any process sheets related thereto shall become the property of the City and shall be identified by the Contractor as such.

17. **RIGHT TO AUDIT**:

A. The Contractor agrees that the representatives of the Office of the City Auditor or other authorized representatives of the City shall have access to, and the right to audit, examine, or reproduce, any and all records of the Contractor related to the performance under this Contract. The Contractor shall retain all such records for a period of three (3) years after final payment on this Contract or until all audit and litigation matters that the City has brought to the attention of the Contractor are resolved, whichever is longer. The Contractor agrees to refund to the City any overpayments disclosed by any such audit.

B. The Contractor shall include section a. above in all subcontractor agreements entered into in connection with this Contract.

18. **SUBCONTRACTORS**:

A. If the Contractor identified Subcontractors in an MBE/WBE Program Compliance Plan or a No Goals Utilization Plan the Contractor shall comply with the provisions of Chapters 2-9A, 2-9B, 2-9C, and 2-9D, as applicable, of the Austin City Code and the terms of the Compliance Plan or Utilization Plan as approved by the City (the "Plan"). The Contractor shall not initially employ any Subcontractor except as provided in the Contractor's Plan. The Contractor shall not substitute any Subcontractor identified in the Plan, unless the substitute has been accepted by the City in writing in accordance with the provisions of Chapters 2-9A, 2-9B, 2-9C and 2-9D, as applicable. No acceptance by the City of any Subcontractor shall constitute a waiver of any rights or remedies of the City with respect to defective Deliverables provided by a Subcontractor. If a Plan has been approved, the Contractor is additionally required to submit a monthly Subcontract Awards and Expenditures Report to the Contract Manager and the Purchasing Office Contract Compliance Manager no later than the tenth calendar day of each month.

B. Work performed for the Contractor by a Subcontractor shall be pursuant to a written contract between the Contractor and Subcontractor. The terms of the subcontract may not conflict with the terms of the Contract, and shall contain provisions that:

i. require that all Deliverables to be provided by the Subcontractor be provided in strict accordance with the provisions, specifications and terms of the Contract;
ii. prohibit the Subcontractor from further subcontracting any portion of the Contract without the prior written consent of the City and the Contractor. The City may require, as a condition to such further subcontracting, that the Subcontractor post a payment bond in form, substance and amount acceptable to the City;
iii. require Subcontractors to submit all invoices and applications for payments, including any claims for additional payments, damages or otherwise, to the Contractor in sufficient time to enable the Contractor to include same with its invoice or application for payment to the City in accordance with the terms of the Contract;
iv. require that all Subcontractors obtain and maintain, throughout the term of their contract, insurance in the type and amounts specified for the Contractor, with the City being a named insured as its interest shall appear; and
v. require that the Subcontractor indemnify and hold the City harmless to the same extent as the Contractor is required to indemnify the City.

C. The Contractor shall be fully responsible to the City for all acts and omissions of the Subcontractors just as the Contractor is responsible for the Contractor's own acts and omissions. Nothing in the Contract shall create for the benefit of any such Subcontractor any contractual relationship between the City and any such Subcontractor, nor shall it create any obligation on the part of the City to pay or to see to the payment of any moneys due any such Subcontractor except as may otherwise be required by law.

D. The Contractor shall pay each Subcontractor its appropriate share of payments made to the Contractor not later than ten (10) calendar days after receipt of payment from the City.

19. **WARRANTY-PRICE**:

A. The Contractor warrants the prices quoted in the Offer are no higher than the Contractor's current prices on orders by others for like Deliverables under similar terms of purchase.

B. The Contractor certifies that the prices in the Offer have been arrived at independently without consultation, communication, or agreement for the purpose of restricting competition, as to any matter relating to such fees with any other firm or with any competitor.

C. In addition to any other remedy available, the City may deduct from any amounts owed to the Contractor, or otherwise recover, any amounts paid for items in excess of the Contractor's current prices on orders by others for like Deliverables under similar terms of purchase.

20. **WARRANTY – TITLE**: The Contractor warrants that it has good and indefeasible title to all Deliverables furnished under the Contract, and that the Deliverables are free and clear of all liens, claims, security interests and encumbrances. The Contractor shall indemnify and hold the City harmless from and against all adverse title claims to the Deliverables.

21. **WARRANTY – DELIVERABLES**: The Contractor warrants and represents that all Deliverables sold the City under the Contract shall be free from defects in design, workmanship or manufacture, and conform in all material respects to the specifications, drawings, and descriptions in the Solicitation, to any samples furnished by the Contractor, to the terms, covenants and conditions of the Contract, and to all applicable State, Federal or local laws, rules, and regulations, and industry codes and standards. Unless otherwise stated in the Solicitation, the Deliverables shall be new or recycled merchandise, and not used or reconditioned.

A. Recycled Deliverables shall be clearly identified as such.

B. The Contractor may not limit, exclude or disclaim the foregoing warranty or any warranty implied by law; and any attempt to do so shall be without force or effect.

C. Unless otherwise specified in the Contract, the warranty period shall be at least one year from the date of acceptance of the Deliverables or from the date of acceptance of any replacement Deliverables. If during the warranty period, one or more of the above warranties are breached, the Contractor shall promptly upon receipt of demand either repair the non-conforming Deliverables, or replace the non-conforming Deliverables with fully conforming Deliverables, at the City's option and at no additional cost to the City. All costs incidental to such repair or replacement, including but not limited to, any packaging and shipping costs, shall be borne exclusively by the Contractor. The City shall endeavor to give the Contractor written notice of the breach of warranty within thirty (30) calendar days of discovery of the breach of warranty, but failure to give timely notice shall not impair the City's rights under this section.

D. If the Contractor is unable or unwilling to repair or replace defective or non-conforming Deliverables as required by the City, then in addition to any other available remedy, the City may reduce the quantity of Deliverables it may be required to purchase under the Contract from the Contractor, and purchase conforming Deliverables from other sources. In such event, the Contractor shall pay to the City upon demand the increased cost, if any, incurred by the City to procure such Deliverables from another source.

E. If the Contractor is not the manufacturer, and the Deliverables are covered by a separate manufacturer's warranty, the Contractor shall transfer and assign such manufacturer's warranty to the City. If for any reason the manufacturer's warranty cannot be fully transferred to the City, the Contractor shall assist and cooperate with the City to the fullest extent to enforce such manufacturer's warranty for the benefit of the City.

22. **WARRANTY – SERVICES**: The Contractor warrants and represents that all services to be provided the City under the Contract will be fully and timely performed in a good and workmanlike manner in accordance with generally accepted industry standards and practices, the terms, conditions, and covenants of the Contract, and all applicable Federal, State and local laws, rules or regulations.

A. The Contractor may not limit, exclude or disclaim the foregoing warranty or any warranty implied by law, and any attempt to do so shall be without force or effect.

B. Unless otherwise specified in the Contract, the warranty period shall be at least one year from the Acceptance Date. If during the warranty period, one or more of the above warranties are breached, the Contractor shall promptly upon receipt of demand perform the services again in accordance with above standard at no additional cost to the City. All costs incidental to such additional performance shall be borne by the Contractor. The City shall endeavor to give the Contractor written notice of the breach of warranty within thirty (30) calendar days of discovery of the breach warranty, but failure to give timely notice shall not impair the City's rights under this section.

C. If the Contractor is unable or unwilling to perform its services in accordance with the above standard as required by the City, then in addition to any other available remedy, the City may reduce the amount of services it may be required to purchase under the Contract from the Contractor, and purchase conforming services from other sources. In such event, the Contractor shall pay to the City upon demand the increased cost, if any, incurred by the City to procure such services from another source.

23. **ACCEPTANCE OF INCOMPLETE OR NON-CONFORMING DELIVERABLES**: If, instead of requiring immediate correction or removal and replacement of defective or non-conforming Deliverables, the City prefers to accept it, the City may do so. The Contractor shall pay all claims, costs, losses and damages attributable to the City's evaluation of and determination to accept such defective or non-conforming Deliverables. If any such acceptance occurs prior to final payment, the City may deduct such amounts as are necessary to compensate the City for the diminished value of the defective or non-conforming Deliverables. If the acceptance occurs after final payment, such amount will be refunded to the City by the Contractor.

24. **RIGHT TO ASSURANCE**: Whenever one party to the Contract in good faith has reason to question the other party's intent to perform, demand may be made to the other party for written assurance of the intent to perform. In the event

that no assurance is given within the time specified after demand is made, the demanding party may treat this failure as an anticipatory repudiation of the Contract.

25. **STOP WORK NOTICE**: The City may issue an immediate Stop Work Notice in the event the Contractor is observed performing in a manner that is in violation of Federal, State, or local guidelines, or in a manner that is determined by the City to be unsafe to either life or property. Upon notification, the Contractor will cease all work until notified by the City that the violation or unsafe condition has been corrected. The Contractor shall be liable for all costs incurred by the City as a result of the issuance of such Stop Work Notice.

26. **DEFAULT**: The Contractor shall be in default under the Contract if the Contractor (a) fails to fully, timely and faithfully perform any of its material obligations under the Contract, (b) fails to provide adequate assurance of performance under Paragraph 24, (c) becomes insolvent or seeks relief under the bankruptcy laws of the United States or (d) makes a material misrepresentation in Contractor's Offer, or in any report or deliverable required to be submitted by the Contractor to the City.

27. **TERMINATION FOR CAUSE:**. In the event of a default by the Contractor, the City shall have the right to terminate the Contract for cause, by written notice effective ten (10) calendar days, unless otherwise specified, after the date of such notice, unless the Contractor, within such ten (10) day period, cures such default, or provides evidence sufficient to prove to the City's reasonable satisfaction that such default does not, in fact, exist. The City may place Contractor on probation for a specified period of time within which the Contractor must correct any non-compliance issues. Probation shall not normally be for a period of more than nine (9) months, however, it may be for a longer period, not to exceed one (1) year depending on the circumstances. If the City determines the Contractor has failed to perform satisfactorily during the probation period, the City may proceed with suspension. In the event of a default by the Contractor, the City may suspend or debar the Contractor in accordance with the "City of Austin Purchasing Office Probation, Suspension and Debarment Rules for Vendors" and remove the Contractor from the City's vendor list for up to five (5) years and any Offer submitted by the Contractor may be disqualified for up to five (5) years. In addition to any other remedy available under law or in equity, the City shall be entitled to recover all actual damages, costs, losses and expenses, incurred by the City as a result of the Contractor's default, including, without limitation, cost of cover, reasonable attorneys' fees, court costs, and prejudgment and post-judgment interest at the maximum lawful rate. All rights and remedies under the Contract are cumulative and are not exclusive of any other right or remedy provided by law.

28. **TERMINATION WITHOUT CAUSE**: The City shall have the right to terminate the Contract, in whole or in part, without cause any time upon thirty (30) calendar days' prior written notice. Upon receipt of a notice of termination, the Contractor shall promptly cease all further work pursuant to the Contract, with such exceptions, if any, specified in the notice of termination. The City shall pay the Contractor, to the extent of funds Appropriated or otherwise legally available for such purposes, for all goods delivered and services performed and obligations incurred prior to the date of termination in accordance with the terms hereof.

29. **FRAUD**: Fraudulent statements by the Contractor on any Offer or in any report or deliverable required to be submitted by the Contractor to the City shall be grounds for the termination of the Contract for cause by the City and may result in legal action.

30. **DELAYS**:

    A. The City may delay scheduled delivery or other due dates by written notice to the Contractor if the City deems it is in its best interest. If such delay causes an increase in the cost of the work under the Contract, the City and the Contractor shall negotiate an equitable adjustment for costs incurred by the Contractor in the Contract price and execute an amendment to the Contract. The Contractor must assert its right to an adjustment within thirty (30) calendar days from the date of receipt of the notice of delay. Failure to agree on any adjusted price shall be handled under the Dispute Resolution process specified in paragraph 49. However, nothing in this provision shall excuse the Contractor from delaying the delivery as notified.

    B. Neither party shall be liable for any default or delay in the performance of its obligations under this Contract if, while and to the extent such default or delay is caused by acts of God, fire, riots, civil commotion, labor disruptions, sabotage, sovereign conduct, or any other cause beyond the reasonable control of such Party. In

the event of default or delay in contract performance due to any of the foregoing causes, then the time for completion of the services will be extended; provided, however, in such an event, a conference will be held within three (3) business days to establish a mutually agreeable period of time reasonably necessary to overcome the effect of such failure to perform.

31. **INDEMNITY**:

A. Definitions:

i. "Indemnified Claims" shall include any and all claims, demands, suits, causes of action, judgments and liability of every character, type or description, including all reasonable costs and expenses of litigation, mediation or other alternate dispute resolution mechanism, including attorney and other professional fees for:
(1) damage to or loss of the property of any person (including, but not limited to the City, the Contractor, their respective agents, officers, employees and subcontractors; the officers, agents, and employees of such subcontractors; and third parties); and/or
(2) death, bodily injury, illness, disease, worker's compensation, loss of services, or loss of income or wages to any person (including but not limited to the agents, officers and employees of the City, the Contractor, the Contractor's subcontractors, and third parties),

ii. "Fault" shall include the sale of defective or non-conforming Deliverables, negligence, willful misconduct, or a breach of any legally imposed strict liability standard.

B. **THE CONTRACTOR SHALL DEFEND (AT THE OPTION OF THE CITY), INDEMNIFY, AND HOLD THE CITY, ITS SUCCESSORS, ASSIGNS, OFFICERS, EMPLOYEES AND ELECTED OFFICIALS HARMLESS FROM AND AGAINST ALL INDEMNIFIED CLAIMS DIRECTLY ARISING OUT OF, INCIDENT TO, CONCERNING OR RESULTING FROM THE FAULT OF THE CONTRACTOR, OR THE CONTRACTOR'S AGENTS, EMPLOYEES OR SUBCONTRACTORS, IN THE PERFORMANCE OF THE CONTRACTOR'S OBLIGATIONS UNDER THE CONTRACT. NOTHING HEREIN SHALL BE DEEMED TO LIMIT THE RIGHTS OF THE CITY OR THE CONTRACTOR (INCLUDING, BUT NOT LIMITED TO, THE RIGHT TO SEEK CONTRIBUTION) AGAINST ANY THIRD PARTY WHO MAY BE LIABLE FOR AN INDEMNIFIED CLAIM.**

32. **INSURANCE**: (reference Section 0400 for specific coverage requirements). The following insurance requirement applies. (Revised March 2013).

A. General Requirements.

i. The Contractor shall at a minimum carry insurance in the types and amounts indicated in Section 0400, Supplemental Purchase Provisions, for the duration of the Contract, including extension options and hold over periods, and during any warranty period.

ii. The Contractor shall provide Certificates of Insurance with the coverages and endorsements required in Section 0400, Supplemental Purchase Provisions, to the City as verification of coverage prior to contract execution and within fourteen (14) calendar days after written request from the City. Failure to provide the required Certificate of Insurance may subject the Offer to disqualification from consideration for award. The Contractor must also forward a Certificate of Insurance to the City whenever a previously identified policy period has expired, or an extension option or hold over period is exercised, as verification of continuing coverage.

iii. The Contractor shall not commence work until the required insurance is obtained and until such insurance has been reviewed by the City. Approval of insurance by the City shall not relieve or decrease the liability of the Contractor hereunder and shall not be construed to be a limitation of liability on the part of the Contractor.

iv. The City may request that the Contractor submit certificates of insurance to the City for all subcontractors prior to the subcontractors commencing work on the project.

v. The Contractor's and all subcontractors' insurance coverage shall be written by companies licensed to do business in the State of Texas at the time the policies are issued and shall be written by companies with A.M. Best ratings of B+VII or better.

vi. The "other" insurance clause shall not apply to the City where the City is an additional insured shown on any policy. It is intended that policies required in the Contract, covering both the City and the Contractor, shall be considered primary coverage as applicable.

vii. If insurance policies are not written for amounts specified in Section 0400, Supplemental Purchase Provisions, the Contractor shall carry Umbrella or Excess Liability Insurance for any differences in amounts specified. If Excess Liability Insurance is provided, it shall follow the form of the primary coverage.

viii. The City shall be entitled, upon request, at an agreed upon location, and without expense, to review certified copies of policies and endorsements thereto and may make any reasonable requests for deletion or revision or modification of particular policy terms, conditions, limitations, or exclusions except where policy provisions are established by law or regulations binding upon either of the parties hereto or the underwriter on any such policies.

ix. The City reserves the right to review the insurance requirements set forth during the effective period of the Contract and to make reasonable adjustments to insurance coverage, limits, and exclusions when deemed necessary and prudent by the City based upon changes in statutory law, court decisions, the claims history of the industry or financial condition of the insurance company as well as the Contractor.

x. The Contractor shall not cause any insurance to be canceled nor permit any insurance to lapse during the term of the Contract or as required in the Contract.

xi. The Contractor shall be responsible for premiums, deductibles and self-insured retentions, if any, stated in policies. Self-insured retentions shall be disclosed on the Certificate of Insurance.

xii. The Contractor shall provide the City thirty (30) calendar days' written notice of erosion of the aggregate limits below occurrence limits for all applicable coverages indicated within the Contract.

xiii. The insurance coverages specified in Section 0400, Supplemental Purchase Provisions, are required minimums and are not intended to limit the responsibility or liability of the Contractor.

B. Specific Coverage Requirements: Specific insurance requirements are contained in Section 0400, Supplemental Purchase Provisions

33. **CLAIMS**: If any claim, demand, suit, or other action is asserted against the Contractor which arises under or concerns the Contract, or which could have a material adverse affect on the Contractor's ability to perform thereunder, the Contractor shall give written notice thereof to the City within ten (10) calendar days after receipt of notice by the Contractor. Such notice to the City shall state the date of notification of any such claim, demand, suit, or other action; the names and addresses of the claimant(s); the basis thereof; and the name of each person against whom such claim is being asserted. Such notice shall be delivered personally or by mail and shall be sent to the City and to the Austin City Attorney. Personal delivery to the City Attorney shall be to City Hall, 301 West 2nd Street, 4th Floor, Austin, Texas 78701, and mail delivery shall be to P.O. Box 1088, Austin, Texas 78767.

34. **NOTICES**: Unless otherwise specified, all notices, requests, or other communications required or appropriate to be given under the Contract shall be in writing and shall be deemed delivered three (3) business days after postmarked if sent by U.S. Postal Service Certified or Registered Mail, Return Receipt Requested. Notices delivered by other means shall be deemed delivered upon receipt by the addressee. Routine communications may be made by first class mail, telefax, or other commercially accepted means. Notices to the Contractor shall be sent to the address specified in the Contractor's Offer, or at such other address as a party may notify the other in writing. Notices to the

City shall be addressed to the City at P.O. Box 1088, Austin, Texas 78767 and marked to the attention of the Contract Administrator.

35. **RIGHTS TO BID, PROPOSAL AND CONTRACTUAL MATERIAL**: All material submitted by the Contractor to the City shall become property of the City upon receipt. Any portions of such material claimed by the Contractor to be proprietary must be clearly marked as such. Determination of the public nature of the material is subject to the Texas Public Information Act, Chapter 552, Texas Government Code.

36. **NO WARRANTY BY CITY AGAINST INFRINGEMENTS**: The Contractor represents and warrants to the City that: (i) the Contractor shall provide the City good and indefeasible title to the Deliverables and (ii) the Deliverables supplied by the Contractor in accordance with the specifications in the Contract will not infringe, directly or contributorily, any patent, trademark, copyright, trade secret, or any other intellectual property right of any kind of any third party; that no claims have been made by any person or entity with respect to the ownership or operation of the Deliverables and the Contractor does not know of any valid basis for any such claims. The Contractor shall, at its sole expense, defend, indemnify, and hold the City harmless from and against all liability, damages, and costs (including court costs and reasonable fees of attorneys and other professionals) arising out of or resulting from: (i) any claim that the City's exercise anywhere in the world of the rights associated with the City's' ownership, and if applicable, license rights, and its use of the Deliverables infringes the intellectual property rights of any third party; or (ii) the Contractor's breach of any of Contractor's representations or warranties stated in this Contract. In the event of any such claim, the City shall have the right to monitor such claim or at its option engage its own separate counsel to act as co-counsel on the City's behalf. Further, Contractor agrees that the City's specifications regarding the Deliverables shall in no way diminish Contractor's warranties or obligations under this paragraph and the City makes no warranty that the production, development, or delivery of such Deliverables will not impact such warranties of Contractor.

37. **CONFIDENTIALITY**: In order to provide the Deliverables to the City, Contractor may require access to certain of the City's and/or its licensors' confidential information (including inventions, employee information, trade secrets, confidential know-how, confidential business information, and other information which the City or its licensors consider confidential) (collectively, "Confidential Information"). Contractor acknowledges and agrees that the Confidential Information is the valuable property of the City and/or its licensors and any unauthorized use, disclosure, dissemination, or other release of the Confidential Information will substantially injure the City and/or its licensors. The Contractor (including its employees, subcontractors, agents, or representatives) agrees that it will maintain the Confidential Information in strict confidence and shall not disclose, disseminate, copy, divulge, recreate, or otherwise use the Confidential Information without the prior written consent of the City or in a manner not expressly permitted under this Agreement, unless the Confidential Information is required to be disclosed by law or an order of any court or other governmental authority with proper jurisdiction, provided the Contractor promptly notifies the City before disclosing such information so as to permit the City reasonable time to seek an appropriate protective order. The Contractor agrees to use protective measures no less stringent than the Contractor uses within its own business to protect its own most valuable information, which protective measures shall under all circumstances be at least reasonable measures to ensure the continued confidentiality of the Confidential Information.

38. **PUBLICATIONS**: All published material and written reports submitted under the Contract must be originally developed material unless otherwise specifically provided in the Contract. When material not originally developed is included in a report in any form, the source shall be identified.

39. **ADVERTISING**: The Contractor shall not advertise or publish, without the City's prior consent, the fact that the City has entered into the Contract, except to the extent required by law.

40. **NO CONTINGENT FEES**: The Contractor warrants that no person or selling agency has been employed or retained to solicit or secure the Contract upon any agreement or understanding for commission, percentage, brokerage, or contingent fee, excepting bona fide employees of bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty, the City shall have the right, in addition to any other remedy available, to cancel the Contract without liability and to deduct from any amounts owed to the Contractor, or otherwise recover, the full amount of such commission, percentage, brokerage or contingent fee.

41. **GRATUITIES**: The City may, by written notice to the Contractor, cancel the Contract without liability if it is determined by the City that gratuities were offered or given by the Contractor or any agent or representative of the Contractor to any officer or employee of the City of Austin with a view toward securing the Contract or securing favorable treatment with respect to the awarding or amending or the making of any determinations with respect to the performing of such contract. In the event the Contract is canceled by the City pursuant to this provision, the City shall be entitled, in addition to any other rights and remedies, to recover or withhold the amount of the cost incurred by the Contractor in providing such gratuities.

42. **PROHIBITION AGAINST PERSONAL INTEREST IN CONTRACTS**: No officer, employee, independent consultant, or elected official of the City who is involved in the development, evaluation, or decision-making process of the performance of any solicitation shall have a financial interest, direct or indirect, in the Contract resulting from that solicitation. Any willful violation of this section shall constitute impropriety in office, and any officer or employee guilty thereof shall be subject to disciplinary action up to and including dismissal. Any violation of this provision, with the knowledge, expressed or implied, of the Contractor shall render the Contract voidable by the City.

43. **INDEPENDENT CONTRACTOR**: The Contract shall not be construed as creating an employer/employee relationship, a partnership, or a joint venture. The Contractor's services shall be those of an independent contractor. The Contractor agrees and understands that the Contract does not grant any rights or privileges established for employees of the City.

44. **ASSIGNMENT-DELEGATION**: The Contract shall be binding upon and enure to the benefit of the City and the Contractor and their respective successors and assigns, provided however, that no right or interest in the Contract shall be assigned and no obligation shall be delegated by the Contractor without the prior written consent of the City. Any attempted assignment or delegation by the Contractor shall be void unless made in conformity with this paragraph. The Contract is not intended to confer rights or benefits on any person, firm or entity not a party hereto; it being the intention of the parties that there be no third party beneficiaries to the Contract.

45. **WAIVER**: No claim or right arising out of a breach of the Contract can be discharged in whole or in part by a waiver or renunciation of the claim or right unless the waiver or renunciation is supported by consideration and is in writing signed by the aggrieved party. No waiver by either the Contractor or the City of any one or more events of default by the other party shall operate as, or be construed to be, a permanent waiver of any rights or obligations under the Contract, or an express or implied acceptance of any other existing or future default or defaults, whether of a similar or different character.

46. **MODIFICATIONS**: The Contract can be modified or amended only by a writing signed by both parties. No pre-printed or similar terms on any the Contractor invoice, order or other document shall have any force or effect to change the terms, covenants, and conditions of the Contract.

47. **INTERPRETATION**: The Contract is intended by the parties as a final, complete and exclusive statement of the terms of their agreement. No course of prior dealing between the parties or course of performance or usage of the trade shall be relevant to supplement or explain any term used in the Contract. Although the Contract may have been substantially drafted by one party, it is the intent of the parties that all provisions be construed in a manner to be fair to both parties, reading no provisions more strictly against one party or the other. Whenever a term defined by the Uniform Commercial Code, as enacted by the State of Texas, is used in the Contract, the UCC definition shall control, unless otherwise defined in the Contract.

48. **DISPUTE RESOLUTION**:

    A. If a dispute arises out of or relates to the Contract, or the breach thereof, the parties agree to negotiate prior to prosecuting a suit for damages. However, this section does not prohibit the filing of a lawsuit to toll the running of a statute of limitations or to seek injunctive relief. Either party may make a written request for a meeting between representatives of each party within fourteen (14) calendar days after receipt of the request or such later period as agreed by the parties. Each party shall include, at a minimum, one (1) senior level individual with decision-making authority regarding the dispute. The purpose of this and any subsequent meeting is to attempt in good faith to negotiate a resolution of the dispute. If, within thirty (30) calendar days after such

meeting, the parties have not succeeded in negotiating a resolution of the dispute, they will proceed directly to mediation as described below. Negotiation may be waived by a written agreement signed by both parties, in which event the parties may proceed directly to mediation as described below.

B. If the efforts to resolve the dispute through negotiation fail, or the parties waive the negotiation process, the parties may select, within thirty (30) calendar days, a mediator trained in mediation skills to assist with resolution of the dispute. Should they choose this option, the City and the Contractor agree to act in good faith in the selection of the mediator and to give consideration to qualified individuals nominated to act as mediator. Nothing in the Contract prevents the parties from relying on the skills of a person who is trained in the subject matter of the dispute or a contract interpretation expert. If the parties fail to agree on a mediator within thirty (30) calendar days of initiation of the mediation process, the mediator shall be selected by the Travis County Dispute Resolution Center (DRC). The parties agree to participate in mediation in good faith for up to thirty (30) calendar days from the date of the first mediation session. The City and the Contractor will share the mediator's fees equally and the parties will bear their own costs of participation such as fees for any consultants or attorneys they may utilize to represent them or otherwise assist them in the mediation.

49. **JURISDICTION AND VENUE**: The Contract is made under and shall be governed by the laws of the State of Texas, including, when applicable, the Uniform Commercial Code as adopted in Texas, V.T.C.A., Bus. & Comm. Code, Chapter 1, excluding any rule or principle that would refer to and apply the substantive law of another state or jurisdiction. All issues arising from this Contract shall be resolved in the courts of Travis County, Texas and the parties agree to submit to the exclusive personal jurisdiction of such courts. The foregoing, however, shall not be construed or interpreted to limit or restrict the right or ability of the City to seek and secure injunctive relief from any competent authority as contemplated herein.

50. **INVALIDITY**: The invalidity, illegality, or unenforceability of any provision of the Contract shall in no way affect the validity or enforceability of any other portion or provision of the Contract. Any void provision shall be deemed severed from the Contract and the balance of the Contract shall be construed and enforced as if the Contract did not contain the particular portion or provision held to be void. The parties further agree to reform the Contract to replace any stricken provision with a valid provision that comes as close as possible to the intent of the stricken provision. The provisions of this section shall not prevent this entire Contract from being void should a provision which is the essence of the Contract be determined to be void.

51. **HOLIDAYS:** The following holidays are observed by the City:

Holiday	Date Observed
New Year's Day	January 1
Martin Luther King, Jr.'s Birthday	Third Monday in January
President's Day	Third Monday in February
Memorial Day	Last Monday in May
Independence Day	July 4
Labor Day	First Monday in September
Veteran's Day	November 11
Thanksgiving Day	Fourth Thursday in November
Friday after Thanksgiving	Friday after Thanksgiving
Christmas Eve	December 24
Christmas Day	December 25

If a Legal Holiday falls on Saturday, it will be observed on the preceding Friday. If a Legal Holiday falls on Sunday, it will be observed on the following Monday.

52. **SURVIVABILITY OF OBLIGATIONS:** All provisions of the Contract that impose continuing obligations on the parties, including but not limited to the warranty, indemnity, and confidentiality obligations of the parties, shall survive the expiration or termination of the Contract.

53. **NON-SUSPENSION OR DEBARMENT CERTIFICATION:**

The City of Austin is prohibited from contracting with or making prime or sub-awards to parties that are suspended or debarred or whose principals are suspended or debarred from Federal, State, or City of Austin Contracts. By accepting a Contract with the City, the Vendor certifies that its firm and its principals are not currently suspended or debarred from doing business with the Federal Government, as indicated by the General Services Administration List of Parties Excluded from Federal Procurement and Non-Procurement Programs, the State of Texas, or the City of Austin.

54. **EQUAL OPPORTUNITY**

A. **Equal Employment Opportunity:** No Offeror, or Offeror's agent, shall engage in any discriminatory employment practice as defined in Chapter 5-4 of the City Code. No Offer submitted to the City shall be considered, nor any Purchase Order issued, or any Contract awarded by the City unless the Offeror has executed and filed with the City Purchasing Office a current Non-Discrimination Certification. Non-compliance with Chapter 5-4 of the City Code may result in sanctions, including termination of the contract and the Contractor's suspension or debarment from participation on future City contracts until deemed compliant with Chapter 5-4.

B. **Americans with Disabilities Act (ADA) Compliance:** No Offeror, or Offeror's agent, shall engage in any discriminatory employment practice against individuals with disabilities as defined in the ADA.

55. BUY AMERICAN ACT-SUPPLIES (Applicable to certain Federally funded requirements)

A. Definitions. As used in this paragraph –

i. "Component" means an article, material, or supply incorporated directly into an end product.

ii. "Cost of components" means -

(1) For components purchased by the Contractor, the acquisition cost, including transportation costs to the place of incorporation into the end product (whether or not such costs are paid to a domestic firm), and any applicable duty (whether or not a duty-free entry certificate is issued); or

(2) For components manufactured by the Contractor, all costs associated with the manufacture of the component, including transportation costs as described in paragraph (1) of this definition, plus allocable overhead costs, but excluding profit. Cost of components does not include any costs associated with the manufacture of the end product.

iii. "Domestic end product" means-

(1) An unmanufactured end product mined or produced in the United States; or

(2) An end product manufactured in the United States, if the cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. Components of foreign origin of the same class or kind as those that the agency determines are not mined, produced, or manufactured in sufficient and reasonably available commercial quantities of a satisfactory quality are treated as domestic. Scrap generated, collected, and prepared for processing in the United States is considered domestic.

iv. "End product" means those articles, materials, and supplies to be acquired under the contract for public use.

v. "Foreign end product" means an end product other than a domestic end product.

vi. "United States" means the 50 States, the District of Columbia, and outlying areas.

B. The Buy American Act (41 U.S.C. 10a - 10d) provides a preference for domestic end products for supplies acquired for use in the United States.

C. The City does not maintain a list of foreign articles that will be treated as domestic for this Contract; but will consider for approval foreign articles as domestic for this product if the articles are on a list approved by another Governmental Agency. The Offeror shall submit documentation with their Offer demonstrating that the article is on an approved Governmental list.

D. The Contractor shall deliver only domestic end products except to the extent that it specified delivery of foreign end products in the provision of the Solicitation entitled "Buy American Act Certificate".

CITY OF AUSTIN
PURCHASING OFFICE
SUPPLEMENTAL PURCHASE PROVISIONS
RFP SMW0127

The following Supplemental Purchasing Provisions apply to this solicitation:

1. **EXPLANATIONS OR CLARIFICATIONS:** (reference paragraph 5 in Section 0200)

   All requests for explanations or clarifications must be submitted in writing to the Purchasing Office no later than 5:00 pm on February 19, 2015 either via fax at (512) 974-2388 or email at shawn.willett@austintexas.gov.

2. **INSURANCE:** Insurance is required for this solicitation.

   A. **General Requirements:** See Section 0300, Standard Purchase Terms and Conditions, paragraph 32, entitled Insurance, for general insurance requirements.

      i. The Contractor shall provide a Certificate of Insurance as verification of coverages required below to the City at the below address prior to contract execution and within 14 calendar days after written request from the City. Failure to provide the required Certificate of Insurance may subject the Offer to disqualification from consideration for award
      ii. The Contractor shall not commence work until the required insurance is obtained and until such insurance has been reviewed by the City. Approval of insurance by the City shall not relieve or decrease the liability of the Contractor hereunder and shall not be construed to be a limitation of liability on the part of the Contractor.
      iii. The Contractor must also forward a Certificate of Insurance to the City whenever a previously identified policy period has expired, or an extension option or holdover period is exercised, as verification of continuing coverage.
      iv. The Certificate of Insurance, and updates, shall be mailed to the following address:

         City of Austin Purchasing Office
         P. O. Box 1088
         Austin, Texas 78767

   B. **Specific Coverage Requirements:** The Contractor shall at a minimum carry insurance in the types and amounts indicated below for the duration of the Contract, including extension options and hold over periods, and during any warranty period. These insurance coverages are required minimums and are not intended to limit the responsibility or liability of the Contractor.

      i. **Worker's Compensation and Employers' Liability Insurance:** Coverage shall be consistent with statutory benefits outlined in the Texas Worker's Compensation Act (Section 401). The minimum policy limits for Employer's Liability are $100,000 bodily injury each accident, $500,000 bodily injury by disease policy limit and $100,000 bodily injury by disease each employee.
         (1) The Contractor's policy shall apply to the State of Texas and include these endorsements in favor of the City of Austin:
            (a) Waiver of Subrogation, Form WC420304, or equivalent coverage
            (b) Thirty (30) days Notice of Cancellation, Form WC420601, or equivalent coverage
      ii. **Commercial General Liability Insurance:** The minimum bodily injury and property damage per occurrence are $500,000 for coverages A (Bodily Injury and Property Damage) and B (Personal and Advertising Injury).
         (1) The policy shall contain the following provisions:
            (a) Contractual liability coverage for liability assumed under the Contract and all other Contracts related to the project.
            (b) Contractor/Subcontracted Work.
            (c) Products/Completed Operations Liability for the duration of the warranty period.
            (d) If the project involves digging or drilling provisions must be included that provide Explosion, Collapse, and/or Underground Coverage.

(2) The policy shall also include these endorsements in favor of the City of Austin:
(a) Waiver of Subrogation, Endorsement CG 2404, or equivalent coverage
(b) Thirty (30) days Notice of Cancellation, Endorsement CG 0205, or equivalent coverage
(c) The City of Austin listed as an additional insured, Endorsement CG 2010, or equivalent coverage

iii. **Business Automobile Liability Insurance:** The Contractor shall provide coverage for all owned, non-owned and hired vehicles with a minimum combined single limit of $500,000 per occurrence for bodily injury and property damage. Alternate acceptable limits are $250,000 bodily injury per person, $500,000 bodily injury per occurrence and at least $100,000 property damage liability per accident.
(1) The policy shall include these endorsements in favor of the City of Austin:
(a) Waiver of Subrogation, Endorsement CA0444, or equivalent coverage
(b) Thirty (30) days Notice of Cancellation, Endorsement CA0244, or equivalent coverage
(c) The City of Austin listed as an additional insured, Endorsement CA2048, or equivalent coverage.

C. **Endorsements:** The specific insurance coverage endorsements specified above, or their equivalents must be provided. In the event that endorsements, which are the equivalent of the required coverage, are proposed to be substituted for the required coverage, copies of the equivalent endorsements must be provided for the City's review and approval.

3. **TERM OF CONTRACT:**

A. The Contract shall be in effect for an initial term of twenty-four (24) months and may be extended thereafter for up to three (3) additional twelve (12) month periods, subject to the approval of the Contractor and the City Purchasing Officer or his designee.

B. Upon expiration of the initial term or period of extension, the Contractor agrees to hold over under the terms and conditions of this agreement for such a period of time as is reasonably necessary to re-solicit and/or complete the project (not to exceed 120 days unless mutually agreed on in writing).

C. Upon written notice to the Contractor from the City's Purchasing Officer or his designee and acceptance of the Contractor, the term of this contract shall be extended on the same terms and conditions for an additional period as indicated in paragraph A above.

D. Prices are firm and fixed for the first twelve (12) months. Thereafter, price changes are subject to the Economic Price Adjustment provisions of this Contract.

4. **INVOICES and PAYMENT:** (reference paragraphs 12 and 13 in Section 0300)

A. Invoices shall contain a unique invoice number and the information required in Section 0300, paragraph 12, entitled "Invoices." Invoices received without all required information cannot be processed and will be returned to the vendor.

Invoices shall be mailed to the below address:

	City of Austin
Department	Watershed Protection Department
Attn:	Donna-Lee Bliss

Address	505 Barton Springs Road #1200
City, State Zip Code	Austin, Texas 78704

B. The Contractor agrees to accept payment by either credit card, check or Electronic Funds Transfer (EFT) for all goods and/or services provided under the Contract. The Contractor shall factor the cost of processing credit card payments into the Offer. There shall be no additional charges, surcharges, or penalties to the City for payments made by credit card.

5. **LIVING WAGES (applicable to procurements involving the use of labor):**

A. The minimum wage required for any Contractor employee directly assigned to this City Contract is $11.39 per hour, unless Published Wage Rates are included in this solicitation. In addition, the City may stipulate higher wage rates in certain solicitations in order to assure quality and continuity of service.

B. The City requires Contractors submitting Offers on this Contract to provide a certification **(see the Living Wages Contractor Certification included in the Solicitation**) with their Offer certifying that all employees directly assigned to this City Contract will be paid a minimum living wage equal to or greater than $11.39 per hour. The certification shall include a list of all employees directly assigned to providing services under the resultant contract including their name and job title. The list shall be updated and provided to the City as necessary throughout the term of the Contract.

C. The Contractor shall maintain throughout the term of the resultant contract basic employment and wage information for each employee as required by the Fair Labor Standards Act (FLSA).

D. The Contractor shall provide to the Department's Contract Manager with the first invoice, individual Employee Certifications for all employees directly assigned to the contract. The City reserves the right to request individual Employee Certifications at any time during the contract term. Employee Certifications shall be signed by each employee directly assigned to the contract. The Employee Certification form is available on-line at https://www.austintexas.gov/financeonline/vendor_connection/index.cfm.

E. Contractor shall submit employee certifications annually on the anniversary date of contract award with the respective invoice to verify that employees are paid the Living Wage throughout the term of the contract. The Employee Certification Forms shall be submitted for employees added to the contract and/or to report any employee changes as they occur.

F. The Department's Contract Manager will periodically review the employee data submitted by the Contractor to verify compliance with this Living Wage provision. The City retains the right to review employee records required in paragraph C above to verify compliance with this provision.

6. **NON-COLLUSION, NON-CONFLICT OF INTEREST, AND ANTI-LOBBYING:**

A. On November 10, 2011, the Austin City Council adopted Ordinance No. 20111110-052 amending Chapter 2.7, Article 6 of the City Code relating to Anti-Lobbying and Procurement. The policy defined in this Code applies to Solicitations for goods and/or services requiring City Council approval under City Charter Article VII, Section 15 (Purchase Procedures). During the No-Contact Period, Offerors or potential Offerors are prohibited from making a representation to anyone other than the Authorized Contact Person in the Solicitation as the contact for questions and comments regarding the Solicitation.

B. If during the No-Contact Period an Offeror makes a representation to anyone other than the Authorized Contact Person for the Solicitation, the Offeror's Offer is disqualified from further consideration except as permitted in the Ordinance.

C. If an Offeror has been disqualified under this article more than two times in a sixty (60) month period, the Purchasing Officer shall debar the Offeror from doing business with the City for a period not to exceed three (3) years, provided the Offeror is given written notice and a hearing in advance of the debarment.

D. The City requires Offerors submitting Offers on this Solicitation to certify that the Offeror has not in any way directly or indirectly made representations to anyone other than the Authorized Contact Person during the No-Contact Period as defined in the Ordinance. The text of the City Ordinance is posted on the Internet at: http://www.ci.austin.tx.us/edims/document.cfm?id=161145

7. **NON-SOLICITATION:**

A. During the term of the Contract, and for a period of six (6) months following termination of the Contract, the Contractor, its affiliate, or its agent shall not hire, employ, or solicit for employment or consulting services, a City employee employed in a technical job classification in a City department that engages or uses the services of a Contractor employee.

B. In the event that a breach of Paragraph A occurs the Contractor shall pay liquidated damages to the City in an amount equal to the greater of: (i) one (1) year of the employee's annual compensation; or (ii) 100 percent of the employee's annual compensation while employed by the City. The Contractor shall reimburse the City for any fees and expenses incurred in the enforcement of this provision.

C. During the term of the Contract, and for a period of six (6) months following termination of the Contract, a department that engages the services of the Contractor or uses the services of a Contractor employee will not hire a Contractor employee while the employee is performing work under a Contract with the City unless the City first obtains the Contractor's approval.

D. In the event that a breach of Paragraph C occurs, the City shall pay liquidated damages to the Contractor in an amount equal to the greater of: (i) one (1) year of the employee's annual compensation or (ii) 100 percent of the employee's annual compensation while employed by the Contractor.

8. **WORKFORCE SECURITY CLEARANCE AND IDENTIFICATION (ID):**

A. Contractors are required to obtain a certified criminal background report with fingerprinting (referred to as the "report") for all persons performing on the contract, including all Contractor, Subcontractor, and Supplier personnel (for convenience referred to as "Contractor's personnel").

B. The report may be obtained by reporting to one of the below governmental entities, submitting to fingerprinting and requesting the report [requestors may anticipate a two-week delay for State reports and up to a four to six week delay for receipt of a Federal report.].

i. Texas Department of Public Safety for any person currently residing in the State of Texas and having a valid Texas driver's license or photo ID card;
ii. The appropriate governmental agency from either the U.S. state or foreign nation in which the person resides and holds either a valid U.S. state-issued or foreign national driver's license or photo ID card; or

iii. A Federal Agency. A current Federal security clearance obtained from and certified by a Federal agency may be substituted.

C. Contractor shall obtain the reports at least 30 days prior to any onsite work commencement. Contractor also shall attach to each report the project name, Contractor's personnel name(s), current address(es), and a copy of the U.S. state-issued or foreign national driver's license or photo ID card.

D. Contractor shall provide the City a Certified Criminal Background Report affirming that Contractor has conducted required security screening of Contractor's personnel to determine those appropriate for execution of the work and for presence on the City's property. A list of all Contractor Personnel requiring access to the City's site shall be attached to the affidavit.

E. Upon receipt by the City of Contractor's affidavit described in (D) above and the list of the Contractor's personnel, the City will provide each of Contractor's personnel a contractor ID badge that is required for access to City property that shall be worn at all times by Contractor's personnel during the execution of the work.

F. The City reserves the right to deny an ID badge to any Contractor personnel for reasonable cause, including failure of a Criminal History background check. The City will notify the Contractor of any such denial no more than twenty (20) days after receipt of the Contractor's reports. Where denial of access by a particular person may cause the Contractor to be unable to perform any portion of the work of the contract, the Contractor shall so notify the City's Contract Manager, in writing, within ten (10) calendar days of the receipt of notification of denial.

G. Contractor's personnel will be required to wear the ID badge at all times while on the work site. Failure to wear or produce the ID badge may be cause for removal of an individual from the work site, without regard to Contractor's schedule. Lost ID badges shall be reported to the City's Contract Manager. Contractor shall reimburse the City for all costs incurred in providing additional ID badges to Contractor Personnel.

H. ID badges to enter and/or work on the City property may be revoked by the City at any time. ID badges must be returned to the City at the time of project completion and acceptance or upon removal of an individual from the work site.

I. Contractor is not required to obtain reports for delivery personnel, including but not limited to FedEx, UPS, Roadway, or other materials delivery persons, however all delivery personnel must present company/employer-issued photo ID and be accompanied by at least one of Contractor's personnel at all times while at the work site.

J. The Contractor shall retain the reports and make them available for audit by the City during regular business hours (reference paragraph 17 in Section 0300, entitled Right to Audit).

9. **ECONOMIC PRICE ADJUSTMENT:**

A. **Price Adjustments:** Prices shown in this Contract shall remain firm for the first 12 months of the Contract. After that, in recognition of the potential for fluctuation of the Contractor's cost, a price adjustment (increase or decrease) may be requested by either the City or the Contractor on the anniversary date of the Contract or as may otherwise be specified herein. The percentage change between the contract price and the requested price shall not exceed the percentage change between the specified index in effect on the date the solicitation closed and the most recent, non-preliminary data at the time the price adjustment is requested. The requested price adjustment shall not exceed twenty percent (20%) for any single line item and in no event shall the total amount of the contract be automatically adjusted as a result of the change in one or more line items made pursuant to this

provision. Prices for products or services unaffected by verifiable cost trends shall not be subject to adjustment.

B. **Effective Date:** Approved price adjustments will go into effect on the first day of the upcoming renewal period or anniversary date of contract award and remain in effect until contract expiration unless changed by subsequent amendment.

C. **Adjustments:** A request for price adjustment must be made in writing and submitted to the other Party prior to the yearly anniversary date of the Contract; adjustments may only be considered at that time unless otherwise specified herein. Requested adjustments must be solely for the purpose of accommodating changes in the Contractor's direct costs. Contractor shall provide an updated price listing once agreed to adjustment(s) have been approved by the parties.

D. **Indexes:** In most cases an index from the Bureau of Labor Standards (BLS) will be utilized; however, if there is more appropriate, industry recognized standard then that index may be selected.

i. The following definitions apply:
   (1) **Base Period:** Month and year of the original contracted price (the solicitation close date).
   (2) **Base Price:** Initial price quoted, proposed and/or contracted per unit of measure.
   (3) **Adjusted Price:** Base Price after it has been adjusted in accordance with the applicable index change and instructions provided.
   (4) **Change Factor:** The multiplier utilized to adjust the Base Price to the Adjusted Price.
   (5) **Weight %:** The percent of the Base Price subject to adjustment based on an index change.

ii. **Adjustment-Request Review:** Each adjustment-request received will be reviewed and compared to changes in the index(es) identified below. Where applicable:
   (1) Utilize final Compilation data instead of Preliminary data
   (2) If the referenced index is no longer available shift up to the next higher category index.

iii. **Index Identification:**

Weight % or $ of Base Price: 100	
Database Name: Consumer Price Index	
Series ID: CUUR0000SEEE	
X Not Seasonally Adjusted	☐ Seasonally Adjusted˜
Geographical Area: All Urban Consumers	
Description of Series ID: Information Technology Hardware and Services	
This Index shall apply to the following items of the Bid Sheet / Cost Proposal: All	

E. **Calculation:** Price adjustment will be calculated as follows:

Single Index: Adjust the Base Price by the same factor calculated for the index change.

Index at time of calculation
Divided by index on solicitation close date
Equals Change Factor
Multiplied by the Base Rate
Equals the Adjusted Price

F. If the requested adjustment is not supported by the referenced index, the City, at its sole discretion, may consider approving an adjustment on fully documented market increases.

10. **INTERLOCAL PURCHASING AGREEMENTS:** (applicable to competitively procured goods/services contracts).

A. The City has entered into Interlocal Purchasing Agreements with other governmental entities, pursuant to the Interlocal Cooperation Act, Chapter 791 of the Texas Government Code. The Contractor agrees to offer the same prices and terms and conditions to other eligible governmental agencies that have an interlocal agreement with the City.

B. The City does not accept any responsibility or liability for the purchases by other governmental agencies through an interlocal cooperative agreement.

38. **CONTRACT MANAGER:** The following person is designated as Contract Manager, and will act as the contact point between the City and the Contractor during the term of the Contract:

Donna-Lee Bliss

Contract Development Analyst

(512) 974-2530

*Note: The above listed Contract Manager is not the authorized Contact Person for purposes of the **NON-COLLUSION, NON-CONFLICT OF INTEREST, AND ANTI-LOBBYING Provision** of this Section; and therefore, contact with the Contract Manager is prohibited during the no contact period.

1.0 INTRODUCTION

The City of Austin (City), population 840,000, is the 13th largest City in the country. The City has gained worldwide attention as a hub for education, business, health, and sustainability. Since 1900, the City's population has doubled every 20 years, with continued projected record-breaking growth into the next decade and beyond. However, Austin has approximately 8000 structures that are within the 100 year floodplain. It also is located in the heart of what is called "Flash Flood Alley."

2.0 BACKGROUND

Austin is in a unique geographic setting where it can receive abundant moisture from the Gulf of Mexico and from waves of energy off of the Pacific Ocean. Some the highest rainfall totals in the world have occurred in this Central Texas Area. Relatively small watersheds are located in the urban core of Austin, and with steep slopes and poor soils, normally dry creek beds with a relatively small amount of rain will turn into quickly rising streams in a matter of minutes.

The City is also seeking a centralized data management system that will perform as a Flooding Common Operating Picture (COP) through a separate solicitation. The forecast flood model and mapping information will be imported for use by the Flooding COP upon the conclusion of both projects.

3.0 PURPOSE

The City, is seeking qualified firms or agencies to provide real-time mapping and modeling services using forecasted rainfall, gauge adjusted radar rainfall, and real-time NWS rainfall into a single integrated solution.

4.0 STATEMENT OF OBJECTIVES

4.1. Forecast hydrologic/hydraulic modeling and mapping shall be performed as a service with outputs available for import into a Flood Early Warning System (FEWS) graphical user interface to provide first responders with the most accurate forecast of flooding conditions as possible.

4.2 Forecast hydrologic/hydraulic modeling must be able to run in real-time using data from gauge adjusted radar rainfall, National Weather Service rainfall, and forecast rainfall (available either publicly or privately) and provide accurate stage and flow hydrographs at locations specified by the City.

4.3 Maps from the output of forecast hydrologic and hydraulic modeling shall be immediately imported into a service for use by first responders.

4.4 Maps available must include the following information, at a minimum:

- 4.4.1 Date/time, extent, and depth of flooding;
- 4.4.2 Numbers of structures at risk
- 4.4.3 Provided finished floor elevations of structures, provide estimated depth of flooding and provide damage estimate based upon Travis Central Appraisal District (TCAD) information;
- 4.4.4 Provide census estimate including estimate of individuals that may have ambulatory issues (STEAR); and
- 4.4.5 Provide location of roadways that are anticipated to be under water.

4.5 Models must be calibrated to existing full range rating stations provided by the U.S. Geological Survey (USGS)– estimated Pearson correlation coefficient at USGS gauge location between 0.90 and 0.99 for range of soil moisture percentages from 0% to 99%.

4.6 Models must account for ambient soil moisture conditions and evapotranspiration rates for the Austin, Texas area.

4.7. Procedures for upgrades and the addition of new models or model updates must be provided.

4.8 Must have a desktop user model available for model calibration and model updates as available and must present an option for City staff to develop the models or for the Proposer to develop and update the models. The desktop user model must have a seamless interface for the importation of radar rainfall products that have been adjusted by ground gauges, or other products.

4.9 Model must run continuously and provide forecasts up to 12 hours in advance based upon National Weather Service forecast rainfall models or greater depending on forecast rainfall information available.

5.0 PROGRESS REPORTS AND DELIVERABLES

5.1 The Contractor shall be able to provide a description of how methodology for real-time hydrologic/hydraulic forecast modeling and mapping can be accomplished using the City's existing Geographic Information System (GIS) information, USGS full range rating stations for calibration, rainfall information from gauge adjusted radar rainfall system, US Census Information, Travis Central Appraisal District (TCAD) information, and the City's information available from the Federal Emergency Management Agency (FEMA) Digital Flood Insurance Rate Map (DFIRM) program models.

5.2 The Contractor shall provide a report that describes the information found in 5.1.

5.3 The Contractor shall provide a list of data needs from the City necessary for this project.

5.4 The Contractor shall provide either a web-based application for use by the City as well as a downloadable information for immediate use by ATXfloods.com for some information or for import for use into FEWS COP. The Contractor shall provide a recommendation for the location of hosting the model and mapping data (either on Contractor's servers or on another location, such as ATXfloods Amazon web services).

5.5 The Contractor must keep all archived data available for a period of one year and provide a downloadable file every year of model outputs for import into the City's KISTER's WISKI database.

5.6 The Contractor shall include recommendations for intervals of training on the use of the modeling and mapping application.

City of Austin
Purchasing Office
0600 Proposal Preparation Instructions
& Evaluation Factors
for Watershed Protection Department Flood Early Warning System – Flood Forecasting Mapping and Modeling System

1. PROPOSAL FORMAT

Prefacing the proposal, the Proposer shall provide an Executive Summary of three (3) pages or less, which shall include a concise and brief overview of the proposed solution and offer. The proposal shall include a sequential table of contents with page numbers linking the content of the offer and shall be clearly identified and organized in the following format and informational sequence:

A. **Tab 1 - Required Documents:** All signed documents and any addendums released should be submitted as a part of this RFP. These documents include: signed **Addendums**, the signed **Offer Sheet** (pages 1-3), and, Section 0835 **Nonresident Bidder Provision**
(If you will be utilizing subcontractors, you must contact the Small and Minority Business Resources Department (SMBR) at (512) 974-7600 to obtain a list of MBE and WBE firms available to perform the service and include the completed 0900 No Goals Utilization Plan with your proposal packet. Include the 0900 No Goals Utilization Plan in Tab 1.) *http://www.austintexas.gov/department/standard-bid-documents*

B. **Tab 2 - Business Organization:** State full name and address of your organization and identify parent company if you are a subsidiary. Specify the branch office or other subordinate element that will perform, or assist in performing, work herein. Indicate whether you operate as a partnership, corporation, or individual. Include the State(s) in which incorporated or licensed to operate.

i. List all professional organizations of which you are a member.

ii. How long has your firm been in business?

iii. Detail any and all procedures, processes and/or infrastructure you have in place to maintain your data systems and business processes in the event of a disaster (i.e. complete power failure, system crash, earthquake, flood, fire, etc.).

C. **Tab 3 - Proposed Solution:** Define in detail your understanding of the requirement presented in the Statement of Objectives of this Request for Proposal and your solution. Provide details of how your organization will meet or exceed the requirements included in the RFP Statement of Objectives, include an explanation of why any exceptions were taken. Provide all details as required in the Statement of Objectives and any additional information you deem necessary to evaluate your proposal. Proposer shall submit with the RFP response, a written plan covering how the information should be received and what software data can be exported into the User Interface. In addition, the Proposed Solution should include a description of potential problems with the data being exported or problems with how the data can be transferred out and made “open” for public use.

D. Tab 4 - Program Plan: Describe your plan for accomplishing required work. Include such time-related displays, graphs, and charts as necessary to show tasks, sub-tasks, milestones, and decision points related to the Statement of Objectives and your plan for accomplishment. Specifically indicate:

i. Work Plan

Describe your Work Plan for achieving Responsibilities as outlined in the Statement of Objectives. Include such time-related displays, graphs, and charts as necessary to show tasks, sub-tasks, milestones, and decision points related to the Statement of Objectives and your plan for accomplishment.

ii. Tasks

Describe your work program by tasks. Detail the entire process to be implemented to complete the required work. This detail should include, but is not limited to, a description of the following:

a. Information needs from the City of Austin;
b. Calibration records of the hydrologic/hydraulic models;
c. Information on how GIS information as described in Section 0500 will be hosted and displayed;
d. A mockup of display information;
e. A description of file format conversion for placement of inundation estimates for placement onto FEWS Common Operating Picture (COP) and also onto City of Austin public website ATXfloods.com upon demand.

iii. Workforce

Describe your workforce as relates to this Proposal. This detail should include, but not be limited to a description of the following:

a. The size and composition of your current workforce. If you do not believe it to be of adequate size to handle the anticipated volume from the City of Austin, detail how many additional employees would be needed and when would they be fully trained.
b. From where do you employ most of your employees (i.e., other agencies, college students, etc.)
c. The average tenure of your staff and the employee turn over during the past three (3) years
d. The training programs you provide your staff
e. The types of quality control measures which your firm utilizes

iv. Documents

Provide, as part of your proposal, samples of the following:

a. Samples detailing the modeling and mapping software.
b. Written documentation of modeling set up, running, calibration, and causes for common errors.

c. Examples of forecast modeling efforts used for other entities and a description on how they were developed.

E. Tab 5 - Project Management Structure:

i. Provide the following information:

a. A general explanation and chart which specifies the organizational and management structure of the agency, how the team will interface with City Watershed Protection Department and Communications Technology and Management Department. For each team member, provide the following information on the organizational chart: name, title/function, percent of time on site, and approximate total hours assigned to the project. Please include how long your management team and key employees have been employed by your company and how long they have been involved in the collection industry.

ii. If the Proposer is a partnership or joint venture between multiple organizations, a copy of the formal written agreement must be submitted that defines each partner's role and responsibilities, and designates one partner as having lead management and fiduciary responsibility for the Program.

F. Tab 6 - Experience: Provide references for a minimum of three (3) projects where the customers are operating a fully functional system of similar scope and size to the one described in this Scope of Work. Describe only relevant corporate experience and individual experience for personnel who will be actively engaged in the project. Do not include corporate experience unless personnel assigned to this project actively participated. Do not include experience prior to 2004. Supply the project title, year, project description including details and size to qualify as applicable to this project, detail if project was completed on time and budget as applicable, and include a contact name, title, e-mail address, present address, and phone number of principal person for whom prior projects were accomplished.

i. Please provide a client list of all your customers who use your software along with current contact information.
ii. Indicate how many clients you have worked with regarding issuing of software and software users.

G. Tab 7 - Lead Negotiator: Include name, address, e-mail, and telephone number of person in your organization authorized to negotiate contract terms and render binding decisions on contract matters.

H. Tab 8 - Cost Schedule/Submission: Information in this tab is required. Detail the estimated costs associated with your proposal. Include the cost of labor, materials, supplies, travel, printing, and fees including administrative burden. Your organization's method of costing may or may not be used but shall be described. Please include all costs associated for an engagement of 24 months and then three additional 12-month extension options.

At a minimum, the following information must be included in Tab 8 of your proposal:

- Cost for software licensing

- Cost and description of software hosting using rainfall from the following sources:
  - Gauge adjusted radar rainfall
  - NWS forecasted rainfall
  - Other privately available rainfall sources (and a description of how those sources are developed, maintained, and distributed)
- Cost for map preparation and hosting
- Cost for data archiving (model output results)
- Cost for training
- Any other costs associated with your solution

i. Travel expenses. All travel lodging expenses in connection with the Contract for which reimbursement may be claimed by the Contractor under the terms of the Solicitation will be reviewed against the ACCD's Travel Policy as published and maintained by the City's Controller's Office and the Current United States General Services Administration Domestic Per Diem Rates (the "Rates") as published and maintained on the Internet at:

http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentId=17943&contentType=GSA_BASIC

No amounts in excess of the Travel Policy or Rates shall be paid. All invoices must be accompanied by copies of detailed receipts (e.g. hotel bills, airline tickets). No reimbursement will be made for expenses not actually incurred. Airline fares in excess of coach or economy will not be reimbursed. Mileage charges may not exceed the amount permitted as a deduction in any year under the Internal Revenue Code or Regulations.

I. **Tab 9 - Section 0605 Local Business Presence Identification Form:** The City seeks opportunities for businesses in the Austin Corporate City Limits to participate on City contracts. A firm (Offeror or Subcontractor) is considered to have a Local Business Presence if the firm is headquartered in the Austin Corporate City Limits, or has a branch office located in the Austin Corporate City Limits in operation for the last five (5) years. The City defines headquarters as the administrative center where most of the important functions and full responsibility for managing and coordinating the business activities of the firm are located. The City defines branch office as a smaller, remotely located office that is separate from a firm's headquarters that offers the services requested and required under this solicitation. Points will be awarded through a combination of the Offeror's Local Business Presence and/or the Local Business Presence of their subcontractors. Evaluation of the Team's Percentage of Local Business Presence will be based on the dollar amount of work as reflected in the Offeror's MBE/WBE Compliance Plan or MBE/WBE Utilization Plan. Specify if and by which definition the Offeror or Subcontractor(s) have a local business presence.

2. EXCEPTIONS

Be advised that exceptions to any portion of the Solicitation may jeopardize acceptance of the Proposal. Provide a "Matrix of Exceptions" to the requirements of the RFP. Identify the requirement, describe the nature of the deviation and provide

an explanation or an alternative. This matrix shall include any exceptions for all sections of the RFP and Scope of Work.

3. **PROPOSAL ACCEPTANCE PERIOD**

All proposals are valid for a period of one hundred and fifty (150) calendar days subsequent to the RFP closing date unless a longer acceptance period is offered in the proposal

4. **PROPRIETARY INFORMATION**:

All material submitted to the City becomes public property and is subject to the Texas Open Records Act upon receipt. If a Proposer does not desire proprietary information in the proposal to be disclosed, each page must be identified and marked proprietary at time of submittal. The City will, to the extent allowed by law, endeavor to protect such information from disclosure. The final decision as to what information must be disclosed, however, lies with the Texas Attorney General. Failure to identify proprietary information will result in all unmarked sections being deemed non-proprietary and available upon public request.

5. PROPOSAL PREPARATION COSTS

All costs directly or indirectly related to preparation of this RFP or any oral presentation required to supplement and/or clarify the offer, which may be required by the City, shall be the sole responsibility of the contractor.

6. EVALUATION FACTORS AND AWARD

A. Competitive Selection: This procurement will comply with applicable City Policy. The successful Proposer(s) will be selected by the City on a rational basis. Evaluation factors outlined in Paragraph B below shall be applied to all eligible, responsive Proposers in comparing proposals and selecting the Best Offer. It is the City's preference to award a single contract to perform the work specified in the Statement of Objectives; however, the City reserves the right to make multiple awards based on service components or groupings of specific work, based on cost, convenience, or any criteria deemed by the City to be the most advantageous. The City also reserves the right to refrain from awarding any service components or groupings of specific work. Award of a Contract may be made without discussion with Proposers after proposals are received. Proposals should, therefore, be submitted on the most favorable terms.

B. Evaluation Factors:

i. 100 points

1. Proposed Solution and Program Plan – 35 Points

- Responsiveness to and understanding of requirements, terms and conditions, sophistication of internal technology
- Implementation plan and timetable for preparing the project as described
- Mock up display and samples of the model and mapping

2. Costs Proposed as per Tab 8 – 25 Points (Proposer offering the lowest cost to the City will be given maximum points, remainder given on a percentage ratio basis)

    - Project costs both annual and maintenance
    - Project costs for training

3. Demonstrated Applicable Experience – 20 Points

    - Demonstrated corporate experience with flood forecasting mapping and modeling
    - Strength of customer references

4. Organization and Management Structure

    - Organizational and service structure
    - Key staff qualifications, tenure and experience

5. Local Presence – 10 Points

    As per Section 0605 included in Tab 9Local business presence of 90 to 100% - 10 points

    - Local business presence of 75 to 89% - 8 points
    - Local business presence of 50 to 74% - 6 points
    - Local business presence of 25 to 49% - 4 points
    - Local business presence of 1 to 24% - 2 points
    - No Local business presence – 0 points

ii. Interviews/Presentations/Demonstrations Optional. Interviews, Demonstrations, and/or Presentations may be conducted with short-listed vendors at the discretion of the City. Maximum 25 points.

The City reserves the right to require short listed vendors selected for demonstrations or presentations to provide a minimum of two (2) most recent years of audited annual reports that evidence the financial health of the organization. In the event that audited financial statements cannot be provided, the Vendor must provide financial information that will enable the City to accurately assess financial stability and viability. Vendors unwilling to provide this information or whose financial information is deemed as not demonstrating financial stability will not be considered for award.

Table of Contents

Cover Image: Inundation mapping in Shoal Creek published in open format with bridge roadways shown above the water surface elevation modeled with V*flo*® during the January 15, 2007, flood in Austin, Texas.

Executive Summary

Vieux & Associates, Inc. (Vieux) is pleased to offer an integrated, proven solution to the Flood Forecasting Mapping and Modeling System (FFMMS) RFP. The Vieux solution builds on current services provided to the Flood Early Warning System (FEWS), and expands services to include new requirements. Vieux has worked closely with FEWS to pioneer a municipal flash flood service that helps protect life and property by providing detailed, local flash flood forecasts in real-time.

After the Memorial Day Flood of 1981, FEWS was established with just a few rain gauges and stream gauges and lots of determination. The flood early warning team had very limited access to information that consisted of rain gauge bucket tips at point locations and stream gauge readings that did not provide hydrologic forecasts. In an attempt to better detect flood conditions with lead-time, in 2004, Vieux started providing radar rainfall to FEWS. This added the benefit of spatial awareness of rainfall patterns containing thousands of pixels of rainfall data and citywide rainfall visualization, with a timeseries of rainfall for each pixel at 15-minute increments. Rainfall over basins that did not have a rain gauge was reported and displayed by using a second sensor, weather radar. Leveraging consulting, City, and NOAA Atlas 14 studies, rainfall thresholds for individual basins were added. This, along with other FEWS advances, marked progress in support technologies.

Success with radar rainfall and threshold based display and notification lead to the adoption of more new technology, including a hydrologic model called *Vflo*®. Hydrographs, generated in real-time, provide a forecast of future flooding. With this tool, FEWS could better understand how flash flooding was occurring and gain, albeit never enough, precious lead-time that is useful for informing and guiding road barricade and emergency crews. FEWS embraced a new world of possibilities offered by technology, from rainfall detection and forecasting to hydrologic prediction, using web-services. With use of these services, Austin has become a global leader in flash flood forecasting applications.

Vieux recognizes that the City of Austin leads the nation and the world in many other areas as well, like education, health, and sustainability. This leadership is spawning growth in population and escalations in construction and property values. The City is located in a geographic setting that is prone to high rainfall intensities and amounts, and combined with steep slopes, is subject to flash flooding. Greater population and property impacts, along with the inevitability of flash flooding have led to greater FEWS responsibilities. FEWS is responsible for monitoring rainfall, water levels and low water crossings in Austin, 24 hours a day, 365 days a year. During a flood emergency, FEWS roles have expanded to encompass issuance of road closures, and work closely with emergency managers for the most effective and timely community response. Even with the use of advanced technology, sudden flooding can occur faster than FEWS can respond. While every storm is different in how it affects the City, with more than 10,000 buildings and 300 bridges, flooding is likely somewhere.

Experience with major floods in Austin has helped to improve Vieux services. The V*flo*® internal framework has been expanded to support multiple rainfall inputs, accounting for some of the uncertainties in rainfall inputs. A radar rainfall product that does not depend on rain gauges is delivered as well as one that is enhanced by accurate and timely rain gauge data, and an additional rainfall product includes forecast rainfall with greater lead-time. Boundary conditions are not assumed but are modeled and documented within the model. With new rainfall products on which accurate flood prediction depends, as well as a major IT infrastructure upgrades, we are ready to move forward with hardened approaches, and robust new features and deliverables.

The Vieux distributed, gridded approach to hydrology uses parameters derived from the City's geospatial data. The modeling and mapping information produced capitalize on open data formats for display, query, reporting, and use of model results in real-time via a web browser. The Vieux flash flood forecasting model, V*flo*®, takes a hydraulic approach to hydrology that is integrated within a single model. This feature is critically important, and because of it, we can make predictions of both discharge and stage throughout a stream reach in real-time. Having the full spatial distribution of rainfall intensities, both current and forecast, over the entire area makes it possible to produce forecast stage simultaneously at many locations, making it ideally suited for the desired inundation mapping in Austin.

V*flo*® has the required characteristic of allowing the model to be calibrated to existing full range rating stations provided by the U.S. Geological Survey (USGS) with estimated Pearson correlation coefficient at USGS gauge location between 0.90 and 0.99 for range of soil moisture percentages from 0% to 99%.The model accounts for ambient soil moisture conditions and evapotranspiration rates for the Austin, Texas area. Vieux has established procedures for FEWS to create and update watershed models.

V*flo*® has a user-friendly desktop model for model calibration with model and updates as they become available. This allows the option for City staff to develop the models or for Vieux to develop and update the models. The desktop user model has a seamless interface for the importation of radar rainfall products that have been adjusted by ground gauges, and other NWS rainfall and forecast products. Training for FEWS personnel addresses new model developments, software upgrades and new features, and review of system performance each year. Procedures for upgrades and the addition of new models or model updates are provided.

V*flo*® runs continuously and provides forecasts 12 or more hours in advance based upon National Weather Service forecast rainfall models, depending on forecast rainfall information available.

There are important judgments that must be made in the development and application of a flash flood model. How much spatial detail is needed for a meaningful result? Is calculating backwater a useful feature or a resource drain with little value for the modeled basins? At what time-step should a model be run to complete in a timely fashion? If a model takes too long to run, the result may arrive too late to be useful. Unsteady, spatially-varied hydraulic

models are notoriously unstable and difficult to setup, and therefore are rarely used in operational flash flood warning. When the numerical hydraulic algorithms of the model are too complicated it may crash, failing to produce results especially during large flood events. Model setup needs to be a feasible task and results must be acceptable. These and other challenges contribute to why other municipalities do not have flood early warning systems that take advantage of models. An effective and workable system requires careful planning and development with the *right technology* designed to meet the challenges of distributed flash flood forecasting in real-time.

Through the addition of a mapping utility to existing hydrograph displays and threshold notifications, we will make the outputs available for import into the FEWS COP, with the aim of providing first responders with the most accurate forecast of flooding conditions as possible. Configuration of the map information will include at a minimum:

- Date/time, extent, and depth of flooding;
- Numbers of structures at risk
- Finished floor elevations of structures, estimated depth of flooding and provide damage estimate based upon Travis Central Appraisal District (TCAD) information;
- Census estimates of impacts, including individuals that may have ambulatory issues (211/STEAR)
- Location of roadways that are anticipated to be under water based on water surface elevation in relation to the low and high chord of the bridge.

All project or service-related objectives requested are met or exceeded in the Vieux proposal. Vieux has the plan, the experience, the value-proposition, and the management structure necessary to deliver the FFMMS in its entirety, without exception. We are excited to continue to work with FEWS, and provide the single integrated system that is requested with continuity of service. Vieux will deliver the requested services that are currently provided, plus the addition of inundation mapping that shows bridge roadway overtopping, damage assessment, and the other required polygon query outputs using the techniques described in following sections.

Our fixed-price offer for FFMMS Services is **$75,000** one-time, **$467,788** for the first 24-month period, and annually at **$215,569** for 12-month extensions (3), thereafter.

Tab 1 - Required Documents

Section 0605: Local Business Presence Identification

A firm (Offeror or Subcontractor) is considered to have a Local Business Presence if the firm is headquartered in the Austin Corporate City Limits, or has a branch office located in the Austin Corporate City Limits in operation for the last five (5) years. The City defines headquarters as the administrative center where most of the important functions and full responsibility for managing and coordinating the business activities of the firm are located. The City defines branch office as a smaller, remotely located office that is separate from a firm's headquarters that offers the services requested and required under this solicitation.

OFFEROR MUST SUBMIT THE FOLLOWING INFORMATION FOR EACH LOCAL BUSINESS (INCLUDING THE OFFEROR, IF APPLICABLE) TO BE CONSIDERED FOR LOCAL PRESENCE.

NOTE: ALL FIRMS MUST BE IDENTIFIED ON THE MBE/WBE COMPLIANCE PLAN OR NO GOALS UTILIZATION PLAN, SECTION 0900 OF THE SOLICITATION.

USE ADDITIONAL PAGES AS NECESSARY NONE

OFFEROR:

Name of Local Firm						
Physical Address						
Is Firm located in the Corporate City Limits? (circle one)	Yes		No			
In business at this location for past 5 yrs?	Yes		No			
Location Type	Headquarters	Yes	No	Branch	Yes	No

SUBCONTRACTOR(S):

Name of Local Firm						
Physical Address						
Is Firm located in the Corporate City Limits? (circle one)	Yes		No			
In business at this location for past 5 yrs?	Yes		No			
Location Type:	Headquarters	Yes	No	Branch	Yes	No

SUBCONTRACTOR(S):

Name of Local Firm						
Physical Address						
Is Firm located in the Corporate City Limits? (circle one)	Yes		No			
In business at this location for past 5 yrs?	Yes		No			
Location Type:	Headquarters	Yes	No	Branch	Yes	No

Section 0815: Living Wages Contractor Certification

Company Name Vieux & Associates, Inc.

Pursuant to the Living Wages provision (reference Section 0400, Supplemental Purchase Provisions) the Contractor is required to pay to all employees directly assigned to this City contract a minimum Living Wage equal to or greater than $11.39 per hour.

The below listed employees of the Contractor who are directly assigned to this contract are compensated at wage rates equal to or greater than $11.39 per hour.

Employee Name	Employee Job Title
Jean Vieux	Project Manager
Baxter Vieux	Principal Engineer
Jonathan Looper	Hydrologist/Hydraulic Engineer
Adam Barnett	Database Manager
Ryan Hoes	Systems Integrator
Brian McKee	Senior Software Developer
Brian Byrne	UI Designer & Developer
Jennifer French	Hydro-Meteorologist/Analyst
Edward Koehler	Coordinating Hydro-Meteorologist
David Buckey	Hydro-Meteorologist Data QA/QC

USE ADDITIONAL PAGES AS NECESSARY

(1) All future employees assigned to this Contract will be paid a minimum Living Wage equal to or greater than $11.039per hour.

(2) Our firm will not retaliate against any employee claiming non-compliance with the Living Wage provision

A Contractor who violates this Living Wage provision shall pay each affected employee the amount of the deficiency for each day the violation continues. Willful or repeated violations of the provision or fraudulent statements made on this certification may result in termination of this Contract for Cause and subject the firm to possible suspension or debarment, or result in legal action.

Section 0835: Non-Resident Bidder Provisions

Company Name Vieux & Associates, Inc.

A. Bidder must answer the following questions in accordance with Vernon's Texas Statues and Codes Annotated Government Code 2252.002, as amended

Is the Bidder that is making and submitting this Bid a "Resident Bidder" or a "non-resident Bidder"?

Answer: Non-resident Bidder

(1) Texas Resident Bidder- A Bidder whose principle place of business is in Texas and includes a Contractor whose ultimate parent company or majority owner has its principal place of business in Texas

(2) Nonresident Bidder- A Bidder who is not a Texas Resident Bidder.

B. If the Bidder id a "Nonresident Bidder" does the state, in which the Nonresident Bidder's principal place of business is located, have a law requiring a Nonresident Bidder of that state to bid a certain amount or percentage under the Bid of a Resident Bidder of that state in order for the nonresident Bidder of that state to be awarded a Contract on such bid in said state?

Answer: No Which State Oklahoma

C. If the answer to Question B is "yes", then what amount or percentage must a Texas Resident Bidder bid under the bid price of a Resident Bidder of that state in order to be awarded a Contract on such bid in said state?

Answer:

MBE/WBE NO GOALS FORM

Section 00450

SOLICITATION NUMBER: RFP SMW0127

PROJECT NAME: Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software

The City of Austin has determined that no goals are appropriate for this project. Even though no goals have been established for this solicitation, the Bidder is required to comply with the City's MBE/WBE Procurement Program should they self identify areas of subcontracting opportunity. This form must be complied with, completed, and signed or the Bidder may be deemed non-compliant.

Specifically, if any service is needed to perform the Contract and the Bidder does not perform the service with its own workforce or if supplies or materials are required and the Bidder does not have the supplies or materials in its inventory, the Bidder shall contact the Department of Small and Minority Business Resources (SMBR) at (512) 974-7600 to obtain a list of City-certified MBE and WBE firms available to perform the service or provide the supplies or materials. The Bidder must also make a Good Faith Effort to use available City-certified MBE and WBE firms. Good Faith Efforts, as defined by the City Code, Chapter 2-9 (A-D)-21, include, but are not limited to, contacting the listed MBE and WBE firms to solicit their interest in performing on the project; using City-certified MBE and WBE firms that have shown an interest, meet qualifications, and are competitive in the market; and documenting the results of the contacts. Post-submission and award, Bidder is also subject to the applicable provisions of the City's MBE/WBE Procurement Program at City Code, Chapter 2-9.

Will subcontractors or subconsultants or suppliers be used to perform portions of this contract?

No ___x___ If no, please sign the No Goals Form and submit it with your Bid/proposal in a sealed envelope.

Yes _____ If yes, please contact SMBR to obtain further instructions and an availability list, and perform Good Faith Efforts. Complete and submit the No Goals Form and the No Goals Utilization Plan with your Bid/proposal in a sealed envelope.

After contract award, if your firm subcontracts any portion of the Contract, it is a requirement to complete Good Faith Efforts and the No Goals Utilization Plan, listing any subcontractor, subconsultant or supplier. Return the completed Plan to the Project Manager or the Contract Manager.

I understand that even though no goals have been established, I must comply with the City's MBE/WBE Procurement Program if subcontracting areas are identified. I agree that this No Goals Form and No Goals Utilization Plan shall become a part of my contract with the City of Austin.

Vieux & Associates, Inc.

Company Name

Jean E. Vieux

Name and Title of Authorized Representative (Print or Type)

Jean E Vieux

Signature

3-23-2015

Date

Addendums

See Original Packet for Signed Addendums

Solicitation: RFP SMW0127, Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software
Addendum #1 Date of Addendum: February 13, 2015
ADDENDUM #2 DATE OF ADDENDUM: February 26, 2015
ADDENDUM #3 DATE OF ADDENDUM: March 3, 2015

ADDENDUM
CITY OF AUSTIN, TEXAS
REQUEST FOR PROPOSAL

Solicitation: RFP SMW0127, Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software

Addendum No: #1 **Date of Addendum: 2/3/2015**

This addendum is to incorporate the following changes to the above referenced solicitation:

1. **Changes:** The Offer Sheet page 1 of the Solicitation has been updated to reflect the following additions:
   - **1.1 Pre-Proposal Conference Time and Date: 1:30pm-2:30pm on February 18, 2015**
   - **1.2 Location: Combined Transportation Emergency Communications Center (CTECC), 2nd Floor Emergency Operations Center, 5010 Old Manor Road, Austin TX 78723**

     Please note that this meeting will be held in a secured facility. Attendees will need to have a government issued picture ID to enter. Also ensure to allow additional time to get through security.

     This meeting will also be available through a GoToMeeting online meeting:

     https://global.gotomeeting.com/join/926642909

     You will be connected to audio using your computer's microphone and speakers (VoIP). A headset is recommended.

     Meeting ID: 926-642-909

2. **AUTHORIZED CONTACT**: The Authorized contact for contractual and technical issues is hereby changed as follows:

   Authorized Contacts:

   Paige McDonald
   Senior Buyer
   (512) 974-2076
   Paige.McDonald@austintexas.gov

   Georgia Billela
   Buyer II
   (512) 974-2939
   Georgia.Billela@austintexas.gov

3. ALL OTHER TERMS AND CONDITIONS REMAIN THE SAME.

APPROVED BY: _____ February 3, 2015

Shawn M. Willett, Corporate Contract Compliance Manager
Purchasing Office, (512) 974-2274
Shawn.Willett@austintexas.gov

ACKNOWLEDGED BY:

Jean E Vieux _____ 3/23/2015

Name Authorized Signature Date

RETURN ONE COPY OF THIS ADDENDUM TO THE PURCHASING OFFICE, CITY OF AUSTIN, WITH YOUR RESPONSE OR PRIOR TO THE SOLICIATION CLOSING DATE. FAILURE TO DO SO MAY CONSTITUTE GROUNDS FOR REJECTION.

REQUEST FOR PROPOSAL ADDENDUM
PURCHASING OFFICE
CITY OF AUSTIN, TEXAS

REQUEST FOR PROPOSAL: SMW0127 ADDENDUM NO. 2 DATE OF ADDENDUM: February 26, 2015

This addendum is to incorporate the following questions and answers:

Q1: The City appears to be requesting the responder provide their own approach to address the Objectives. How does the City intend to review cost information such that there is an "apples to apples" comparison between responders?

A1: Cost will be reviewed on a case-by-case basis. The City will not compare proposals to each other, but rather compare them to what was requested in the scope of work.

Q2: Should cost information be provided in a manner that aligns costs with each specific Objective, and will cost be evaluated in the scoring per Objective or totaled?

A2: Yes, costs should line up with their appropriate objective and proposers should total all costs.

Q3: There appears to be overlap between Objectives 4.7, 4.8, and 4.9 in this SOO and SMW0126, Graphical User Interface for Flood Early Warning System. Should the responder to SMW0127 be able to address *all* Objectives, or could these three Objectives (4.7-4.9) be addressed by the firm selected for SMW0126?

A3: There is some overlap between the objectives for the Flood Mapping and Modeling software (RFP SMW0127) and the Graphical User Interface for Flood Early Warning System (RFP SMW0126). The City reserves the right to pick and choose from each Contractor's proposal in order to create the optimal flood early warning system, meaning that a single Contractor's proposal could be combined with elements from another proposal.

Q4: Do you have a map of the areas to be mapped?

A4: Yes, the map is attached following these questions and answers.

Q5: Would the City like to include any critical infrastructure?

A5: We can provide a spatial file that details the locations of structures like bridges and their elevations, buildings and their FFE's, as well as whether the structure is critical infrastructure. Part of the response should include identifying what data you would need from us.

Q6: Are there any dams to be included as a risk factor?

A6: If the dam is part of the model, then we would need to include the dam in the model in order to create an accurate floodplain prediction.

Q7: Would you like to include any back-water effects into the areas for mapping? An example would be a clogged bridge.

A7: If a proposer has a mechanism for looking at backwater in a forecast model, he/she is urged to include it with his/her proposal. It is not a minimum standard; however a proposer should include anything above the minimum he/she feels would be beneficial to the City.

Q8: The RFP mentioned an annual revision to the program. Are we to assume that the city would like an additional yearly proposal for those revisions?

A8: If a proposer's models are to be "hosted" to run continuously in real time – and as a part of the proposer's solution, then the City will need to see the revisions, operating costs, or software fees.

Q9: During the Q & A at the pre-proposal meeting, we heard statements that the City is not looking for engineering services, but rather for a vendor to provide software and training. Could you please confirm this?

A9: That is correct. The City does not wish to contract professional services on this particular solicitation, but rather for the end deliverables. We understand an entity that does not already have software that meets this purpose may perform services to create the product the City seeks; however the City wishes to purchase the software with training services. For instance, currently, the City receives spatially-distributed 15-minute hyetographs from a radar vendor for all of Travis County. From that spatially distributed rainfall those are ingested into a model (Vflo). The model creates forecasts for the brown triangles (watchpoints in an earlier slide) every fifteen minutes. From those stage and flow hydrographs created every fifteen minutes, RainVieux as a service takes the peak stage and peak flow and time it occurs and ships that to us within an XML file. That XML file is then imported into our internal GIS servers that (similar to RAS mapping) takes those water surface elevations and creates a raster and an extent of flooding polygon. The attributes from the peak stage, flow, and time are displayed on our intranet site. We use a combination of processes: Gauge Adjusted Radar Rainfall, peaks from the stage and flow points from the Vflo models that we've developed for a series of watersheds; those are then imported into a GIS package that develops the forecast floodplain polygons. We need a system that will simplify this process.

Q10: The City's Scope of Work, Section 4.5 states "Models must be calibrated...." Shall the bidder calibrate the models or will the City do this?

A10: The City does not have a preference on this matter. Please state in your proposal what you believe to be the best practice.

Q11: Will the contractor provide models or provide a framework for city staff to develop models?

A11: The City seeks a general way of modeling. We are not looking for someone to build a model for every creek. We have data we have used to build models, and in most cases those are static models. We need a way to take data that we have and put it into a general model that creates output data that we can use in real time for flood warning. That said, if the software develops models on its own based on input information, we would not be opposed. While it is above and beyond the minimum standards set forth in the Scope of Work, the City is also not opposed to a software that assists in developing or calibrating the model.

Q12: How much of the existing FEWS models do you anticipate being used?

A12: The City seeks to use the same data: the same impervious cover data, the same soil information, the same cross sections for channel. We already had that information for the models we've developed from a variety of sources like FEMA models and other City of Austin datasets. We would be able to reuse that data. However, we would not expect an import tool that translates from one file type to another.

Q13: Do you intend to use any part of your current modeling software?

A13: Our base requirements are listed in the Scope of Work; however we do not state a preference on this subject. The City seeks the best proposed system at the best cost, be it a totally new system developing all the models from scratch or one that integrates our currently used products. We do expect that our current intranet flood mapping would not be useful in the future due to its limitations.

Q14: Where are the latest versions of the watershed maps and floodplains?

A14: A map of the watersheds is provided with this addendum. Currently, the floodplain models (our floodplains as defined by FEMA) are available through FEMA's website as well as the City's FloodPro website (austintexas.gov/floodpro). The City's real time flood maps are currently not in a "shareable" format.

Q15: Is the acronym "FEWS" specific to the City of Austin?

A15: We are referring to the City of Austin Flood Early Warning System group.

Q16: Are there any additional datasets for integration?

A16: The City seeks a framework as opposed to someone actually building the models. For instance, if an entity has software that could calculate local flooding by use of a model of City of Austin storm water infrastructure, that entity should include that information in the proposal. Please let us know in your proposal if your system requires any additional information from the City.

Q17: Do you work independently or do you share information with other entities or communities?

A17: The City works with the Lower Colorado River Authority. LCRA has publicly available stream gauges and rain gauges. To the extent that something is publicly available and would improve the accuracy of the model, we would like to incorporate it.

Q18: Do you need the capability to recalibrate the models?

A18: There should be some type of interface so that a desktop user can perform calibration by importing historic storm events and comparing those against historic gauge data or high water marks.

Q19: If I propose a new software package and models, and tell you it meets all the requirements listed, would I stop short of telling you my costs to create and calibrate the models?

A19: We are looking for a cost for the system as opposed to the cost of professional services to later come back and perform calibration. Currently, the Contractor has a model and we use the model and input data into it, then give it back to the Contractor. We pay the Contractor to run the model, and then feed the data from the model back to the City.

Q20: Should we include a consulting fee to actually build the model (over and above providing the framework for the model)?

A20: The City seeks the framework, which may include ongoing fees for maintenance of the software and/or software upgrades, but the actual professional services in order to build the model is NOT part of this RFP. The City would like training, though. That it specifically indicated in the RFP. We need a fully integrated system that is a service [i.e. Software as a Service, or SaaS]. In other words, it runs continuously, rain or shine, it ingests real time rainfall that is occurring over Travis County as well as forecasted rainfall. Then produces a series of maps that include both extent as well as depth of flooding that can be applied over GIS or geospatial layers such as structures that might be at risk, be they bridges, critical facilities, residences, facilities where we have individuals with ambulatory issues. We want that incorporated into a complete package with this project. There would be some amount of model building required in order to show us how to use the product, but we are not expecting you to go and develop watershed models of the rest of the watersheds in Austin. We are NOT asking for engineering services. This is going to be a commodity with a service component. We are looking for a deliverable, rather than the intellectual services behind that deliverable.

Q21: The software currently operates as an off-site service?

A21: Yes.

Q22: In this case, you are not looking for that type of solution in the future? Or are you open to that solution also?

A22: Currently, the only portion that is hosted is the hydrologic/hydraulic models. The modeling package we use is Vflo. That is a model we obtain as a desktop version and we develop a watershed model for a specific watershed and we identify where we want to have forecasts. That model runs continuously taking in rainfall, so every fifteen minutes we get an update as a service. We are getting information back from that we feed into a GIS process that we run within the City of Austin network. We would like to be able to expand our mapping capabilities with a modeling package. We could run it on- or off-site, depending on the proposal. Right now, a portion is running on-site, and another portion is running off-site. The development of the models is done internally--The City develops those, and is responsible for adjusting those as needed over a period of time as they are calibrated.

Q23: Does the city have an archive of data such as radar solutions, or would this be part of the solution?

A23: Yes, we have an archive.

Q24: Is the output from the developed model expected to be populated automatically as an input to the FEWS model or would manual data transfer be acceptable?

A24: Manual data transfer would not be acceptable with the exception of developing the model and then manually upload the model to the server. If it is running on a mapping server that generates the inundation polygons, and manual transfer the inundation polygons somewhere else is necessary, that would not be acceptable.

Q25: Are you comfortable now with the products you receive from the H&H modeling that you currently do, including the transfer of critical information into decision support products including forecast inundation services? If so, it seems the emphasis is on 1. the ability to integrate the existing tools and technology and information products

2. the key emphasis is on real-time, making sure the system can be fully real-time including all the integrated components, and 3. maintaining states and do much better with forecasting, not just what's happening now but what will happen in the near future, as far as the ability to develop decision support products.
Those 3 points are key, and you would most likely be comfortable maintaining or keeping the technical components that you currently operate including the H&H and geospatial aspects of the system? If not, what are the key features of the current approach that you are not entirely happy with and where you would like to see some improvements made?

A25: The biggest limitation for our current modeling solution is that we have software that generates stage and flow information at certain points but that same software package does not display the inundation polygons. It generates an XML file that a different, in-house software package uses to show the inundation polygons.

The biggest limitations are that 1. we have one software package that performs one task, that then information – which is not all of the information we desire, such as flooded structure count, ability to view historical data, or do after-action reports using inundation polygons generated - is sent somewhere else. There are some things the current system does well and some things we would like to see improved with this RFP process. Those limitations would be fixed by providing more actionable information: intersecting the inundation with other data sources such as bridge heights, structure finished floor elevations, potentially census data with population. We would like to see actionable data rather than just a map of a shape of a polygon.

The due date for questions has been extended to Monday, March 2, 2015 at 5:00 PM Central.

The Bid Due Prior To: and Public Bid Opening: dates have been extended to Thursday, March 26, 2015 at 3:00 PM.

The sign-in sheet from the Pre-Proposal meeting is attached to this document.

All other terms and conditions remain the same.

BY THE SIGNATURES affixed below, this Addendum is hereby incorporated and made a part of the above-referenced Solicitation.

APPROVED BY:

Paige McDonald, Senior Buyer
Purchasing Office, 512-974-2076

ACKNOWLEDGED BY:

Jean E Vieux		3/23/2015
SUPPLIER	**AUTHORIZED SIGNATURE**	**DATE**

RETURN ONE (1) COPY OF THIS ADDENDUM TO THE PURCHASING OFFICE, CITY OF AUSTIN, PRIOR TO BID OPENING OR WITH YOUR SEALED BID. FAILURE TO DO SO MAY CONSTITUE GROUNDS FOR REJECTION OF YOUR OFFER.

REQUEST FOR PROPOSAL ADDENDUM
PURCHASING OFFICE
CITY OF AUSTIN, TEXAS

REQUEST FOR PROPOSAL: SMW0127 ADDENDUM NO. 3 DATE OF ADDENDUM: March 3, 2015

This addendum is to incorporate the following questions and answers:

Q1: What is the source data?
A1: The source data is City of Austin 2012 2-foot contour flown LiDAR, which is publicly available here: ftp://ftp.ci.austin.tx.us/GIS-Data/Regional/contours/2012/contours_2012.txt
Additional resources can be found here: ftp://ftp.ci.austin.tx.us/GIS-Data/Regional/coa_gis.html

Q2: What is the base resolution?
A2: The base resolution is 18cm.

Q3: What is the provided format?
A3: The data is contour elevation lines as of spring 2012. It does include classifications for elevated structures.

Q4: What is extent?
A4: Geographic extent:
Bounding rectangle
Extent type Extent used for searching
--West longitude -98.070494
--East longitude -97.441688
--North latitude 30.613421
--South latitude 30.006476
--Extent contains the resource Yes

Extent in the item's coordinate system
--West longitude 3012733.093994
--East longitude 3206194.949195
--South latitude 9977842.937904
--North latitude 10194161.738205
--Extent contains the resource Yes

All other terms and conditions remain the same.

BY THE SIGNATURES affixed below, this Addendum is hereby incorporated and made a part of the above-referenced Solicitation.

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Paige McDonald, Senior Buyer
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Tab 3 - Proposed Solution

Vieux recognizes the magnitude and distributed nature of flood threats and its impact on the citizens of Austin Texas. The City takes the protection of its citizens seriously, and extends the FEWS services to help protect against flood hazards. In 1981, the deadly Memorial Day flood killed 13 people – two of which died in their house adjacent to Shoal Creek. This flood disaster motivated the City to establish FEWS. A unique setting exists in Central Texas, where copious Gulf moisture combines with steep terrain in an urban setting. While large flood events have been known to occur every decade or so, there are lesser events that also cause public safety concerns. Many houses and buildings (structures) are in the floodplain and subject to flooding from streams that reach out of bank. Bridges can be cutoff on the approaches creating an impassable avenue for escape or evacuation. Besides stream flooding, local flooding at intersections also occurs, necessitating road and intersection closures. Especially hazardous are the low water crossings prevalent in the urban and lesser-developed areas of the City and Travis County, which are mapped via ATXfloods.com to help inform the public or hazardous conditions.

A. Hydrologic and Hydraulic Modeling Approach

We combine three essential components within a single business entity to provide a complete solution: 1) radar and hydrometeorology data services for quality controlled rainfall, 2) Hydrologic & Hydraulic Modeling for real-time applications, and 3) Software IT for production modeling and mapping.

Rainfall accuracy is the first step in achieving accurate hydrologic and derivative hydraulic outputs, stage and inundation. Radar in particular, has many advantages for flash flood forecasting in urban and developing watersheds. If properly quality controlled and enhanced for accuracy, radar provides instantaneous rainfall intensity over broad areas at high resolution. However, the NEXRAD data source is complex and cannot be relied upon as a black box input for hydrologic or hydraulic modeling, particularly not real-time. To be considered adequately sophisticated, the system must apply algorithms to mitigate clutter/anomalous data, and have self-monitoring to understand the accuracy and reliability of rainfall products generated. Radar products, both merged with rain gauge and those that are independent of rain gauges, provide more reliability in terms of rainfall rates, and the runoff produced from modeling.

Two observed rainfall products: gauge-adjusted radar rainfall (GARR), and the NWS digital precipitation rate (DPR), are based on recent dual-polarization advancements implemented recently for the NEXRAD system. DPR is independent from rain gauges and relies on vertical and horizontal polarized microwave pulses. Even with these new advances in polarimetric radar, inherent biases in the DPR rainfall product exist, and are discussed further in the following sections regarding our hydrometeorological monitoring and evaluation process.

Current and forecast rainfall products are ingested by the distributed physics-based hydrologic model, *Vflo*®. Forecast rainfall from two products: 1) PreVieux, a nowcasting product based on storm movement, intensification, or decay detected by radar and projected forward up to 60 minutes, and 2) HRRR, a longer-term product combining numerical weather prediction modeling and radar. The HRRR is produced by the NOAA/National Center for Environmental Prediction through data assimilation of radar and other surface observations used to constrain initial conditions of the NWP. By merging radar with an ensemble of NWP model forecasts, the high-resolution nature of convective precipitation is

better captured. Every hour out to 15 hours, this product is generated. ***Vieux has a mature process and is experienced with implementation of QPF in forecast flooding, leveraging both PreVieux (0-60 min) and HRRR (1-15 hr) as a merged product with GARR. We know that the production cycle of the HRRR can occasionally lag behind, thus necessitating the insertion of an intermediate hour previously generated by the HRRR to replace the missing hour (usually the first hour is missing).***

The HRRR reflectivity product has a temporal resolution of 15 minutes and 3-km spatial resolution. These five inputs seen in Figure 2are tailored to the specific needs of Austin and the watersheds for which flood forecasting is requested. V*flo*® responds to the rainfall intensity provided by radar, gauge, and QPF to provide detailed locations of flooding in normally dry creek beds that can become torrents in the matter of minutes extending to hours during intense and prolonged rainfall across Austin, from Lake and Rattan in the north, to Onion Creek in the south.

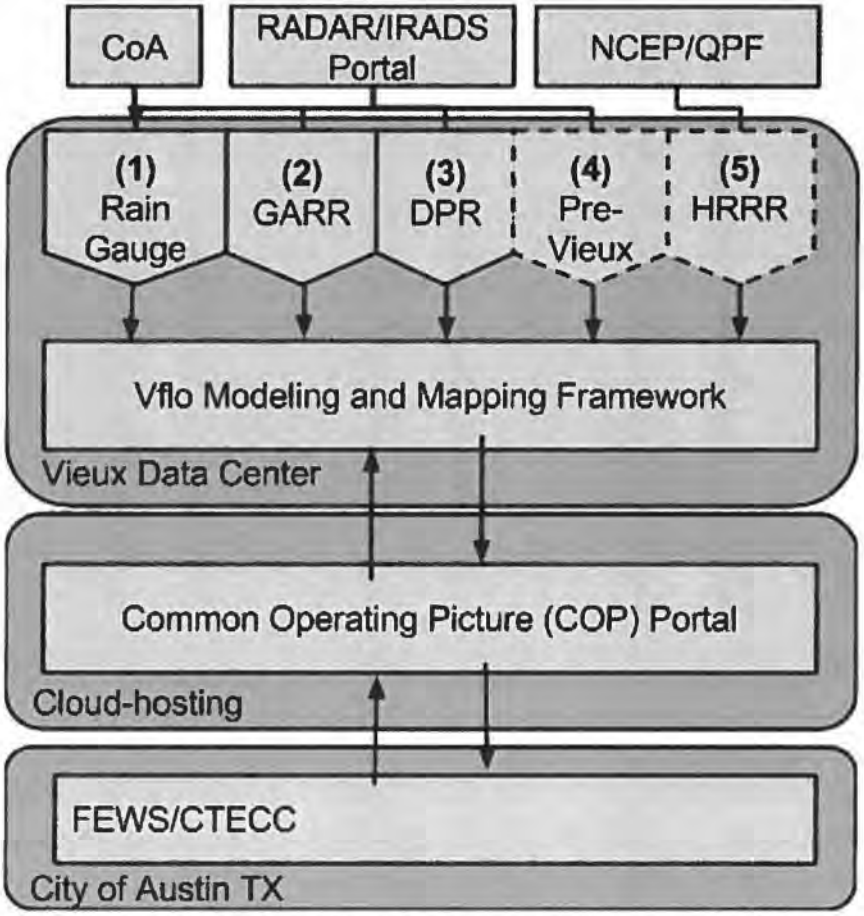


Figure 2 Five data feeds configured for current and forecast rainfall inputs to the V*flo*® Modeling and Mapping Framework

Rainfall detection relies on advances in radar technology including dual polarization. Rain gauge networks are leveraged separately, and in concert with the Vieux Radar Rainfall system. A diversity of networks are included besides those maintained by the City, namely Lower Colorado River Authority, Upper Brushy Creek Water Conservation and Irrigation District, and NOAA/NWS. Major upgrades are ongoing to the rain gauge operated by the City and LCRA to improve coherent data transmission and reliability, mainly since the October 31, 2013 storm that caused major damages in Onion Creek and other basins in the City. USGS stream gauges have been hardened to reduce the threat from washout in Onion Creek and tributary locations.

Alert notifications are generated by the Vieux system providing text/emails when thresholds are crossed. The monitoring system helps the FEWS staff identify intense rainfall in the vicinity the HHDs and supports dam safety personnel with alerts of possible overtopping.

The innovative hydrologic information system is built upon radar hydrology and Internet information access, with initial implementation of radar added in 2004. The flood modeling system has inaugurated in 2007 with a pilot watershed, and then for remaining basins in 2010. Many times since then, the radar-based distributed modeling system has proven useful during storms producing heavy precipitation and flooding.

Major technological systems harnessed by FEWS in their work include:

1. Rain Gauges and Telemetry
2. USGS Stream Gauges (ELOS)
3. Kister/WISKI Database
4. Vieux Radar-Rainfall and Real-time H&H modeling
5. FEWS Inundation Mapping
6. Low water Crossing (LWC) automatic gate arms, and flashing lights via SCADA
7. Road closures issued and managed via ATXFloods.com

There is a need to integrate the diverse information provided by these seven systems. ***To facilitate data flows among each subsystem, a cloud-based architecture would enhance mapping and modeling during emergency flood conditions.*** The rainfall and flood data resident on the real-time system will require archiving in the Kister/WISKI Database, and the capability to make this transfer efficient given its large size. Many of these data elements are integrated by Vieux in the current system, which will be extended to meet or exceed requirements. This will be accomplished through adoption of cloud-based services, increased model accuracy/refinement, and new functions and features described as deliverables, especially through integration in the COP portal. Communicating flood risk within a limited timeframe for action requires knowing where, when and how deep the flood will be. This type of mission critical information could be made more exact and efficient through modifications and extension of the present system.

V*flo*® has the necessary attributes to meet the evolving needs for accurate maps of inundation in real-time that helps FEWS communicate the risk of flooding in the near-term, i.e. the next 15-minutes or more, and in the longer-term, 12 hours or more, on major and minor streams affecting Austin. This forecast objective demands accurate and detailed rainfall inputs, both currently detected and quantitative precipitation forecasts (QPF). The present system that FEWS relies on does just that, using radar and rain gauges for current rainfall, and forecast rainfall that assimilates current radar with numerical weather prediction to provide accurate depths and location of precipitation for H&H model input. The modeling approach accounts for the variability in rainfall, and detailed watershed characteristics affecting runoff rates throughout the City's basins, namely soils, land use/cover, and hydraulic cross-sectional data.

B. Hydrometeorological Monitoring and Evaluation

Vieux is an industry leader in provision of accurate radar rainfall for hydraulic and hydrologic applications because we internally apply quality control and accuracy enhancement to NEXRAD radar data. Our current radar rainfall service capitalizes on skill and ability to utilize multiple radar products from the two radars serving Austin. We are monitoring the accuracy and reliability of both radars, KGRK to the northeast, and KEWX south in New Braunfels. As sufficient self-monitoring data is accumulated, we will select and apply the most accurate dual polarization products along with our GARR rainfall products. As seen in Figure 3, DPR from KGRK and KEWX are not uniformly accurate. If they were, then the departures from rain gauge accumulations, would center on 0.0 (horizontal line on the x-axis) during the period of September 5-7, 2014, expressed as a bias on the right-hand y-axis, departures between radar and gauges range from a low of -1.5 for KGRK to a high of 0.46 for KEWX. Because the 15-minute bias is shown at daily resolution, they overlap with both negative and positive values on any given day when rain occurred as shown by the inverted gray bars indicating number of gauges receiving measurable precipitation. A value of 0 bias would indicate that the radar was in perfect agreement with gauge, but this usually occurs only during non-rainfall periods. When both DPR products are produced by KEWX and KGRK, the bias is often opposite in sign, i.e. one is negative while the other shows a positive bias with respect to ground observations. In May 2015, the NWS Radar Operations Center plans to deploy a significant new algorithm that should improve DPR and its ability to detect rainfall accuracy. We will continue to monitor the NEXRAD system and its changes to help ensure the best possible radar products are used and appropriate automated QA/QC is implemented.

Radar accuracy enhancement is essential, since its accuracy can be low by 50% or too high by more than 100%

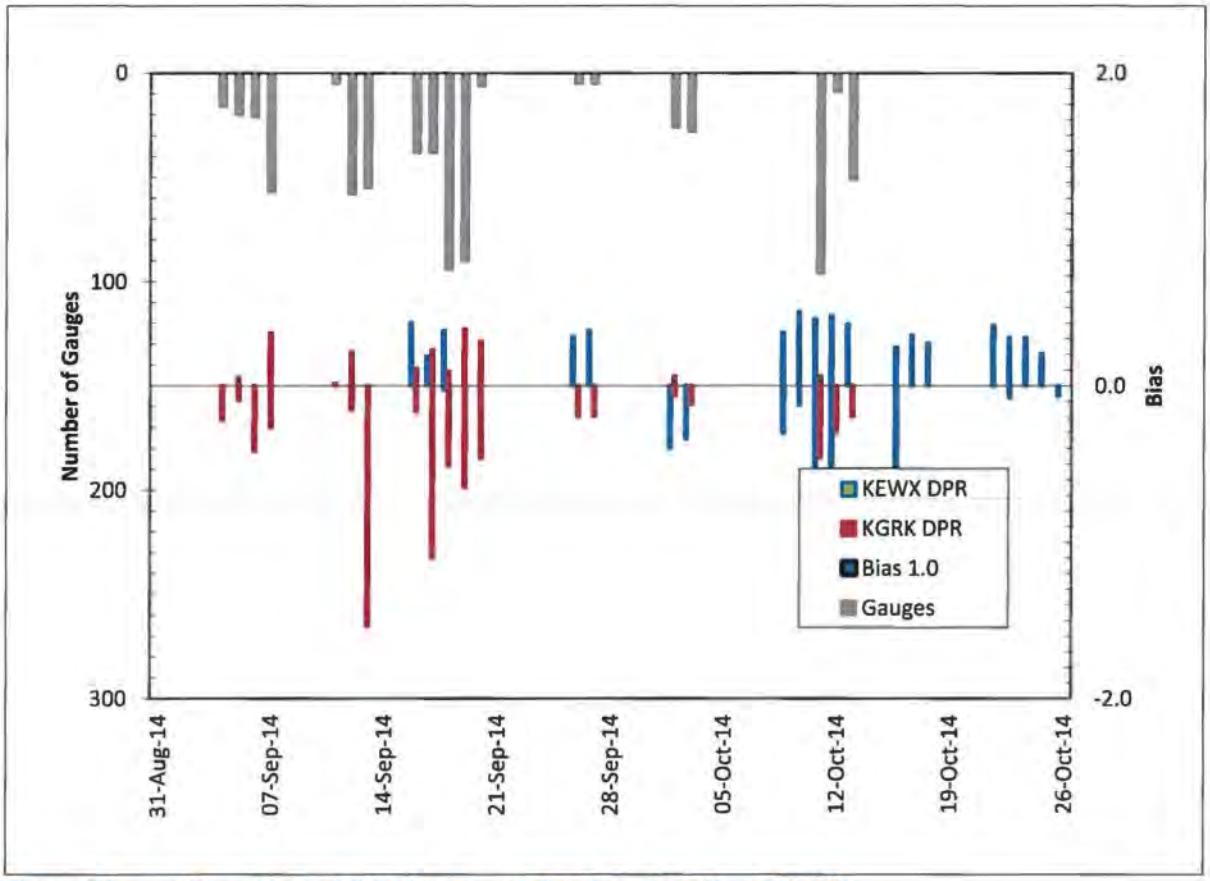


Figure 3 Non-uniform bias exhibited by recent DPR from KGRK and KEWX

The GARR system can reject erroneous precipitation gauges in real-time based on statistical analysis of outliers and thresholds. Because we monitor rain gauge inputs used in GARR production, we have web pages for reporting gauge status, which is tabulated and accessed via our current Dashboard. Figure 4 shows a Gauge Status webpage with the hours since the last gauge report during 1, 6, 24, 48, and 72 hours. These pages show our operational monitoring of gauges, their transmission latency, depth accumulation of gauge-radar pairs, and the inclusion/exclusion during GARR production due to statistical outlier detection. Also shown in this figure, are the gauge status last report (upper), scatter plot of radar and gauge (lower center), and raw/calibrated radar (lower right).

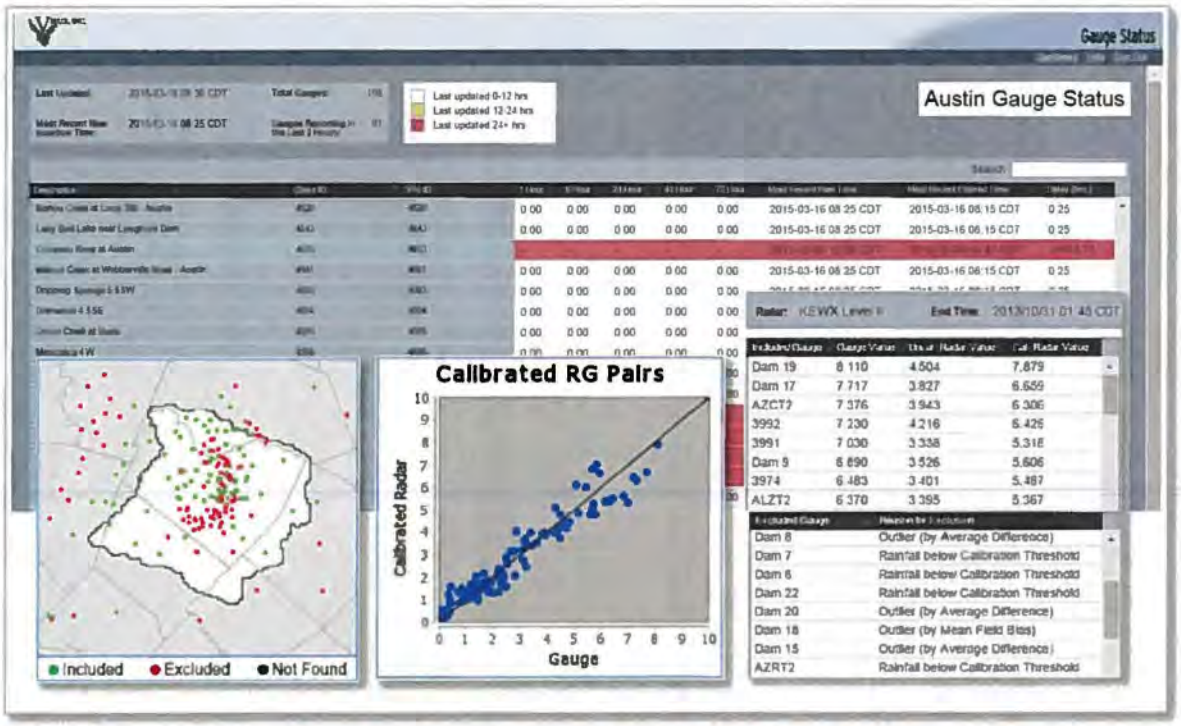


Figure 4 Keeping track of Gauge Status during operational 1, 6, 24, 48, and 72-hr periods, and the gauge latency, outlier detection, and reasons for exclusion

Besides current rainfall, *future rainfall* represented by PreVieux/HRRR QPF is used to extend lead-time and warning of impending flood levels. A recent advance in QPF was achieved with the addition to the suite of hydrograph forecasts that include those generated with input from PreVieux (0-60 min), and the High-resolution rapid refresh, or HRRR (1-15hr) product. On March 16, 2015, the NWS numerical weather prediction (NWP) models indicated precipitation approaching the watersheds affecting Austin. As the combination of PreVieux/HRRR QPF data is generated (see Figure 5 below), it is incorporated into the operational hydrologic modeling of watersheds affecting the City to produce *forecast stage* from *forecast rainfall*.

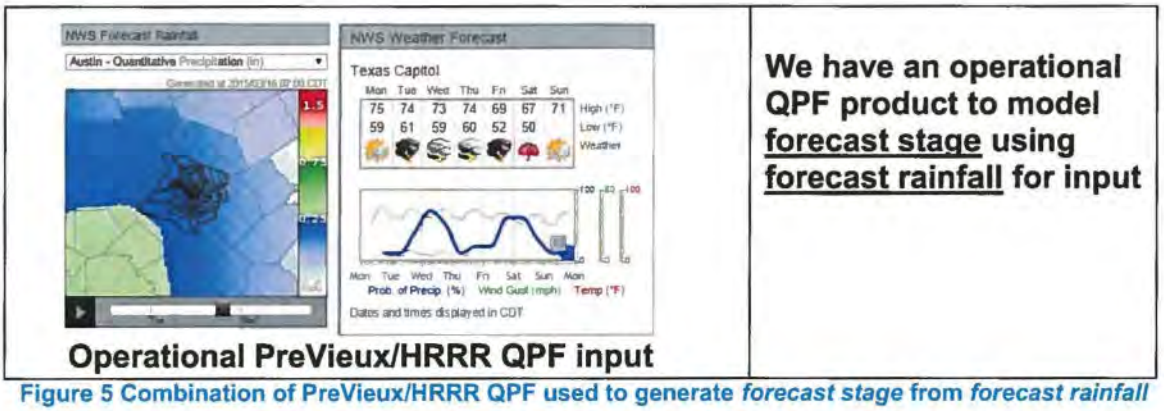


Figure 5 Combination of PreVieux/HRRR QPF used to generate *forecast stage* from *forecast rainfall*

Because rain gauge networks can fail or be unreliable, particularly during heavy precipitation, we have increased radar product reliability through addition of hydrographs

generated independently with DPR. Good agreement is seen in Figure 6, among three simulated stage hydrographs (GARR+QPF, GARR, and DPR) compared with observed stage during the first peak, while the second peak shows divergence between GARR and DPR with the latter showing better agreement with observed. In Figure 7, larger divergence is evident among the hydrographs produced with DPR (from KGRK) where it underestimates the observed stage (7 ft versus 10 ft), while the GARR hydrograph overestimates. Because we monitor NEXRAD products from both KEWX and KGRK, we can identify reasons for inaccurate stage forecasts. In Figure 8, the rainfall totals produced by DPR for KEWX (left) and KGRK (center) appear quite different. Notably, there is a lack of any rainfall above 4 inches (no yellow pixels) in the KGRK DPR, especially across the forecast watersheds and urban core of Austin. The KGRK GARR relied on a NEXRAD Level-3 reflectivity product together with rain gauges to produce rainfall exceeding 6 inches (red pixels) in real-time (right) rainfall during this recent event. ***We continue monitor performance of hydrometeorological inputs, and have the ability to construct sophisticated combinations of radar products for accurate and reliable inputs used in generation of real-time hydrographs.***

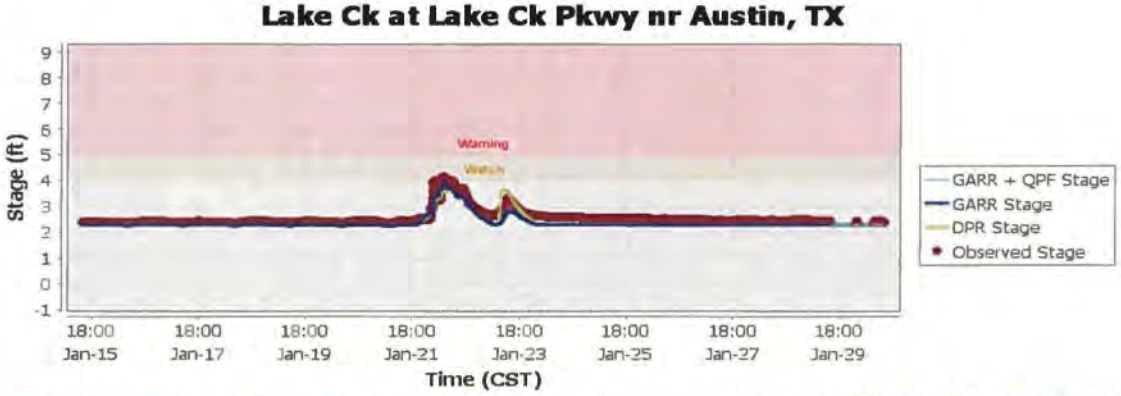


Figure 6 Forecast and observed stage with hydrographs generated from GARR (dark blue), GARR+QPF (skyblue), and DPR (light green), January 21-23, 2015

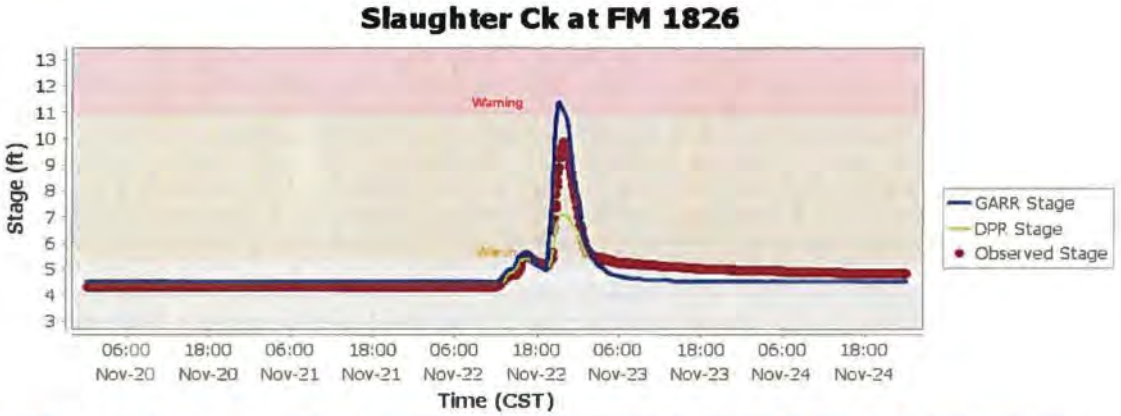


Figure 7 Evaluation of over/under estimation of hydrograph response using GARR and DPR for Slaughter Creek at FM 1826 on November 22, 2014

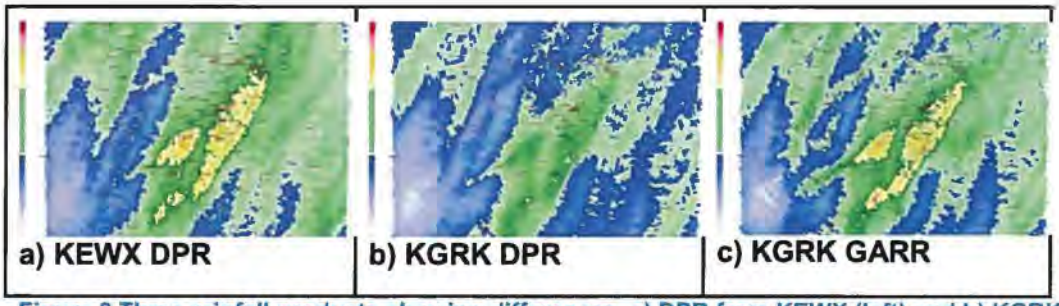


Figure 8 Three rainfall products showing differences, a) DPR from KEWX (left) and b) KGRK (center), and c) KGRK GARR (right) produced in real-time, November 22, 2014

GARR improvement continues to leverage dual polarization products for QA/QC and accuracy enhancements. Vieux has modified the GARR production to capitalize on recent CoA rain gauge network improvements made since the Halloween Event 2013. For reliability, we maintain DPR as a model input that is *independent* from rain gauges. Current Vieux Laboratory analysis includes using both KEWX and KGRK radars with appropriate bias adjustment made to each radar individually, and then mosaicked. This innovation will provide coverage that is more effective across the 4,483km^2 domain. KEWX DPR typically (but not always) overestimates rainfall, while KGRK is closer to rain gauge accumulations (but not always as illustrated by the November 22, 2014 event). A mean field bias (MFB) of currently available rain gauges can be applied to the mosaic of KGRK and KEWX DPR. By this mosaic procedure, we expect to mitigate attenuations and other inconsistencies between radars introduced since dual polarization was implemented by the NWS.

- ✓***Vieux has a progressive program for radar hydrometeorological accuracy enhancement for real-time flood forecasting applications.***
- ✓***Through self-monitoring and robust merging of radar and rain gauge data, we continue to find ways to improve data quality.***

C. Project Objectives

1. FFMMS as an Operational Web-service

Forecast hydrologic/hydraulic modeling and mapping is currently operational as a web-service with output made available for import into the Flood Early Warning System (FEWS) interface via XML. We propose improvements be made to the existing web services through updating model parameters; making rainfall products more robust and accurate; revising soil moisture routines to account for measured ET; and refining model rating curves to make numerical results more accurate. In terms of the modeling and mapping information produced, integration will capitalize on open data formats for display, query, reporting, and use in the FEWS COP, graphical user interface.

There are risks associated with unsteady hydraulic modeling (numerical instability in particular), besides the added complexity and work effort for the model setup. The question whether benefits achieved with full unsteady hydraulic modeling is sufficiently great to merit the additional cost of setup and risk of malfunction during real-time modeling of a flood, can be answered by examining the relative magnitude of the elevations associated with channel slope versus backwater. Examination of the period-of-record discharge maxima, reveals headloss at Shoal Creek and 12th would be less than a few inches. In Onion Creek, near Driftwood, and near Hwy 183, bridge entrance head-loss would also be minimal (0.89 inches). During the Halloween Event in Onion Creek, at the Hwy 183 bridge there would be about 21 inches of head-loss during the peak stage, 40-ft depth. When these incremental depths associated with headloss are mapped, the horizontal extent is almost imperceptible. While *Vflo*® does not propagate this difference upstream; this headloss is already accounted for within the grid cell containing a bridge rating curve. The change in channel elevation amounts to a difference of 3.6 ft in Onion creek, while in Shoal Creek, the difference is even greater, with a 5.4 ft drop from grid to grid (channel slope is greater in Shoal ~2.5%). Thus, headloss is not even as great as the change in channel elevation from one model grid to the next.

Even the most detailed hydraulic model cannot account for larger uncertainties during a flood, say those caused by debris caught on a bridge or changes in channel geometry caused by scour. At the gridded model resolution, 60-m in Shoal to 250-m in Onion, head-loss would be small compared to changes in elevation associated with the slope of the channel. This statement is another way of expressing the validity of applying the kinematic wave analogy to flood routing in the City's watersheds. As a result, diffusive

Full St. Venant hydraulic approaches to unsteady flow/backwater modeling could introduce:

- ✓ *complications in model setup*
- ✓ *added computational burden*
- ✓ *model numerical instability during real-time operations (model crashes)*

wave modeling could be an unnecessary complication that requires even finer timesteps than kinematic wave modeling, not to mention inherent numerical difficulties.

Other factors that are addressed in this proposal are tools for correcting or improving rating curves, model soil depth, ET rates, and real-time rainfall accuracy through application of new dual-polarization algorithms. Accurate rainfall rate is a much more important impact on the accuracy of water surface elevations than the hydraulic impacts associated with headloss or backwater.

2. Real-time FFMMS - Current and Forecast Rainfall Input

Forecast hydrologic/hydraulic modeling already runs in real-time using data from gauge adjusted radar rainfall, National Weather Service rainfall, and forecast rainfall (available from PreVieux and from the NWS as a blended ensemble, thus providing accurate stage and flow hydrographs at locations specified by the City.

Mapping of real-time inundation requires a real-time hydrologic/hydraulic model that can run as a web-service to produce flow and stage distributed throughout the watershed drainage network. The integration of modeling with radar and gauge rainfall distributed over the forecast basins enables the system to meet or exceed requirements of the City. ***Vflo® is a real-time model developed from the outset to operate in continuous mode with radar rainfall inputs.*** We also have in-house control over rainfall data that is 1) quality controlled to exclude invalid radar or rain gauges readings; 2) a merged product consisting of radar/gauge to produce spatial/temporally bias corrections for accurate model input. Besides GARR input, the system takes advantage of new Dual Polarization radar rainfall intensities that are independent from real-time rain gauge transmission and associated (un)reliability. *Vflo®* takes rainfall intensities from GARR and applies it to the continuously-updated soil model, and routes the runoff through an integrated hydraulic/hydrologic model of the drainage network in each of ten basins affecting the City, producing hydrographs and maximum forecast stage at 599 locations. The model is gridded so that it can account for the spatial variation of soils, landuse, developed area and make forecasts internally, not just at the outlet of a subwatershed area as with prevalent lumped-basin hydrology models.

Vflo® takes an approach to hydrology that is integrated in such a way that prediction of both discharge and stage throughout a stream reach can be made in real-time. Having the full spatial distribution of forecast stage and flow hydrographs simultaneously at many locations makes it suitable for inundation mapping. Figure 9(a) shows gauge adjusted radar rainfall over Williamson Creek during October 13, 2013. Figure 9(b) shows several stage hydrographs produced from GARR input showing exemplary agreement in the rising limb when stage crosses warning and watch levels. Once the gauge comes back online, the modeled recession limb is quite close to observed, thus making it possible to forecast the time when the road closure should be opened.

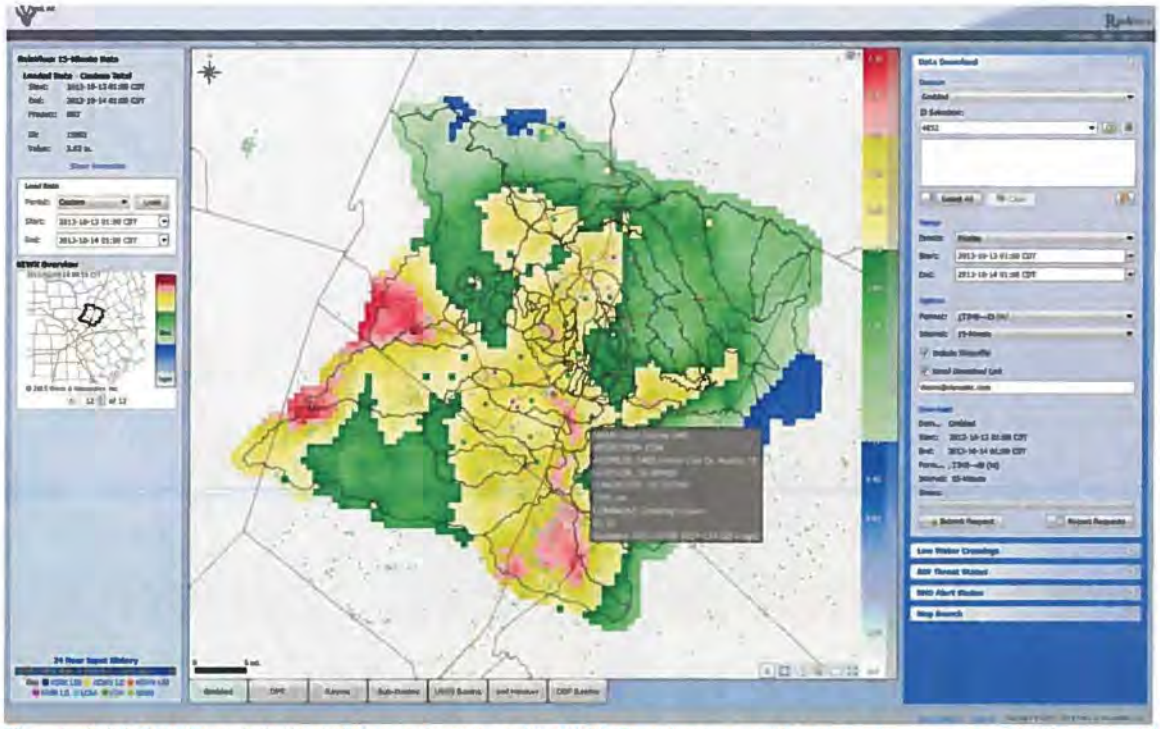


Figure 9 (a) GARR rainfall total from October 13, 2013 flood event with road closure for Golf Course LWC at 5400 Jimmy Clay Drive (mouse over). ATXFloods.com locations are indicated by the many small green circle icons on this display.

Linking together separate models within a frameworks typically relies on updating a simple conceptual hydrologic model with stream gauge observations. These approaches can be made to work on large slow responding rivers atypical for urban basins such as Austin's. Because of the short streamflow response time, there is likely too short of a time to get hydraulic stage, especially on small quick responding urban streams. When there is a dry streambed, or when real-time observed USGS data is lagging "now-time," such updating methods have difficulty producing reliable results. Having model predictions that accurately predict time-of-crossing thresholds and ultimate peak stage is a key forecast objective achieved by the current *Vflo*® model. Figure 10 demonstrates the close agreement between real-time forecast and observed stage as it crosses the *watch* and *warning* levels on a multi-peak hydrograph. Using the physics of rainfall intensity interacting with the soils, landuse, and hydraulics of the drainage network, the operational model is able to reproduce the observed response. This is the case, even when there is USGS stream gauge interruption between 07:00-19:00 CDT in Figure 10, where there is a coherent model response produced during the rising and recession limbs independent of the gauge. Improvements will address soil moisture modeling, ET, and rating curves.

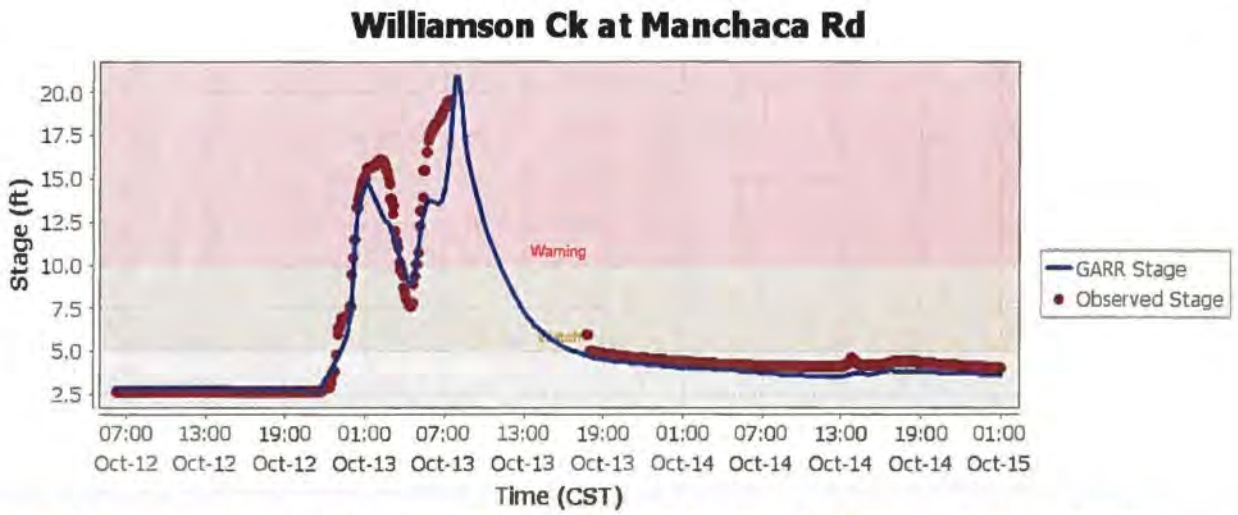


Figure 10 Stage produced with GARR in Williamson Creek at Manchaca Rd during the October 13, 2013 event

3. Immediate Import of Forecasts for First Responders

We will produce maps and make them available for use by FEWS Operators in CTECC. Our current system produces two types of maps in open format: 1) using current rainfall as input, and 2) forecast rainfall (HRRR and PreVieux). These maps are generated from the maximum stage of inundation in the forecast period and transferred to the City of Austin/FEWS for mapping with their ArcGIS server. We will perform the mapping in-house, published in an open format, and transmitted for rendering in the FEWS COP, thus facilitating integration and display. Our output can be seamlessly published in MapBox as shown in Figure 11 where inundation depth is color coded, superimposed on a basemap with structure icons.

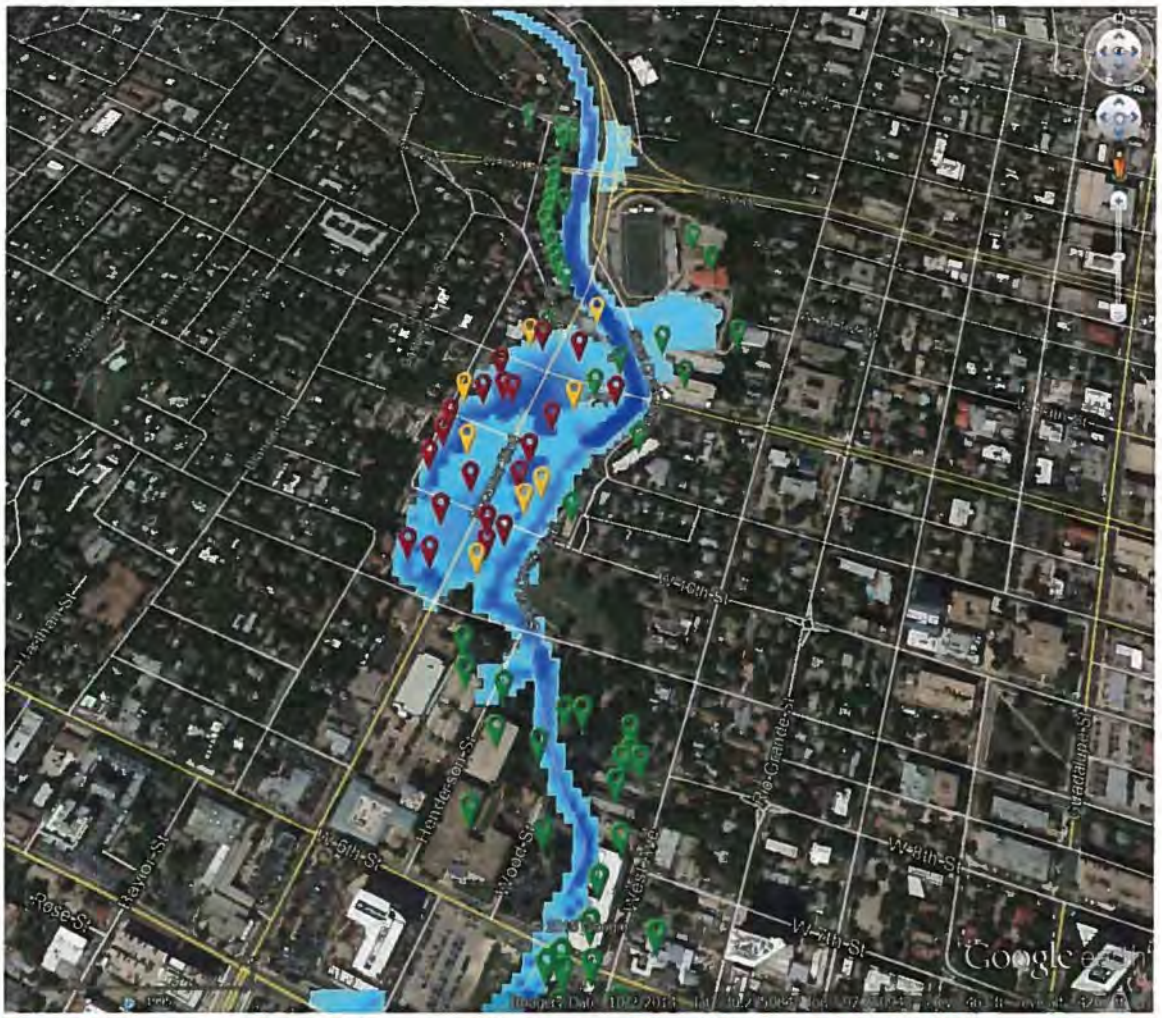


Figure 11 ***Vieux map of inundation near 12th street and Shoal Creek published in KML open format***

4. Minimum Map information

We have the technology to provide mapped forecast stage (relative to maximum depths in forecast period), and to provide critically important information defining flood stage and time to flood level. Requirements will be met or exceeded for showing the following:

- ✓ Date/time, extent, and depth of flooding;
- ✓ Numbers of structures at risk
- ✓ Finished floor elevations of structures, estimated depth of flooding and provide damage estimate based upon Travis Central Appraisal District (TCAD) information;
- ✓ Census estimates of impacts, including individuals that may have ambulatory issues (211/STEAR)
- ✓ Location of roadways that are anticipated to be under water based on water surface elevation in relation to the low and high chord of the bridge.

Forecast stage is mapped in Figure 12 showing the location of bridge roadways that are above/under water using the Vieux mapping utility for an event in Shoal Creek (January 15, 2007). We will flag structures that are at risk based on TCAD elevation data, and bridges

given the roadway and low chord elevations. ***We will work with FEWS staff to convey the necessary attributes such as STEAR/211 locations, or TCAD first floor elevations, low/high chord bridge elevations, and thus effectively interchange data objects between the FEWS COP and the FFMMS.*** Another view is shown in Figure 13 rendered this time in 3D with similar structure information, first floor elevation, compared with the forecast water surface elevation from V*flo*®.

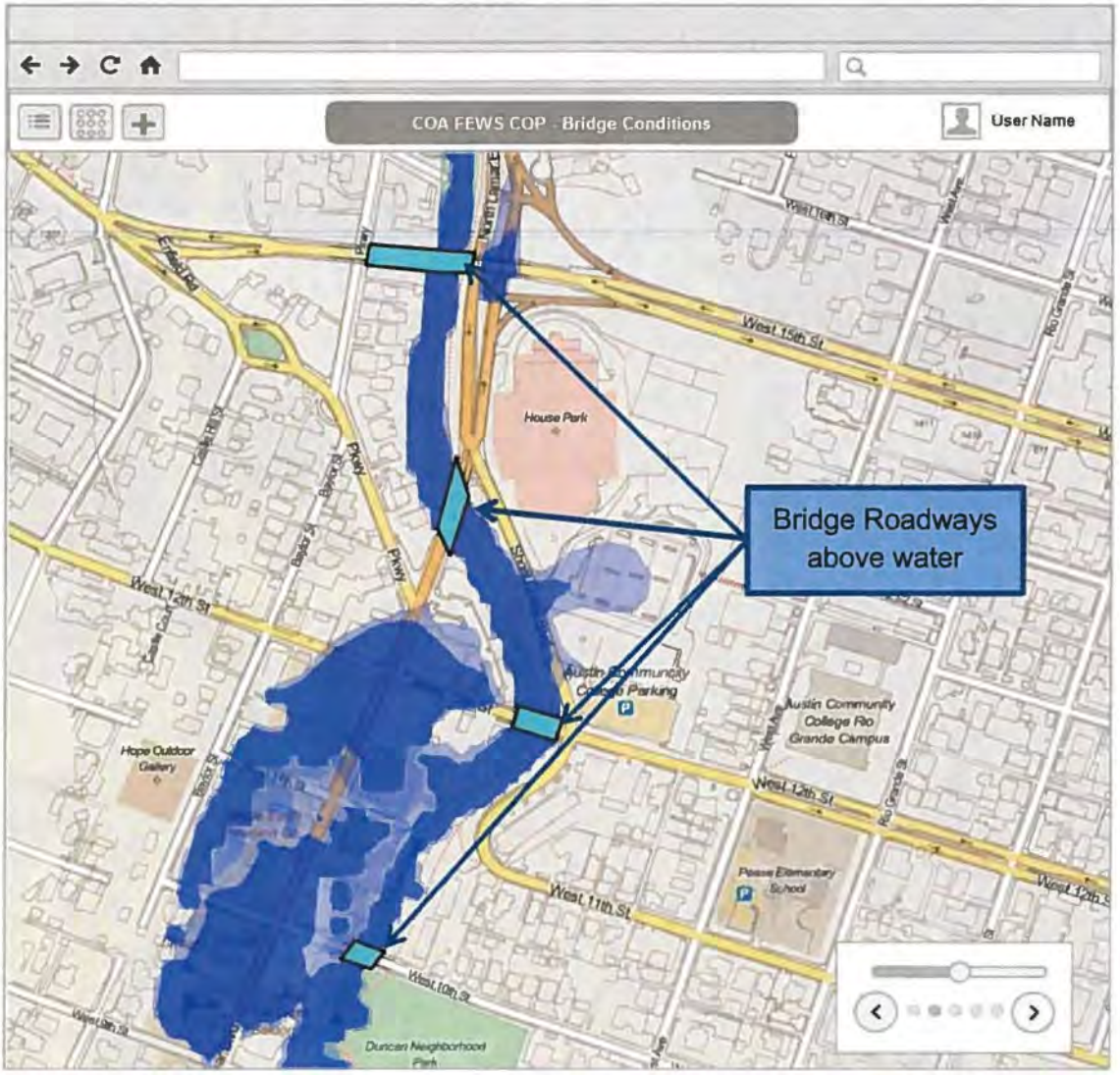


Figure 12 Inundation map showing bridges that are above/below water surface elevation based on low/high chord elevations

In preparation for real-time mapping, our QA/QC procedure will be performed as described below for the current basin models, and when future map locations/basins are modified or added. Because V*flo*® maps inundation where there is a channel cell in the model, some stream reaches may need editing such as side channels along the mainstem. To increase the mapping accuracy and usefulness for operations, model modifications may require addition/subtraction cells along the mainstem or tributaries, or improve the channel hydraulic

definition (replace trapezoidal cross-section with cross-sections or rating curves). We have planned QA/QC of the inundation mapping supporting data described in Tab 4 A. Workplan.

A data policy will be established for information that can only be used internally by FEWS, and that information that can be shared publicly, for example private STEAR data. Policies will be examined for current data shared via ATXFloods.com includes Open Data: *Closures XML*, *City of Austin rain gauge XML*, and *City of Austin stream gauge XML*. Consideration will be given to data required in the COP, and for sharing with other CoA departments, for high level briefings, or with the public. Figure 13 shows a sample view of our *Vflo*®–generated XML inundation depth mapping with 3D rendering. ***While other options exist for publishing 3D information in open data format, e.g. Mapbox, the map shown here is rendered in Google Earth.*** This view demonstrates the type of display format intended for general audiences with reduced information content. Details are shown for a structure from the TCAD database with a first floor elevation of 470.12 ft msl. The depth in the *Vflo*—model cell is greater than 8.2 ft, whereas the structure symbol is flagged as *red* because the depth at the structure is greater than 1.0-ft depth of inundation (interpolated as >5.0 ft). Within the work effort associated with the FEWS COP development, we will coordinate the *type* of information communicated and its *format*.

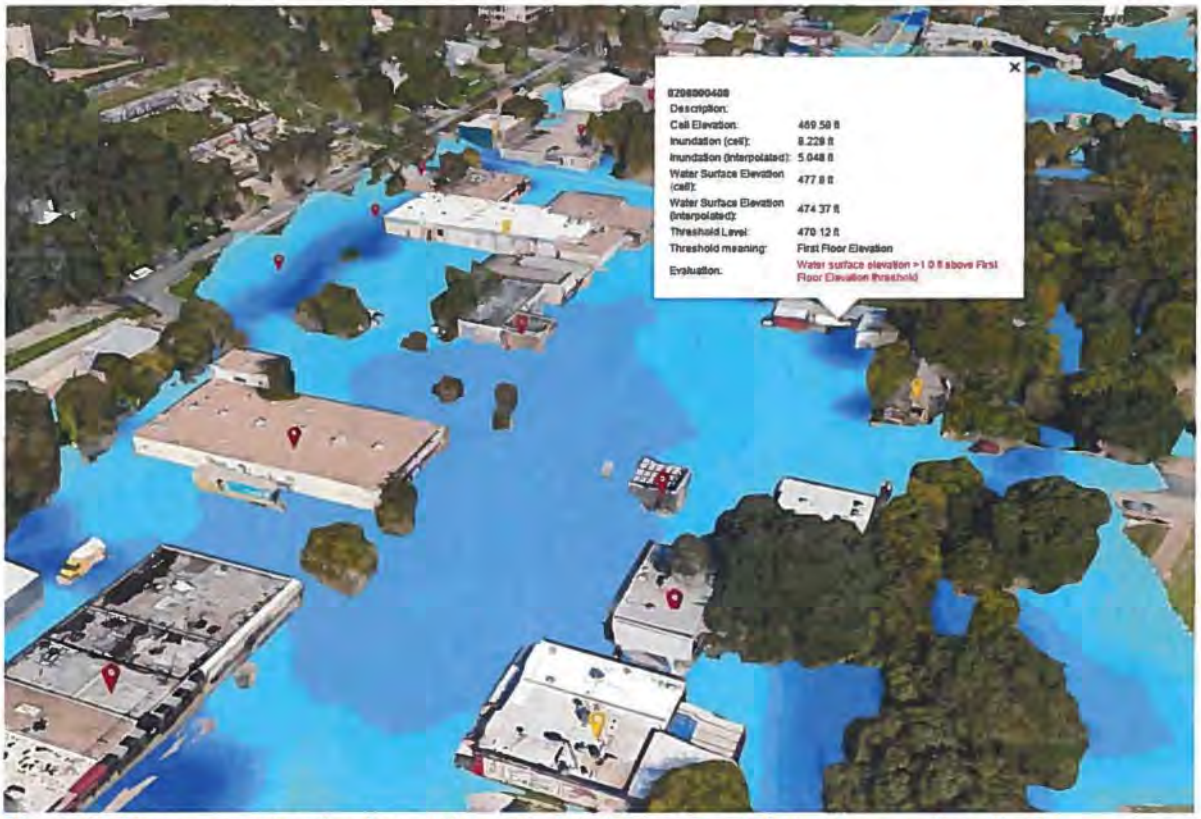


Figure 13 Storm event showing inundation with details on a flooded structure rendered in 3D

5. Model Calibration to USGS Observed Streamflow

There are twelve calibrated watershed models arranged in ten (10) operational models, all of which were calibrated to available past events at the time they were put into operation, and then revised as new events occurred. Calibration assistance is provided to FEWS personnel, and most models exhibit this tight correlation for the range of soil moisture observed. Now with additional recorded inputs/outputs archived over the period of model operation, mainly since 2007, we will expand calibration, from *several* to *many* events in continuous mode, for the following basins currently modeled in Table 1a, and at active stream gauging locations in Table 1b.

Table 1a Major subbasins modeled in current operational *Vfl*

Major Subbasins Modeled in *Vflo*®	
Walnut Creek	L. Bear Creek
Little Walnut Creek	Bear Creek
North Boggy Creek	Slaughter Creek
Tannehill Br Boggy Creek	Williamson Creek
Fort Br Boggy Creek	Kincheon Br Williamson Creek
Boggy Creek	Wiliamson Creek at Oak Hill
Bull Creek	West Bouldin Creek
Lake Creek	East Bouldin Creek
Waller Creek	Carson Creek
Shoal Creek	
Onion Creek	
Blunn Creek	

Table 1b Active USGS and COA stream gauge locat

Site_Id	Water shed	Sitename	Drains to	Operator
08158600	WLN	Walnut Ck @ FM 969	Colorado	USGS
08158200	WLN	Walnut Ck @ Dessau Rd	08158600	USGS
08158380	LWA	Little Walnut Ck @ Geogian Dr	08158600	USGS
TAN	TAN	Tannihill Br Boggy Ck @ ped bridge (mouth)	08158050	COA
FTB	FOR	Fort Br Boggy Ck @ Webberville Rd	08158050	COA
08158035	BOG	Boggy Ck @ Webberville Rd	08158050	USGS
08158045	FOR	Fort Br Boggy Ck @ Manor Rd	FTB	USGS
08158030	BOG	Boggy Ck @ Manor Rd	08158035	USGS
08154700	BUL	Bull Ck @ Loop 360 First Crossing	Lk Austin	USGS
08105886	LAK	Lake Cr @ Lake Creek Pkwy	N. Brushy	USGS
08157560	WLR	Waller Ck @ East 1st St	Town Lake	USGS

Site_Id	Water shed	Sitename	Drains to	Operator
08157540	WLR	Waller Ck @ Red River St	08157560	USGS
08157500	WLR	Waller Ck @ 23rd St	08157540	COA/USGS
08156910	WLR	Waller Ck @ Koenig Lane	08157000	USGS
08156800	SHL	Shoal Ck @ t W 12th St.	Town Lake	USGS
08156675	SHL	Shoal Ck @ Silverway Dr.	08156700	USGS
08159000	ONI	Onion Ck @t US 183	Colorado	USGS
08158827	ONI	Onion Ck @ Twin Creeks Rd nr Manchaca, TX	08159000	USGS
08158700	ONI	Onion Ck near Driftwood, TX	08158800	USGS
LBR	LBR	L. Bear Ck @ FM 967	08159000	COA
LBA	LBR	L. Bear Ck @ Stoneledge Quarry	LBR	COA
ZAR	BER	Bear Ck near Manachaca, TX	08159000	COA
08158810	BER	Bear Ck below FM 1826	08158819	USGS
FBU	BER	Bear Ck @ FM 1826	08158810	COA
08158860	SLA	Slaughter Ck @ FM 2304	08159000	USGS
08158840	SLA	Slaughter Ck @ FM 1826	08158860	USGS
08158970	WMS	Williamson Ck @ Jimmy Clay Rd	08159000	USGS
08158930	WMS	Williamson Ck @ Manchaca Rd	08158970	USGS
08158927	WMS	Kincheon Br Williamson Ck @ William Cannon Blvd.	08158930	USGS
08158920	WMS	Wiliamson Ck @ Oak Hill (US 290)	09158922	USGS
08155400	BAR	Barton Ck above Barton Springs	Town Lake	USGS
08155300	BAR	Barton Ck @ Loop 360	08155400	USGS
08155240	BAR	Barton Ck @ Lost Creek Blvd.	08155300	USGS
08155200	BAR	Barton Ck @ SH 71 near Bee Caves, TX	08155240	USGS
08155541	WBO	W Bouldin Ck @ Oltorf Rd	Town Lake	USGS
CAR	CAR	Carson Ck @ Posten Ln	Town Lake	COA
08157700	BLU	Blunn Ck near Little Stacy Park	Town Lake	COA/USGS

Updates and review of existing operational models will help identify improvements in the soil moisture accounting, soil depth, cross-section/rating curves, and related hydraulic configuration, as needed. Assistance with calibration of new and existing models addresses improvements for rating curves, soil moisture, and continuous modeling result interpretation, as needed. Calibration leverages archival GARR and observed/simulated streamflow collected since project inception. Specific calibration review of existing models includes improvements made to the hydrologic/hydraulic modeling web-service:

- ✓ **Improve hydraulic characteristics at bridge and inundation cross-sections**
- ✓ **Enhance soil moisture modeling parameters including soil depth and ET measurements**
- ✓ **Assist with continuous model calibration**

For new models setup by FEWS, we will review, upload, and assist with placing them into operations.

6. Soil Moisture and ET Accounting

The *Vflo*® soil moisture engine characterizes the degree of soil saturation (soil moisture), with potential ET input and current rainfall distribution. This in turn, influences the watershed response to rainfall during wet (and dry or intermediate periods). The soil moisture engine keeps track of radar rainfall over each grid, affecting infiltration and actual ET, which is used to initialize soil moisture accounting continuously. Figure 14 shows a map of soil moisture after the flood on October 13, 2013. Interestingly, review of the archival soil moisture revealed that it was relatively dry at the outset, with only 17% saturation (not shown) antecedent to this flood-producing rainfall.

With gridded GARR and ET as model inputs, automated accounting of soil moisture makes it possible to predict "tomorrow's flood" from "yesterday's soil moisture."

We use historical ET to compute losses to the atmosphere from the soil model, there could be instances where ET differs from expected climatological rates, particularly during droughts, or between rainfall events, which may limit the predictive power of the model. We propose utilizing measurements of ET to modify soil moisture computations operationally. With records of measured ET, we will evaluate its use in continuous simulation model calibration, and compare simulated soil moisture with measured.

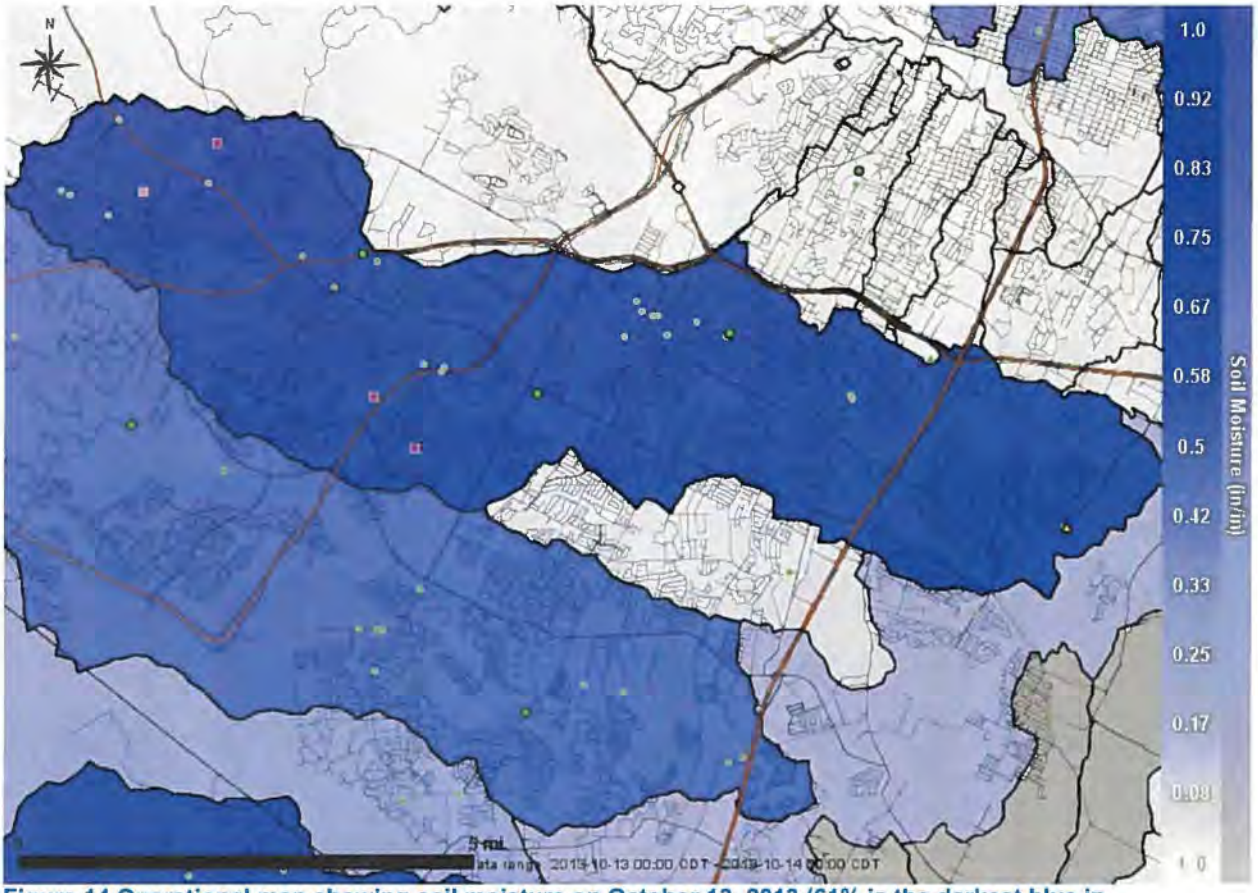


Figure 14 Operational map showing soil moisture on October 13, 2013 (61% is the darkest blue in Williamson Creek)

7. Procedures for Creating New Models and Providing Updates

We have established procedures for FEWS to provide model updates, and for deploying new basin models. This functionality exists within the combined package of Operational *Vflo*®, and Desktop *Vflo*® software. The desktop model supports City staff to: a) assemble model parameters using their geospatial data and importation of FEMA Flood Insurance Study model cross-sections; b) process LiDAR digital elevation data with AutoBOP; c) cutting cross-sections or importing the City's FIS/HEC-RAS model cross-sections and rating curves, with editing capabilities; and d) load GARR along with a variety of other rainfall formats such as rain gauge or synthetic SCS hyetographs. This procedure has worked well for the operational *Vflo*® basin models, namely the 599 watchpoints that are now operational for FEWS Operators, and at the 27 USGS flow monitoring stream gauges.

Training for FEWS personnel is planned that will address new model developments, software upgrades and new features, and review of the rainfall system and model performance each year. We have provided this training for the City nearly every year over the last 5 years. Software development schedule since 2004 resulted in upgrades from version 4.0 to version 7.0. While applicable to other users, a substantial number of added features specifically address modeling needs raised by City of Austin FEWS personnel.

Server software as operated by Vieux will be updated. As the City adds models, forecast location watchpoints, or new rain or stream gauges, the ingest and display of these data will be incorporated into the system, and updates applied as requested to the Vieux Data Center servers.

8. Desktop Model for FEWS Setup/Calibration

FEWS personnel are familiar with setting up *Vflo*® models and calibrating them with archival GARR downloaded from the Vieux System. Desktop *Vflo*® supports City staff to: i) assemble model parameters and use GARR that is archived for use by the City, besides input of USGS streamflow data.

The Desktop interface facilitates event and continuous model simulation analyses, model calibration for multiple-event runs, sensitivity testing for understanding which parameter(s) control watershed response, and automated calibration for searching the range of model response across one or many storm events. An example of running many iterations on several events is illustrated in Figure 15 for Williamson Creek that was calibrated using seven events dating from 2007 and 2009, only two of which exceeded 1000 cfs at USGS 08158903. From these recorded events, initial saturation ranged from 0% to 45%, with the largest event (3,352 cfs) on January 13, 2007 initialized at 18% antecedent soil moisture. Optimal soil infiltration parameter maps (saturated hydraulic conductivity and soil depth) found were 0.79 in/hr and 41 inches of fillable porosity. A number of calibration trials are shown for this particular watershed is shown by the inset in Figure 15, indicating convergence after about 600 iterations for the five events using AutoCal. These parameters exercise control over flood magnitude for dry and wet antecedent conditions, and the range in between, which work together to produce the particular response to a storm event.

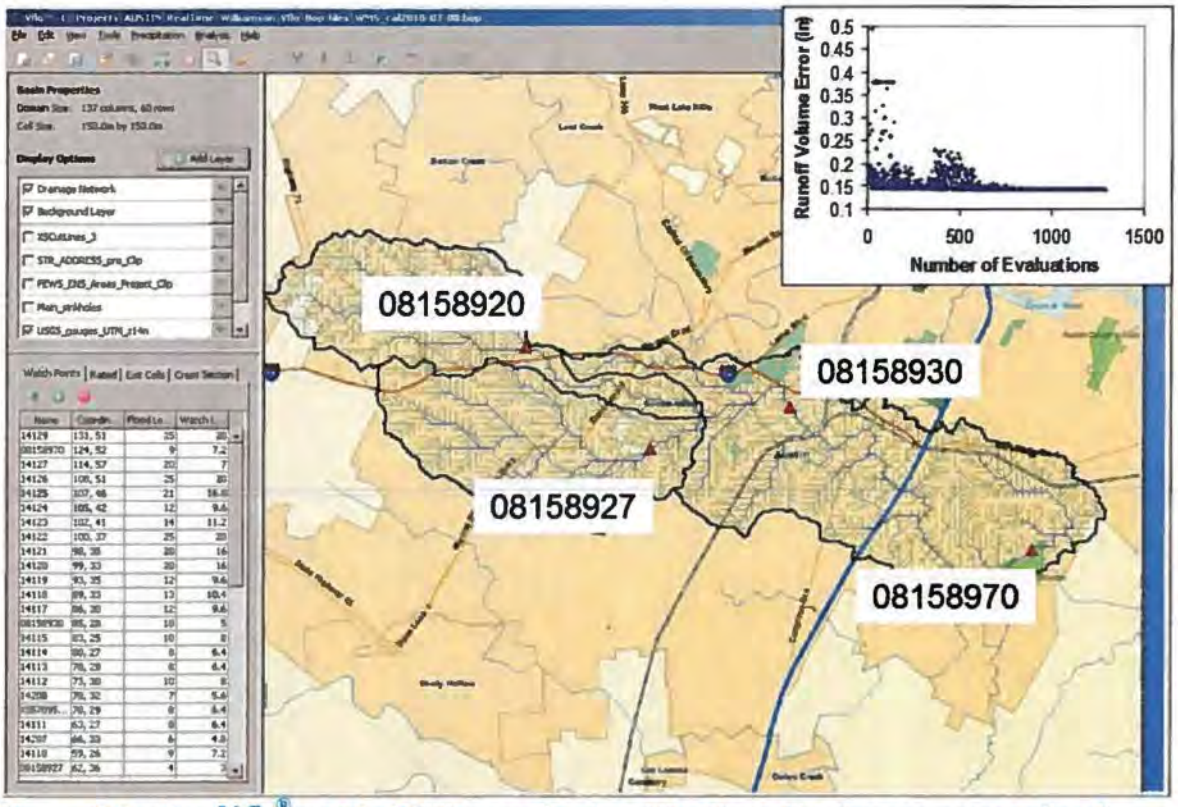


Figure 15 Desktop *Vflo*® model of Williamson Creek and iterative calibration convergence (inset)

9. Continuous Model Forecasting with NWS Forecast Rainfall

Vieux operates the processing servers that input radar and gauge data for purposes of generating hydrologic forecasts. *Vflo*® ***runs continuously to provide forecast stage and discharge with forecast precipitation, meeting or exceeding 12 hours in advance.*** Two forecast rainfall products are available and used by the City, namely HRRR and PreVieux, which merges the spatial detail afforded by weather radar, with numerical weather prediction for periods from 1 to 15 hours to provide hydrographs produced using GARR plus quantitative Precipitation Forecasts (QPF). The HRRR data source was brought into the FEWS forecasting suite to provide flood outlooks and extended situational awareness. Display consists of 1) projected inundation stage as XML based on current rainfall GARR, and 2) display of HRRR as color-coded maps of precipitation depth for the FEWS region centered on Austin. The HRRR forecast precipitation is continuously updated every hour, and is now added as an input to generate forecast inundation maps. Using PreVieux and HRRR as QPF plus GARR, the forecast stage was based on forecast rainfall, and was generated the night before at 22:52. In this case, seen in Figure 16 (an internal notification), the ***HRRR indicated a potential threshold crossing 14 hours in advance.***

Austin USGS Forecast Stage Alert (Issued on Sun, Mar 8 22:52 CDT)

Basin	ID	Name	Stage	Time(CDT)	Status
Williamson Mainstem	08158970	WMS_USGS_JimmyClayDr	7.21 ft	2015-03-09 13:45	Watch
Source: Vflo GARR + QPF Stage					

Figure 16 Internal email notification issued the night before, showing watch status the next day

In Figure 17, Vieux produced hydrographs based on HRRR QPF plus GARR to realize *forecast* maximum stage based on *forecast* rainfall. On the next day, March 9th at 13:45, the hydrograph does cross the watch threshold indicated in Figure 18.

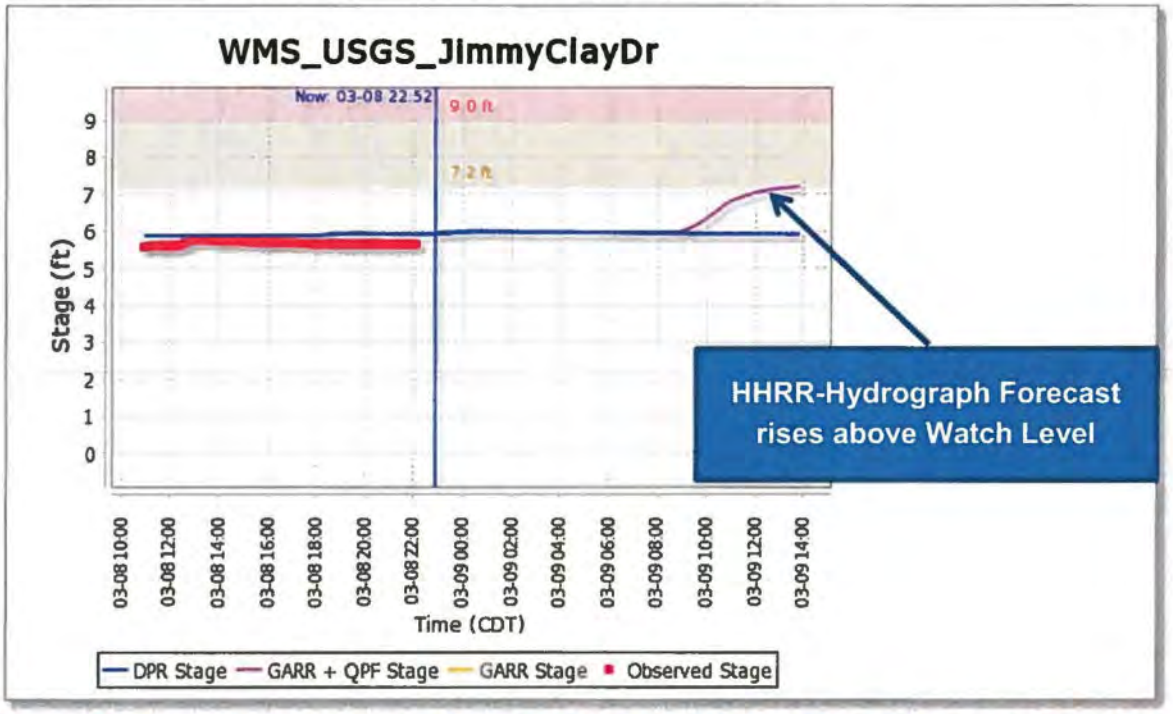


Figure 17 Hydrograph shown crossing the watch threshold at 13:45 on March 9th, generated the night before on March 8th just before 11:00 pm

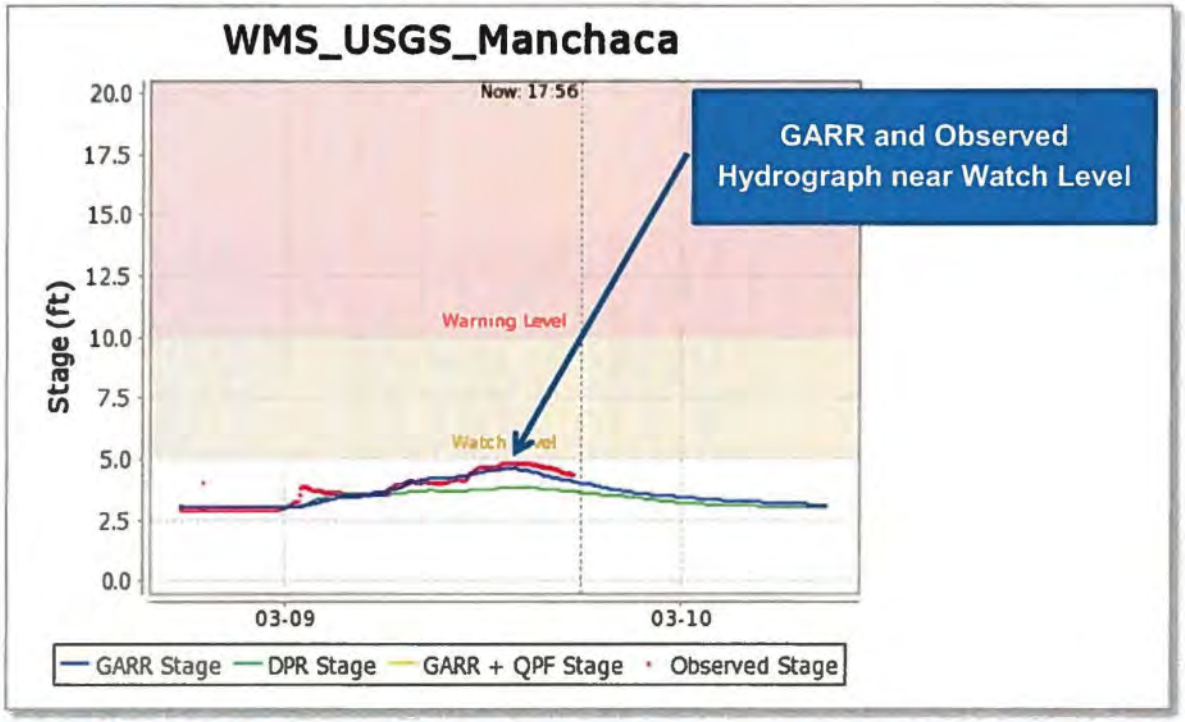


Figure 18 Hydrograph actually produced did show stage near the watch level as forecast by the HRRR from the night before

Tab 4 - Program Plan

Vieux will provide FEWS continuity of service for the FFMMS web-services. By so doing, we will seamlessly continue to operate GARR/DPR and QPF rainfall-runoff and flood forecasts while the proposed work plan elements are performed and put into place. Our Work Plan consists of taking the existing system and extend its mapping and output capabilities to meet or exceed FEWS flood-related information technology requirements.

A. Work Plan

The following tasks will be accomplished in the process of providing continuity of service, and in development and deployment of inundation mapping and program improvements and updates. Before and after each major task, a meeting will be scheduled with FEWS to coordinate goals and objectives. The sequencing of the tasks will be performed as seen in the timeline that follows.

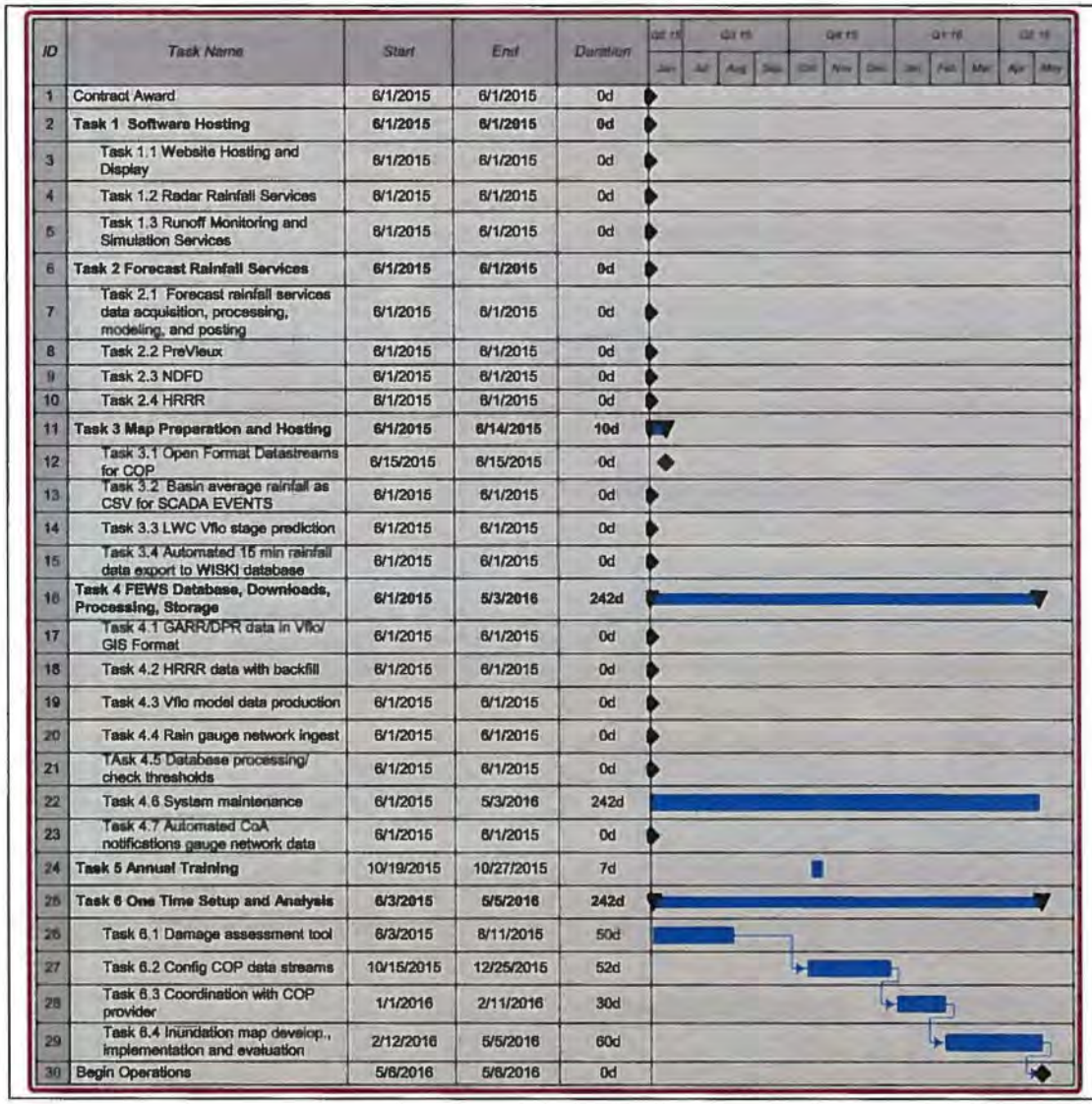
Tasks

1. **Model Review**
   a. Apply model performance review
   b. Incorporate measured ET and into soil moisture model
   c. Apply stream celerity and rating curve checks
   d. Integrate into model-mapping into operations with QA/QC of inundation
   e. Review model calibration, soil parameters and imperviousness, hydraulic rating curves to ensure full range at stream gauges, and hydraulic rating curves/cross-sections at the 599 watch point locations.
2. **Inundation Mapping Engine**
   a. Review and develop plan for inundation mapping that considers: 1) polygon inundation of bridges/structures relying on STEAR/TCAD locations and channel cross-sections, and 2) raster based approach using drainage direction, and 3) develop open-source geospatial mapping to compute and publish results.
   b. Provide enhanced mapping with details published as an open format map such as WMS/WFS, KML, or JSON
   c. Improve stage inundation accuracy in hosted models through examination and adjustment of channel hydraulics at 599 watchpoints
   d. Add information from TCAD and STEAR databases, and decision support for structures groups with time-to-flood
   e. QA-QC inundation mapping components
   f. Begin operations for in-house inundation mapping and publish to COP Portal
3. **Rainfall Product Generation and Quality Improvement**
   a. Monitor and review NWS radar upgrades, and CoA updates to rain gauge network configuration.
   b. Work with FEWS to ingest rain gauge data via LDM telemetry or other
   c. Review GARR processing and accuracy improvements for Dual Polarization radar products, and make necessary improvements to processing algorithms.
   d. Monitor, review, and make recommendation as new gauges are added or adjustments are made to CoA/LCRA/UBCWCID rain gauges, and any other gauge networks used such as USGS or NWS ASOS

4. **Vieux Data Center - Server/IT Deployment**
   a. Migrate the FFMMS modeling, database and processes from current physical servers into the new VMware environment, and replicate on the DR system
   b. Establish connections and definition of format and storage/retrieval protocols with the Kisters/WISKI database and DB syncing frequency.
   c. Make data connections for elements used in the mapping program including any confidential data such as 211/STEAR or other internal FEWS/APD/AFD data.
5. **Ongoing Support and Training**
   a. Operate Vieux Data Center FFMMS
   b. Perform periodic review and assistance with *Vflo*® modeling and mapping
   c. Assist Austin with model assembly review and calibration
   d. Perform annual training and performance review of models

B. Timeline

The following timeline assumes a start date of June 1, 2015. Coordination of the inundation mapping and other data streams published for use in the COP will depend on other contract timelines and task duration. We understand that if the COP is awarded to another provider that work may not begin until 6-9 months after award. If Vieux is awarded the COP, then work begins earlier on the functionality integration of the inundation mapping, damage estimates, and related information from the FFMMS.



ID	Task Name	Start	End	Duration
1	Contract Award	6/1/2015	6/1/2015	0d
2	**Task 1 Software Hosting**	**6/1/2015**	**6/1/2015**	**0d**
3	Task 1.1 Website Hosting and Display	6/1/2015	6/1/2015	0d
4	Task 1.2 Radar Rainfall Services	6/1/2015	6/1/2015	0d
5	Task 1.3 Runoff Monitoring and Simulation Services	6/1/2015	6/1/2015	0d
6	**Task 2 Forecast Rainfall Services**	**6/1/2015**	**6/1/2015**	**0d**
7	Task 2.1 Forecast rainfall services data acquisition, processing, modeling, and posting	6/1/2015	6/1/2015	0d
8	Task 2.2 PreVieux	6/1/2015	6/1/2015	0d
9	Task 2.3 NDFD	6/1/2015	6/1/2015	0d
10	Task 2.4 HRRR	6/1/2015	6/1/2015	0d
11	**Task 3 Map Preparation and Hosting**	**6/1/2015**	**6/14/2015**	**10d**
12	Task 3.1 Open Format Datastreams for COP	6/15/2015	6/15/2015	0d
13	Task 3.2 Basin average rainfall as CSV for SCADA EVENTS	6/1/2015	6/1/2015	0d
14	Task 3.3 LWC Vflo stage prediction	6/1/2015	6/1/2015	0d
15	Task 3.4 Automated 15 min rainfall data export to WISKI database	6/1/2015	6/1/2015	0d
16	**Task 4 FEWS Database, Downloads, Processing, Storage**	**6/1/2015**	**5/3/2016**	**242d**
17	Task 4.1 GARR/DPR data in Vflo/ GIS Format	6/1/2015	6/1/2015	0d
18	Task 4.2 HRRR data with backfill	6/1/2015	6/1/2015	0d
19	Task 4.3 Vflo model data production	6/1/2015	6/1/2015	0d
20	Task 4.4 Rain gauge network ingest	6/1/2015	6/1/2015	0d
21	TAsk 4.5 Database processing/ check thresholds	6/1/2015	6/1/2015	0d
22	Task 4.6 System maintenance	6/1/2015	5/3/2016	242d
23	Task 4.7 Automated CoA notifications gauge network data	6/1/2015	6/1/2015	0d
24	**Task 5 Annual Training**	10/19/2015	10/27/2015	7d
25	**Task 6 One Time Setup and Analysis**	**6/3/2015**	**5/5/2016**	**242d**
26	Task 6.1 Damage assessment tool	6/3/2015	8/11/2015	50d
27	Task 6.2 Config COP data streams	10/15/2015	12/25/2015	52d
28	Task 6.3 Coordination with COP provider	1/1/2016	2/11/2016	30d
29	Task 6.4 Inundation map develop., implementation and evaluation	2/12/2016	5/5/2016	60d
30	Begin Operations	5/6/2016	5/6/2016	0d

Timeline Highlights

Tasks 1-4 begin with contract award assuming there is no lapse in our current contract providing continuity in service.

Task 5 Training occurs annually, and is tentatively scheduled in the last week of October, 2015.

Task 6 Beginning with contract award, and depends on the COP contract date. Tasks 6.1-6.4 depend on coordination with FEWS and the COP provider and their task sequencing and duration. Actual dates of task completion will vary, and depends on the COP contract and work plan.

C. Workforce

Our workforce is organized to provide the requested services spanning radar rainfall to distributed runoff modeling, inundation mapping, and data systems operation. We have direct experience with FEWS serving them over ten years with flood forecasting modeling and mapping. Our software team members, as a group, have worked with Austin for the last 11 years, and are experienced in developing the systems that provide FFMMS information. To support graphical user interfaces, a recent hire has expanded our capabilities in UI/UX design and development. The management team consists of Jean Vieux and Baxter Vieux. Jean has led the project team since we started doing business with CoA in 2004. Baxter Vieux has a breadth of experience and knowledge of the technical requirements involved in radar-based flood modeling services, and specifically with the City of Austin-FEWS. Hydrologic/hydraulic model configuration and leadership is provided by an experienced hydrologist/hydraulic engineer with expertise with *Vflo*® modeling of City of Austin watersheds. We have internal expertise represented by *in-house* hydrometeorologists who have worked on GARR production for the City of Austin using CoA rain gauges, and are skilled in tailoring the NWS radars (especially dual-polarization algorithms) for input to the modeling system.

Our workforce is organized to provide the entire FFMMS services within a single organization. We have the necessary personnel with the knowledge skills and abilities, and direct experience with the FEWS system and needs. Our software team members are led by programmers with years of experience in developing the systems that provide information for operation of the current FFMMS, and with a recent hire, we can add UI/UX design and development experience useful in website design and inundation mapping in open format.

The management team consists of Jean Vieux who has led the project team since we started doing business with CoA in 2004. Baxter Vieux works closely with the development team and has technical management skills that span the depth and breadth of the requested technology. Subject matter expertise needed in the configuration of the COP will be provided by our in-house hydrometeorologist and hydrologist/hydraulic engineer, who have worked on CoA GARR and hydrologic/hydraulic modeling web-services over the last decade.

Project Management

1. Jean Vieux, Project Manager
2. Baxter Vieux, Technical Director

Web/UI/UX Development and Software/IT

1. Brian Byrne, Web Development/UI Design
2. Brian McKee, Web Development/UI Design
3. Adam Barnett, Systems Integration/Data Management
4. Ryan Hoes, Systems Integration

Subject Matter Team

1. Hydrologist/Hydraulic Engineer
2. Hydro-meteorology Radar Rainfall

The average length of employment for Vieux employees is 11 years. Our stable work force of 10 employees includes a new employee who was hired at the beginning of this month. He has applied his experience in the creation of a new watchpoints grid view. The next newest employee has been with the firm more than five years. Two employees have terminated in the past ten years making the turnover less than 2% per year. Vieux employees have outstanding academic, performance, and commitment qualifications. More than half of our team has been working together for more than a decade, some starting as summer interns in the early 2000's.

Much effort in the last three years has been spent hardening and updating backend software processes, and IT equipment to prepare for this and other projects. Our radar rainfall processing system has been rebuilt giving it more flexibility, and the databases it relies on have been consolidated, reorganized, and optimized. The *Vflo*® internal framework now supports multiple rainfall inputs so in the event of rain gauge network interrupts, a radar rainfall product that does not depend on rain gauges is delivered. Boundary conditions set at USGS stream gauges are no longer assumed to be in place (washout can occur), but are modeled and extended rating curves documented as well. Analysis of what happened in that event; what worked and what did not, revealed needed improvements (hardening and redundancy) for USGS, FEWS, and Vieux. With many corrective actions behind us, as well as, a major system upgrade, we have the current personnel resources to move forward and build the FFMMS that FEWS needs.

D. Training

Training programs are provided to our employees on a formal and informal basis. Last month an employee took formal training off-site for operations of the Nimble storage/server with VMWare. This system and accompanying training will reduce time and effort managing our internal datacenter. All Vieux employees are lifelong learners. Our technical lead is a professor emeritus, and a professional engineer in multiple states including Texas, and maintains continuing education credits. Several development team members have earned distinguished academic recognitions.

Active participation in multiple professional societies keep key team members in touch with industry practices and advances while make contributions to these advancements as well. Conference materials and knowledge is transferred back to the team in post conference meetings. When we attend conferences, we bring back materials and provide them, with training, to our employees where appropriate. For example, presentations at the American Meteorological Society (AMS) on recent advances in NOAA forecast weather products, and radar development provided key development guidance over the last few years. Both Software/IT and Hydromet team members engaged in NOAA-provided web-based training on dual-polarization radar technology in preparation for its use in radar QA/QC, and in software algorithm development.

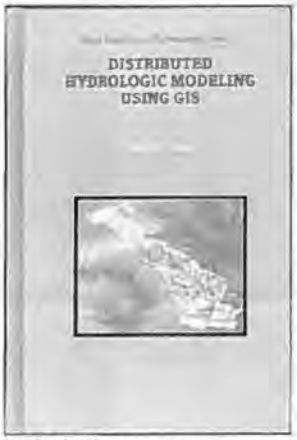
The development team consumes web-based training and presents new technologies and applications in weekly meetings. Software support and IT cross-training is essential so the team member on-call is prepared to address needs, and also for project development. If one task is complete, any member of the team is able to select and task that they can complete to move a project forward.

E. Documents

Descriptions of how the software was used for other projects, how it is setup, and methods for avoiding errors or misrepresentation of hydrologic processes or GIS datasets used to model rainfall-runoff in a watershed using radar-based precipitation inputs. Three documents are provided as follows:

a) **Distributed Hydrologic Modeling Using GIS. Baxter E. Vieux, Springer, 2nd Edition. Monograph on *Vflo*® and GIS.** Used by government agencies and universities as a reference for distributed physics-based hydrologic modeling.
b) ***Vflo*® 6.1 Model Features** – Model features list and descriptions for Inundation, Continuous, and Storm Builder
c) **Journal of Hydrology -** An assessment of distributed flash flood forecasting accuracy using radar and rain gauge input for a physics-based distributed hydrologic model – Paper describing *Vflo*® model performance during Tropical Storm Hermine. Results show that GARR rainfall accuracy is essential to obtaining the forecast stage accuracy observed during this event in Austin Texas. Using *less accurate rainfall input* such as only rain gauges, would severely *degrade* model prediction accuracy.

a) Distributed *Hydrologic Modeling Using GIS.* Baxter E. Vieux, Springer, 2nd Edition. ISBN 1-4020-2459-2, 289 pages.



Distributed Hydrologic Modeling Using GIS
Series : Water Science and Technology Library , Vol. 48
Vieux, B.E.
September 2004
ISBN: 1-4020-2460-6

Springer

About this book

This monograph sets forth a unified approach and principles for modeling hydrologic processes distributed in space and time using geographic information systems (GIS). The focus of this Second Edition is on the principles of how to implement a distributed model using geospatial data to simulate hydrologic processes. Once we embark on fully distributed representations of hydrologic processes, conservation laws form the basis for modeling, and spatial data management becomes necessary. A physics-based approach involves the laws that govern the complexities of all the paths that water travels, from precipitation falling over a river basin to the flow in the river. Advances in computational power and spatial data management systems now support our ability to create detailed mathematical representations of a watershed. Technology has enabled the transformation of hydrologic modeling from lumped to distributed representations with the advent of new sensor systems such as radar and satellite, high performance computing, and orders-of-magnitude increases in data storage. Global digital datasets of elevation at thirty meters (or smaller) or soil moisture estimates from satellite and through data assimilation offer tantalizing detail that could be used in distributed hydrologic models to better manage water resources and to improve hydrologic prediction. Worldwide geospatial data has become readily available in GIS format. A modeling approach that can utilize this data for hydrology offers many possibilities. GIS data formats, spatial interpolation, and resolution have important effects on hydrologic simulation of the major hydrologic components of a watershed. Examples are provided that illustrate how to represent a watershed with spatially distributed data along with the many pitfalls inherent in such an undertaking. Since the First Edition, software development and applications have created a richer set of examples, and a deeper understanding of how to perform distributed hydrologic analysis and prediction. This Second Edition is oriented towards a commercially available distributed model called *Vflo*™. The basic edition of this model, with a 30 day license, is included on the enclosed CD-ROM. Audience This volume will be valuable for researchers, faculty, upper division undergraduate and graduate students, hydrologists, physical geographers, hydrometeorologists, and practitioners in civil, agricultural, and water resources engineering.

Written for:

Researchers, faculty, upper division undergraduate and graduate students, hydrologists, physical geographers, hydrometeorologists, and practitioners in civil, agricultural, and water resources engineering.

b) Vflo® 6.1 Model Features

Vflo®: A Physics-Based Distributed Hydrologic Model

Vflo® features a hydraulic approach to hydrologic modeling that capitalizes on worldwide available geospatial datasets and spatially-distributed rainfall in a physics-based context. The Vflo® model was designed to use the full information content of radar rainfall as model input, and high-resolution geospatial data for model parameterization.

Vflo® is a fully distributed, physics-based hydrologic model capable of utilizing geographic information and multi-sensor precipitation input to simulate rainfall-runoff from small urban catchments to major river basins. Vflo® provides real-time and post-analysis prediction of rainfall-runoff. Applications include flood prediction and emergency management, low impact development evaluation, land use planning studies, and water resources management with climate scenarios.

Vflo® relies on the conservation laws for mass and momentum to characterize the basin response to precipitation. The model uses a regular grid to compute infiltration, update soil moisture, and route overland and channel runoff using the kinematic wave approximation. Continuous simulation of runoff is possible with the addition of long-term distributed rainfall maps and definition of evapotranspiration rates for specific vegetative cover. Because the model uses a hydraulic approach to hydrology, runoff generation and routing are computed within the same equations. Precipitation can be derived from radar and gauge networks for model input. Infiltration excess, saturation excess, and mixed infiltration processes can be modeled. The distributed approach makes it possible to generate a hydrograph at any location in the drainage network. Model parameters are setup using GIS data representing hydraulic roughness based on land use/vegetative cover maps, and infiltration estimated from soil maps and impervious areas. Channel hydraulic properties can be input directly based on geomorphic relationships, extracted from high-resolution digital elevation data, or using stage-discharge rating curves for bridges or stream gauges.

Vflo® 6.1 builds on previous versions and offers a number of innovative new features, making the creation of a high-resolution hydrologic model for both urban and natural watersheds as efficient and accessible. Key features include:

- ✓ Urban drainage modeling with Pipes Network extension
- ✓ Inundation available as an extension to Vflo® Desktop
- ✓ Improved hydrograph result display including average upstream rainfall
- ✓ Improved geospatial data display options
- ✓ Internal terrain processing (AutoBOP) dramatically reduces GIS preprocessing steps
- ✓ Automated project creation reduces initial setup time to just minutes
- ✓ Online Help provided as a dynamic knowledge base
- ✓ Compatible with Windows 7 and 64-bit operating systems
- ✓ New solver produces more reliable simulations –
  - Higher-order accuracy numerical solution
  - Achieves better agreement with observed discharge with more realistic hydraulic roughness
  - Efficient handling of complex hydraulic rating curves at bridges or other structures
  - Realistic hydrograph routing in steep terrain
- ✓ Reach profile and wave celerity maps help identify hydraulic parameter outliers and improve solution convergence
- ✓ Integrated graphing of upstream rainfall and discharge/stage hydrographs
- ✓ Consistent time zone data definition and conversion
- ✓ Improved interface expands the use of geospatial data and radar data
- ✓ Parameter value mapping and display options
- ✓ Geographic projection system support
- ✓ Statistical results manager organizes and analyzes model output
- ✓ Dynamic online help provides model features and usage together with tutorials and model theoretical background
- ✓ Precipitation Wizard
  - Improved handling of radar formats and spatial interpolation of point rain gauge data
- ✓ AutoCalibration (AutoCal)
  - Explores parameter space to identify optimal parameter pairs for multiple storm sets
  - Uses Genetic Algorithm to test parameters within specified ranges
  - Graphs a variety of error statistics such as mean square error, and maps error surface for two parameters
  - Saves results for later review

- ✓ Enhanced licensing support for groups and organizations

Extensions

- ✓ Sensitivity (separate license)
  - Batch operation supports sensitivity testing for user specified parameter ranges
  - Output is summarized in a text file for review and analysis
- ✓ Continuous (separate license)
  - Improved management and display of continuous soil moisture, rainfall, and runoff
  - Save simulation results for later reference and review
  - Load distributed rainfall and evapotranspiration
- ✓ Inundation (separate license)
  - Improved mapping of stage hydrographs/infiltration for channels or all cells
  - Animation controls for timestep and animation period
  - Exports timeseries image files for documentation and graphical display
  - Improved/updated user interface
  - Save configuration as an inundation project file
- ✓ Storm Builder (separate license)
  - Allows generation of dynamic storms for specific hyetograph shapes
  - Results are automatically exported to the model domain for simulation and saving
- ✓ Pipe Network (separate license)
  - Pipe inlets modeled as hydraulic or percentage diversions from surface cell
  - Import of SWMM input files containing network geometry and properties
  - Outputs modeled hydrographs showing effects of pipe inlets on primary and secondary flow

Each of the following extensions requires a separate license in addition to the *Vflo®* Desktop license. RainVieux and Sensitivity are standalone programs, while Continuous, Storm Builder, and Inundation are launched by the user from within *Vflo®* Desktop.

Pipe Network

Pipes is an extension to Vflo® Desktop for modeling the influence of storm sewers as a secondary drainage network diverting flow from the primary overland and channel network. For example, diversions to detention basins or tunnels can be modeled using hydraulic inlet rating curves, percent diversion, or fixed discharge. Geometry of the pipe network and inlet locations can be imported as a simple text file containing coordinates and pipe length and diameter, or directly from the Storm Water Management Model (SWMM) input configuration. The drainage network in *Vflo®* is shown in Figure 1 where the SWMM pipe network has been imported to represent the storm sewer network.

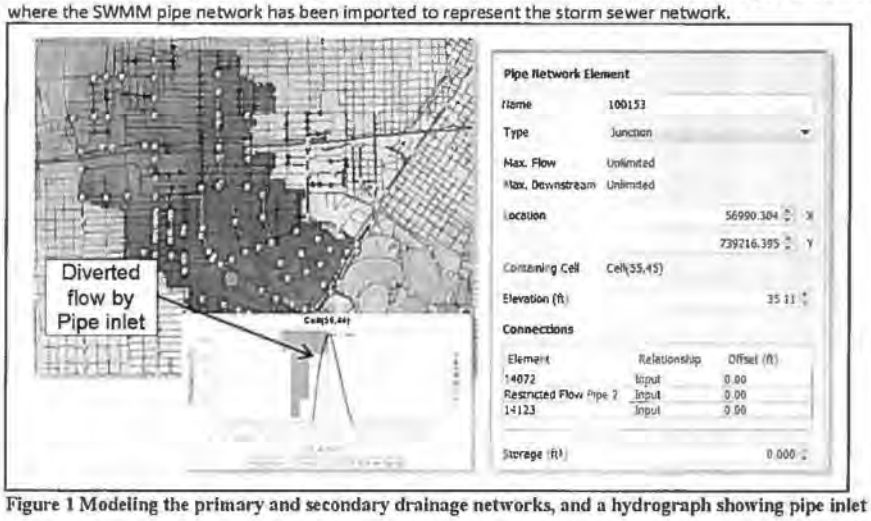


Figure 1 Modeling the primary and secondary drainage networks, and a hydrograph showing pipe inlet diversion

Sensitivity

Sensitivity is a standalone *Vflo®* extension for exploring model response to a range of parameter values and for identifying optimal parameter sets. Sensitivity runs *Vflo®* for input parameter values and generates peak discharge, volume, and time-to-peak as output for each parameter combination. Sensitivity is a stand-alone program that can be run independently from *Vflo®*. This mode of independence frees computer resources and allows the user to run sensitivity tests on a separate server in an unattended, batch mode. Basin overland properties, precipitation data, and a configuration file defining parameter ranges and steps are required.

Continuous

Continuous is an extension to *Vflo®* Desktop that automatically tracks the effects of soil moisture. Soil moisture does not need to be manually input as degree of saturation preceding an event; rather, Continuous Simulator establishes soil models so that *Vflo®* is properly initialized for any event. Soil moisture is based on distributed rainfall and evapotranspiration rate input. Output includes instantaneous flow rate, average flow rate over time step, average depth of flow over drainage area upstream of watch point, and total cumulative depth upstream (Figure 2). The Continuous extension is useful in evaluating and preparing a watershed model for real-time operational use, and for modeling complex dynamic systems involving aquifer recharge, spring flow, and distributed runoff.

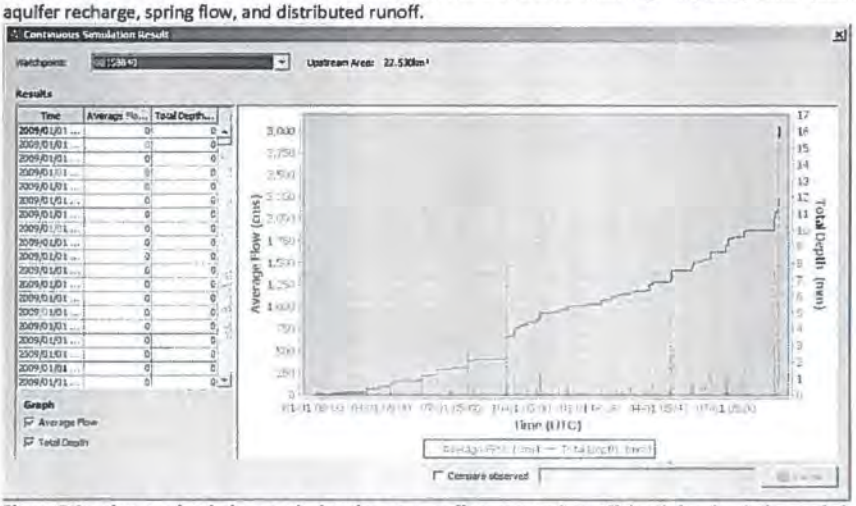


Figure 2 Continuous simulation result showing average flow rate and runoff depth for simulation period.

Inundation

Inundation is a *Vflo®* extension that provides images, animations, and data showing the extent of forecast or simulated inundation, which is an indication of flood risk. The extension's inundation products seen in Figure 3 are especially useful for flood management applications: forecast inundation is useful for operational decisions, warning and notification, and coordinating emergency response modeled on the Desktop in preparation for operational modeling with the *Vflo®* Server Edition.

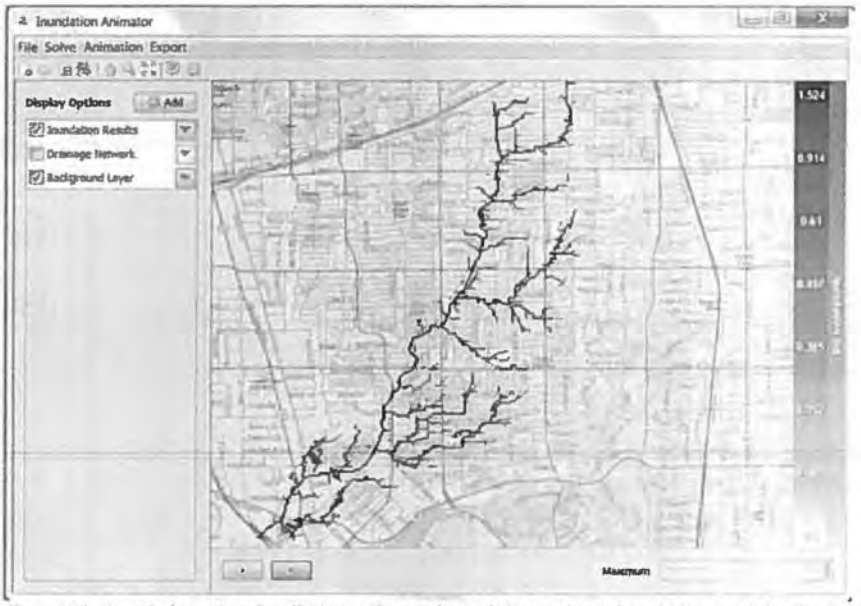


Figure 3 The Inundation extension displays a time series and the maximum inundation depth for flood analysis

Storm Builder

Storm Builder is a *Vflo®* extension that produces a dynamic storm with user-defined direction and speed of movement over a watershed. The timeseries of rainfall is defined by a typical hyetograph defining percent accumulation of rainfall with percent duration of a hypothetical storm. Once the depth and duration is specified along with movement (Figure 4), the hyetograph is passed over the watershed producing dynamic input. The results are loaded into automatically, and can be saved for future use.

Figure 4 Storm Builder rainfall wizard interface and resulting dynamic storm movement across the watershed

Our protocol shown in Table 2 outlines QA/QC steps used in setup of inundation mapping. We will coordinate with the City to obtain the most up-to-date files needed for this procedure. A requested file list related to modeling and mapping work effort is presented below.

Table 2 Protocol for QA/QC of inundation mapping

A. HYDROLOGIC AND HYDRAULIC ANALYSES	
A.1 Hydrologic Analyses	
Generate Discharge from Rainfall DDF	Run *Vflo*® with 2, 5, 10, 25, 50, 100, and 500-yr rainfall input and generate discharge hydrographs at 599+ watchpoints
Compare simulated peaks with FIS Model	Compare *Vflo*® with FIS, and verify consistency for 2, 5, 10, 25, 50, 100 and 500-yr discharge
Discharge Selection	Verify that discharges selected from rating curve are smoothly varying for 2, 5, 10, 25, 50, 100, and 500-yr discharge
A.2 Hydraulic Modeling	
Model conversion	Verify that *Vflo*® model was adapted using FEMA cross-sections/rating curves at 599 points and additional locations as needed for mapping.
Hydraulic structure verification	Coordinate with local/state transportation agency to verify hydraulic model represents current bridge/structure and to determine imminent plans for structure replacement and/or revision.
Generate flows for design storm recurrence intervals	Run 2, 5, 10, 25, 50, 100, and 500-yr flows through *Vflo*® model and produce flood polygons.
Profile validation/calibration	Verify that WSELs were validated/calibrated against historical gage data or other study data (if available). Check agreement with existing FEMA FIS.
Target WS elevations	Verify for each high chord and low chord elevation of bridges, that there is a valid Q from the bridge rating curve without discontinuities. Modify rating curve as needed to generate required values.
Vertical Datum	Verify that the vertical datum is consistent for

	the LIDAR, high and low chord of the bridges, and *Vflo*® cross section. Adjust the vertical datums to a consistent reference if they are different.
B. MAPPING	
B.1 Inundation Polygons	
WSEL boundary checks	Perform reasonability check with WSEL boundary shapefiles, orthophotography, and rasters /contours. Ensure transitions along the boundary are consistent with the raster/contour data. Check agreement with FEMA Flood Insurance Study.
Inter-profile consistency	Ensure boundaries for higher WSELs are always coincident or outside boundaries for lower WSELs.
Minimum elevation mapping	Ensure lowest WSEL polygon covers stream and channel banks visible from orthophotography.
Islands	Remove "islands" that should not be inundated, by providing sufficient elevation associated with planimetric features or editing the LiDAR elevation, as needed.
Disconnected wetted areas	Remove incorrect mapping of wetted areas that result from depressions not connected with the flow.
Overtopping	Ensure structures indicated as overtopped in the hydraulic model are mapped accordingly.
Depth Grid Rasters	Review subset of LiDAR elevations used in the mapping interface to ensure coverage of maximum extent (500yr) plus a buffer.
Grid/Layer pairing	Ensure there is a corresponding LiDAR elevations for each channel in *Vflo*®, and to the extent of the WSEL boundary.
Edge trimming	Ensure that small *Vflo*® channels are trimmed to remove spurious branches in the flow network along the mainstem of each creek.
Overtopping	Ensure that grid cells for dry areas have their depths set to zero or are elevated sufficiently. Verify elevations for buildings/roadways/bridges that are not overtopped.
Grid/Layer consistency	Ensure that wetted areas have positive depths

	and non-wetted area depths are set to zero. For islands that were removed from the polygon mapping, the overlying grid cell depths should be set to be consistent with those of the nearest adjacent wetted cells.

F. Requested information

The following Table 3 lists the initial information requested from the City for supporting the QA/QC of model inundation mapping.

Table 3 Requested list of files from CoA, and related information needs

Data	Requirements
Building Structure Footprints	• Closed polygon shapefile • Finish floor elevations for each structure
Bridge Polygons	• Closed polygon shapefile • A CROSS_SECT field that is associated with each cross section used for inundation mapping
Culvert Polygons	• Closed polygon shapefile • A CROSS_SECT field that is associated with each cross section used for inundation mapping
Cross Sections	• High and Low Chord elevation for each structure • Datum for High and Low Chord should be in NAVD 88 Vertical Datum. • Vertical units should be specified • Polyline shapefile • Horizontal station number for each cross section along the stream centerline • Horizontal station units should be specified. • CROSS_SECT field that can be used with bridge and culvert polygons
Bare Earth DEM	• Datum for Bare Earth DEM should be in NAVD 88 Vertical Datum. • Vertical units should be specified • The DEM should have buildings removed to reflect bare earth. • Hydraulic structures such as bridges decks, and top of roadway over culverts should be removed to provide a hydraulically sound DEM. • Metadata providing the date of the data used to create the DEM.

Bare Earth LIDAR	• Datum for Bare Earth LIDAR should be in NAVD 88 Vertical Datum. • Vertical units should be specified • LAS or LAZ bare earth processed LIDAR data • This should be the high resolution point cloud used to create the Bare Earth DEM • Metadata providing the date the LIDAR data was obtained
HEC-RAS FIS Models	• Compare model cross-sections with those used in *Vflo*®
Inundation polygon shapefiles from Flood Insurance Studies	• Inundation polygon shapefiles compared for QA/QC with the operational real-time system.

G. Examples of Forecast Modeling Efforts

a) **Real-time urban runoff simulation using radar rainfall and physics-based distributed modeling for site-specific forecasts.** The first article describes setup and operation of a flash flood warning model in Houston Texas. Operational deployment of radar-based hydrologic forecasting systems rely on multisensor precipitation estimates that use radar and gauge rainfall rates as input. This flood forecasting system provides critical information to the Texas Medical Center (TMC) in Houston is the Rice University/TMC Flood Alert System. The TMC is the largest medical center in the world, covering a 691-acre campus with 42 member institutions, including 13 hospitals. Over 62,000 people are employed in these facilities. Imminent flooding in Brays Bayou adjacent to the medical center dictates that specific actions be taken that include placing member institutions on alert, closing floodgates, or suspending patient care and evacuating the hospitals/facilities. The TMC is located at Main Street just upstream where it crosses Brays Bayou. Tropical Storm (TS) Allison caused the shutdown of the TMC in 2001, whereas a shutdown was narrowly averted during TS Francis in 1998. Beginning in 1997, this is the first flash flood application that Vieux stood up, initially with radar inputs to HEC-1, and later in 2003 with *Vflo*® modeling in real-time using GARR. Vieux continues to support operations today and is our longest running operational model.

b) **Evaluation of Fourmile Hydrologic Model and Updates for 2015 Flood Season**. The second article is a recent report describing operation of a system that uses GARR derived from NWS radar and the Urban Drainage and Flood Control District rain gauges to provide flood warning. A wildfire in 2010 altered the capacity of an 8000 acre area called the Fourmile Burn Area (FBA), dramatically increasing the threat of flooding in the City of Boulder and in outlying areas in Boulder County. Vieux setup this system for UDFCD to provide flood alerts based on discharge thresholds at key locations throughout the burn-impacted watersheds and in the City of Boulder at Broadway in North Boulder and in the urban core.

c) **Role of river stage, precipitation, and weather forecasts in knowing how much stormwater runoff will arrive and when.** The third article concerns a forecasting system for the Trinity River Authority. It is published in the *2013 StormCon Conference Proceedings*, describing requirements for harnessing GARR and forecast precipitation for site-specific flood forecasting during construction. The information system produced forecasts and notifications of future and current river conditions along West Fork and Elm Fork, tributaries of the Trinity River. The system was put into operation for the duration of a trunkline sewer rehabilitation project near near Irving TX that was located in the floodplain. The project sites along the tributaries were subject to flooding from rainfall runoff, and discharge released from five upstream reservoirs.

a) Real-time urban runoff simulation using radar rainfall and physics-based distributed modeling for site-specific forecasts.

10th International Conference on Urban Drainage, Copenhagen/Denmark, 21-26 August 2005

Real-time urban runoff simulation using radar rainfall and physics-based distributed modeling for site-specific forecasts

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**Corresponding author, e-mail bvieux@ou.edu*

ABSTRACT
Quantitative precipitation estimates (QPE) derived from radar are useful in runoff simulation in urban drainage. Simulation experiments using radar data sampled at various resolutions identify the limits to predictability for various basin sizes. Spatial resolution of radar rainfall used as input to a distributed model affects prediction error and scales with drainage area. Radar data used in this analysis are derived from both S-band (NEXRAD) and X-band radars. Using radar QPE derived from the existing WSR-88D (KHGX) as input to a physics-based hydrologic model of Brays Bayou (260 km^2) provides a baseline for comparison and guides design of future radar networks. Results of experiments using historical radar events, including the tropical storm Allison, indicate that accurate rainfall-runoff predictions in real-time are possible and useful for site-specific forecasts. Radar and distributed hydrologic model provide accurate rainfall and runoff data supporting site-specific flood information.

KEYWORDS
Urban drainage; stormwater; flooding; radar; distributed hydrologic modelling; GIS.

INTRODUCTION
Stormwater runoff significantly impacts flooding and water quality in urban areas. Advances in stormwater runoff modeling, as well as in radar technology for the detection and forecasting of complex precipitation patterns, help to characterize the performance of urban drainage infrastructure at both regional and local scales. Customized flood forecasting depends on three subsystems to support real-time operations. The three subsystems described in this paper consist of 1) monitoring current rainfall, 2) projecting future rainfall, and 3) distributed runoff prediction of flow levels in the main channel of Brays Bayou. Recent revisions to the Flood Alert System (FAS) have made several improvements including the operation of both a lumped and physics-based distributed model providing ensemble operational forecasts in Brays Bayou for the TMC.

Customized Flood Forecasting
Advances in technology such as real-time radar rainfall, automatic stream gage systems, and automated data reporting dissemination via the Internet have made it possible to develop and operate customized site-specific warning systems. Operational deployment of radar-based distributed flood forecasting systems rely on multisensor quantitative precipitation estimates (QPE) that use radar and gauge rainfall rates as input (Vieux et al., 2003) whereas historically, operational flood forecasting relied on using lumped conceptual models. A customized

operational flood forecasting system that provides critical information to the Texas Medical Center (TMC) in Houston is the Rice University/TMC Flood Alert System (www.floodalert.org). The TMC is the largest medical center in the world covering a 2.8-km^2 campus with 42 member institutions that include 13 hospitals. Over 62,000 people are employed in these facilities. Imminent flooding in Brays Bayou adjacent to the medical center dictates that specific actions be taken that include placing member institutions on alert, closing floodgates, or suspending patient care and evacuating the hospitals/facilities. The forecast point of interest to the TMC is located at Main Street just upstream where it crosses Brays Bayou. Tropical Storm (TS) Allison caused the shutdown of the TMC in 2001, whereas a shut down was narrowly averted during TS Francis in 1998. Information derived from the TMC-customized system supports operations and logistical measures designed to reduce flood losses, and further details on the system may be found in Bedient et al. (2000); Bedient et al. (2002); and Bedient et al. (2003).

Flooding Concerns in Urban Areas

The TMC can be impacted by either of two flood production mechanisms common in urban areas, regional- and local-scale flooding, caused by the main channel of Brays Bayou and local drainage from Harris Gully, which interacts with Brays Bayou. Localized flooding, also called nuisance flooding, occurs where stormwater inlet capacity is exceeded by runoff resulting from intense and often short-lived rainfall. Regional flooding is the consequence of rainfall-runoff accumulating from watershed areas that are developed, undeveloped, or of mixed land use. The interaction between these scales occurs in low gradient topography where backwater from channels conveying regional-scale runoff reduces the efficiency of local culverts draining smaller-scale areas. Otherwise, the two processes are independent with local runoff feeding forward to the regional-scale runoff without feedback. The time scales of these two processes may or may not coincide depending on the distribution of rainfall over the regional scale watershed and localized intense cells embedded in the larger-scale precipitation producing atmospheric conditions. Examples are convective cells embedded within a tropical storm, or intense stormcells embedded in frontal precipitation feature. The network of local drainage infrastructure (small watersheds) embedded in the regional scale watershed is a significant challenge to both the analysis of such systems and the prediction of the hydrologic response. The complex interaction of input with drainage infrastructure presents challenges to the design of stormwater drainage infrastructure, the management of flooding, flood mitigation, and real-time forecasting of multi-scale urban drainage systems with multi-scale inputs.

Real Time Predictions

Making predictions in real-time with a hydraulic model is difficult because of inaccuracies in model parameters, rainfall input inaccuracy, or unknown upstream flow rates. Real-time systems for mapping expected areas of inundation require input of flow rates from another source to generate inundated areas using sophisticated 2-D hydrodynamic models. Even the inflow between river gauging stations requires some model estimation of watershed response in the intervening areas. Upstream gauging points and rainfall-runoff models are viable sources of real-time flow information. Both lumped and physics-based distributed rainfall-runoff models may be used for this purpose.

Distributed hydrologic modeling relies on geospatial data used to define topography, landuse/cover, soils, and precipitation input. Distributed hydrologic modeling may be termed physics-based if it uses conservation of momentum, mass and energy to model the processes. Solution of flow analogies (e.g. kinematic, diffusive wave, or full dynamic) employs

numerical methods with a discrete representation of the catchment as a finite difference or finite element grids. Example models, termed physics-based or physically-based distributed models (PBD), include *r.water.fea*; a parallel version of *r.water.fea* called the distributed hydrologic model (DHM); *Vflo*™ distributed hydrologic model (Vieux and Vieux, 2002, and Vieux et al. 2003). The digital revolution in geospatial data has helped develop and make physics-based modeling practical.

Radar Capabilities

Radar capability to provide accurate rainfall estimates over large areas at high resolution has the potential to provide needed rainfall inputs to models for inundation forecasts and custom flood alert systems. The WSR-88D radar deployed in the US by the US National Weather Service (NWS) is a 10-cm wavelength (S-band) radar. It is designed for long-distance surveillance given the ability of 10-cm wavelengths to penetrate rainfall with little attenuation. With a 10-cm wavelength, under most conditions, the useful range is considered to be 180 km or less. The NEXRAD precipitation processing algorithm employed by the NWS produces precipitation estimates out to 230 km. As distance increases, the beam measures higher above average ground level (AGL) because of the angle of the first tilt beam, which is 0.5 degree. At 180 km, the beam is 3.5 km AGL and may overshoot low clouds. Additional details on hydrologic applications of radar, and its characteristics related to precipitation measurements, may be found in Einfalt et al. (2004).

The radar beam overshoot at long distances of 10-cm wavelength radars results in undersampling of the atmosphere below several kilometers. In areas of warm-process precipitation generation low in the atmosphere, the overshoot can lead to underestimation of the rainfall. To overcome this limitation, a new radar system is being developed called NetRAD composed of X-band radars that will sample lower in the atmosphere than NEXRAD radars. Lower tilt elevations are possible because of the lower peak beam power than NEXRAD. Figure 1 shows planned configuration of X-band radars that will cover the Brays Bayou watershed. The Collaborative Adaptive Sensing of the Atmosphere (CASA) Engineering Research Center is undertaking development and deployment of this system to accomplish enhanced precipitation estimation for purposes of detecting flood producing rainfall and other severe weather hazards such as tornadoes.

Figure 1. Location of Brays Bayou in Houston and Harris Counties in relation to planned X-band radars.

Real-Time Radar Rainfall

Gauge adjusted radar rainfall provides high-resolution input to the modeling subsystem in real-time. The system uses NWS radar data (Level 2) from the nearby NEXRAD radar (KHGX) located approximately 50 km away. Radar data accuracy is enhanced using rain gauge data in real-time to provide high-precision radar rainfall for quantitative hydrologic applications. Figure 2 shows the 1-degree by 1-km spatial resolution of the data over Harris Gully contained within Brays Bayou. The main channel of Brays Bayou flows from southwest in an easterly direction in the lower right portion of the aerial photograph.

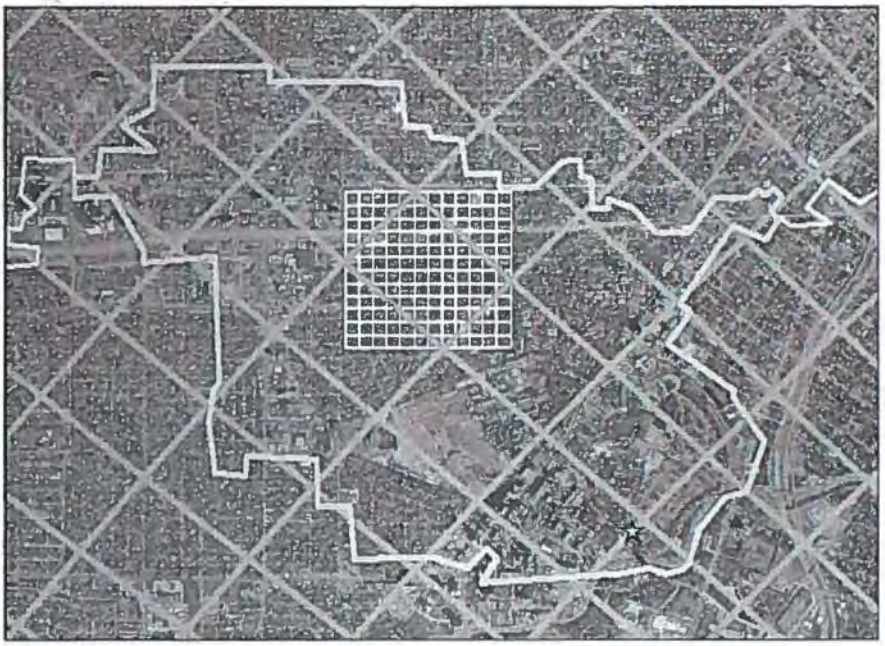

Figure 2. Radar sample volume resolution over Harris Gully. The large grid is the 1 x 1 km radar grid from the NEXRAD radar. The high-resolution inset is at 100-meter resolution representative of X-band radar resolutions. The TMC is seen in the photograph at the bottom center indicated by the star, which is the discharge location of the box culverts draining Harris Gully.

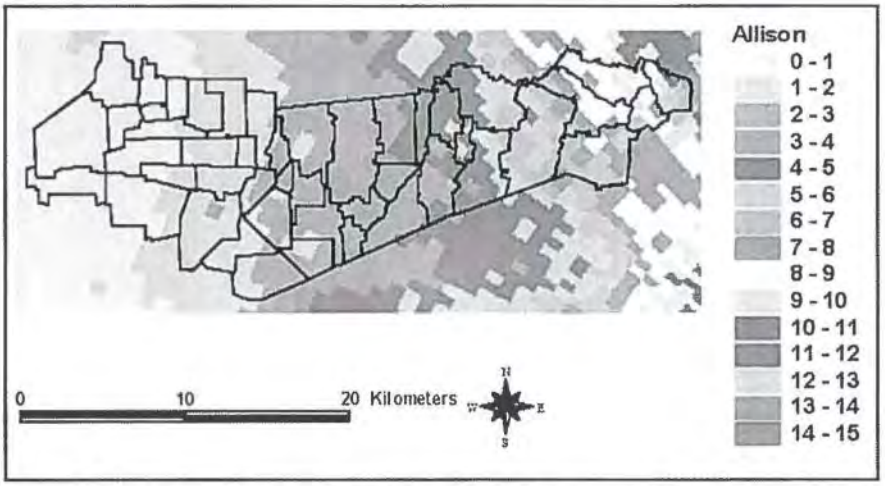

Figure 3. Rainfall event total map over Brays Bayou for Tropical Allison on June 5, 2001.

Display of this information is important for emergency management decision making. Figure 4 shows the real-time rainfall-runoff monitoring web page used to display rainfall and runoff over the watershed.

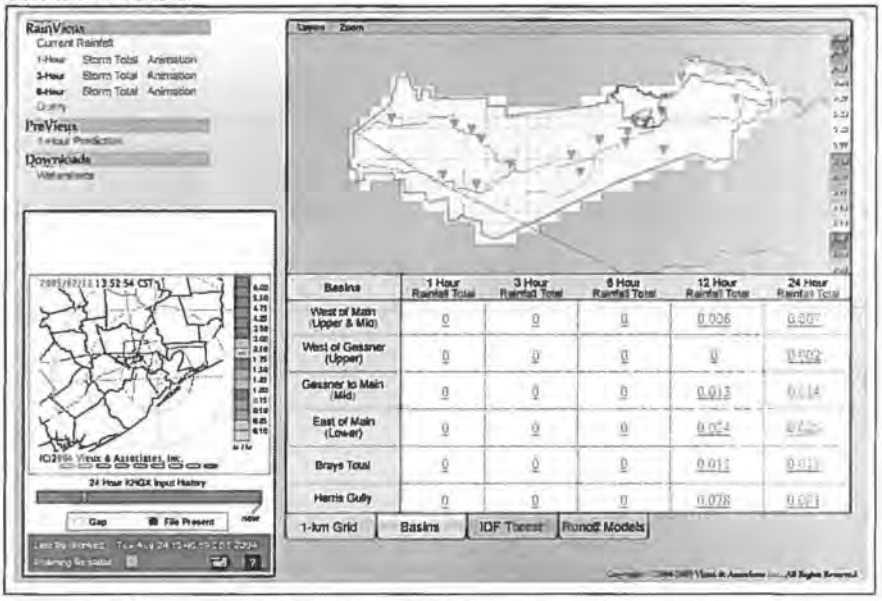

Figure 4. Web page for rainfall and runoff display with map features, stream and rain gauges. Rainfall totals, animations and a regional display shows approaching rainfall.

Data display options include radar bin resolution and aggregated basin averages as requested. Several options exist for the display of areas exceeding a pre-defined rainfall threshold and display of runoff from the model ensemble.

Real-time hydrologic prediction

Real-time runoff prediction using radar and rain gauge input is supported with V*flo*™, a fully distributed, physics-based hydrologic model capable of utilizing geographic information and multi-sensor precipitation input to simulate rainfall runoff from rural and urban catchments. Model setup and is based on terrain, land cover and impervious areas, and channel hydraulics. Figure 5 shows an example of GIS data used to setup the model. Hydraulic roughness shown here from V*flo*™ is derived from 30-m Land Sat according to the dominant land use/cover classification (Vieux, 2005).

The characteristics of Brays Bayou and modeling studies have been reported by Vieux and Bedient (2004). The basin has a drainage area of 260 km^2 at the Main Street gauge operated by the USGS. At low flows (<4 m^3/s), stages are influenced by tidal fluctuations, which is the meaning of the term "bayou". The region is highly urbanized with about 85% of the watershed developed. The lower 42 km of channel is concrete lined with a trapezoidal cross-section that has a 15-m bottom width and 3:1 side slopes in the downstream areas including near Main Street. Extending to the headwaters, channel bottom widths decrease to ~5 m with the same 3:1 side slopes. Slopes in overland and channel areas are quite flat ranging from a maximum of 4.96% to a minimum of 0.001% downstream of Main Street to the East. Channel slopes above Main Street are generally 0.055% or flatter with upstream channel slopes in the

headwaters around 0.2%. For additional details, see Vieux and Bedient (2004); Bedient et al. (2003); Bedient et al. (2000, 2003); and Holder et al. (2002). Runoff model ensemble estimates are provided by both HEC-1 and the physics-based model *Vflo*™, which after setup, calibration, and validation is operated in real-time. Through event reconstruction, Vieux and Bedient (2004) found that the achievable model accuracy is approximately 11.8% in peak discharge, 12 min in timing, and 11.1% in runoff volume at the Main Street gauge with a drainage area of 260 km^2. Figure 5 shows the finite element network representing the drainage direction defined by LiDAR topographic elevations. The hydrograph is shown for an event that occurred in July 24-25, 2003. The accuracy of the event shown was achieved in post-analysis after controlling for radar bias. To enhance prediction accuracy in real-time, radar bias correction will be achieved using real-time gauges.

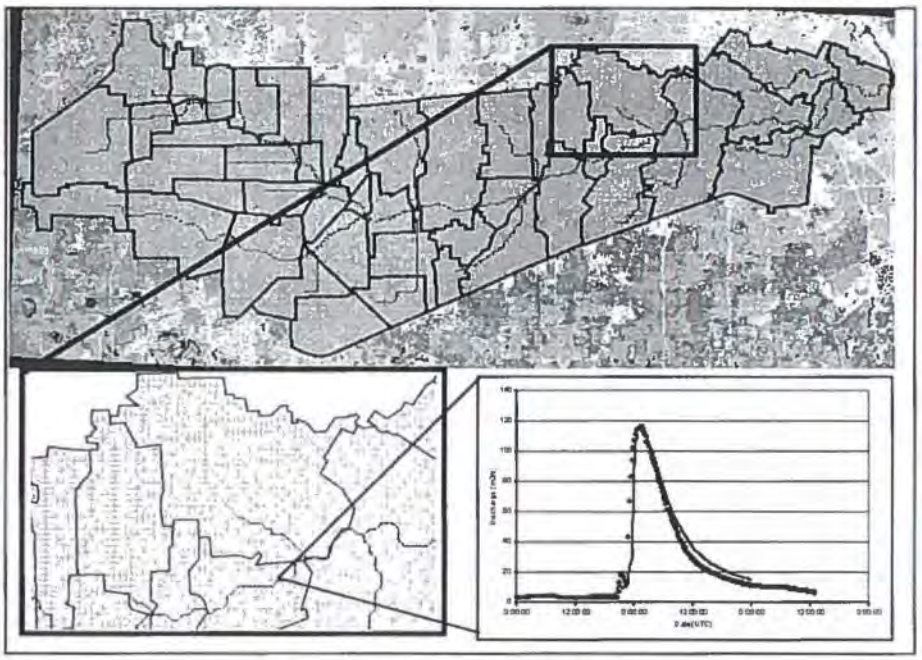

Figure 5. Vflo drainage network map of overland flow hydraulic roughness (upper and lower left image). A hydrograph produced at Main Street is shown in the lower right.

SUMMARY

Stormwater runoff significantly impacts flooding and water quality in urban areas. Operation of radar-based distributed flood forecasting systems relies on radar and gauge rainfall rates as input. The complex interaction of QPE input with drainage infrastructure presents challenges to the design of stormwater drainage infrastructure, the management of flooding, flood mitigation, and real-time forecasting of multi-scale urban drainage systems with multi-sensor inputs. Advances in stormwater runoff modeling and radar technology for the detection and forecasting of complex precipitation patterns, help characterize the performance of urban drainage infrastructure at both regional and local scales. Improvements in technology such as real-time radar rainfall, automatic stream gage systems, and automated data reporting

dissemination via the Internet have made it possible to develop and operate customized site-specific warning systems. Real-time runoff prediction using radar and rain gauge input is supported by a distributed, physics-based hydrologic model capable of utilizing geographic information and multi-sensor precipitation input to simulate rainfall runoff from rural and urban catchments.

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ACKNOWLEDGEMENT

We are grateful for funding from NSF Award No. 0313747, Engineering Research Center, Collaborative Adaptive Sensing of the Atmosphere, University of Massachusetts, Amherst, MA.

b) UDFCD – Boulder/Fourmile Creek Evaluation Study

Evaluation of Fourmile Hydrologic Model and Updates for 2015 Flood Season

Prepared
March 10, 2015

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1 Introduction

This report reviews the V*flo*® model hydrologic simulation and forecast performance during the 2013-2014 flood seasons including the September Flood of 2013. In terms of infiltration capacity, the Fourmile Burn Area (FBA) recovery is investigated for 2011-2014. Based on a model performance review, recommendations are made in preparation for the 2015 operational flood season. The model updates are based on observations from the 2011-2014 flood seasons, and any observed improvement in the FBA saturated hydraulic conductivity (KSAT).

1.1 Background

Vieux, Inc. provides real-time hydrologic prediction services to the UDFCD for monitoring the hydrologic conditions along Boulder Creek, Fourmile Creek (FMC), and Fourmile Canyon Creek (FMCC). The setup of the hydrologic forecast model was accomplished in a three-phase project that resulted in the setup, calibration/validation, and finally an operational model for the Boulder Creek, FMC, and FMCC Basins, beginning with the 2011 flood season and continuing through 2014.

1.2 Objectives

The following are the specific objectives that are the focused of this report.

1. Review V*flo*® model performance during the 2013-2014 flood seasons, including the September Flood of 2013
2. Determine whether the FBA has recovered based on calibrated model results from 2011-2014, and data contained in RainVieux.
3. Develop recommendations for model updates in preparation for the 2015 flood season.

Locations chosen for evaluation of model performance are presented in Table 1, and shown in Figure 1.

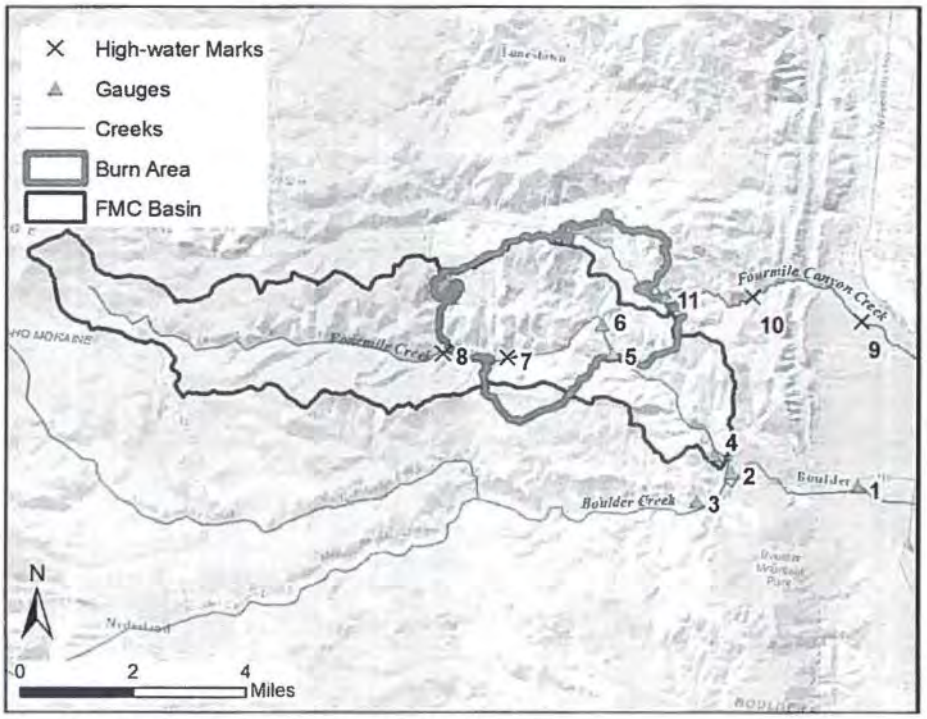

Figure 1 Locations for model performance analysis within the FBA

Table 1 Locations for model performance analysis

ID	Name	Gauge ID	Drainage Area (mi^2)	Description
1	Boulder Creek at Broadway	4583	134.5	Boulder Creek at Broadway, City of Boulder, CO (BOCOBOCO)
2	Boulder Creek at Bridge	4423	128.8	Boulder Creek downstream of confluence with Fourmile Creek
3	Boulder Creek at Orodell	4403	102.1	Boulder Creek upstream of confluence with Fourmile Creek
4	FMC at Orodell	06727500	24.2	Fourmile Creek at Orodell, CO

ID	Name	Gauge ID	Drainage Area (mi^2)	Description
5	FMC at Crisman	06727410	19.2	Fourmile Creek at Logan Mill Road near Crisman, CO
6	FMC at Salina	4413	18.9	Fourmile Creek at Salina, CO
7	FMC d/s of Emerson Gulch	High-water Mark[1]	14.7	Fourmile Creek Downstream of Emerson Gulch
8	FMC u/s of burn area	High-water Mark[1]	9.0	Fourmile Creek Upstream of Burned Area
9	FMCC at Broadway	High-water Mark[1]	7.6	Fourmile Canyon Creek at Broadway, City of Boulder, CO
10	FMCC at Pinto Dr.	High-water Mark[1]	4.0	FMCC at Pinto Dr.
11	FMCC at Burn Outlet	06730160	1.8	Fourmile Canyon Creek near Sunshine, CO

Notes: [1]High-water marks measured by Jarrett (2013)

2 Events

This section describes evaluation of the operational system performance for the 2013 and 2014 seasons. The September Flood of 2013 occurred in this period, and is examined to identify if the model over-predicted during this very large event.

2.1 Flood Season 2013

The events considered in 2013 consist of two events of differing magnitude. With model input derived from the operational system, re-construction of the following events is considered.

1. Minor event on August 26, 2013
2. Major flood of September 11-12, 2013

The minor event that occurred on August 26, 2013 was important because it improved the operational system before the September 2013 event occurred. The August event provided an opportunity to adjust the KSAT parameter for the FBA. During this event, there was a large over prediction of peak streamflow at the downstream location, FMC at Orodell.

2.1.1 Event on August 26, 2013

On August 26, 2013, the rainfall totaled between 0.5 - 1.0 inches between 16:00 - 23:00 MDT over the FBA (Figure 2). Rainfall rates for shorter periods (less than 10 minutes) exceeded 2.5 in/hr within the middle of the FBA. However, runoff from this area was over-predicted by the real-time hydrologic model. The KSAT parameter for the FBA used prior to this event was 0.07 in/hr. This was based on the assumption that the FBA infiltration rate was low due to the 2010 fire effects. Through event calibration, the KSAT parameter exhibited recovery from the initial 2013 estimate of 0.07 in/hr. Model simulations were performed showing the impact of increasing the KSAT parameter for the FBA using 0.07, 0.25, and 0.3 in/hr (Figure 3). The KSAT parameter changes are discussed in more detail in Section 3 below.

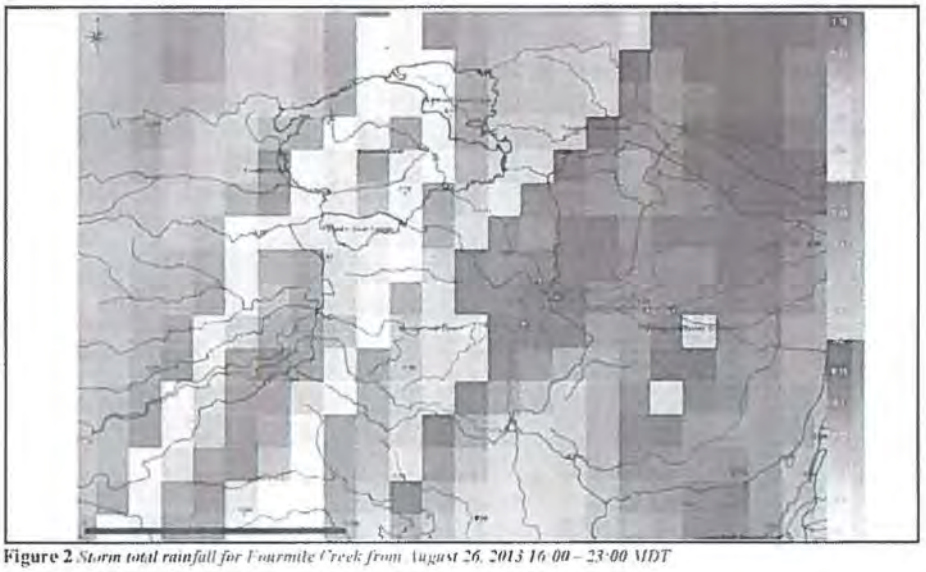

Figure 2 *Storm total rainfall for Fourmile Creek from August 26, 2013 16:00 – 23:00 MDT*

When KSAT was changed from 0.07 in/hr to 0.3 in/hr, the simulated runoff volume matched with the observed runoff volume for the August 26, 2013 event. The third panel in Figure 3 shows the improved simulation with a peak discharge of 25 cfs. In retrospect, it was fortunate that the model was adjusted after this event. If the model had not been adjusted, then there could have been a larger over-prediction during the September Flood of 2013.

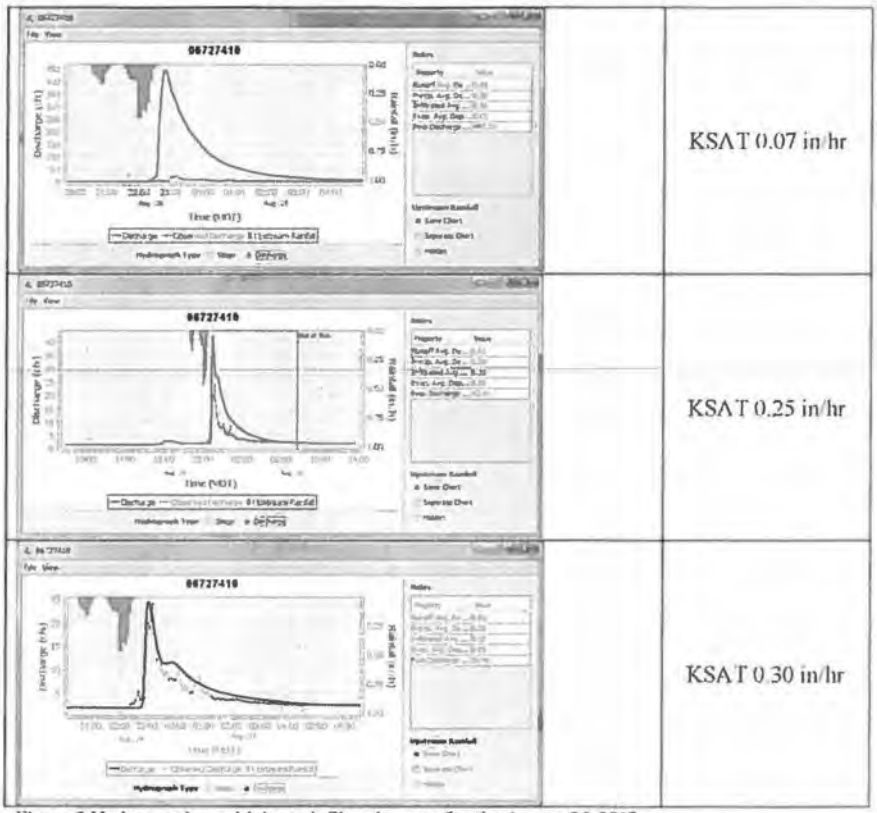

Figure 3 Hydrograph sensitivity to infiltration rate for the August 26, 2013

2.1.2 September Flood of 2013

The September Flood of 2013 occurred on September 11-13, 2013. Due to stream gauge failures and sedimentation or bypassing, field-measured high water marks, determined after the event, are used to validate model performance at several locations (Houck, 2014; Jarrett, 2013; USGS, 2014). The peak stage and discharge measured for each of the USGS gauges is shown in Table 2. The "ID" next to each location corresponds with the data shown in Figure 1 and Table 2. The last col. of Table 2 presents the operational values from USGS or UDFCD ALERT gauges, some of which were subsequently revised.

Table 2 Comparison of simulated and observed peak discharge estimates for the September Flood of 2013

ID	Name	Gauge ID	Simulated (cfs)	Observed Houck (2014) (cfs)	Observed Jarrett (2013) (cfs)	Observed USGS - Revised (cfs)	Operational USGS or ALERT (cfs)
1	Boulder Creek at Broadway	4583	4,352				4,948 (ALERT)
2	Boulder Creek at Bridge	4423	4,053				3,783 (ALERT)
3	Boulder Creek at Orodell	4403	2,552		2,020		1,761 (ALERT)
4	FMC at Orodell	06727500	3,290	2,733	2,300	2,510	1,210 (USGS)
5	FMC at Crisman	06727410	1,793			2,040	1,270 (USGS)
6	FMC at Salina	4413	1,694		3,300		595 (ALERT)
7	FMC d/s of Emerson Gulch		594		1,070		
8	FMC u/s of burn area		256		490		
9	FMCC at Broadway		3,807		1,460		
10	FMCC at Pinto Dr.		1,836		1,080		
11	FMCC at Burn Outlet	06730160	1,112			1,090	203 (USGS)

The simulated and observed peak discharge estimates are compared in Figure 4. The dashed line indicates the one-to-one line between simulated and observed peak discharge, and the solid black line indicates the linear regression line fit through the origin. Observed peak discharge estimates, in Figure 4, are obtained from three sources:

1. UDFCD ALERT gauge network (indicated by filled circles)
2. USGS revised stream gauge estimates (indicated as filled squares)
3. Peak discharge estimates by Jarrett (2013) (indicated by x's)

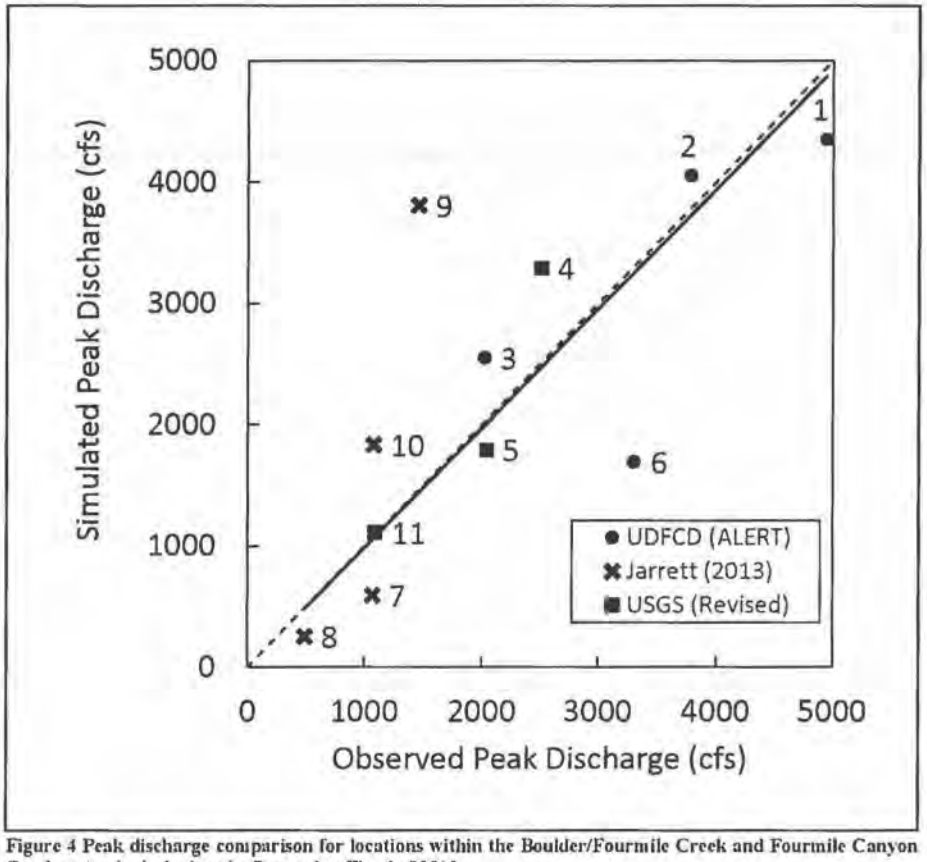

Figure 4 Peak discharge comparison for locations within the Boulder/Fourmile Creek and Fourmile Canyon Creek watersheds during the September Flood of 2013

Comparisons are made for the three main creeks within the hydrologic model: Boulder Creek, FMC, and FMCC. For Boulder Creek, the simulated peak discharge percentage error ranged between -12% to +26%. The model predicted 2,552 cfs. while Jarrett (2013) estimated 2,020 at the Boulder Creek at Orodell (ID 3) location. For the FMC sites, the simulated peak discharge

for the Orodell gauge (ID 4) was overestimated by 31% (780 cfs) when compared with the revised USGS estimate. While, the simulated peak discharge for the Crisman site (ID 5) was underestimated by 12% (247 cfs). For FMC at Salina, the observed peak discharge estimate was 3,300 cfs. This estimate appears to be uncertain since it is 1,000 cfs greater than the downstream estimate for FMC at Orodell. Based on high-water marks measured in the field by Jarrett (2013), simulated peak discharge was under-predicted at two locations. ID 7 located in the FBA, and at ID 8, which is upstream. For the FMCC, the largest overestimate was 3,807 cfs versus the estimate of 1,460 cfs (Jarrett, 2013) for the FMCC at Broadway (ID 9). However, when the KSAT parameter for non-burn areas is adjusted from 0.5 to 1.4 in/hr, the simulated peak would be 1,610 cfs or within +10 %. At the location of FMCC at Pinto Drive (ID 10), the model also over-predicted due to the assumed KSAT=0.5 in/hr, which is apparently too low for non-burn areas. For the USGS gauge located at FMCC at Burn Outlet site (ID 11), simulated peak discharge was nearly equal to the observed peak discharge (within 22 cfs), or only 2%. The simulated hydrographs for locations representative of Boulder Creek, FMC, and FMCC are shown in Figure 5. Appendix A includes hydrographs for all 11 sites.

The greatest difference between simulated and observed peak discharge was for the drainage area downstream of the FBA, in both FMC and FMCC. In the areas of FMC and FMCC, where the September 2010 fire did not affect infiltration significantly (i.e. non-burn areas), the infiltration rates should have been greater than originally assumed. The KSAT parameter for the FBA during the September Flood of 2013 was 0.30 in/hr, and the KSAT parameter for the drainage area downstream of the FBA was 0.50 in/hr. The initial estimate of 0.5 in/hr was conservative to ensure that the model *did not* generate runoff for the drainage area downstream of the FBA. For the September Flood of 2013, there was approximately 1.3 inches of runoff generated for this area. This amount of runoff was large for non-burn areas, and is most likely due to the assumed value of KSAT = 0.5 in/hr that caused the greater than expected runoff depth. In post analysis, KSAT was varied between 0.5 – 1.5 in/hr to see the runoff sensitivity for this area during the event as shown in Table 3. The KSAT parameter of 1.1 in/hr results in a peak discharge that is more consistent with the revised USGS peak discharge of 2,595 cfs for FMC at Orodell, than the operational value of 3,290 cfs. In areas of the FMC and FMCC not affected by the FBA, the model computed the volume of infiltration during this event to be 9.3 out of 10.2 inches of rainfall. Some of this infiltrated volume returned as streamflow as evidenced by prolonged recession limbs of observed hydrographs. This quick return flow process was not accounted for in the model due to its configuration as a flood alert application.

A similar overestimate of peak discharge occurred for the FMCC at Broadway (ID 11). The simulated peak discharge during the event was 3,807 cfs while the observed was 1,460 cfs. The majority of the drainage area for the site (76%) is downstream of the FBA. The KSAT parameter for the non-burn area had been estimated at 0.5 in/hr. Revising KSAT to 1.4 in/hr brings the simulated peak discharge into agreement with the estimated value by Jarrett (2013).

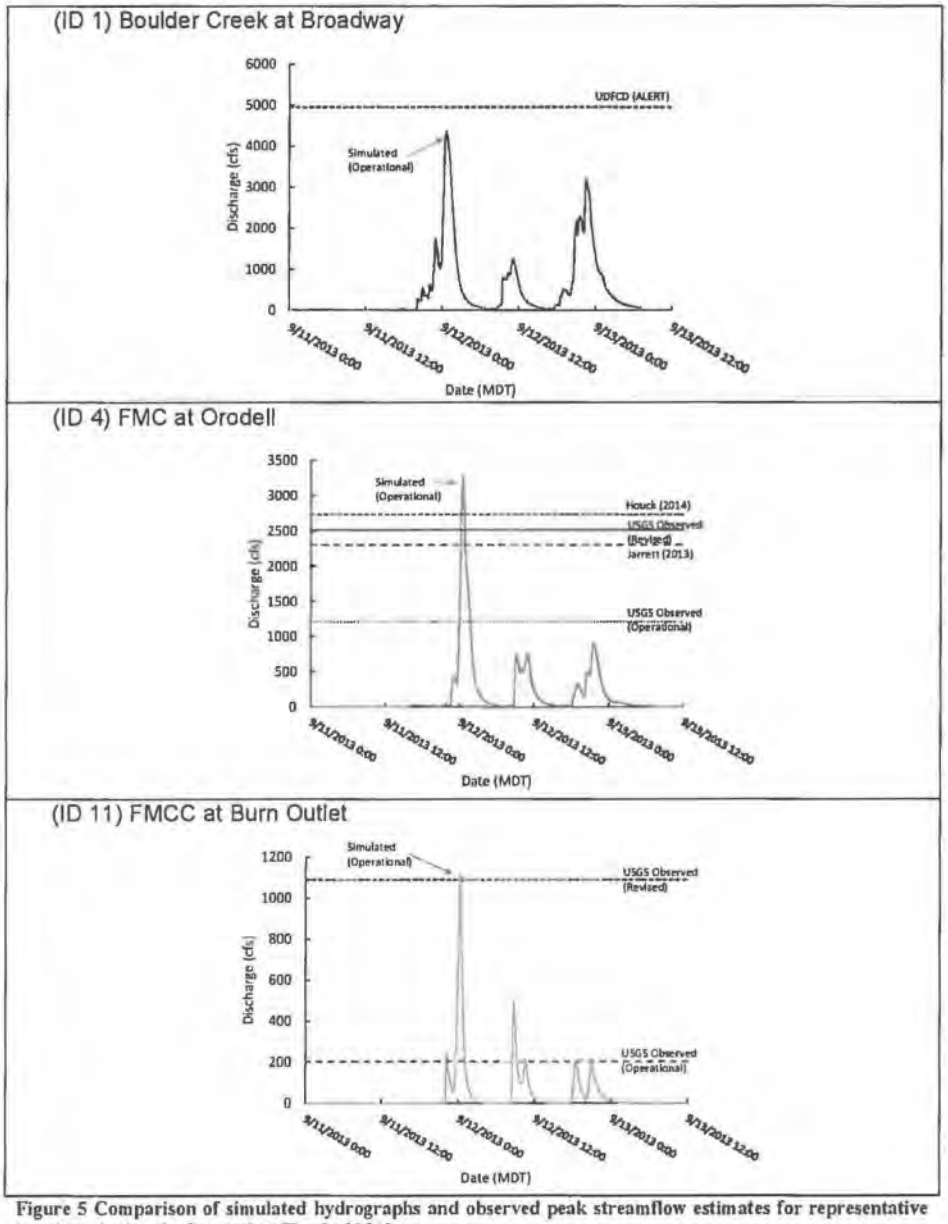

Figure 5 Comparison of simulated hydrographs and observed peak streamflow estimates for representative locations during the September Flood of 2013

The hydrologic model does not account for flow bypass of stream gauges, or degradation/aggradation of stream beds; nor can it model the effects of debris dams or the sudden release or surge of streamflow when debris dams fail during an event of this magnitude. Since the September Flood of 2013, USGS has revised the rating curve for FMC at Orodell (06727500), seen in Figure 6. The shift accounts in part for the alteration in channel geometry and hydraulics resulting from this event.

Table 3 Peak discharge sensitivity with respect to KSAT for FMC at Orodell gauge

KSAT (in/hr)	Orodell Peak Discharge (cfs)	Simulated Runoff Depth (in)	Rainfall Depth (in)	Simulated Runoff Coefficient
0.5	3,290	1.31	10.2	0.110
1.0	2,595	0.92	10.2	0.093
1.1	2,490	0.85	10.2	0.083
1.5	2,259	0.63	10.2	0.061

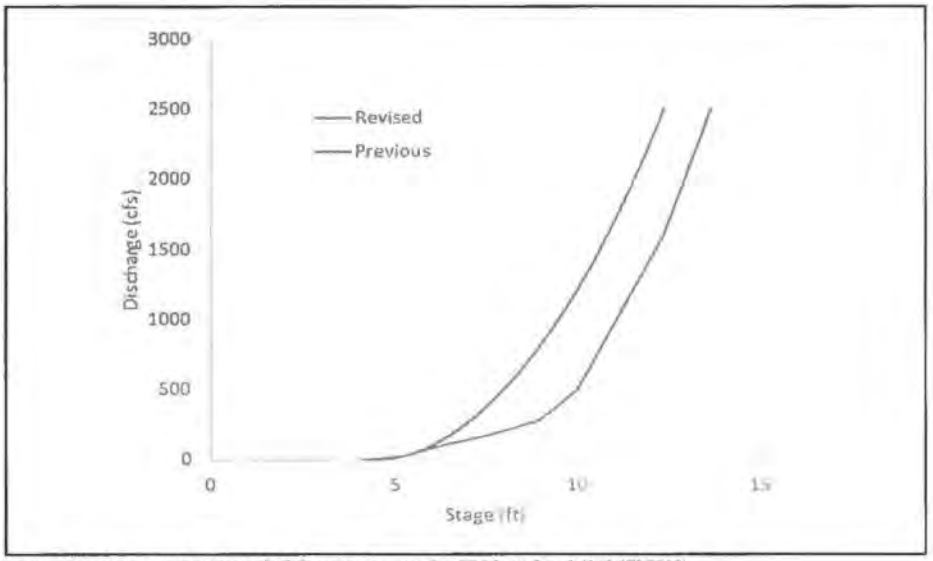

Figure 6 Previous and revised USGS rating curves for FMC at Orodell (06727500)

Table 4 provides the range of runoff depths that were estimated from the model during the event. The runoff coefficients ranged from 0.07 – 0.19. The greatest runoff coefficient occurred for the Fourmile Canyon Creek area. The majority of the runoff for this area was generated from the FBA that had a reduced infiltration rate of 0.3 in/hr. The observed runoff depth was difficult to estimate for this event due to sediment and streamflow gauge malfunctions during the event. Rating curves have been modified by the USGS to account for changes to the cross sections due to this event.

Table 4 Runoff depth and runoff coefficients for USGS gauges for the September Flood of 2013

Name	USGS Gauge	Simulated Runoff Depth (in)	Rainfall Depth (in)	Simulated Runoff Coefficient
FMC at Orodell	06727500	0.71	8.35	0.085
FMC at Crisman	06727410	0.55	7.84	0.070
FMCC at Burn Outlet	06730160	2.11	11.06	0.19

3 FBA Recovery Evaluation

An objective of this study is to evaluate whether the FBA exhibits recovery in its infiltration properties. Within the model, one of the key parameters for controlling the infiltration rate is the KSAT parameter. Mean KSAT estimates have been estimated for the 2011 - 2014 seasons using events that occurred during each season.

The 2014 season provided some information about the infiltration capacity of FBA, even though there were only small events (Figure 7). Two direct runoff events occurred during this period on May 23rd and May 30th. During the May 23rd event, snowmelt accounted for 40 cfs of the total runoff. The observed peak discharge from direct runoff was 44 cfs and the simulated peak discharge from direct runoff was only 3 cfs. Using a KSAT value of 0.3 in/hr, the simulated results agreed closely, 23 cfs (observed) compared with 18 cfs (simulated). Note that the snowmelt-generated runoff is shown with an adjustment to baseflow on May 23rd.

Another small event occurred on July 30th, as seen in Figure 8. The observed peak discharge from this event was 15 cfs, and the simulated peak discharge was 48 cfs, with both less than the flood threshold of 200 cfs. On August 7, 2014, there was another small event, with zero observed flow response, and only 3.3 cfs simulated flow (not shown due to its small magnitude). Neither of these events produced observed direct runoff from the FBA as evidenced by UDFCD ALERT gauges or USGS stream gauges.

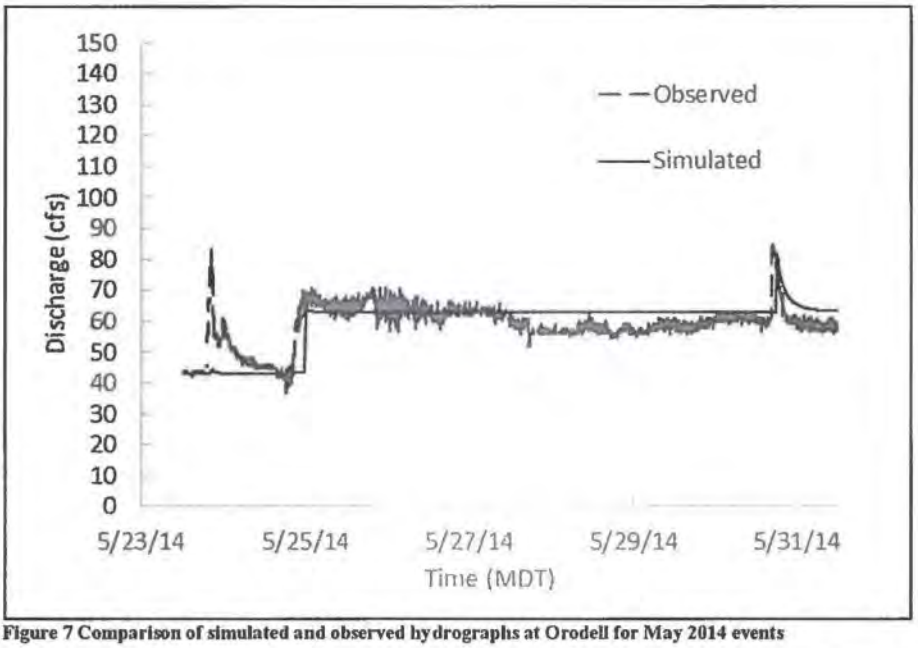

Figure 7 Comparison of simulated and observed hydrographs at Orodell for May 2014 events

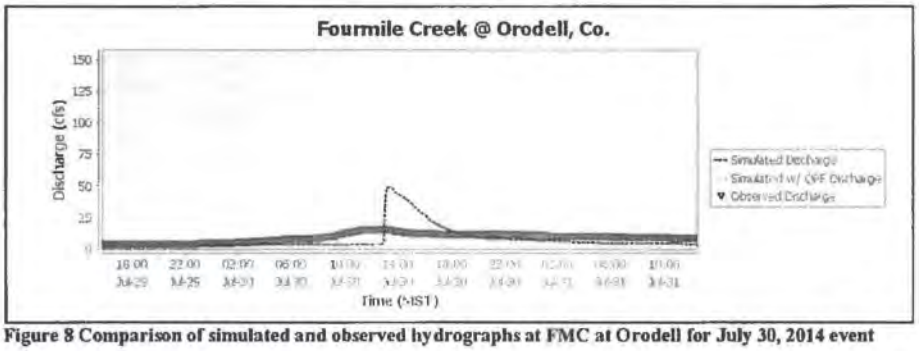

Figure 8 Comparison of simulated and observed hydrographs at FMC at Orodell for July 30, 2014 event

Even though the 2014 events are small in magnitude, the simulated and observed runoff results indicate that the model tends to over-predict in the July and August events with KSAT=0.3 in/hr. During the May 30th event, this value of KSAT did produce a hydrograph response consistent with the observed flow FMC at Orodell. This performance in 2014 suggests that recovery in the FBA may justify using a value of KSAT that is higher than 0.3.

Projections of model recovery for the coming season, 2015, is examined and based on infiltration changes for flood seasons, 2011-2014. Figure 9 shows the operational mean KSAT progression

during each season from 2011 to 2014 for FBA. In 2011, the initial estimate of KSAT was assumed 0.0 in/hr, and then increased in subsequent years through calibration to observed hydrographs. In the first part of 2012, KSAT was 0.0 in/hr, and then adjusted to 0.07 in/hr after calibration to six storm events during that season. Thus, on average for 2012, the value was 0.04 in/hr. In late 2013, and continuing into 2014, it was increased from 0.07 in/hr to 0.3 in/hr as a result of the August 26th 2013 event. Projection of recovery in the FBA for the coming season, 2015, is KSAT =0.4 in/hr. This estimate is based on the increase in KSAT of about 0.10 in/hr from 2013 to 2014.

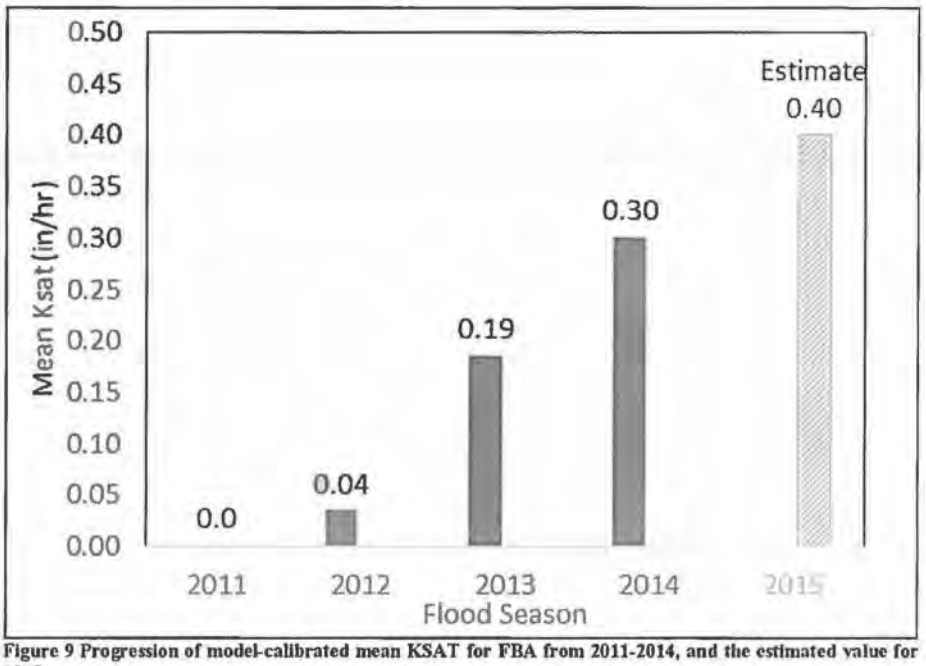

Figure 9 Progression of model-calibrated mean KSAT for FBA from 2011-2014, and the estimated value for 2015

4 Summary and Recommendations

This report reviews the *Vflo*® model performance during the 2013-2014 flood seasons including the September Flood of 2013. Evaluation of the FBA recovery is also made, and is based on calibrated model results for each flood season since 2011. Based on the review of the model performance, recommendations are presented below in preparation for the 2015, operational flood season.

From model calibration, the KSAT parameter has increased from an assumed initial value of 0.0 in/hr in 2011, to 0.3 in/hr in 2014. During the September Flood of 2013, downstream and outside of the FBA, the model over-predicted peak discharge by 31% at FMC at Orodell, most likely due to excess runoff generated by the model in non-burn areas. On Boulder Creek at Orodell, the model forecast was relatively close at 2,552 cfs, compared with 2,020 estimated from a high-water mark. For the FMCC at Pinto and Broadway locations, the model over-predicted due to assumed KSAT values assigned to non-burn areas that were too low. After adjusting for non-burn area infiltration upstream of FMCC at Broadway, the agreement was 1,610 cfs simulated versus 1,460 cfs estimated. Similarly, the model agreed closely with field-measured high-water marks, to within 12% and 2% at FMC at Crisman and FMCC at Burn Outlet, respectively. Evidence suggests that KSAT should be increased in three areas: 1) within the FBA, 2) in the *non-burn* area above the FMC at Orodell gauge, and 3) in the *non-burn* area in FMCC to reduce direct runoff.

When considering the most reliable streamflow measurements for the September 2013 Flood, the model did not appear to over-predict, with a mean absolute percentage error of 12% at four locations in Fourmile Creek, Fourmile Canyon Creek and in Boulder Creek. In cases where over-prediction did occur, these appear to be related to assumed model parameters, which have been revised to represent better the conditions in non-burn areas.

Recommendations

Model preparation for the 2015, operational season includes the following recommendations.

1. Continue with KSAT of 0.3 in/hr until storm events demonstrate that adjusting the KSAT model parameter to 0.4 in/hr for the FBA is merited.
2. Adjust non-burn areas of the model outside of the FBA to have higher infiltration, namely, increase KSAT to 1.1-1.4 in/hr from 0.5 in/hr.
3. Adjust rating curves in the model to reflect current conditions, as determined by USGS
4. Perform a model stress test to identify potential numerical instabilities due to rating curve modifications.
5. Compare initial soil moisture estimates with the Critical Zone Observatory (CZO) soil moisture probes for the Boulder Creek Basin, and initialize the model accordingly for 2015.

5 References

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c) Role of river stage, precipitation, and weather forecasts in knowing how much stormwater runoff will arrive and when.

ROLE OF RIVER STAGE, PRECIPITATION, AND WEATHER FORECASTS IN KNOWING HOW MUCH STORMWATER RUNOFF WILL ARRIVE AND WHEN

Baxter Vieux, Vieux and Associates Inc., Norman, OK
Jean Vieux, Vieux and Associates Inc., Norman, OK
Wayne Hunter, RPS Espey, Dallas, TX

Date: Thursday, August 22
Time: 8:30 – 9:00 a.m.
Session Number: P72

Key Words: Flood, Rainfall, forecast, construction, sewer rehabilitation

INTRODUCTION

The industry has benefited from the advent of real-time hydrologic warning systems as a tool for improving operations of reservoirs and other riverine hydraulic considerations to reduce the potential for flooding and to improve operations performance for hydraulic management of wet weather hydraulics storage and conveyance. Harnessing weather forecast and river condition information is part of a project for the rehabilitation of sewer pipelines in the City of Irving, Texas. Because of the project location in the floodplain of the Trinity River, the system helps reduce risks during construction. The real-time monitoring system described here was effectively deployed for the Trinity River Authority (TRA) during a major construction phase by the team of RPS Espey and Vieux & Associates, Inc.

TRA is a water conservation and reclamation district encompassing 18,000 square miles of the watershed of the Trinity River. The watershed encompasses 17 Counties and the river extends generally from the Dallas Fort Worth metroplex in North Central Texas to the Gulf of Mexico. TRA operates water storage, conveyance and treatment systems as well as some of the largest wastewater conveyance and treatment systems in the United States. The Central Regional Wastewater System (CRWS) provides wastewater service to a large service area in the DFW metroplex encompassing 20 municipalities and the DFW International Airport. The CRWS includes a 162 MGD advanced wastewater treatment plant and a conveyance system of over 200 miles of interceptor ranging in sizes up to 110-inch diameter pipe.

Large regional wastewater systems like the CRWS are vulnerable to the effects of riverine flooding, given that the CRWS' largest pipelines in the system run parallel to extremely dynamic river segments in the upper reaches of the Trinity River. Floodways and floodplains encompass the river and these pipelines and are in some cases conveying stormwater flows that expand the cross sectional distance of the river from less than 30 feet to several thousand feet wide during storm events. Figure 1 shows the location of the forecast domain (box) and the tributary watersheds indicated within the Trinity River Basin that drains from near the Oklahoma-Texas border in the north to Galveston Bay along the Texas Gulf Coast.

Construction and installation of the lining cannot be interrupted without warning because floodwaters could cause havoc with the curing process of the liner and with the downstream wastewater treatment plant that would receive the discharge. This requirement motivates the need for an information system that combines the forecasting and notification of future and current river conditions along West Fork and Elm Fork, tributaries of the Trinity River. A combination of upstream reservoir stage, projected streamflow, and weather forecasts are needed to make construction decisions: when to begin the cure-in-place lining, when to suspend, and when to resume lining installation. The chosen construction technology is a recent innovation that also benefits from weather and hydrologic information technology

tailored for the specific stormwater application and the geographic location of the project. Stormwater forecast information provides the most lead-time for precipitation forecasts, up to 72-96 hours in advance (Stormwater, 2013a,b).

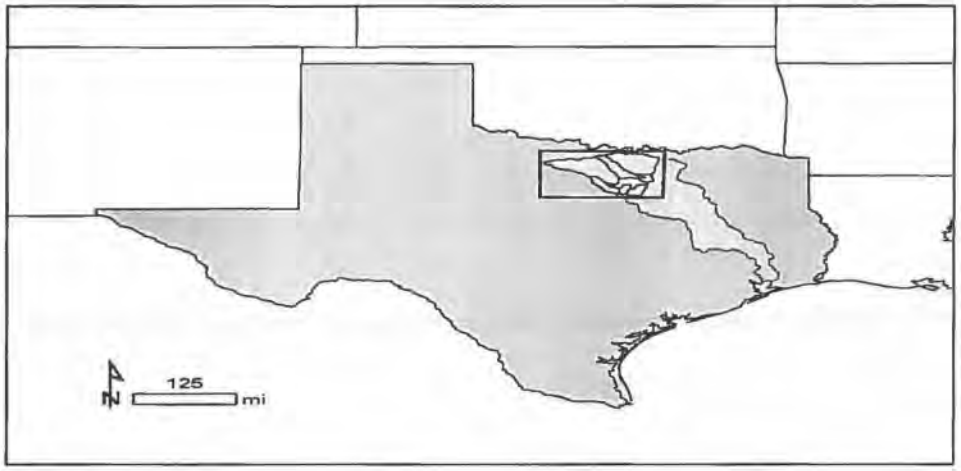

Figure 1 Location of project (box) in tributaries (green) of the upper Trinity River Basin (blue) located in Texas

METHODOLOGY

Current and forecast precipitation is the main driver of the hydrologic system composed of controlled drainage areas upstream of reservoirs that drain to the site, and uncontrolled drainage below these reservoirs determines the river stage that can inundate the temporary openings constructed to line the sewer. The system integrates current flood pool elevations, observed river stage, weather forecasts and precipitation estimates to provide a near real-time forecast horizon to a week ahead. The outlook provided consists of precipitation and the expected hydrologic response in the rivers. The status of hydrologic risk is monitored by multiple data feeds that are integrated in a display and notification system. A dashboard hosts project-specific weather/precipitation related information with a range of forecast length and associated accuracy. Specific system components and the integration of the information include:

1. Precipitation forecasts at the project location site.
2. Precipitation tracking using gauge-adjusted radar rainfall.
3. Stream flow observation.

4. Flood pool reports display along with provided runoff volume and average rainfall thresholds for multiple upstream reservoirs.

Construction of the trunkline sewer rehabilitation project depends on knowing streamflow adjacent to the sites. In situ lining operations cannot be interrupted without warning, motivating the need for an information system that combines the forecasting and notification of future and current stream flow conditions for this project along West Fork and Elm Fork, tributaries of the Trinity River. A combination of three upstream reservoir stages, projected streamflow, and weather forecasts are needed to make construction decisions; when to begin, when to suspend, and when to resume lining installation. Current and forecast precipitation is the main driver of the hydrologic system composed of controlled drainage areas upstream of reservoirs that drain to river adjacent to the site, and uncontrolled drainage below these reservoirs, which combine to affect river stage that can inundate the temporary openings in the sewer system constructed to line the sewer.

The system prepared for this project integrates observed streamflow stage, weather forecasts and precipitation estimates to provide a near real-time and up to a week ahead of time for precipitation and hydrologic response. The construction sites that could be impacted from flooding are adjacent to the Elm Fork of the Trinity River, but in addition to the Elm Fork's downstream confluence with the West Fork which created a backwater effect, which potentially would engulf portions of the construction sites during wet weather periods.

Notification Watch and Warning Levels

Watch and warning levels correspond to either stage in reservoirs in feet above mean sea level, or discharge values for the tributary stream determined for each construction site. A *Watch Level* is a depth or discharge value that indicates that precautions are needed, while the more critical *Warning Level* indicates flooding of the site is imminent. Table 1 shows the watch and warning levels set for the five watch points.

Table 1 Watch and warning level settings for five watch points

Watch Point Name	Watch Level	Warning Level
Lake Lewisville	521ft	522ft
Grapevine Lake	534ft	535ft
Lake Worth	593ft	594ft
West Fork Trinity River at Grand Prairie, TX	1440cfs	1800cfs
Elm Fork Trinity River at Spur 348, Irving, TX	3200cfs	4000cfs

For the reservoir gauge status, the Warning Level is based on stage or depth of the pool, and is set to the top of the conservation pool. When the reservoir's stage is above this level, the reservoir will likely begin discharging through its spillway, causing downstream flow. For the stream gauges near the project site, status is based on discharge. The warning level is set to the level of discharge that represents the stage at the project site reaching approximately 402ft. For the Elm Fork gauge, this is 4000cfs. For the West Fork Gauge, this is 1800cfs. These levels are consistent with those that appear in action item 3 of the Site Evacuation Plan that contains actions regarding when the Contractor's evacuation plan should be activated.

RESULTS

The system integrates hydrologic information includes reservoir pool levels and stream gauges. The forecast lead-time was demonstrated on several locations since the system's inception. Stage at the five watch points, three reservoirs and projected streamflow at the two sites, are shown in Figure 2. Rainfall

can be displayed as basin averages or as gridded maps as shown in Figure 3 for the event on August 18-20, 2012 (upper). In the lower portion of Figure 3, the gridded rainfall is computed from a combination of radar and rain gauge data that enhances its accuracy (Bedient et al., 2013). During this event on August 17th, a streamflow notification was triggered based on predicted streamflow shown in Figure 4, showing observed flow from a USGS stream gauge. The predicted stage (blue solid line) is obtained from an upstream gauge that peaks at 21:00 CST on the 18th. The observed stage (red circle symbols) is taken from a stream gauge located in close proximity to the site, which peaks the next day at 10:00 CDT on the 19th. The weather forecast indicated that precipitation was to be expected with days in advance before the stage rose above the watch and warning levels set at 1440 cfs and 1800 cfs, respectively. The lead-time gained through automated and proactive monitoring proved invaluable to the construction management and operations during this and other events.

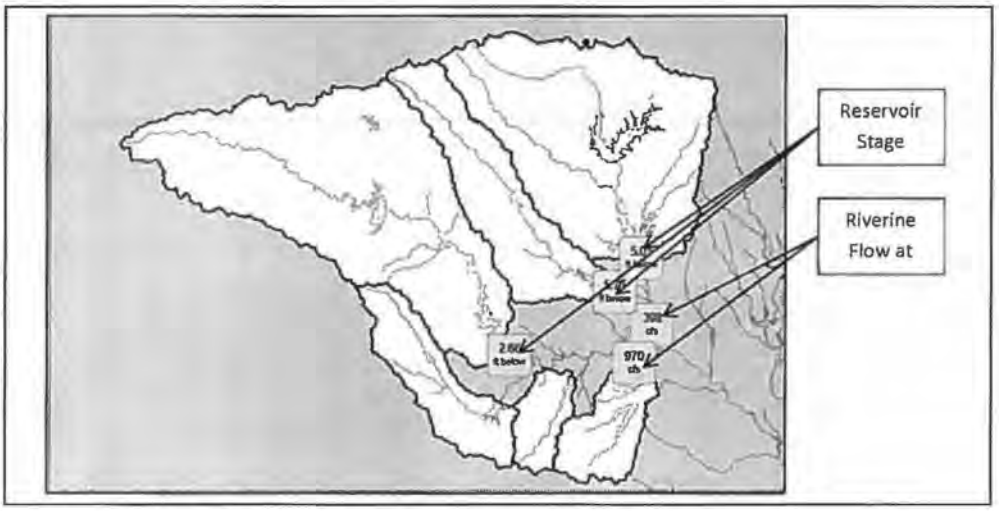

Figure 2 Watershed map and flood pool information at three reservoirs and two sites

SUMMARY

The status of this project is ongoing with continuous forecast information supporting construction activities in 2012-2013. At this time, virtually all of the construction for the CAC-11 Project has been completed, ahead of schedule. Throughout the construction process, real time wet weather monitoring has been used by TRA's construction inspection staff, TRA operations, and the contractor, maintained by RPS Espey and Vieux Associates. The users of the system have routinely accepted automated emails of both Watch Levels and Warning Levels via cell phone emails, allowing all of the construction forces to effectively plan construction activities adjacent to a very dynamic river. Over this construction period, Elm Fork flows have flooded the construction site five times, yet in each instance there has been no impact to construction. So from an operational standpoint, TRA has recognized a benefit for this unique use of real time weather monitoring to avoid impacts to TRA's operation and improvement program for this large regional wastewater system.

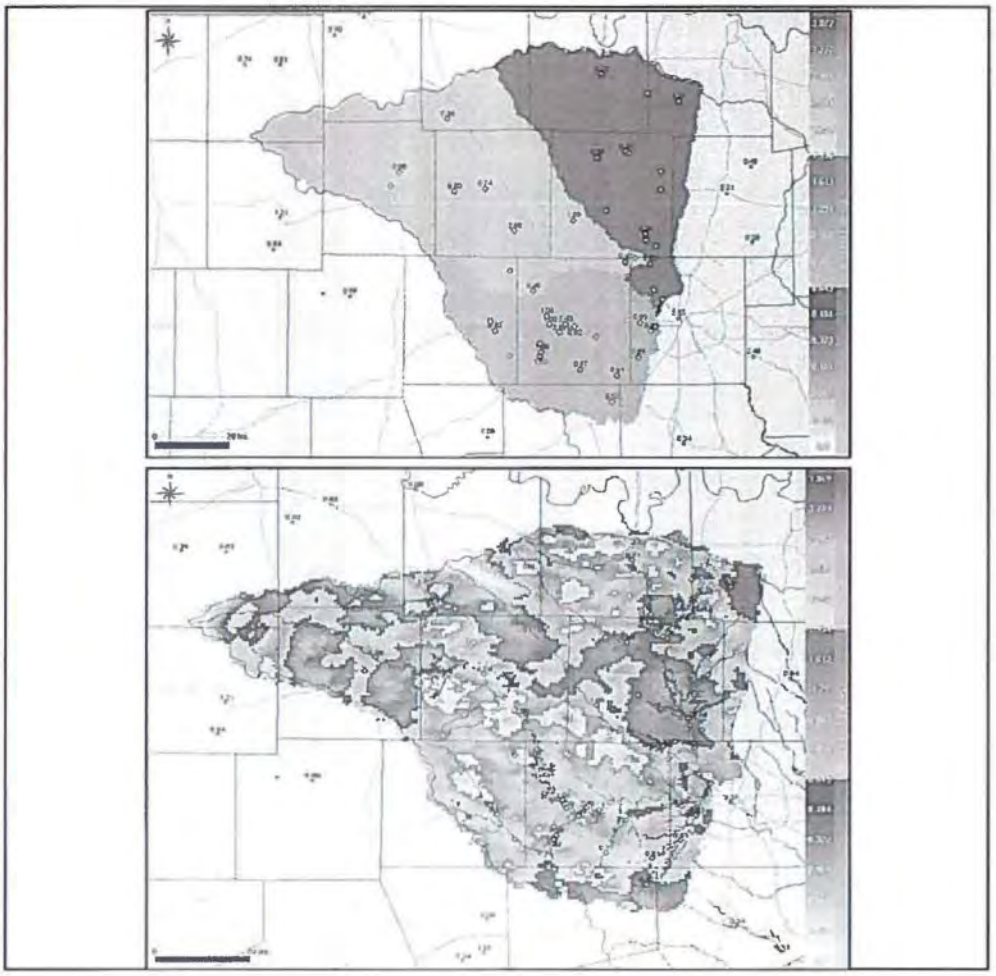

Figure 3 Rainfall reported as basin averages for the event on August 18th - 20th 2012 (upper), and gridded rainfall storm total during the same period (lower)

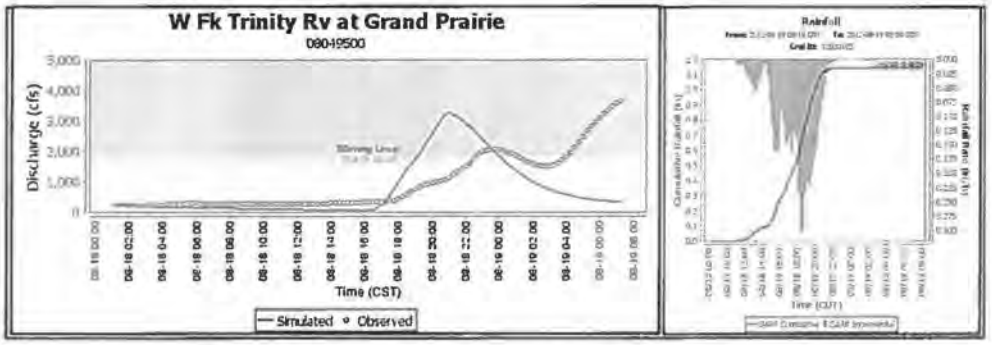

Figure 4 Forecast and observed hydrologic response on the West Fork of the Trinity River on August 17, 2012 (left) and rainfall temporal distribution of intensities for a selected location (right).

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http://www.stormh2o.com/SW/Articles/New_Stormwater_Forecast_Service_Announced_20626.aspx

BIOSKETCH

Dr. Vieux is an expert in hydrology with specialties in stormwater modeling, radar rainfall, and distributed hydrologic modeling. He is Professor Emeritus at the University of Oklahoma. Over one hundred publications appear as book chapters, refereed journal articles, and papers in conference proceedings. He is the author of *Distributed Hydrologic Modeling Using GIS,* and coauthor of *Hydrology and Floodplain Analysis.* As principal of his engineering firm, Vieux & Associates, Inc., he oversees development of radar rainfall and distributed hydrologic monitoring systems; and consulting studies in design storm development, and stormwater modeling.

Mr. Hunter has been managing and performing design of wastewater pipelines for new and rehabilitation of pipes ranging up to 104-inch diameter for 29 years. Mr. Hunter has made presentations and prepared numerous technical papers on large diameter pipeline rehabilitation condition assessment, design considerations, and construction considerations. Mr. Hunter's experience includes 14 years of managing pipeline design for the Trinity River Authority and 15 years of pipeline design for MWH and RPS Espey.

Tab 5 - Project Management Structure

Within one organization, the FFMMS project is supported by eleven personnel total (two of which are principals of the firm). Personnel include two (2) in project management, and nine (9) in software/scientific technical roles assigned to the project.

A. Organizational Structure

The organizational chart in Figure 19 shows each of the three teams and personnel assignment is shown. These teams support the FFMMS major areas of: 1) Software/IT, 2) Hydrology/hydraulics, and 3) Hydrometeorology. Baxter Vieux provides overall technical management, and is responsible for oversight and conceptualization of radar rainfall algorithms and real-time physics-based hydrology/hydraulic modeling. Jean Vieux leads the overall project management, client communication, and coordination of the team. The 10 personnel and their project roles are assigned as follows.

Within a single entity, Vieux has the necessary structure: 1) hydrologic/hydraulic modeling and 2) hydrometeorology to 3) software/IT expertise to deliver a web-service for flood forecasting modeling and mapping.

Project Management
1. Jean E. Vieux, Project Manager
2. Dr. Baxter E. Vieux, Principal Engineer

UI/UX Development and Software IT
3. Brian Byrne, UI/UX Design Developer
4. Brian McKee, Programmer/Conceptual Design
5. Adam Barnett, Programmer/Database
6. Ryan Hoes, System Analyst/Backend Processes

Hydrology/Hydraulics
7. Jonathan Looper, Hydrologist/hydraulic Engineer

Hydro-meteorology Radar Rainfall
8. Edward Koehler, Senior Hydrometeorologist
9. Jennifer French, Hydrometeorologist
10. David Buckey, Hydrometeorologist

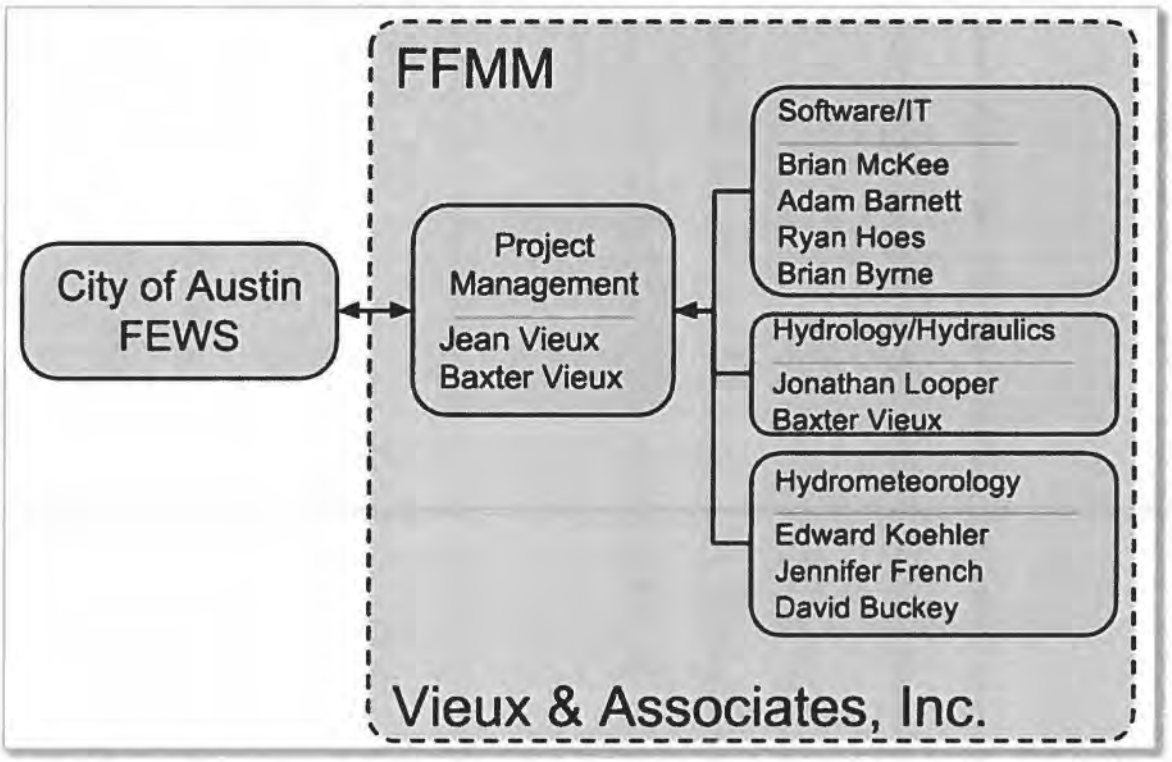


Figure 19 Vieux organizational chart with teams and assignment

B. Financial Strength

Vieux is financially stable with growing revenues. We lead the industry in web-based delivery of radar rainfall and runoff services, with growth steadily increasing as seen in Figure 20 below.

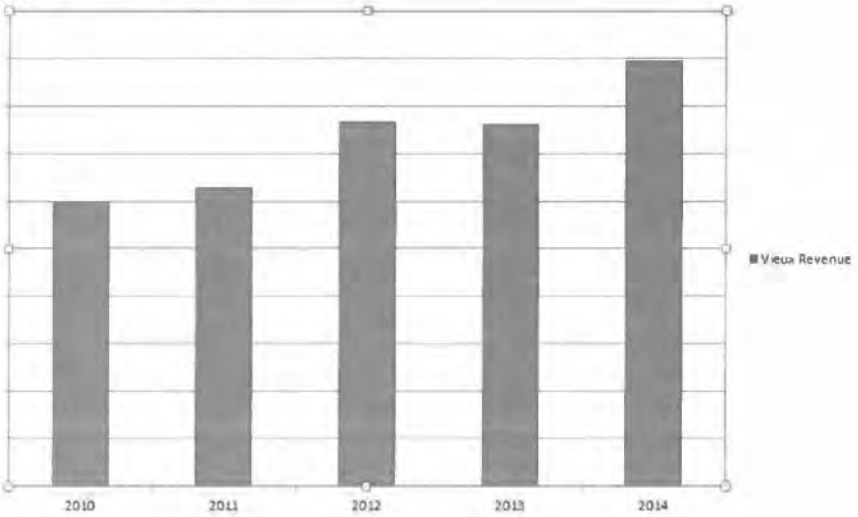


Figure 20 Vieux financial growth in revenue from 2010 - 2014

Tab 6 - Experience

A. Prior Experience and Number of Users/Organizations

Vieux & Associates Inc. (Vieux Inc.) has experience in providing real-time flood monitoring software services. Our software system collects, stores, analyzes and disseminates rainfall and water level information useful in flood monitoring. Sensor data integration with radar-based precipitation estimation, operational hydrologic modeling, and related information system technology are provided to major water management organizations. The number of users of our software for our three principal products: V*flo*®, RainVieux, and PreVieux, is presented below in Table 1. These numbers reflect project-based license installations and/or perpetual (ongoing) licensed installations. The model software exists both as a desktop application, and as a web-based (hosted) application. These are distinct applications because V*flo*® Desktop is a hydrologic model used to setup and analyze watersheds in preparation for real-time applications, and to test "what-if" scenarios. The Vieux-hosted edition of V*flo*® exists on an operational server for real-time flood forecasting. There are 120 users that have access to the web-based hosted V*flo*® version, and 183 users have acquired licenses to use Desktop V*flo*®. RainVieux is used mainly as a web-based application for display, query, and analysis of rainfall along with sensor timeseries data with georeferenced overlays. There are 392 users among 53 organizations with access to a dashboard that includes RainVieux. There are four users of desktop RainVieux applications. Forecast rainfall is supported by a web-based application called PreVieux, which has 194 users that have access to a dashboard setup that includes PreVieux.

Table 1 Number of software users with project-based licenses and/or perpetual (ongoing) installations.

Software	Users	Notes
1. V*flo*®		
1.1. **Vieux-hosted**	120	Dashboard Users
1.2. **User Desktop**	189	Licenses
2. RainVieux		
2.1. **Vieux-hosted**	392	Users with web-access
2.2. **User Desktop**	4	Users with desktop versions
3. PreVieux		
3.1. **Vieux-hosted**	194	Dashboard installations

The client list presented in Table 2 comprises web-hosted systems supported with radar rainfall monitoring (RainVieux), predictive rainfall forecasting (PreVieux), and/or Flood/stormwater modeling (V*flo*®). These clients receive services that are hosted by Vieux Inc. and are used for rainfall monitoring, flood forecasting, and water resources applications. Seven of these systems are located in the State of Texas. These numbers represent

selected projects where radar rainfall, flood modeling, and forecast rainfall applications were utilized.

Table 4 Selected web-hosted clients and commercial software product usage

No.	Selected Clients	Service	RainVieux	Pre-Vieux	*Vflo*®
1	Texas Medical Center/Rice University-Flood Alert System, Houston, TX[1]	1997-Present	1	1	1
2	Metropolitan Sewer District of Greater Cincinnati, OH	2000-Present	1	0	0
3	3 Rivers Wet Weather, Inc. Pittsburgh, PA	2003-Present	1	1	0
4	Edwards Aquifer Authority, San Antonio TX[1]	2004-Present	1	0	0
5	City of Indianapolis, IN	2004-Present	1	1	0
6	Flood Early Warning System, City of Austin, TX[1]	2006-Present	1	2	1
7	Metropolitan St. Louis Sewer District, St. Louis, MO	2006-Present	1	0	1
8	Florida Water Management Districts (Five Districts)	2007-Present	5	0	0
9	Sugar Land Flood Alert System, Sugar Land TX[1]	2010-Present	1	0	1
10	Harris County Flood Control District (HCFCD), Houston TX[1]	2010-2013	1	0	0
11	Miami-Dade Water and Sewer Department, Miami FL	2010-Present	1	1	0
12	City of Tulsa, OK	2010-Present	1	0	0
13	Fourmile Burn Area - Urban Drainage and Flood Control District, Denver, CO	2011-Present	1	1	1
14	City of Fort Worth - Public Works, TX[1]	2011-Present	1	0	0
15	City of Columbus, OH	2011-2013	1	0	0
16	Trinity River Authority - CAC 11 Forecasting System, Arlington TX[1]	2012-2013	1	1	1
17	Philadelphia Water Department, Philadelphia	2012-Present	1	0	0

	PA				
18	City and County of Denver - Urban Drainage and Flood Control District, Denver, CO	2013-Present	1	1	0
19	Ameren Missouri - Lake of the Ozarks Reservoir Inflow Tool	2013-Present	1	1	1
	Web-hosted Systems =		**23**	**10**	**7**

Notes: [1]Seven Vieux Inc. systems serve locations in the State of Texas.

B. Client References

References provided below are familiar with our software services and expertise. Permission is given for the City of Austin to contact these personnel who are familiar with our services.

1. **City of Austin, Flood Early Warning System** - Susan Janek, P.E. Email: Susan Janek@ci.austin.tx.us, Phone: (512) 974-3327.
2. **Ameren Missouri** - Phillip M. Thompson, Plant Manager, Email: pthompson@ameren.com, Phone: (573) 365-9201
3. **Urban Drainage and Flood Control** - Kevin Stewart, P.E., Manager/UDFCD Information Services & Flood Warning Program. Email: kstewart@udfcd.org, Phone: (303) 455-6278.

C. Reference Letters

Ameren Missouri - Phillip M. Thompson

Ameren MISSOURI

Osage Energy Center

March 12, 2015

City of Austin, Flood Early Warning System
One Texas Center
505 Barton Springs Rd. 12th Floor
Austin, TX 78704

Dear Sir/Madame:

I enthusiastically endorse the Vieux & Associates team for their abilities in developing our Reservoir Information Tool. They helped us create a tool for my organization that was transformative in how we perform our business processes.

Our goal was to build a comprehensive model that would use near real-time gauge adjusted Doppler Radar data to place water on our 2500 sq. mi. drainage area then route that water down the basin ultimately providing an inflow hydrograph for our control point, Bagnell Dam. Our basin normally responds slowly to moderate rainfall events but it can respond very quickly in extreme precipitation events. The tool built for us has exceeded our expectations.

The following elements provide an overview or highlight or our system:

- The runoff models were developed are performing extremely well.
- The HMI display of data was developed to be consistent with the way our employees were accustomed working with it which is typically on 6 hour increments but can be customized by the user to display according to user selections.
- All the operational information needed to be available on a single page that allowed graphing of data sets, turned on or off, as desired by the user. A very high level of skill and sophistication in software development is apparent. They were very responsive to incorporating our needs and showed extraordinary knowledge of both highly technical data and software development tools.
- Currently Vieux hosts our servers and data applications for the reservoir inflow application, along with their Data Center. The reliability of the system has exceeded my expectations.
- Vieux developed a stand-alone system housed at our power plant for us to run "what-if" scenarios used to test operational changes and run models even if communication through the internet is disrupted. Because the model states and forecasts are updated continuously between our servers and Vieux, the application allows us to run hypothetical scenarios.

617 River Road | Lake Ozark, MO 65049 | AmerenMissouri.com

Ameren MISSOURI

Osage Energy Center

I offer my highest recommendation for Vieux & Associates and would be happy to discuss or demonstrate our system if you have need. Please do not hesitate to contact me if I can offer further details or answer any questions.

Sincerely,

Phillip M. Thompson P.E.
Plant Manager – Osage Energy Center
Ameren Missouri
(573) 365-9201
pthompson@ameren.com

617 River Road | Lake Ozark, MO 65049 | AmerenMissouri.com

Urban Drainage and Flood Control - Kevin Stewart

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

Paul A. Hindman, Executive Director
2480 W. 26th Avenue, Suite 156B
Denver, CO 80211-5304

Telephone 303-455-6277
Fax 303-455-7880
www.udfcd.org

March 23, 2015

RE: City of Austin, Texas Flood Early Warning System

Dear City of Austin Flood Early Warning System Managers:

The purpose of this letter is to wholeheartedly endorse Vieux & Associates for their valuable professional work on our local flood warning program that serves the Denver-Boulder, Colorado metropolitan area. The Urban Drainage and Flood Control District has used their radar rainfall and hydrologic modeling services for natural and urban applications since 2011.

In 2010 a wildfire in the foothills near Boulder created a seriously elevated flood threat. The creek bed is usually dry, which makes monitoring and modeling challenging. The V*flo* model was able to simulate basin runoff characteristics and generate real-time information. That, coupled with their radar rainfall services, has allowed alerts and notifications to be sent with adequate lead-time, however short, to decision-makers responsible for issuing early warnings specifically targeted at the most highly threatened areas. Prediction of flash flood events like the 2013 Front Range Flood has led to a better understanding of basin responses. Easily-understood graphical interfaces are highly beneficial in communicating flood threats and expected impacts. What happened during the disastrous flooding experienced in Boulder County in 2013 illustrates how decision-support systems like those offered by Vieux & Associates directly influence the life-saving actions taken. No lives were lost from the devastating floodwaters that came out of that 2010 burn area. We are continuing this service.

This year we are expanding RainVieux (both current and forecast rainfall) services from coverage over the City and County of Denver to the entire UDFCD forecast area. Situational awareness and site specific information is a highly-prized feature of the technology that Vieux has provided.

Please let me know if I can offer any further details concerning our experience with Vieux & Associates.

Sincerely,

Kevin G. Stewart, P.E.
Manager, Information Services and Flood Warning Program

KGS/mc

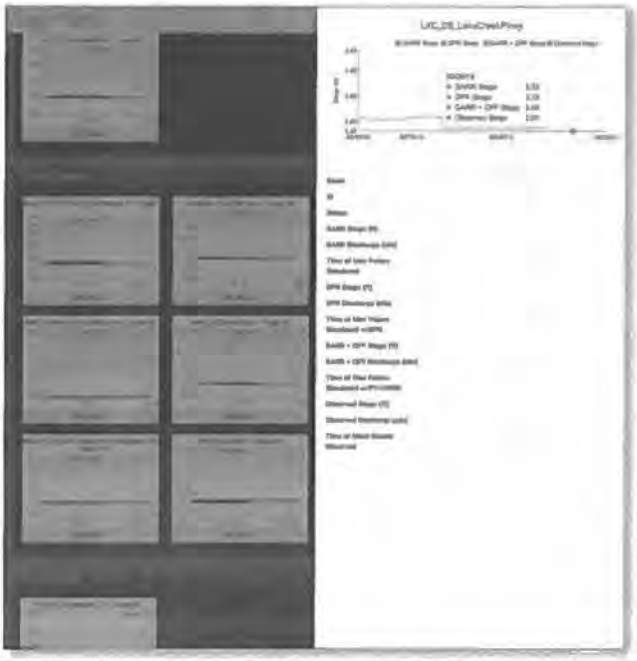
Working with you since 1969

D. Project Profiles

Project 1 - City of Austin Radar Rainfall and Hydrologic Services

Contact: Susan Janek, P.E., City of Austin TX
(512) 974-3327
Owner: City of Austin, TX
Project Cost: $174,000/yr (2014), Completed on time and under budget
Dates: 2004-Present
Role: Vieux (Prime)

Vieux Inc. began providing Gauge Adjusted Radar Rainfall (GARR) to the City of Austin FEWS and Austin Wastewater Utility in 2004. This rainfall data was accessed for display, query and download using a graphical user interface called RainVieux that maps rainfall between gauges. The value of having access to spatially distributed and quality controlled rainfall information was nearly immediately recognized. Later, in 2006, depth-duration-frequency thresholds were added to basins to help alert FEWS interpret the significance rainfall amounts as it uniquely affected each basin. Forecast rainfall was added by our service called PreVieux, a radar-based nowcasting algorithm used to alert FEWS staff when a basin is likely to receive 1.0 inch or more of rainfall. In 2007, in an effort to provide more and better basin forecasts, we began delivering real-time hydrologic model simulations as a web-service using V*flo*®. Confidence grew in the modeling results and the knowledge of time and place of flooding (in advance) became an expected piece of information that formed the basis of FEWS operations. Expanded basin modeling was added where we provide the maximum forecast depth of flooding and its time via XML for FEWS to map 599 points of inundation using their ArcGIS server. Because of the growing number of applications provided, there was a need for a single sign-in method for web access. In 2012, we assembled these applications on a Dashboard to improve the user experience and ease of administration. Recently, Vieux began delivering a similar XML file, but for



forecast stage based on *forecast rainfall* (see HRRR hydrograph at right). Mobile access to the table of watchpoints values was created so stage levels and forecasts are available on multiple devices. The Watch Point table display is updated to be more effective and easier for FEWS operators for decision support.

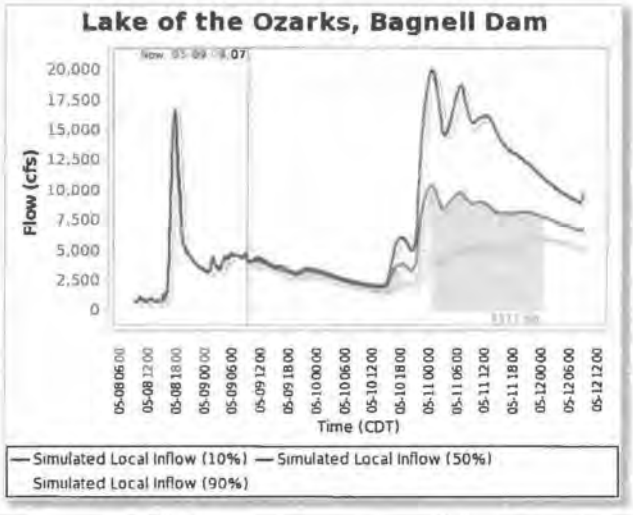
Project 2 - Ameren Missouri - Reservoir Inflow Tool

Contact: Phillip M. Thompson
Plant Manager, Ameren Missouri
Phone: (573) 365-9201, Email: pthompson@ameren.com
Owner: Ameren Missouri
Project Cost: $200,000 (2013-2014), $20,000/yr Ongoing, Completed on time and under budget
Dates: 2013-Present
Role: Vieux (Prime)

Dashboard components - Operational Rainfall-Runoff, GARR, Forecast Weather Inputs, Reservoir Routing and Operation, ET/Soil Moisture Modeling, and What-if

The 2,410 mi^2 drainage area of Bagnell Dam and Lake of the Ozarks (LOZ) is located in Central Missouri at the confluence of the Niangua and Osage Rivers. The combined drainage area upstream of both reservoirs is 13,950 mi^2.

The purpose of this project was to provide a Reservoir Inflow Tool and web-services for Bagnell Dam operators to manage inflow, lake elevation affecting LOZ, and hydroelectric power generation. The *Vflo®* model was setup and configured as a component of the Reservoir Inflow Tool operating on Vieux Data Center servers, and locally with the What-if Module. Inputs come from automated QA/QC of radar and rain gauge inputs. The model provides inflow hydrographs in real-time, routes flow through the reservoir, and incorporates QPF inputs to generate 10, 50, and 90% chance stage/discharge hydrographs. The tool accounts for upstream discharge from both *uncontrolled* watershed areas, and the USACE Harry S. Truman (HST) dam and reservoir, with boundary conditions set at measured discharge points (USGS and HST).



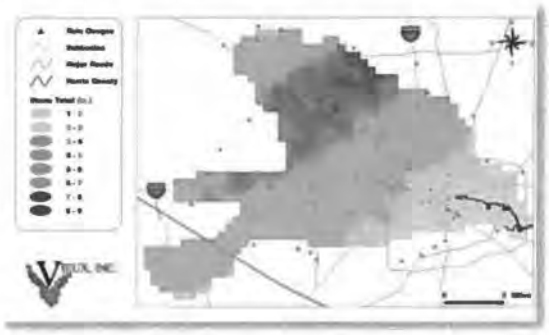
A Dashboard contains applications for the user to access, query and display GARR and *Vflo®* results. Integration with the

Ameren plant information SCADA (Pi) database provides access to sensor observations, and allows users to test *what-if* scenarios for gate operations and upstream reservoir releases. Alerts and notifications are provided for a variety of conditions related to forecast rainfall (QPF), current rainfall (QPE), and changes in lake elevation or inflow discharge. Message content is sent via email and by automated messaging, a RESTful web-service API used to make voice phone calls.

Project 3 - Harris County Flood Control District, Radar Rainfall Monitoring

Contact: Ataul Hannan
Owner: Harris County Flood Control Project (HCFCD)
Project Cost: $96,000
Dates: 2009-2013
Role: Vieux (Prime)

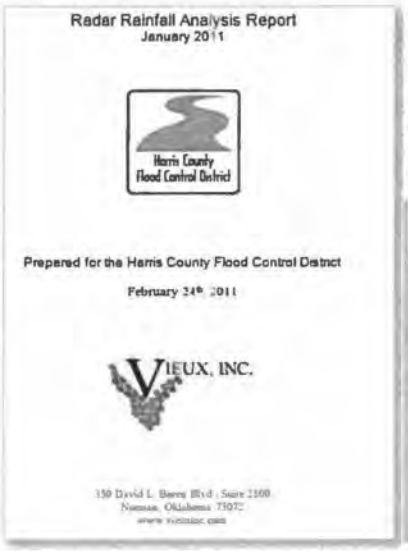
Historical Analysis - GARR Storm Total



Real-time system - GARR Storm Total

Real-time Radar Rainfall System

Vieux provides real-time and archival monthly quality control, reporting, and data QA/QC for Harris County. Rain gauge data from 223 HCFCD gauges are transmitted in real-time via FTP, and ingested into RainVieux for production of Near-Real-time (NRT) rainfall. At the end of each month, QA/QC procedures are applied to the gauge data, and radar on a daily basis. The radar and local rain gauge data is used to create high-resolution accurate rainfall over the 8371 sq. km watershed area that comprise the HCFCD area of responsibility. The 15-minute radar

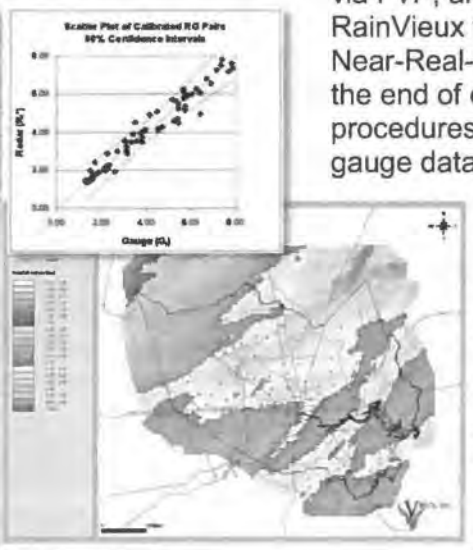

Radar Rainfall Analysis Report
January 2011

Harris County Flood Control District

Prepared for the Harris County Flood Control District

February 24th 2011

VIEUX, INC.



rainfall depths are used as input to hydrologic models coupled with hydraulic models to predict stage in near real-time for locations flooded by complex runoff and hydraulic interactions.

Auto-reporting of rainfall depth, event periods, radar and rain gauge data usage, statistical characterization, depth-duration-frequency analysis, and summary event descriptions.

This function was provided to HCFCD as well as other clients for delivery of precise and detailed storm event documentation. Retrospective analysis was performed to backfill the database for significant historical events. Six events, from December 1995 to November 2003, were processed for 83 subbasins in White Oak and Buffalo Bayous. Review of the 223 HCOEM gauges provided enhanced rainfall data by excluding certain gauges from analysis. The multiplicative bias correction factors for the six events ranged from a high of 3.6 to as low as 0.77. Based on the calibrated average difference for all events, the radar rainfall agreed with the rain gauge accumulations within ±3.8%.

Project 4 - Ft. Worth Flood Warning System Study

Contact: Andrew M. Rooke, P.E., CFM
Principal, Project Director, AECOM (now with AMR Consultants, Inc.)
Phone: 512-657-2940 Email: Andrew.Rooke@AMRconsults.com
Project Cost: $100,000
Dates: December 2010-July 2011
Role: Vieux, Inc. (Subcontract)

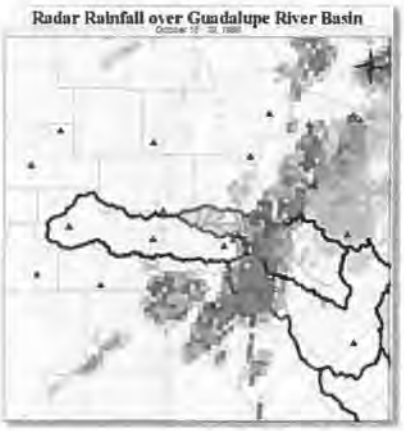
For 16 selected rainfall events, radar rainfall estimates at 1x1-km and 5-minute increments were generated using NWS level 2 radar rain gauge data. Vieux, Inc. calculated, analyzed and delivered storm return period for each event in relation to flooded areas and rainfall depth and intensity distribution by stream/watershed and gridded rainfall maps for each event for use in hydrologic modeling.

Resulting data and report were delivered for use in stormwater modeling and for characterization of the NWS MPE. A separate report detailed data improvements provided by Vieux, Inc. and differences compared to the NWS Stage 3/MPE data achieved by careful QA/QC. Findings included the effects of using hourly NWS multi-sensor rainfall, which tended to smooth and reduce the more intense storm depths, contain artifacts associated with improper or no QA/QC of rain gauge data included in MPE production by the NWS.

Project 5 - Radar Rainfall Event Analysis, Flood Protection Plan
City of San Marcos TX

Contact: Brian Reis, RPS Group (Formerly Espey)
(512) 326-5659 Email: brian.reis@rpsgroup.com
Project Cost: $15,000
Dates: 2007
Role: Vieux, Inc. (Subcontract)

Vieux Inc. provided radar rainfall analysis in support of the city-wide flood protection plan completed in 2007 for the City of San Marcos TX. Processing of the October 16-20, 1998, event provided detailed rainfall data for hydrologic model development/validation for flood-prone areas in the City. Rainfall processing using state-of-the-art radar and rain gauge data was performed for a one of the most massive flood-producing events in Texas. The storm event was one of the largest on record and provided input for simulated-observed flow comparisons at selected locations where high water marks existed. Gauge-adjusted radar rainfall data was aggregated for watersheds divided into Blanco, Sink, Purgatory, San Marcos, Cottonwood and Willow watersheds, and the Guadalupe River upstream of Gonzales. This event was processed using US National Weather Service (NWS) radar data from KRGK located near New Braunfels, TX. Hourly rain gauge data from 23 NWS cooperative observer stations were reviewed and used to quality control radar bias. Rainfall timeseries in 5 and 15-minute intervals were generated at 1x1-km resolution for hydrologic model analysis of flooding during this event.

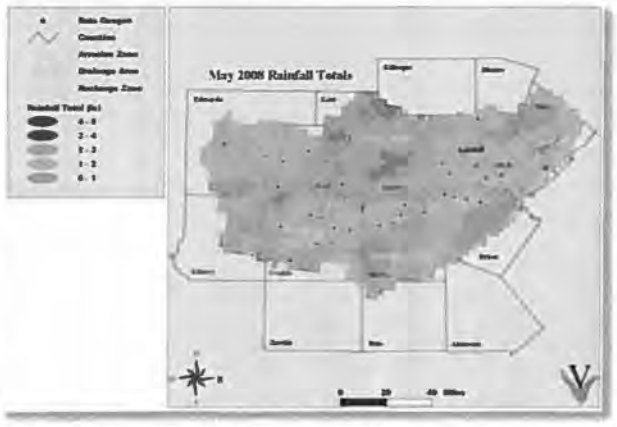


Project 6 - NEXRAD Monthly adjusted radar rainfall and rainfall post-analysis data processing

Contact: Jim Winterle, P.G., Director, Data Management and Modeling
Edwards Aquifer Authority
900 E Quincy Street
San Antonio, TX 78215
(210) 547-2214 Email: jwinterle@edwardsaquifer.org
Project Cost: $35,700 (2015)
Dates: 2007-Present
Role: Vieux, Inc. (Subcontract)

Services assist with estimating rainfall available for recharge to the Edwards Aquifer Authority. Monthly processing of NWS radar rainfall is performed for the aquifer areas using rain gauge data supplied by the EAA. Quality controlled radar and rain gauge data is assembled to cover the jurisdictional boundaries of EAA that includes all or parts of Uvalde, Medina, Atascosa, Bexar, Comal, Guadalupe, Hays, and Caldwell counties. Rain Gauge Network Analysis was performed to identify spatial distribution needs for the network when used alone or in conjunction with radar. Network density requirements, relocation, additions, and removal of rain gauges were considered and recommendations made for improving the gauge network.

Precipitation Enhancement Program Review and Evaluation



In a study performed by Vieux Inc., the spatial and temporal distribution of rainfall after cloud seeding was used to test effectiveness. Correlations between pumpage from the San Antonio Water System and rainfall were developed using archival radar. This information helped evaluate the effectiveness of EAA's Precipitation Enhancement Program.

Project 7 - Radar Rainfall and Flash Flood Forecasting Boulder/Fourmile Creek

Contact: Kevin G. Stewart, P.E. Manager, Information Services and Flood Warning Program, Urban Drainage and Flood Control District, Denver, Colorado
Phone: 303-455-6277 Email: kstewart@udfcd.org
Owner: Urban Drainage and Flood Control District (UDFCD)
Project Cost: $15,000 (6 months in 2014)
Dates: 2011-Present
Role: Vieux, Inc. (Prime)

Vieux supports UDFCD with real-time radar rainfall services and distributed hydrologic forecasting services for the Boulder/Fourmile Creek are in Colorado. Vieux developed *Vflo*® model datasets for setup and calibration in preparation for real-time. Storm event data processing and analysis of archival radar and rain gauge data included five storms that produced significant flows in Boulder/Fourmile Creek.

The distributed approach to hydrologic modeling represented by *Vflo*® relies on the physics of overland and channel flow hydraulics together with soil moisture and infiltration modeling for tracking continuous runoff and streamflow from natural areas and those modified by the burn. The integrated approach supports evaluation of flash flood potential and protective measures in burn areas, and for hydrologic forecasting.

This project was composed of three phases, and continues in the third phase with real-time flash flood forecasting services. In Phase I, an initial model of Fourmile Creek was setup and evaluated for the effects of the wildfire burn area. In Phase II, the model was expanded to include areas draining to locations in the City of Boulder, and prepared for real-time operational flood forecasting. In the third phase, the model was

put into operation with near-real-time precipitation and short term quantitative precipitation forecasting. UDFCD was provided Desktop *Vflo*® and supporting datasets for evaluation of the model. To simulate drainage from Fourmile Creek and the burn area, the soil properties were modified to represent infiltration rates due to surface sealing, and adjustment of hydraulic roughness in the burn areas characteristic of vegetation removal. Storm Builder was used to test dynamic storms to observe the variation of hydrologic response depending on storm movement over the Fourmile Burn Area. Testing also allowed the District to propose for use by the NWS, storm thresholds for issuance of flood threat advisories. Response to a 1 inch per hour storm was based on the locally-derived CUHP hyetograph, to provide flash flood.

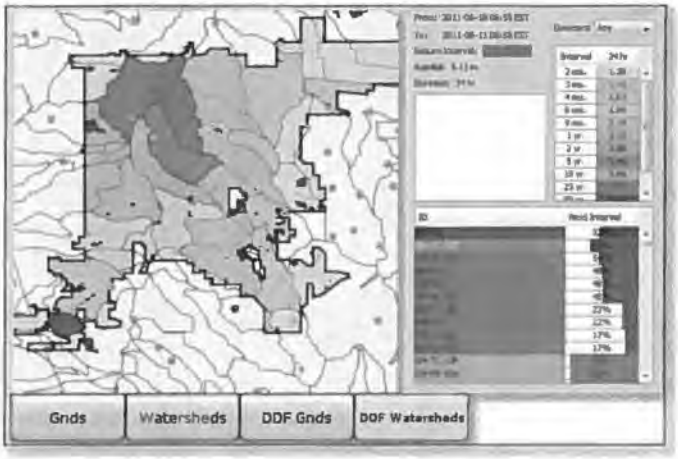
Preparation for real-time flood forecasting, enhancements included addition of hydraulic cross-sections in Fourmile Creek, Fourmile Canyon Creek, and North and Middle Boulder Creek. Cross-sections interpreted from aerial photography were used to develop a geomorphic relationship between drainage area and channel width. Rating curves developed by the USGS for stream gauge locations were updated since the September Flood of 2013. Model evaluation was performed for this significant flood event that is estimated to exceed 1000-yr return frequency. Adjustments made where necessary to agree better with peak discharge estimated from high-water marks at ungauged locations.

During operation of the system for real-time flash flood forecasting services, the model is placed into operation with continuous radar rainfall data input (QPE and QPF), and web-service support and access provided as follows:

1. Operation of a website for 6 months per year
2. Rainfall (QPE) RainVieux Service
3. Forecast (QPF) PreVieux Service
4. *Vflo*® Real-time Service

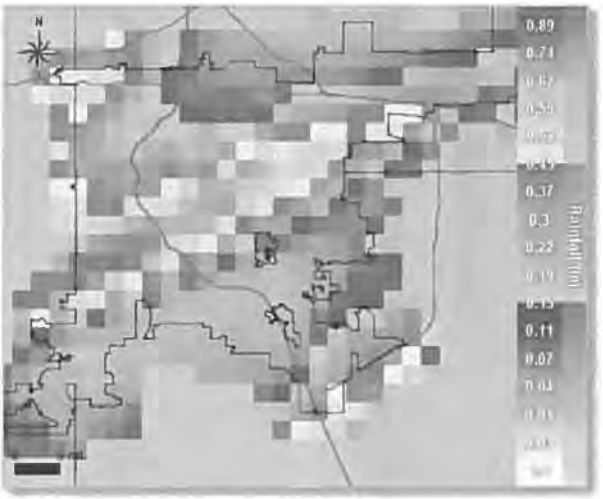
Project 8 - Real-time Rainfall Information Services

Contact: Saeed Farahmandi, P.E., Director, Denver Stormwatch" (Rain Men)
(303) 446-3607 Email: saeed.Farahmandi@denvergov.org
Owner: Department of Public Works, Wastewater Management Division, City and County of Denver, Colorado
Project Cost: $8,000 (6 months in 2014)
Dates: 2013-Present
Role: Vieux (Prime)



This radar-based rainfall information tool supports emergency response to help protect the public from flooding at locations distributed throughout the area of responsibility of Denver Wastewater. Summer-time convective storms can develop quickly producing heavy precipitation, though often of short duration. Initiated in 2013, the web-service provides Denver Wastewater with real-time notifications when rainfall was projected to exceed specified thresholds, and to archive rainfall for hydrologic information review and planning studies. Rainfall information is needed by the City and County of Denver, Colorado, Department of Public Works, Wastewater Management Division (Denver Wastewater) for problem areas that experience flooding during intense rainfall.

The domain covers approximately 600 sq. mi. GARR data from three NEXRAD radars are mosaicked over the UDFCD district boundaries and then subset over Denver. The information services rely on radar and rain gauge input to produce maps of rainfall intensity called gauge-adjusted radar rainfall (GARR). Quantitative prediction forecasts (QPF) are also derived from GARR, providing predictive rainfall lead-time. PreVieux provides these projections out to at least one hour, and can be set to 30-45 min given fast developing storms in the region. Thresholds are set for depth and duration, and notifications triggered when either *current* or *forecast* rainfall crosses these thresholds for each location.



NWS radars and ALERT gauges operated by UDFCD will be used to extend beyond the targeted domain to provide notification about advancing storms. UDFCD provides rain gauge information for accuracy enhancement at 1-minute intervals. To limit the number of notification messages, they are aggregated to reporting areas defined by Denver Wastewater. Notification messages format consist of "720 Confluence Pond Precipitation-AR 1.02 inches in 1hour alarm at 09/14/2013 15:52:50." Flood-prone area locations along with dams that pose a hazard are targeted in the alert notifications based on average depth of rainfall.

E. Personnel Experience

We have outstanding staff, with the highest skill and reputation to serve FEWS. Our cadre of professionals are highly trained, and well experienced with the Austin/FEWS data, modeling needs, radars and gauges, and with their watersheds. All but one recent hire have worked together on the FEWS projects for the past 10 years. Collaboration is exercised in each group to make seamless, high-level service possible. The table shown below presents the solid history of corporate experience and collaboration on our projects.

The following personnel were members of the project team for each of the Projects listed above. Bryan Byrne is the new higher that is working on design (and re-design) of the current City of Austin web page design for hydrographs arranged by basin among other user interface re-development.

Personnel	Project Profile Key							
	1	2	3	4	5	6	7	8
Jean Vieux, Project Manager	X	X	X	X	X	X	X	X
Baxter Vieux, Principal Engineer	X	X	X	X	X	X	X	X
Edward Koehler, Senior Hydrometeorologist	X	X	X	X	X	X	X	X
Ryan Hoes, Systems Analyst	X	X	X	X	X	X	X	X
Adam Barnett, Software/IT	X	X	X	X	X	X	X	X
Jennifer French, Hydrometeorologist	X	X	X	X	X	X	X	X
Brian McKee, Software/IT	X	X	X	X	X	X	X	X
David Buckey, Hydrometeorologist	X	X	X	X	X	X	X	X
Brian Byrne, Web Developer, UI/UX	X							

F. Project Personnel and Corporate Experience

All ten employees have direct experience with City of Austin FEWS over the last ten years since 2004. The following personnel have experience with the listed projects as shown here, and in the project team resumes that follow.

1. Team Resumes

Software and client project experience is listed for each member, and cross-referenced to the Project Summaries listed above.

NAME	Jean E. Vieux
TITLE	President/CEO
PROJECT ASSIGNMENT	Project Manager
EDUCATION	MS Environmental Science, University of Oklahoma, 1995 Specialization in Environmental GIS Applications
TRAINING	*2000 ArcIMS,* ESRI, San Antonio, TX *1999 Fundamentals-Advanced Visual Basic 6.0 Programming Concepts,* St. Louis, Missouri, *Programming* *1999 MapObjects with VB,*ESRI Oklahoma City, OK *1999 Introduction to Land Records*, ESRI, Ft. Worth, Texas

1998 Visual Basic/InternetMap Server,ESRI, OKC, OK
1998 Avenue Programming, ESRI (SCAUG), Norman, OK

YEARS WITH FIRM 23

Ms. Vieux is co-founder of Vieux & Associates and President/CEO where she serves as project manager for radar rainfall and hydrologic prediction system services. She has led projects involving radar, hydrologic modeling, and GIS for more than 20 years. She oversees radar rainfall and hydrologic prediction system services maintaining client relations, project management, and communications.

Employment History

President and Co-Founder of Vieux, Inc., 1992-present

Activities

American Society of Civil Engineers Affiliate, 2005-2010; American Meteorological Society; Water Environment Federation, Collection Systems Committee- 2005-2008, Manual of Practice No. 6 (2005-2007), NEXRAD rainfall monitoring practice

Listed projects: Project 1 - City of Austin Radar Rainfall and Hydrologic Services, Project 2 - Ameren Missouri - Reservoir Inflow Tool, Project 3 - Harris County Flood Control District, Radar Rainfall Monitoring, Project 4 - Ft. Worth Flood Warning System Study, Project 5 - Radar Rainfall Event Analysis, Flood Protection Plan City of San Marcos TX, Project 6 - NEXRAD Monthly adjusted radar rainfall and rainfall post-analysis data processing, Project 7 - Radar Rainfall and Flash Flood Forecasting Boulder/Fourmile Creek, Project 8 - Real-time Rainfall Information Services.

Relevant Project Experience

Metropolitan Sewer District of Greater Cincinnati. Radar Rainfall Services and Storm Builder. During the Design Storm Study and Storm Builder Interface development, Ms. Vieux exercised project management of a multidisciplinary team, handled client interactions, and assisted in training provided to MSDGC staff and consulting engineers in the use of RainVieux and Storm Builder dashboard applications. She manages client relations and internal staffing for *ongoing* radar rainfall services. Spatial and temporal data characteristics for hydraulic modeling and reporting requirements, with 5-minute and 1x1-km resolution data delivered in near real-time. Monthly delivery of reports and data correction/review is provided to the client to support planning and design of the separate and combined sanitary sewer system.

Trinity River Authority, CAC-11 Flood Forecasting System. Ms. Vieux was responsible for developing this project with the Trinity River Authority and the RPS Group engaged in construction management. Demanding requirements for the forecasting system involved predictions of flood levels adjacent to construction along the tributaries of the Trinity River in North Texas. The award-winning project received distinction from the National Hydrologic Warning Council in 2013. Diverse components included reservoir releases and riverine flood stage response with inputs from gauge-adjusted radar rainfall and probabilistic rainfall inputs.

City of Austin, Texas, Flood Early Warning System - Radar Rainfall and Hydrologic Services. Ms. Vieux manages radar rainfall and hydrologic services for the City of Austin, Flood Early Warning System. Close coordination with the City guides feature

development and ongoing services. Radar rainfall at 1x1-km and in 15-minute increments is generated. The system has been hardened by adding an additional NEXRAD dual-polarization rainfall product that is independent of rain gauges. Web-services are provided for display, query, aggregation, analysis and download of the data is available. Hydrologic services include the operation of multiple-resolution hydrologic models setup and run continuously for automated flood information. The models are run in parallel with two rainfall-inputs, providing an ensemble stage and discharge forecasts. Interaction with USGS and other sensor sources supports operational boundary conditions in Onion Creek, thus providing automated failover. The automated monitoring and alerts are provided 24/7 and 365 days/year.

Publications

Vieux, B.E. and J.E. Vieux, 2005a. Rainfall Accuracy Considerations Using Radar and Rain Gauge Networks for Rainfall-Runoff Monitoring. Chapter 17 in *Effective Modeling of Urban Water Systems*, Monograph 13. Eds., W. James, K. N. Irvine, E. A. McBean & R.E. Pitt. ISBN 0-9736716-0-2.

Vieux, B.E. and J.E. Vieux, 2005b. Statistical evaluation of a radar rainfall system for sewer system management. *J. of Atmospheric Research*, 77, pp. 322– 336.

Vieux, B.E., and J.E. Vieux, 2010. Real-time Stormwater Modeling. 2010 AWRA Annual Conference, Philadelphia, November 1-4, 2010.

NAME	**Baxter E. Vieux, PhD, Texas PE**
TITLE	Principal Engineer
PROJECT ASSIGNMENT	Senior Engineer and System Design
EDUCATION	Ph.D. Michigan State University, 1988 MSCE, Kansas State University, 1982 BSCE Water Resources, University of Kansas, 1978
REGISTRATION	Professional Engineer: OK, OH, KS, TX, NCEES 2009
YEARS WITH FIRM	23

Baxter E. Vieux's professional focus is radar rainfall and distributed hydrologic modeling. He is distinguished in operational forecasting of precipitation and runoff. As Principal Engineer, he provides conceptual design and oversees technology development for rainfall and runoff monitoring software and services. He has over 100 publications appearing as textbooks, journal articles, and conference proceedings. Dr. Vieux developed the first commercially available distributed hydrologic model, *Vflo®*, US Patent No. 7,136,756-Method for determining runoff.

Listed projects: Project 1 - City of Austin Radar Rainfall and Hydrologic Services, Project 2 - Ameren Missouri - Reservoir Inflow Tool, Project 3 - Harris County Flood Control District, Radar Rainfall Monitoring, Project 4 - Ft. Worth Flood Warning System Study, Project 5 - Radar Rainfall Event Analysis, Flood Protection Plan City of San Marcos TX, Project 6 - NEXRAD Monthly adjusted radar rainfall and rainfall post-analysis data processing, Project 7 - Radar Rainfall and Flash Flood Forecasting Boulder/Fourmile Creek, Project 8 - Real-time Rainfall Information Services.

Relevant Project Experience

Ameren Reservoir Inflow System Lake of the Ozarks. As senior engineer provided project conceptualization and oversight in the development of interface functionality for

reservoir inflow forecasting. Supervised deployment of the real-time system including hydraulic modeling of riverine and lake components, distributed hydrologic model setup and calibration/validation, system configuration for reservoir operations and notifications and alerts, and project management. Reservoir forecasting is based on releases from the USACE Harry S. Truman Dam and Lake of the Ozarks/Bagnell Dam, and uncontrolled inflow hydrographs predicted using distributed hydrologic modeling that relies on inputs from Gauge-Adjusted Radar Rainfall and NWS QPF out to 7 days, along with stream gauge boundary conditions.

Trinity River Authority, CAC-11 Flood Forecasting System. As senior engineer responsible for the interface components and configuration to meet client requirements during construction along the tributaries of the Trinity River in North Texas. Components include forecasting effects of reservoir releases on riverine flood stage response with inputs from gauge-adjusted radar rainfall and probabilistic inputs based on the NWS 7-day QPF.

Employment History

Principal Engineer, Vieux, Inc., 1992-Present. Established system requirements for GARR processing, stormwater modeling, and oversees technical operations for clients, 1992-present

Professor Emeritus, University of Oklahoma, 2013-present

Full Professor, University of Oklahoma, 2000-present; Associate Professor, 1995-2000; Assistant Professor, 1990-1995

Visiting Assistant Professor, Michigan State University, 1988-1990

Assistant State Conservation Engineer, USDA-NRCS, Michigan, 1985-1988

State Conservation Engineer (acting), USDA-NRCS, Michigan, 1984-1985

Project Engineer, USDA-NRCS and PL-566 Watershed Project, Kansas, 1978-1984

Selected Publications

Rendon, S., B.E. Vieux, C.S. Pathak, 2010. Estimation of regionally specific Z-R relationships for radar-based hydrologic prediction. American Society of Civil Engineers/Environmental and Water Resources Institute, World Water & Environmental Congress 2010, May 16-20, Providence, Rhode Island, USA.

Vieux, B.E., J.M. Imgarten, 2012. On the scale-dependent propagation of hydrologic uncertainty Using High-Resolution X-Band Radar Rainfall Estimates. Journal of Atmospheric Research. Volume 103, pp. 96-105.

Bedient, P.B., W.C. Huber, B.E. Vieux, 2012. *Hydrology and Floodplain Analysis*. Fifth Edition, Prentice-Hall, Inc., One Lake St., Upper Saddle River, NJ 07458. ISBN 0-13-256796-2. p. 801.

2. UI/UX Development and Software/IT

NAME	Brian Byrne
TITLE	UI Designer & Developer
PROJECT ASSIGNMENT	Design and develop web interfaces for the display of scientific data, including graphs, maps (Leaflet/MapBox) and tabular data. Update existing interfaces for improved data flow, usability, and cosmetics on modern/mobile browsers. Interface with and improve data APIs.

EDUCATION	Oklahoma City Community College (OCCC) - Computer Sided Design: Multimedia Emphasis
EXPERIENCE	UI Developer Devon Energy 2014 – 2015 Lead Designer Ground State Studios 2002 – 2014 Website Design & Broadcast Motion Graphics UI/UX Designer & Motion Graphics Works 24 2010 – 2014 After Effects, Photoshop, Illustrator, CSS3, HTML5, Javascript Motion Designer PDC Productions 2005 – 2010 After Effects, Photoshop, Lightwave, & Illustrator Freelance Contract Designer Directing Design 2004 –2010 Website Design and HTML/CSS: Photoshop, Illustrator & Dreamweaver Flash Animation & Web Designer Incite Advertising 2005 Designed websites, promotional materials & Flash animations for corporate clients.
YEARS WITH FIRM	1 month
Listed projects:	Project 1 - City of Austin Radar Rainfall and Hydrologic Services

NAME	**Brian M. Mckee**
TITLE	Software/IT Java Developer
PROJECT ASSIGNMENT	Web development lead/Open Source Software
EDUCATION	B.S. Computer Science, Magna Cum Laude, University of Oklahoma, 2007; M.S. Computer Science, University of Oklahoma, 2008
YEARS WITH FIRM	9
NAME	**Ryan Hoes**
TITLE	Systems Analyst/Software Developer
PROJECT ASSIGNMENT	Development/Integration
EDUCATION	B.S. Computer Engineering, University of Oklahoma, 2002. Special Distinction. MBA expected May 2012
YEARS WITH FIRM	14
NAME	**Adam Barnett**
TITLE	Software/IT Java Developer

PROJECT ASSIGNMENT	IT Operations and Database Management
EDUCATION	B.S. Computer Science, University of Oklahoma, 2004
YEARS WITH FIRM	11

3. Hydrometeorology

NAME	**Edward Koehler**
TITLE	Senior Hydro-Meteorologist
PROJECT ASSIGNMENT	System Setup, Team Management, QA/QC
EDUCATION	M.S. Meteorology, University of Oklahoma, 2005 B.S. Meteorology, Pennsylvania State University, 2002
YEARS WITH FIRM	14
NAME	**David Buckey**
TITLE	Hydro-Meteorologist
PROJECT ASSIGNMENT	**Support Personnel** - Operational Radar Rainfall QA/QC
EDUCATION	M.S. Meteorology, University of Oklahoma, 2009 B.S. Florida State University, 2007, magna cum laude
YEARS WITH FIRM	5
NAME	**Jennifer French**
TITLE	Hydro-Meteorologist
PROJECT ASSIGNMENT	**Project** - Operational Radar Rainfall QA/QC
EDUCATION	M.S. Meteorology, University of Oklahoma, 2005 B.S. Meteorology, Pennsylvania State University, 2002
YEARS WITH FIRM	8

4. Hydrology and Hydraulics

NAME	**Jonathan P. Looper**
TITLE	Hydrologist/Hydraulics Engineer
PROJECT ASSIGNMENT	Hydrologist/Hydraulics Engineer
EDUCATION	Ph.D. University of Oklahoma, 2013 MSCE, University of Oklahoma, 2012 BSCE, University of Oklahoma, 1999
REGISTRATION	Professional Engineer: OK, OH, NCEES 2009 Certified Floodplain Manager (CFM) - OK
YEARS WITH FIRM	9
LISTED PROJECTS:	Project 1 - City of Austin Radar Rainfall and Hydrologic Services, Project 2 - Ameren Missouri - Reservoir Inflow Tool, Project 3 - Harris County Flood Control District, Radar Rainfall Monitoring, Project 4 - Ft. Worth Flood Warning System Study, Project 5 - Radar Rainfall Event Analysis, Flood Protection Plan City of San Marcos TX, Project 6 - NEXRAD Monthly adjusted radar rainfall and rainfall post-analysis data processing, Project 7 - Radar Rainfall and Flash Flood Forecasting Boulder/Fourmile Creek, Project 8 - Real-time Rainfall Information Services.

Tab 7 - Lead Negotiator

Lead Negotiator

Jean E. Vieux
350 David L. Boren Blvd., Suite 2500
Norman, OK 73072
jean.vieux@vieuxinc.com
405 325-1818

Tab 8 - Cost Schedule/Submission

This offer is valid for 150 days from closing date, March 26, 2015.

A. Services

1. Cost for software license maintenance
Maintenance for 2 existing *Vflo*® Desktop licenses
Maintenance for existing *Vflo*® Extensions:
Sensitivity Desktop
Continuous Desktop
Inundation Desktop
2. Cost and description of software hosting using rainfall from the following sources
2.1 Website Hosting and Display
RainVieux data display pages showing rainfall (3 month minimum online)
RainVieux system monitoring page for radar and rain gauge inputs received
Austin Gauge Status page
Watch Points Table with hydrograph thumbnail images and data
PreVieux rainfall display page (gridded, basin-averaged, accumulation)
GARR Calibration Statistics Page
Dashboard sign-on with password protection feature
Display Control Features
Tab Gridded GARR Rainfall, Basins, Subbasins, HHD, DDF Threat, Runoff
Tab DPR NWS Radar
Control GIS Layers toggle on/off
Control Current 24-hr radar input history tracking
Control Pan and Zoom
Control ID Search/Locate/Activate
Inundation at 599 Points of Interest (POI) mapping display, and archiving, and retrieval
Dropdown - Data download
Dropdown- Percent to Next Threshold
Dropdown - Depth Duration Frequency
Soil moisture display page with basin mouse-over averages
Data display pages showing hydrograph stage (3 month minimum)
KISTERS annual data archive for 4883 grids
2.2 Radar Rainfall Services
NEXRAD Radars primary, secondary (KEWX/KGRK) L2/L3 Reflectivity
Rain gauge-only coverage interpolated from City of Austin and adjacent Networks
Automated Failover from primary/secondary or mosaic of radars to rain gauge
Dual Polarization Product - Digital Precipitation Rate (DPR)
GARR/DPR data processing requirements -

Gridded data resolution at 1x1 km, with 15 min intervals
Gridded data production
Basin/subbasins boundary aggregation data production
High Hazard Dam location sampling
Streets and street names displayed as scalable vector data
Mouseover display of rainfall and stage
Time Aggregations
Data access for gridded rainfall at 1, 3, 6 hour and query
Data access for basin-averaged rainfall at 1, 3, 6 hour and query periods
Rainfall animation for 1, 3, 6 hour and query periods
2.3 Runoff Monitoring and Simulation Services
Basin/subbasins model simulation
Walnut Ck
Little Walnut Ck
North Boggy Ck
Tannihill Br Boggy Ck
Fort Br Boggy Ck
Boggy Ck
Bull Ck
Lake Cr
Waller Ck
Shoal Ck
Onion Ck
L. Bear Ck
Bear Ck
Bear Ck below FM 1826
Slaughter Ck
Williamson Ck
Kincheon Br Williamson Ck
Wiliamson Ck at Oak Hill
W Bouldin Ck
Carson Ck
Blunn Ck
East Bouldin Ck
Soil moisture continuous modeling
Basin aggregation of gridded degee of saturation with daily re-distribution
Model hydrograph generation inputs
GARR Hydrograph Simulation
DPR Hydrograph Simulation
QPF GARR+PreVieux+HRRR Hydrograph Simulation
2.4 Forecast Rainfall Services
Forecast rainfall services data acquisition, processing, modeling, and posting for web

display.
PreVieux production processing, and basin accumulations
NDFD digital forecast database
HRRR data feeds and missing data backfill
3. Cost for map preparation and hosting
3.1 Open Format Data-streams for COP
Damage Assessment Maximum Flood Inundation and Structure Summary in COP Open Format
Model state for COP/What-if
Mapping inundation stage results in COP open format
GARR display in COP open format
Hydrograph display - USGS and *Vflo*® in COP open format
3.2 Basin average rainfall as CSV for SCADA EVENTS/ALARMING SOFTWARE
3.3 LWC *Vflo*® stage prediction as CSV for SCADA EVENTS/ALARMING SOFTWARE
3.4 Automated 15 min rainfall data export to WISKI database
4. Cost for data archiving (model output results)
4.1 GARR Data (*Vflo*® and CSV format)
4.2 HRRR Data
4.3 *Vflo*® Model database and output file production
Db storage/retrieval (usgsbasin_vflorain.txt, Vflo_Status, Vflo_rain, Vflo_LWC.txt)
4.4 Rain gauge network data ingest
City of Austin
Upper Brushy Creek WCID
LCRA
NWS
USGS
4.5 Database processing and check for thresholds, DDF, Inundation, and Action levels
Basin Thresholds with DDF and Actions
High Hazard Dam thresholds
Inundation action and display
4.6 System maintenance and apply updates for new or modified rain gauge, high hazard dam, or basin
Automated notification for CoA rain gauge network outages
Database management review and update and optimization
4.7 Map inundation results archive database and output file production
5. Training
5.1 FFMMS and *Vflo*® on-site training
Training Session, 2 trainers, 2 days @ $5000 (travel costs included)
6. One-time Setup and Analysis
Damage Assessment: Development, implementation, evaluation
Configuration and setup for COP data streams, estimated
Coordination with COP provider, negotiated
Inundation map development, implementation, and evaluation

B. Cost Summary

The fixed price contract amount is presented below for the items required in the Statement of Objectives and summarized according to the first year, initial one-time costs, 24-month total, and additional 12-month extensions (3) that contain a 10% cost adjustment more than the initial 24-month period. Justification for the recurring costs are based on an estimate of four software/IT personnel of 29 hrs/person per month, and a team hourly rate including fringe overhead and administrative costs at $150/hr, or $207,899 (average over five years not including one-time setup).

Itemized Costs

SERVICES	One-time	Recurring Annual
1) Cost for software licensing		$4,644
2) Cost and description of software hosting using rainfall from the following sources: a) gauge-adjusted radar rainfall, b) NWS forecast rainfall, d) runoff modeling software hosting		$128,500
3) Cost for map preparation and hosting		$40,750
4) Cost for data archiving (model output results)		$17,500
5) Cost for training		$5,000
6) One-time setup and analysis		
Damage Assessment: Development, implementation, evaluation	$25,000	
Configuration and setup for COP data streams, estimated	$25,000	
Coordination with COP provider, negotiated	TBD	
Inundation map development, implementation, and evaluation	$25,000	
Total	**$75,000**	**$196,394**

Summary Costs

Item			Annual
	One Time	24 Month Total	12 Month Extension
FFMMS Services =	**$75,000**	**$467,788**	**$215,569**

Tab 9 - Section 0605 Local Business Presence Identification

There are no local businesses included in this bid.

Rev. 2/25/16 dlb

Revisions to SMW0127 Mapping/Modeling

		Initial Contract Term		Total for Initial Term	Year 3	Year 4	Year 5	TOTAL NTE	NOTES
	Description	**Year 1**	**Year 2**						
1	Vflo Model Licens	$ 7,995.00	$ 3,597.00	$ 11,592.00	$ 3,597.00	$ 3,597.00	$ 3,597.00	$ 22,383.00	
7	Real-time continuous simulations	$ 73,388.00	$ 68,388.00	$ 141,776.00	$ 68,388.00	$ 68,388.00	$ 68,388.00	$ 346,940.00	
8	Setup: mapping forecast model outpus & post-processed products	$ 12,500.00	$ 12,500.00	$ 25,000.00	$ -	$ -	$ -	$ 25,000.00	
9	Map Display & Hosting	$ 45,750.00	$ 40,750.00	$ 86,500.00	$ 40,750.00	$ 40,750.00	$ 40,750.00	$ 208,750.00	Vieux Data Services are fixed for FFMMS
10	Data Archiving & User Retrieval	$ 17,500.00	$ 17,500.00	$ 35,000.00	$ 17,500.00	$ 17,500.00	$ 17,500.00	$ 87,500.00	
11	Mapping & Model Results Prep in Open	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$25K eliminated as VAI has both contracts
12	Maps of Output Forecast Maps	$ 12,000.00	$ 12,000.00	$ 24,000.00	$ 12,000.00	$ 12,000.00	$ 12,000.00	$ 60,000.00	
13	Training Costs	$ 6,500.00	$ 6,500.00	$ 13,000.00	$ 6,500.00	$ 6,500.00	$ 6,500.00	$ 32,500.00	
	Radar Rainfall (begins when current MA #NS10*33 expires)	$ -	$ -	$ -	$ 98,386.00	$ 98,386.00	$ 98,386.00	$ 295,158.00	for Radar Rainfall Services
Total Contract Costs		**$ 175,633.00**	**$ 161,235.00**	**$ 336,868.00**	**$ 247,121.00**	**$ 247,121.00**	**$ 247,121.00**	**$ 1,078,231.00**	

City of Austin

Purchasing Office, Financial Services Department
P.O. Box 1088, Austin, TX 78767

October 23, 2015

Vieux & Associates, Inc.
Jean E. Vieux
President
350 David I. Boren Blvd, Suite 2500
Norman, OK 73072

Subject: Best and Final Offer of RFP SMW0127, Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software

Dear Ms. Vieux:

Thank you for your response to the Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software solicitation for the City of Austin. The City has identified Vieux & Associates, Inc. as a finalist and is requesting a Best and Final Offer (BAFO) from your company in regards to your submittal.

The BAFO pricing document is attached and must be completed on the form provided. Except for the Additional Offerings section, pricing for all line items listed on the BAFO must be included. The cost for acquisition of radar rainfall, gauge data, and NWS forecast products is currently part of your existing contract. Do not include these prices within this proposal. Please read the notes of the instructions. For instance, if the Hydrologic Model and Hydraulic Model are the same, then the City should only be charged for one model. Further, if the model already includes the ability to run in a continuous simulation mode or if the model is already setup to ingest rainfall from a variety of sources, then that cost is already built into the model and there should not be a need to include any additional costs.

Once a vendor is selected, prior to the Go Live date, the model forecast component of your current contract will be eliminated (and either moved into this proposed contract) or placed with another vendor's contract.

Please note that the City wants to have an externally hosted solution. There will not be any reliance on internal GIS servers or on COA data servers (such as WISKI).

All information is due back to me by 3:00 PM, local time, on Friday, October 30, 2015.

Thank you for your participation in this competitive solicitation. We appreciate your interest in doing business with the City of Austin.

Sincerely,

Georgia Billela
Buyer II
City of Austin
Purchasing Office

BEST AND FINAL OFFER, RFP # SMW0127, MAPPING & MODELING SOFTWARE -(Revised)

The City will provide the Gauge Adjusted Radar Rainfall. The Contractor shall indicate the method and format of delivery. The City will also provide the Contractor with access to 5 minute ELOS data from USGS. The City will provide address to LDM for LCRA, Base Reflectivity Upper Brushy Creek WCID, and City (when available). Costs for any further adjustment for National Weather Service or other precipitation is not considered in this evaluation. Contractor shall identify any additional information needs with this Best and Final Offer form.

	Description RFP Reference 4.2, 4.5, 4.6, and 4.8	Name of Model	Cost per Seat	No. of Seats	Total Cost for Acquisition	Annual Software Upgrade & Maint. Costs	Total cost for years 2-5	Total Cost, acquisition and maintenance
1.	Hydrologic Modeling Software License for City Desktop Development	Vflo - 1 new license at $7995 for increase	$2,665.00	3	$7,995.00	$3,597.00	$14,388.00	$22,383.00

NOTE: Hydrologic Models for as many City desired watersheds shall be included in the software cost for the model (watershed model development is provided by the City). This cost shall include 3 licenses for the desktop model. The desktop hydrologic model shall be able to receive variable rainfall (temporal and spatial) for analysis (4.2 and 4.8), be Calibrated Radar Rainfall and Base Reflectivity from DPR to the USGS stations (4.5), and account for ambient soil moisture conditions and evapotranspiration rates for the Austin, Texas area (4.6). The City desires the desktop model to run in a MS Windows environment.

	Description RFP Reference 4.1 and 4.2	Name of Model	Cost
2.	Cost for model modification (if needed) for use with 1) spatial and temporal rainfall from separate rainfall radar vendor, 2) National Weather Service Doppler radar (indicate with Base Reflectivity or rainfall derived products), and 3) National Weather Service High Resolution Rapid Refresh Model. Note if any other spatial or temporal forecast rainfall products can be utilized. If the cost of the model already includes these features, then the cost is $0. Hosting solution shall produce ensemble forecasts using at a minimum, the three products listed above.	Vflo	$0.00

	Description RFP Reference 4.1 and 4.2	Name of Model	Cost per Seat	No. of Seats	Total Cost for Acquisition	Annual Software Upgrade & Maint. Costs	Total cost for years 2-5	Total Cost
3.	Hydraulic Modeling Software License for COA Desktop Development	Vflo contains hydraulic model	$0.00	3	$0.00	$0.00	$0.00	$0.00

NOTE: Hydraulic model parameters may be included within the same model suite as the Hydrologic Model. In that case, then the cost for this line item shall be $0. Assumes that first years acquisition cost includes maintenance.

	Description RFP Reference 4.8	Name of Model	Cost
4.	Cost for model modification (if needed) to receive outputs from hydrologic model for incorporation for forecast mapping in the hydraulic model. Please note that the information from the hydrologic model and incorporation of that data into the hydraulic model shall be seamless.	Vflo	$0.00

	Description	Total Cost of 1-Time Setup
5.	Pilot Project: if a pilot project is recommended for this solution, then that cost shall be itemized.	$0.00

	Description	Total Cost for 1-time Setup
6.	Initial H/H Model Setup and Continuous Simulation If the proposed desktop hydrologic/hydraulic models already contains capabilities for continuous simulation, then this cost is $0.	$0.00

	Description RFP Objective 4.1, 4.2 and 4.3	Location and Name of External Server	Initial Setup Cost	Annual Cost Server Hosting	Total Annual Costs Server Hosting (5 Years)	Total Cost Initial Cost + Hosting
7.	Real-time continuous simulation and external hosting solution costs: cost for remote model simulation and hosting (not located on COA Servers or included within COA current KISTERS/WISKI environment) for continuous simulation, taking into account changing soil moisture conditions, and utilizing real-time rainfall from the following sources: Contractor prepared gauge adjusted radar rainfall, National Weather Service rainfall (specify the type of product used).	Vieux Data Center (Cost for contractor-prepared GARR, and forecast rainfall PreVieux, NDFD, and HRRR at $98,386/yr) are not included). Server licensing costs for model hosting are included.	$5,000.00	$68,388.00	$341,940.00	$346,940.00

NOTE -- If additional model licensing is involved, then this line item cost needs to included in this location and a comment field shall be provided This cost should also include any licensing costs for hosting on an external server.

	Description RFP Reference 4.3 and 4.4	Name and description of mapping software	Total Setup Cost
8.	Setup for Mapping of Forecast Model Outputs and for Post-Processed Products: this cost shall include the meeting times necessary for putting together the NEEDS ASSESSMENT to the City for the structure information, finished floor elevations, elevations of Bridges, and some roads, TCAD overlays, and access to the STEAR database. It shall also include the setup of the mapping functionality to take the outputs from to the hydrologic and hydraulic models and produce the maps.	Vflo Inundator - Server Edition. Total Setup Cost for configuring the inundation mapping module, production of maps with input from Vflo, and related files defining City Structure information, finished floor elevations, bridges, selected roads, TCAD building foot print overlays and access to STEAR database. (Hosting and website mapping service is included in 10.)	$25,000.00

NOTE: Consideration needs to be taken that the COA may only have a few watersheds available for mapping. Procedures for cost adjustment should be included for the updating of the maps when necessary. Procedures should also be in place to edit the maps when necessary.

	Description RFP Reference 4.3 and 4.4	Initial Setup Cost for Server Hosting	Annual Costs for Server Hosting	Total Annual Costs Server Hosting (5 Years)	Total Cost Initial Cost + Hosting
9.	Map Display and Hosting: this cost shall include the setup of the remote hosting website and service for the maps.	$5,000.00	$40,750.00	$203,750.00	$208,750.00

NOTE: It is assumed that the cost for the setup of the hosting website and for the maps of the forecasts shall be available for those watersheds as indicated in Addendum No. 2 to this RFP.

	Description RFP Reference 5.5; Section 0600, H	Location & Name of External Server for Storage	Total Acquisition Cost for Initial term (24 months)	Cost for Each option year after initial term	Total Cost of the 3 Option years	Total Cost Initial Cost + Option years
10.	Data Archiving and User Retrieval of Model and Map Results from external hosted solution	Vieux Data Center	$35,000.00	$17,500.00	$52,500.00	$87,500.00

NOTE: Data archiving and user retrieval shall be through remote hosting as indicated above. Minimum time for storage of results is for one year. However, the City will consider longer storage, but costs shall include that description.

	Description RFP Reference 5.4	Total Initial Cost
11.	Mapping & Model Results Preparation in Open Format for use within City Proposed Common Operating Picture: Cost is a one time setup cost for making the outputs of the models and maps available in an open format for incorporation into the Common Operating Picture. This is for the sharing of both polygon and model raster data.	$25,000.00

	Description RFP Reference 4.3 and 4.4	Initial Term of the Contract	Cost for each option year after initial term	Total of the 3 Options years	Total Cost
12.	Maps of Output of Forecast Maps (depth & raster shape files): Cost shall be an annual hosting costs and presentation and placement of the data in a location that is utilized by the GUI.	$24,000.00	$12,000.00	$36,000.00	$60,000.00

NOTE: Cost of service of hosting shall be based on watersheds as indicated on Addendum No. 2 to this RFP.

	Description RFP Reference Section 0600 Section H	Total First Year Cost for Training	Cost for each option year after initial term	Total of the 3 Options years	Total Cost
13.	Training Costs -- Topics Include: Model Setup, CaliBase Reflectivityation, Data Incorporation, Model Setup for Continuous Real-Time Simulation and External Hosting.	$6,500.00	$6,500.00	$19,500.00	$26,000.00

	Total Contract Amount:	$801,573.00

TO: Veronica Lara, Director
Department of Small and Minority Business Resources

FROM: Shawn Willett, Corporate Contract Compliance Manager

DATE: January 6, 2015

SUBJECT: Request for Determination of Goals for Solicitation No. RFP SMW0127

Project Name:	Flood Forecasting Mapping and Modeling software for WPD Flood Warning System
Commodity Code(s):	20811
Estimated Value:	$400,000

Below are scopes of work for this project as determined by the Purchasing Office and Department that are contained in this solicitation.

No subcontracting opportunities have been identified for this project, this is a commodity purchase for a software system.

The Departmental Point of Contact is: Donna Lee Bliss at Phone: 512-974-2530

Per paragraph 8.2.1 of the Rules Governing the Minority and Women Owned Business Enterprise Procurement Program, please approve the use of the above goals by completing and returning the below endorsement. If you have questions, please call me at 512-974-2274.

____ **Approved w/ Goals** ✓ **Approved, w/out Goals**

Recommend the use of the following goals based on the below reasons:

a. Goals: _____% MBE _____% WBE

b. Subgoals _____% African American _____% Hispanic

_____% Native/Asian American _____% WBE

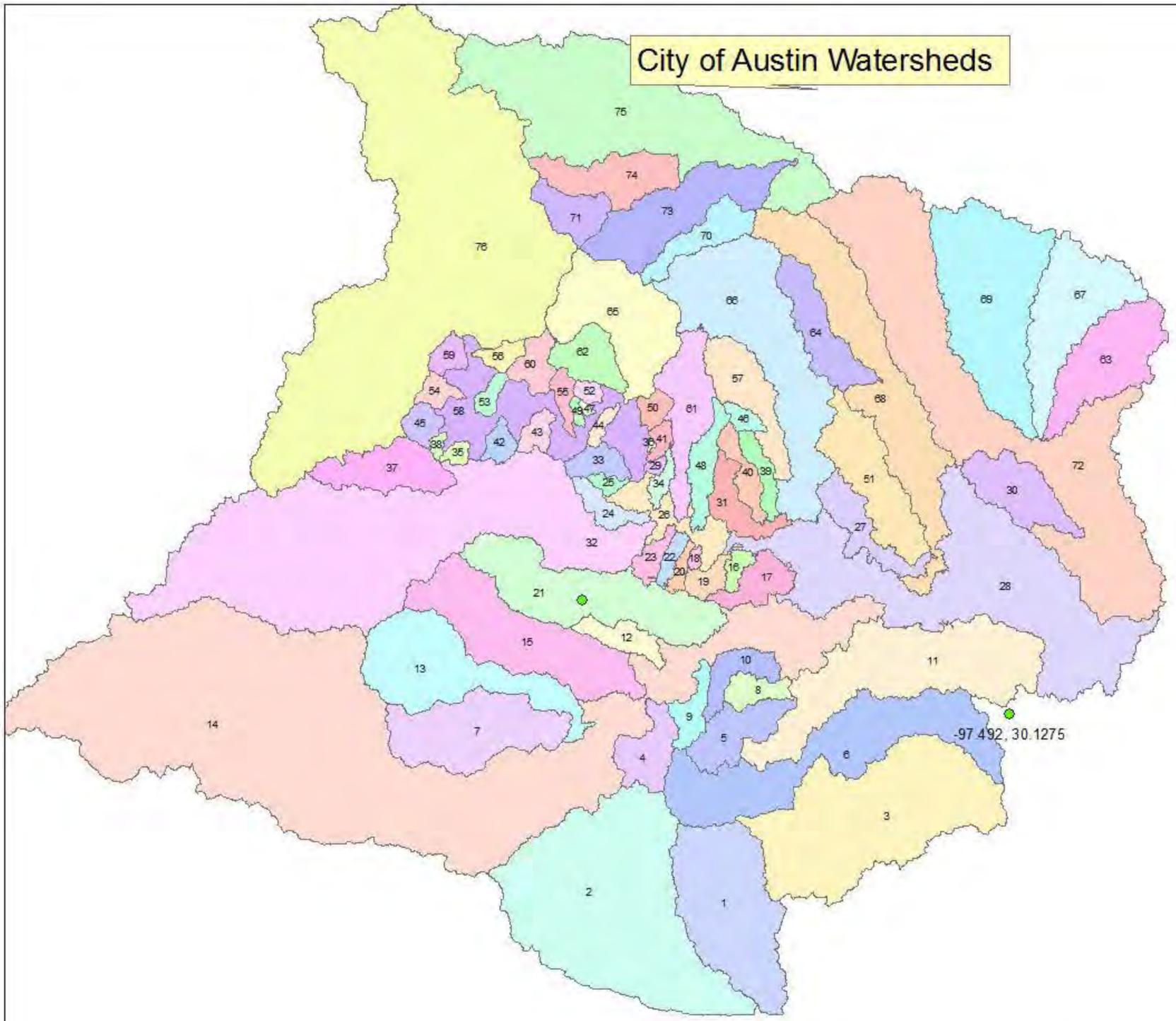
This determination is based on the following reasons:

This is a commodity purchase for WPD flood warning system. There are no subcontracting opportunities. However, there are 6 certified firms listed

Donna L Bliss Date: 1/6/2015

Veronica Lara, Director

City of Austin Watersheds



MapID	DCM_CODE	DCM_NAME
1	ELS	Elm Creek South
2	PLM	Plum Creek
3	CDR	Cedar Creek
4	RIN	Rinard Creek
5	SFD	South Fork Dry Creek
6	MAH	Maha Creek
7	LBR	Little Bear Creek
8	NFD	North Fork Dry Creek
9	MAR	Marble Creek
10	CTM	Cottonmouth Creek
12	SBG	South Boggy Creek
13	BER	Bear Creek
14	ONI	Onion Creek
15	SLA	Slaughter Creek
16	CCE	Country Club East
17	CAR	Carson Creek
18	HRP	Harper's Branch
19	CCW	Country Club West
20	BLU	Blunn Creek
21	WMS	Williamson Creek
22	EBO	East Bouldin Creek
23	WBO	West Bouldin Creek
24	EAN	Eanes Creek
25	LBE	Little Bee Creek
26	TWN	Town Lake
27	ELM	Elm Creek
28	COL	Colorado River
29	TYS	Taylor Slough South
30	LOC	Lockwood Creek
31	BOG	Boggy Creek
32	BAR	Barton Creek
34	JOH	Johnson Creek
33	BEE	Bee Creek
35	BOH	Bohls Hollow
37	LBA	Little Barton Creek
36	HUK	Huck's Slough
38	CED	Cedar Hollow
39	FOR	Fort Branch
40	TAN	Tannehill Branch
41	TYN	Taylor Slough North
42	CMF	Commons Ford Creek
43	CRN	Cuernavaca Creek
44	STP	St. Stephens Creek
45	HNY	Honey Creek
46	BMK	Buttermilk Branch
47	HOG	Hog Pen Creek
48	WLR	Waller Creek
49	CNR	Connors Creek
50	DRN	Dry Creek North
51	DKR	Decker Creek
52	CWR	Coldwater Creek
53	STN	Steiner Creek
54	HRN	Harrison Hollow
55	TRK	Turkey Creek
56	BRW	Bear Creek West
57	LWA	Little Walnut Creek
58	LKA	Lake Austin
60	PAN	Panther Hollow
59	RDR	Running Deer Creek
61	SHL	Shoal Creek
62	WBL	West Bull Creek
63	DNE	Dry Creek NE
64	HRS	Harris Branch
65	BUL	Bull Creek
66	WLN	Walnut Creek
67	WLW	Willow Creek
68	GIL	Gilleland Creek
69	CTW	Cottonwood Creek
70	RAT	Rattan Creek
72	WLB	Wilbarger Creek
71	BCP	Buttercup Creek
73	LKC	Lake Creek
74	SBR	South Brushy Creek
75	BRU	Brushy Creek
76	LKT	Lake Travis
11	DRE	Dry Creek East

Flood Forecasting, Mapping, and Modeling

Statement of Objectives

Tomas Rodriguez, P.E., CFM | Matt Porcher, CFM
Susan Janek, P.E., CFM | Kevin Shunk, P.E., CFM

02.18.2015

FEWS Flood Early Warning System

City of Austin WATERSHED PROTECTION

Outline

- The City of Austin Flood Early Warning System
- 3 RFPs
- Discussion of Current FEWS Mapping Software
- Objectives for new FEWS Mapping Software Solution
- Questions

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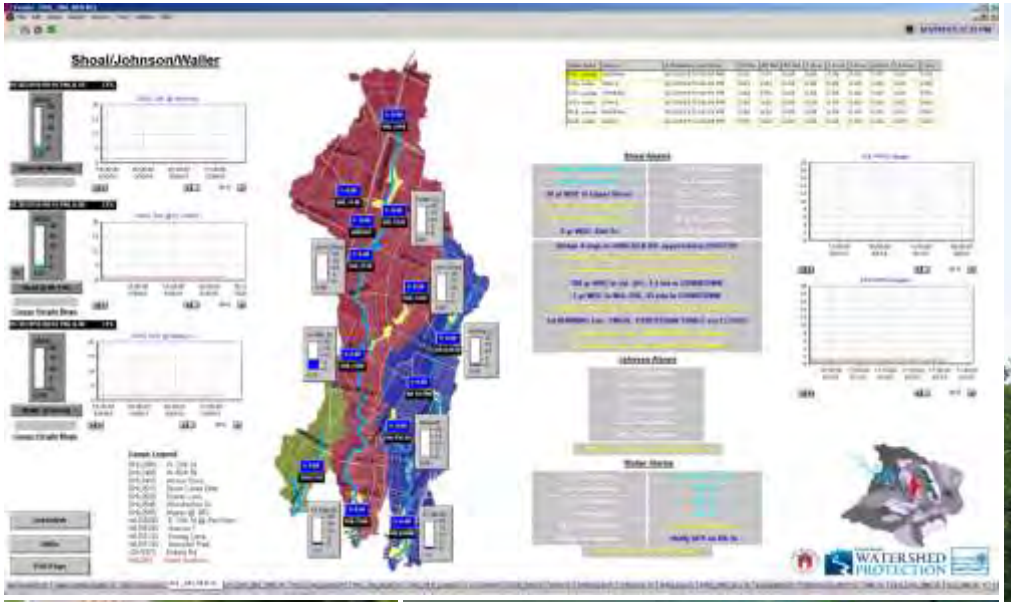
The City of Austin
Flood Early Warning System


Austin American-Statesman

13 die as floods ravage city; losses estimated in millions

The City of Austin
Flood Early Warning System



The Halloween Flood
10.31.2013






Credit: Reagan Hackleman

Outline

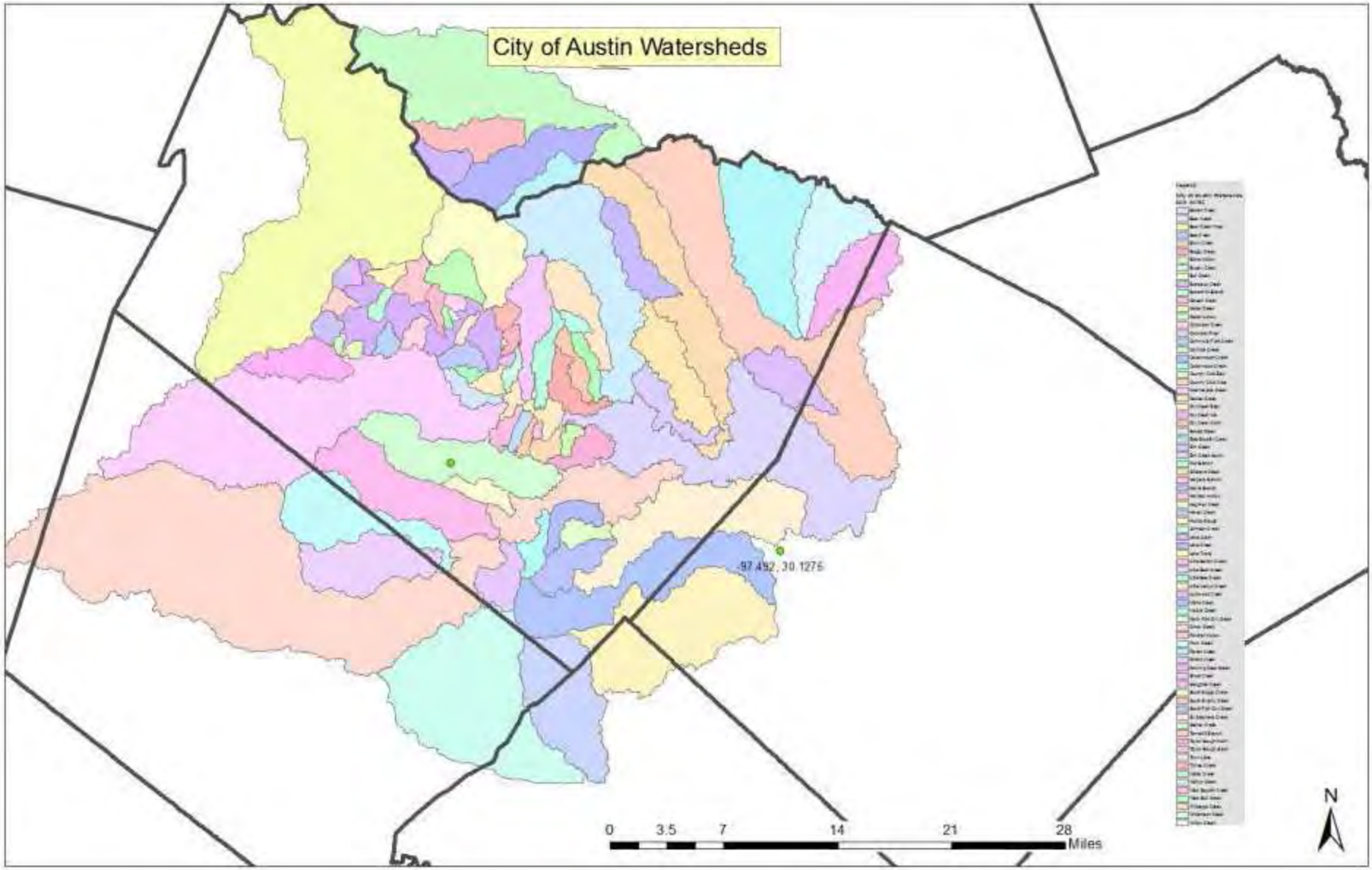
- The City of Austin Flood Early Warning System
- 3 RFPs
- Discussion of Current FEWS Mapping Software
- Objectives for new FEWS Mapping Software Solution
- Questions

3 RFPs

- In response to the Corrective Action Plan (CAP) for the Halloween Flood
- 3 interrelated RFPs
  - Common Operating Picture
  - Flood Forecasting, Mapping, and Modeling
  - Flood Cameras
- The City reserves the right to make multiple awards

Outline

- The City of Austin Flood Early Warning System
- 3 RFPs
- Discussion of Current FEWS Mapping Software
- Objectives for new FEWS Mapping Software Solution
- Questions


City of Austin Watersheds
-97.492, 30.1275
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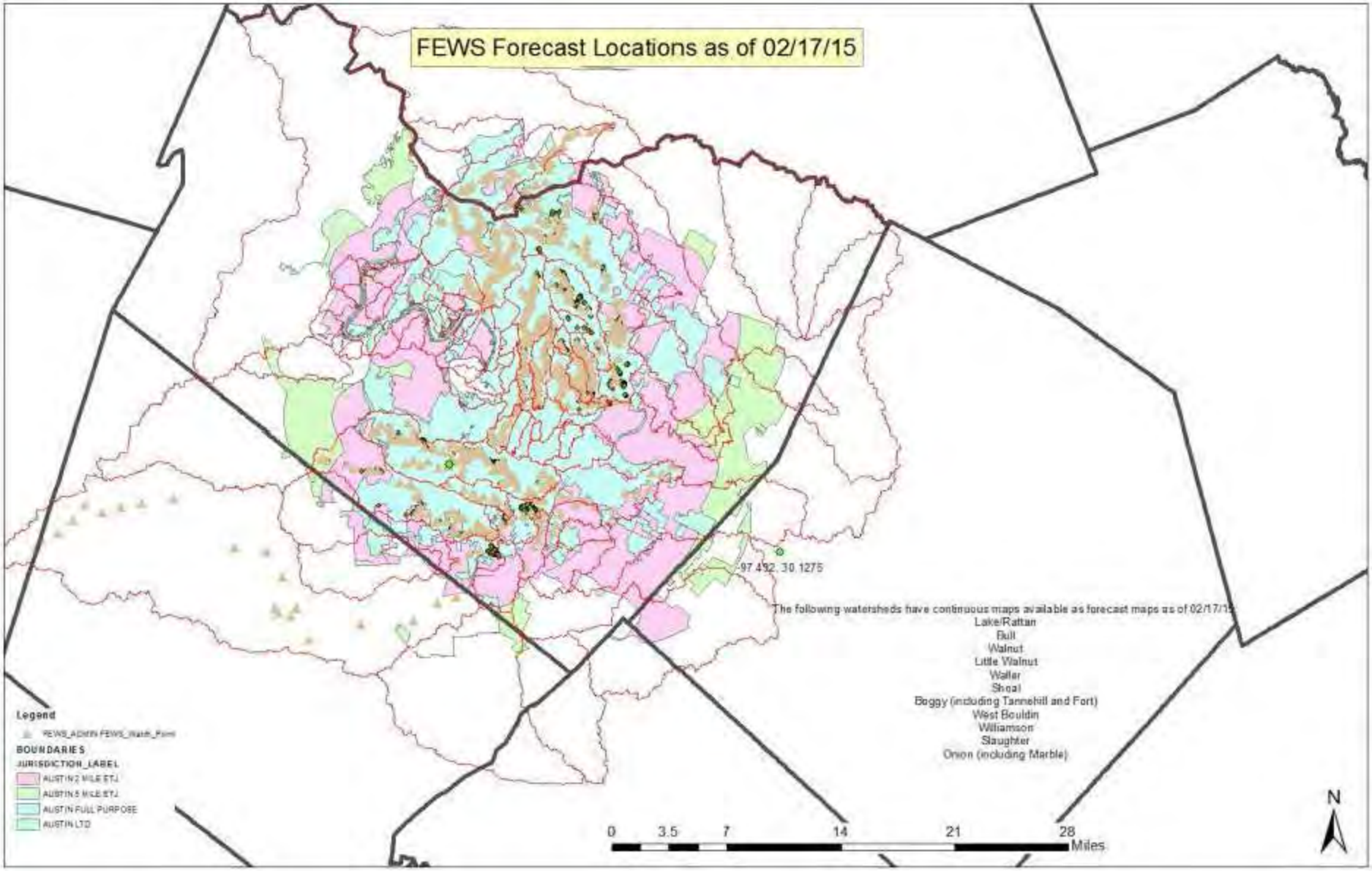
FEWS Forecast Locations as of 02/17/15
-97.492, 30.1275
The following watersheds have continuous maps available as forecast maps as of 02/17/15
Lake/Rattan
Bull
Walnut
Little Walnut
Waller
Shoal
Boggy (including Tannehill and Fort)
West Bouldin
Williamson
Slaughter
Onion (including Marble)
Legend
FEWS_ADMIN.FEWS_Watch_Point
BOUNDARIES
JURISDICTION_LABEL
AUSTIN 2 MILE ETJ
AUSTIN 5 MILE ETJ
AUSTIN FULL PURPOSE
AUSTIN LTD
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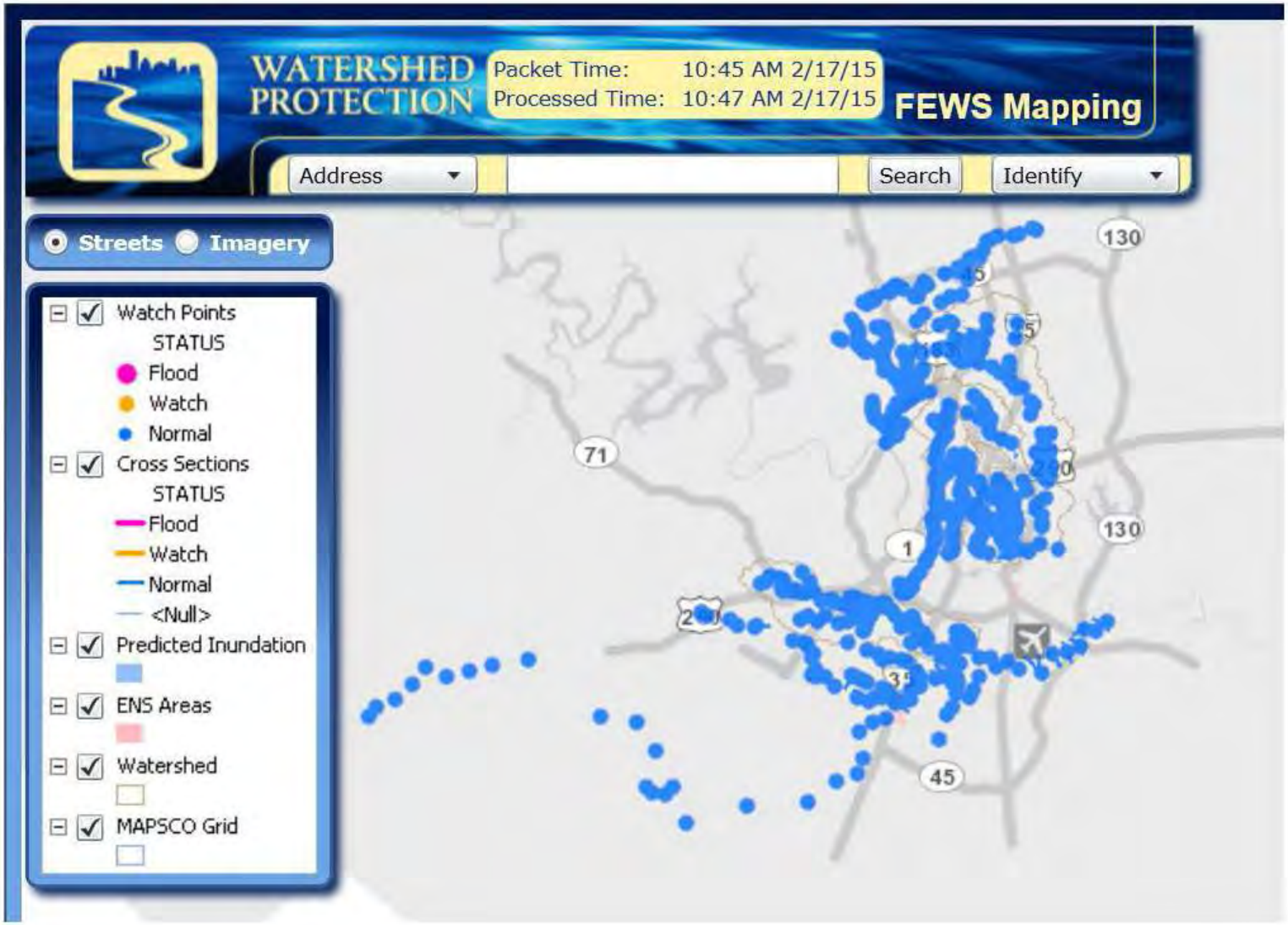


Current Intranet Forecast Mapping Service

Limitations of FEWS Current Forecast Mapping

- No history/ability to review floodplain predictions
- No flooded structure count
- Difficult to share information (e.g. maps and structure counts) with first responders
- Only takes into account rain that has already fallen (does not factor in predicted rainfall)

Outline

- The City of Austin Flood Early Warning System
- 3 RFPs
- Discussion of Current FEWS Mapping Software
- Objectives for new FEWS Mapping Software Solution
- Questions

Purpose

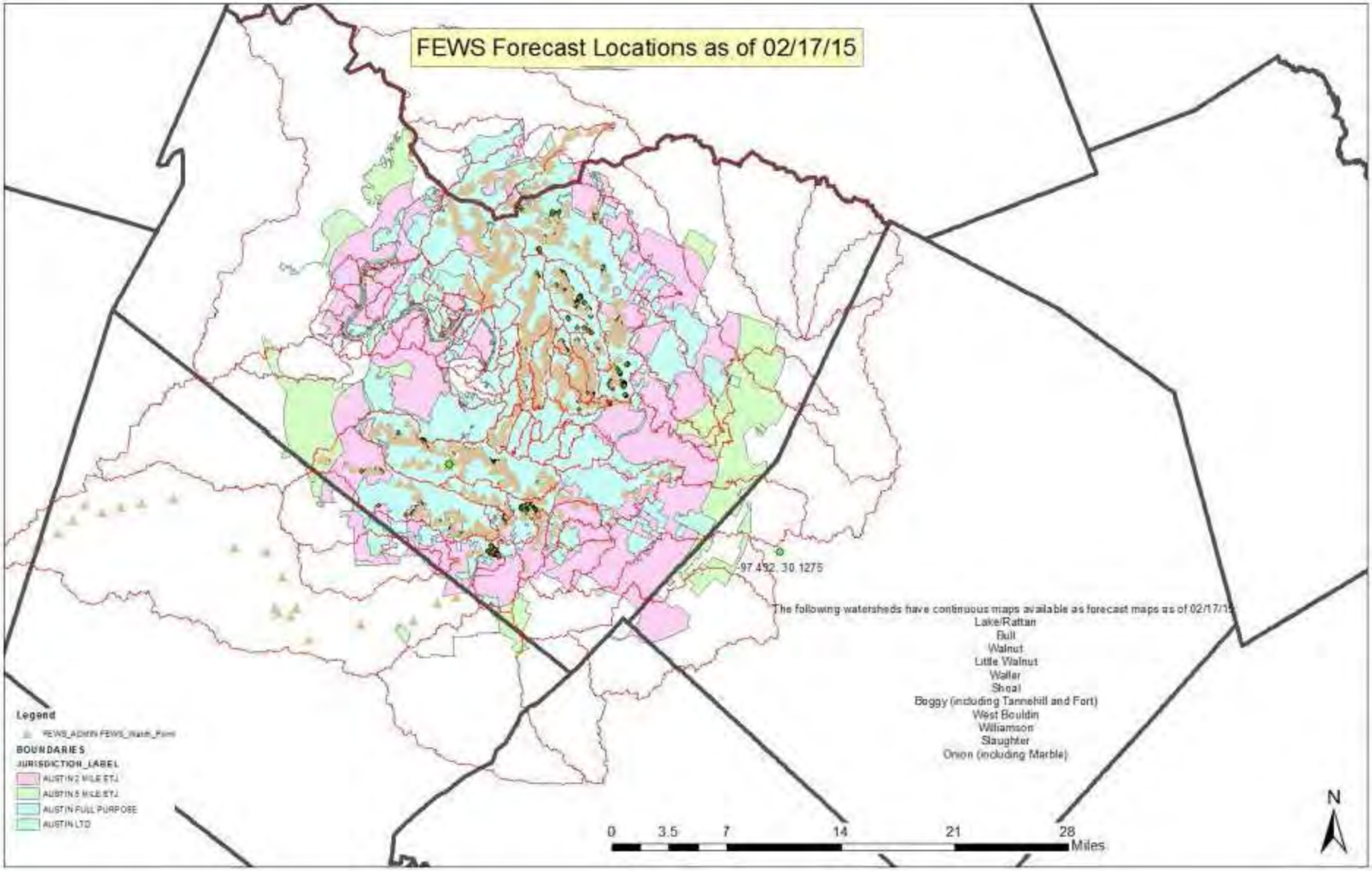
The City is seeking qualified firms or agencies to provide real-time mapping and modeling services using forecasted rainfall, gauge-adjusted radar rainfall, and real-time National Weather Service rainfall into a single integrated solution.

Objectives

4.1. Forecast modeling and mapping shall be performed as a service with outputs available for import into FEWS graphical user interface (or Common Operating Picture).

Objectives

4.2. Forecast modeling and mapping shall run in real-time using data from gauge-adjusted radar rainfall, National Weather Service rainfall, and forecast rainfall (from public or private source) and provide accurate stage and flow hydrographs at locations specified by the City.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Williamson
Slaughter
Onion (including Marble)
Legend
FEWS_ADMIN.FEWS_Watch_Point
BOUNDARIES
JURISDICTION_LABEL
AUSTIN 2 MILE ETJ
AUSTIN 5 MILE ETJ
AUSTIN FULL PURPOSE
AUSTIN LTD
0
3.5
7
14
21
28
Miles
N

Objectives

4.3. Maps from the output of forecast hydrologic and hydraulic modeling shall be immediately imported into a service (e.g. the FEWS graphical user interface) for use by first responders.

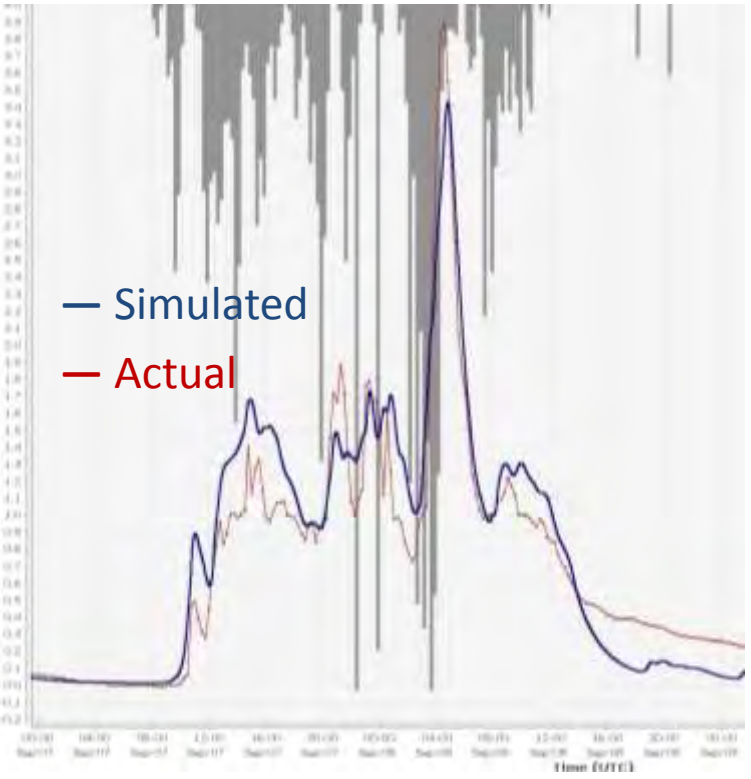
Objectives

4.4 Maps should include the following :

- 4.4.1 Date/time, extent, and depth of flooding
- 4.4.2 Numbers of structures at risk
- 4.4.3 Estimate of depth of flooding and damage cost estimate (using TCAD appraisal information)
- 4.4.4 Number of people flooded (census estimate) and individuals with ambulatory issues (STEAR)
- 4.4.5 Location of roadways anticipated to flood

Objectives

4.5. Models must be calibrated to existing full range rating stations provided by USGS (estimated Pearson correlation coefficient between 0.9 and 0.99)



Objectives

4.6. Models must account for ambient soil moisture conditions and evapotranspiration rates for the Austin, Texas area

Objectives

4.7. Procedures for upgrades and the addition of new models or model updates must be provided

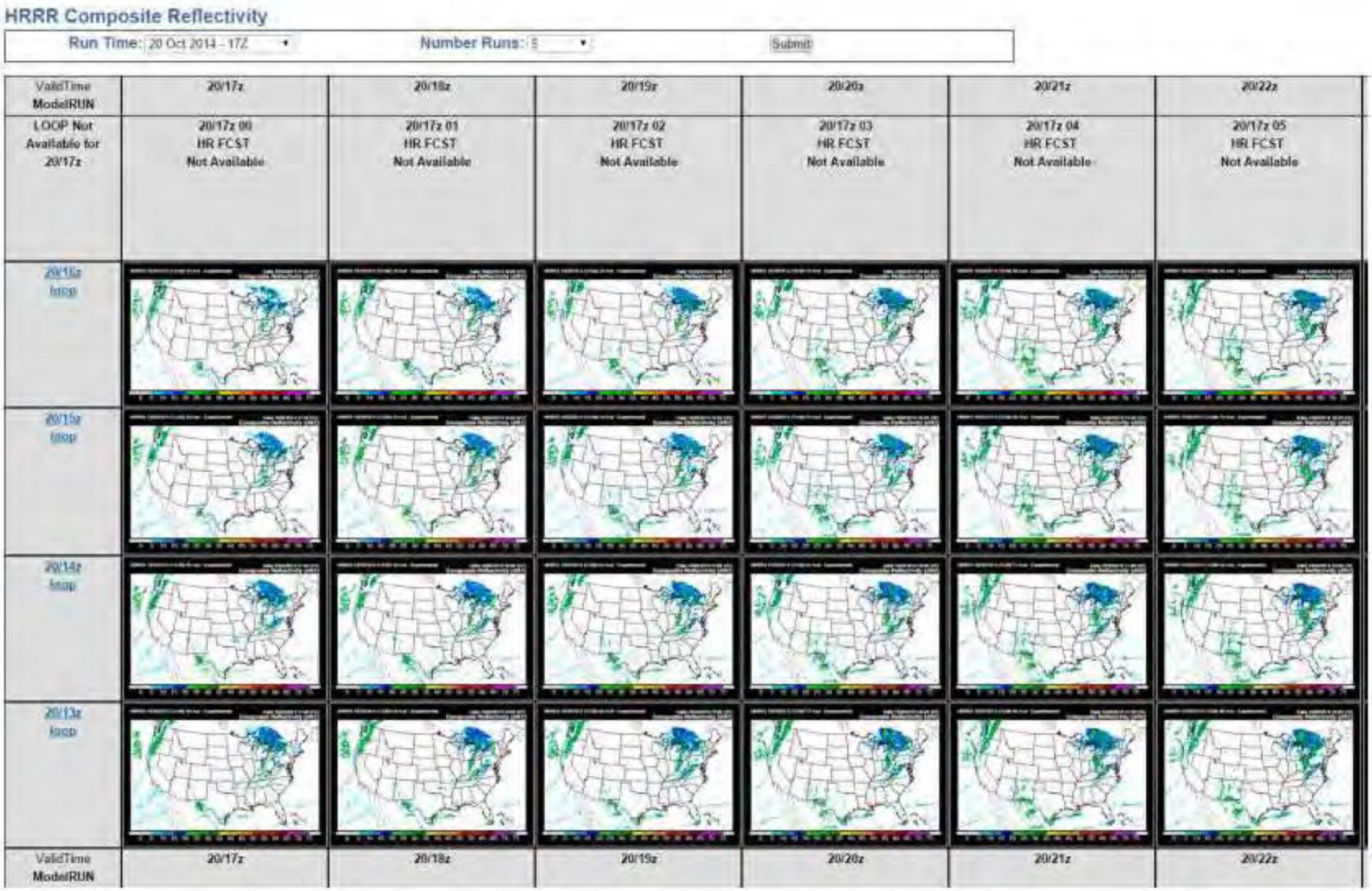
Objectives

4.8. There must be a desktop user model available for model calibration and model updates and must present an option for City staff to develop the models or for the Proposer to develop and update the models. The desktop user model must have a seamless interface for the importation of rainfall products (for model calibration/verification).

Objectives

4.9. The model must run continuously and provide forecasts up to 12 hours in advance based upon NWS forecast rainfall models or greater depending on forecast rainfall information available.

Objectives


HRRR Composite Reflectivity
Run Time: 20 Oct 2014 - 17Z
Number Runs: 6
Submit
ValidTime
ModelRUN
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20/18z
20/19z
20/20z
20/21z
20/22z
LOOP Not Available for 20/17z
20/17z 00 HR FCST Not Available
20/17z 01 HR FCST Not Available
20/17z 02 HR FCST Not Available
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20/17z 04 HR FCST Not Available
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20/16z loop
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20/14z loop
20/13z loop
ValidTime
ModelRUN
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20/19z
20/20z
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Objectives


Graph Display
Onion Ck at US Hwy 183
Now
11-11 19:14
Warning
Watch
Stage (ft)
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
18:00 Nov-09
22:00 Nov-09
02:00 Nov-10
06:00 Nov-10
10:00 Nov-10
14:00 Nov-10
18:00 Nov-10
22:00 Nov-10
02:00 Nov-11
06:00 Nov-11
10:00 Nov-11
14:00 Nov-11
18:00 Nov-11
22:00 Nov-11
Time (CST)
Data
2014-11-09 19:00 CST
2014-11-12 01:00 CST
Legend
Display on chart
Series
Style
Unit
Max. Value
Time of Max.
Stage (ft)
DPR Stage ft 4.16 2014-11-09 ...
GARR Stage ft 4.16 2014-11-09 ...
GARR Stage - No Boundaries ft 4.07 2014-11-09 ...
Observed Stage ft 4.95 2014-11-09 ...
Discharge (cfs)
Levels
Name
Style
Value
Warning 21.0 ft
Watch 17.0 ft

Questions?

1. What areas of the city should be included?

Modeling should include watersheds with any part within the City of Austin

2. Would the city like to include any critical infrastructure? Critical infrastructure should be protected from the 500-year storm, and includes hospitals, police and fire stations.

We can provide a spatial file showing bridges (and their elevations) and footprints of structures (including FFE and whether the structure is critical infrastructure).

3. Are there any dams to be included as a risk factor?

Dams should not be included as a risk factor but should be incorporated as part of the model.

4. Would you like to include any back-water effects into the areas for mapping?

While it is not required, we would certainly be interested in seeing back-water effects as part of the model.

5. The RFP mentioned an annual revision to the program. Are we to assume that the city would like an additional yearly proposal for those revisions?

If the models are to be hosted as part of the proposed solution, then we would need to see annual fees as part of a proposal.

FEWS Flood Early Warning System

City of Austin WATERSHED PROTECTION

ADDENDUM
CITY OF AUSTIN, TEXAS
REQUEST FOR PROPOSAL

Solicitation: RFP SMW0127, Hydrologic/hydraulic Flood Forecasting Modeling and Mapping Software

Addendum No: #1 **Date of Addendum: 2/3/2015**

This addendum is to incorporate the following changes to the above referenced solicitation:

1. **Changes:** The Offer Sheet page 1 of the Solicitation has been updated to reflect the following additions:
   - **1.1 Pre-Proposal Conference Time and Date: 1:30pm-2:30pm on February 18, 2015**
   - **1.2 Location: Combined Transportation Emergency Communications Center (CTECC), 2nd Floor Emergency Operations Center, 5010 Old Manor Road, Austin TX 78723**

     Please note that this meeting will be held in a secured facility. Attendees will need to have a government issued picture ID to enter. Also ensure to allow additional time to get through security.

     This meeting will also be available through a GoToMeeting online meeting:

     https://global.gotomeeting.com/join/926642909

     You will be connected to audio using your computer's microphone and speakers (VoIP). A headset is recommended.

     Meeting ID: 926-642-909

2. **AUTHORIZED CONTACT**: The Authorized contact for contractual and technical issues is hereby changed as follows:

   Authorized Contacts:

   Paige McDonald
   Senior Buyer
   (512) 974-2076
   Paige.McDonald@austintexas.gov

   Georgia Billela
   Buyer II
   (512) 974-2939
   Georgia.Billela@austintexas.gov

3. ALL OTHER TERMS AND CONDITIONS REMAIN THE SAME.

APPROVED BY: _____ February 3, 2015

Shawn M. Willett, Corporate Contract Compliance Manager
Purchasing Office, (512) 974-2274
Shawn.Willett@austintexas.gov

ACKNOWLEDGED BY:

_____	_____	_____
Name	Authorized Signature	Date

RETURN ONE COPY OF THIS ADDENDUM TO THE PURCHASING OFFICE, CITY OF AUSTIN, WITH YOUR RESPONSE OR PRIOR TO THE SOLICIATION CLOSING DATE. FAILURE TO DO SO MAY CONSTITUTE GROUNDS FOR REJECTION.

M E M O FOR RECORD

DATE: 5/9/16

SUBJECT: MA 6300 NA160000103 Mapping and Modeling

This project was a CTM project that Central Purchasing help solicited. The contract will be monitored by the Watershed Protection Department, however all future contract actions, only CTM Purchasing has the authority to change, add, delete, or revise this contract.

Georgia Billela
Senior Buyer

To: Mayor and Council Members

From: Marc A. Ott, City Manager

Date: April 11, 2014

Subject: HSEM Halloween Flood After Action Report

Enclosed is the final copy of the Austin/Travis County Halloween Flood After Action Report (AAR). This AAR was produced as a result of the heavy rain and flooding that occurred October 31, 2013. As you know, this was a record event exceeding the flooding that occurred in Austin in 1921.

This AAR was compiled by the Office of Homeland Security and Emergency Management (HSEM) and the Travis County Office of Emergency Management (TCOEM). Thirty-one City departments, along with 10 County agencies and four regional stakeholders conducted an internal AAR examining their individual department's response to this incident. The Deputy City Manager also led a day-long review of the incident that was attended by 92 participants. The information from this day-long review and the reports prepared by the individual departments were used in the preparation of this final document.

While responding to and recovering from any emergency presents challenges, organizations are also afforded the opportunity to take a closer look at their response efforts and identify areas for improvement. Based on all the information received, findings were classified into three broad areas as defined in HSEM internal procedures for producing an AAR. Those categories are "worked well," "needs improvement," and "did not work." Out of the 277 total findings contained in this report, 106 worked well, 123 need improvement and only 48 items (approximately 20% of the entire findings) did not work.

The Halloween Flood highlighted a variety of successes and opportunities for improvement. Highlights from the report include:

- Responder agencies reacted quickly to this incident and multiple City departments worked together with almost 400 City employee volunteers to offer high-quality services to affected persons.
- The City will work to improve its ability to provide public education and outreach efforts, as well as timely communication and dissemination of information to the public, especially to the non-English speaking populations.
- Develop plans to utilize the new Regional Notification System for future incidents.
- Review and update all plans, procedures and annexes cited in the report.

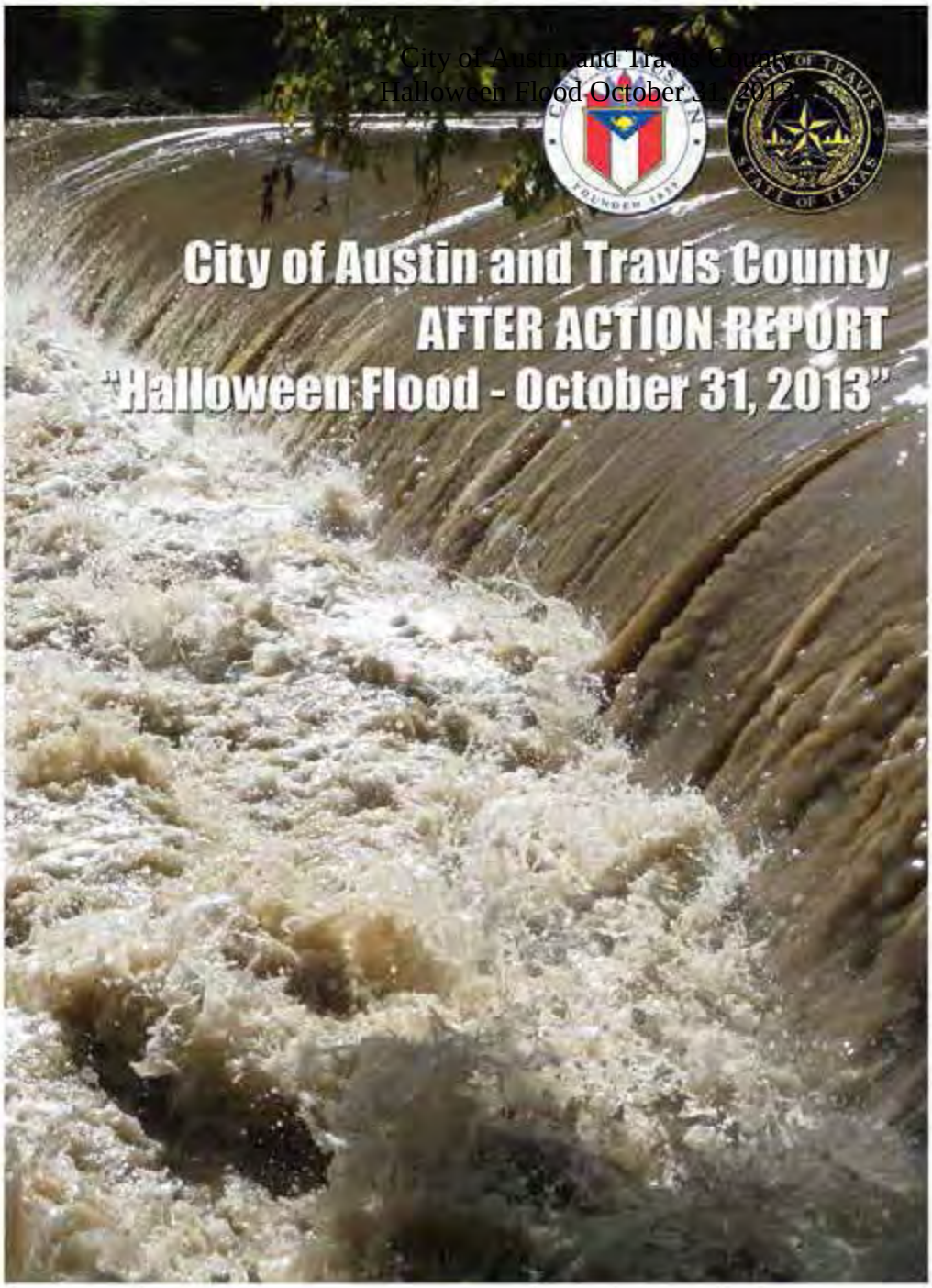
All 171 items identified as opportunities for improvement are included in the Corrective Action Plan (CAP) attached to the AAR as Appendix 1. The items in this CAP have been assigned to the appropriate City departments/County agencies and/or regional stakeholders for appropriate action. HSEM and TCOEM will monitor the actions taken to ensure the items in this CAP are all addressed according to the timeframe identified. We plan to complete the recommended improvements within six months.

I'd like to extend my personal thanks to the hundreds of City/County employees who responded to this event and to you for your policy leadership in this unfortunate incident.

If you have any questions or need any additional information, please let me know.

Thank you.

xc: Michael C. McDonald, Deputy City Manager
Robert Goode, Assistant City Manager
Sue Edwards, Assistant City Manager
Bert Lumbreras, Assistant City Manager
Rey Arellano, Assistant City Manager
Anthony Snipes, Assistant City Manager
Ray Baray, Assistant to the City Manager



City of Austin and Travis County
AFTER ACTION REPORT
"Halloween Flood - October 31, 2013"

Submitting Jurisdiction: City of Austin

Name of Person Submitting: Otis J. Latin, Sr., Director HSEM
Address: P.O. Box 1088
Austin, TX 78767-1088
Telephone Number: 512-974-0450
Fax Number: 512-974-0499
Email Address: otis.latin@austintexas.gov

Submitting Jurisdiction: Travis County

Name of Person Submitting: Pete Baldwin, Emergency Management Coordinator
Address: P.O. Box 1088
Austin, TX 78767-1088
Telephone Number: 512-974-0450
Fax Number: 512-974-0499
Email Address: pete.baldwin@co.travis.tx.us

List of Agencies Participating in February 24, 2014 After Action Review

City of Austin Agencies	
Animal Services Office (ASO)	Communications & Public Information Office (CPIO)
Austin Community Emergency Response Team (CERT)	Communications and Technology Management (CTM)
Austin Energy (AE)	Controller's Office
Austin Fire Department (AFD)	Economic Development Department (EDD)
Austin Police Department (APD)	Fleet Services Department (FSD)
Austin Public Library (APL)	Homeland Security & Emergency Management (HSEM)
Austin Resource Recovery (ARR)	Human Resources Department (HRD)
Austin Transportation	Law Department
Austin/Travis County Emergency Medical Services (EMS)	Neighborhood Housing & Community Development (NHCD)
Austin/Travis County Health & Human Services Department (A/TCHHSD)	Office of the Medical Director (OMD)
Austin Water Utility (AWU)	Parks and Recreation Department (PARD)
Austin 3-1-1	Planning and Development Review Department (PDRD)
Aviation Department	Public Works Department (PWD)
Building Services Department (BSD)	Purchasing
City Manager's Office (CMO)	Watershed Protection Department (WPD)
Code Compliance Department (CCD)	
Travis County Agencies	
Travis County Constable Precinct Four	Travis County Public Information Office
Travis County Office of Emergency Management (TCOEM)	Travis County Sheriff's Office (TCSO)
Travis County ESD # 2 – Pflugerville	Travis County STAR Flight
Travis County Health & Human Services & Veterans Service (TCHHS/VS)	Travis County Transportation Nature Resources (TNR)
Travis County Medical Examiner's Office (TCMEO)	
Stakeholder Agencies	
American Red Cross	Texas Gas Services
Austin Independent School District (AISD)	Volunteer Organizations Active in Disaster (VOAD)

List of Acronyms & Abbreviations

AAR	After Action Report
ADRN	Austin Disaster Relief Network
AE	Austin Energy
AFD	Austin Fire Department
AHJ	Authority Having Jurisdiction
AHS	Austin Humane Society
AISD	Austin Independent School District
APD	Austin Police Department
APL	Austin Public Library
ARES	Amateur Radio Emergency Services
ARR	Austin Resource Recovery
ART	After Hours Response Team
A/TCHHSD	Austin/Travis County Health & Human Services Department
ATV	All-Terrain Vehicle
AWACS	Austin Warning and Communications System
AWU	Austin Water Utility
BSD	Building Services Department
CAP	Corrective Action Plan
CASH-P	Capital Area Shelter Hub Plan
CASPER	Community Assessment for Public Health Emergency Response
CCD	Code Compliance Department
CERT	Austin Community Emergency Response Team
CIP	Capital Improvement Project
CMO	City Manager's Office
COA	City of Austin
COOP	Continuity of Operations
Corps	Army Corps of Engineers
CPIO	Communications & Public Information Office
CTECC	Combined Transportation, Emergency & Communication Center
CTM	Communications & Technology Management
DOC	Department Operation Center
DSO	Disaster Summary Outline
EDD	Economic Development Department
EMS	Austin/Travis County Emergency Medical Services
ENS	Emergency Notification System
EOC	Emergency Operations Center
ERT	Emergency Response Team
ESF	Emergency Support Function
FAC	Flood Assistance Center
FEWS	Flood Early Warning System
FEMA	Federal Emergency Management Agency
FSD	Fleet Services Department
GIS	Geographic Information System
GO	General Obligation

HMGP	Hazard Mitigation Grant Program
HR	Human Resources
HRD	Human Resources Department
HSEM	Homeland Security & Emergency Management
HVAC	Heating, Ventilation & Air Conditioning
IAP	Incident Action Plan
ICS	Incident Command System
IMT	Incident Management Team
IT	Information Technology
JIC	Joint Information Center
LAC	Local Assistance Center
LCRA	Lower Colorado River Authority
NHCD	Neighborhood Housing & Community Development
NWS	National Weather Service
OMD	Office of the Medical Director
PARD	Parks and Recreation Department
PDA	Preliminary Damage Assessment
PDRD	Planning & Development Review Department
PIO	Public Information Office
PSC	Plans Section Chief
PWD	Public Works Department
Review	After Action Review
SAR	South Austin Regional Wastewater Treatment Plant
SBDP	Small Business Development Program
SHEC	Sand Hill Energy Center
SOG	Standard Operations Guidelines
TCHHS/VS	Travis County Health and Human Services & Veterans Service
TCMEO	Travis County Medical Examiner's Office
TCOEM	Travis County Office of Emergency Management
TCSO	Travis County Sheriff's Office
TDEM	Texas Division of Emergency Management
TNR	Travis County Transportation & Natural Resources
USGS	United States Geological Service
VOAD	Volunteer Organizations Active in Disaster
VMS	Volunteer Management System
WPD	Watershed Protection Department

Table of Contents

1.0 Executive Summary

1.1 *Storm Overview*

Flooding is the most common hazard for the Austin area. Flooding can occur at any time during the year; however, floods most often occur in the late spring or fall. Flooding is a problem for several reasons, including Austin's proximity to the moisture-laden Gulf atmosphere; its rainfall intensity and duration; its thin, easily saturated soils, and Austin's proximity to the uneven terrain of the Hill Country. Flash floods have been responsible for more deaths in Central Texas than any other hazard.

Due to a dying tropical system from the Pacific Ocean and a merging trough of low pressure, the City of Austin and Travis County experienced flooding during the evening of October 30 and the morning hours of October 31, 2013. The storm started around 2000 hours on Wednesday, October 30, 2013, and ended by approximately noon on Thursday, October 31, 2013. The ground was saturated from storms that had occurred earlier in the month, so the majority of the rainfall became runoff. Figure 1 is a graphic produced by the National Weather Service (NWS) indicating the amount of rainfall from the Halloween Storm in Central Texas. The Watershed Protection Department (WPD) Flood Early Warning System (FEWS) engineers added the watershed boundaries to the map for better clarification of the amount of rainfall in the watersheds.

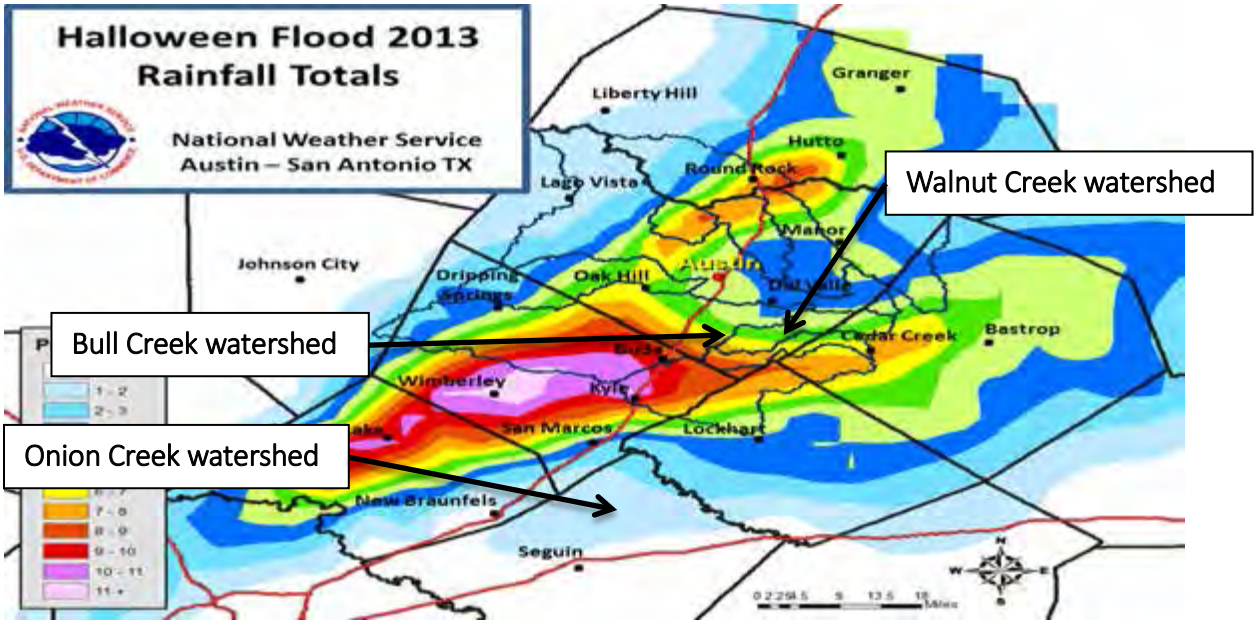


Figure 1 – Graphic produced by the National Weather Service

During the evening hours of October 30 and into the morning hours of October 31, Walnut Creek, Shoal Creek, Williamson Creek, and Bull Creek all flooded out of their banks. However, the most significant flooding occurred along lower Onion Creek in southeast Austin. Flooding in the Onion Creek watershed exceeded the record stage and flow at the United States Geological

Service (USGS) gauge located at U.S. Highway 183 South. The provisional data from the USGS indicated that this gauge peaked at 40.15 feet, which broke the previous record of 38.00 feet from the September 9, 1921, Storm. In Austin/Travis County, there were 745 homes that received some level of flood damage. Of these, 116 were completely destroyed, 441 received major damage, 122 had minor damage and 66 were reported as being affected. In Travis County, four people lost their lives due to this storm.

More than 40 road closures occurred, the first occurring at 2100 hours on October 30, 2013. The first roads started reopening 30 hours later.

1.2 *Emergency Operations Center (EOC) Overview*

The Austin/Travis County EOC (Figure 2) is a specially-equipped facility from which emergency management and government officials provide general guidance and direction, provide emergency information to the public, coordinate state and federal support, and coordinate resource support for emergency operations.

In response to heavy rains falling in the Austin/Travis County vicinity, representatives from the Austin Office of Homeland Security and Emergency Management (HSEM), in addition to the City of Austin Watershed Protection Department (WPD) Flood Early Warning System (FEWS) Engineers (who shifted their operations from One Texas Center), reported to the Austin/Travis County EOC at approximately 0130 Hours on Thursday, October 31, 2013.

Figure 2 – Austin/Travis County Emergency Operations Center

Public Works Department (PWD) Street and Bridge Operations was activated and a representative reported to the EOC at 0230 hours, because WPD needed assistance with road closures. The Austin Fire Department (AFD) moved from their Department Operations Center (DOC) to the EOC at 0530 hours.

Based on continual rainfall and the need for interagency coordination, the EOC was formally activated at 0600 Hours on Thursday, October 31 with the Travis County Office of Emergency Management (TCOEM), Austin Police Department (APD), Austin/Travis County Emergency Medical Services (EMS), Communication & Public Information Office (CPIO), Travis County Sheriff's Office (TCSO), Travis County Transportation and Natural Resources (TNR), Capital Metro and the American Red Cross being paged to join those agencies already in the EOC.

Because the Halloween Floods were multijurisdictional incidents, the EOC was established as a Unified Area Command to oversee the management of the multiple incidents that were each being managed by an Incident Command System (ICS) structure. The EOC Unified Area Command set the overall strategy and priorities, allocated critical resources according to priorities, ensured that incidents were properly managed, and ensured that objectives were met and strategies followed.

At approximately 0700 hours, AFD and HSEM initiated the first Emergency Notification System (ENS) to notify residents in selected flooding areas about hazardous conditions. An additional ENS notification was sent at approximately 0930 hours. Initial response activities included the monitoring of flood gauges and the evacuation of selected residential areas. Based on the need for evacuations, preparations were initiated for sheltering activities.

As the rain began to end and the flood waters receded, focus shifted to conducting a damage assessment of the affected area, debris removal and the restoration of utilities. Multiple City Departments, including Parks and Recreation Department (PARD), WPD, Austin Water Utility (AWU), Austin Resource Recovery (ARR), and PWD along with Travis County TNR were involved in a concentrated effort to remove debris from the affected areas.

On October 31, 2013, a meeting was held in the EOC and the Director of CCD was appointed Recovery Coordinator to oversee short and long-term recovery activities for the City of Austin. CCD was assigned the task of performing damage assessments in the affected areas within the City of Austin. Specific attention was given to the need to provide information to citizens about the status of their residence once it was inspected.

During this meeting the Deputy Director of ARR was assigned the role of Debris Removal Branch Director. APD and TCSO were tasked with providing an increased law enforcement presence in the affected area in order to deter any potential looters.

Additionally, plans were developed to provide for re-entry into the affected area, provide for long-term sheltering needs and open and operate a Flood Assistance Center (FAC) to serve as a ‘one-stop shop’ for those impacted by the flood.

Two shelters were initially opened on October 31, 2013 for residents impacted by the flooding. One was at a local church and the second was at a City-owned PARD facility. Eventually, the two shelters were consolidated into a single location and the Flood Assistance Center, located at the Dove Springs Recreation Center, provided both sheltering operations as well as assistance services.

EMS community health paramedics began meeting with residents impacted by the flood in the shelters, the neighborhoods, and eventually at the Flood Assistance Center in the following days. The community health paramedics assisted those affected in getting replacement medications, contacting their physicians and arranging clinic visits for several days after the flood.

The Flood Assistance Center was staffed by various government agencies and non-profit service providers, provided social services, and assistance to those impacted by flooding, as well as assisted in the coordination of volunteer efforts.

Extensive resources were committed to the completion of the Preliminary Damage Assessment (PDA). This was done in conjunction with City and County staff as well as representatives from the Texas Division of Emergency Management (TDEM). Staff from the TCOEM worked closely with the State in the development and submission of a Disaster Summary Outline (DSO).

On November 4, 2013, the Mayor of Austin issued a Declaration of Local State of Disaster (Appendix 2) and submitted a letter of request for assistance to the Governor of Texas. Additionally, on November 4, 2013, the Travis County Judge issued a Travis County Flooding Disaster Declaration (Appendix 3) and submitted a letter of request for assistance to the Governor of Texas. Subsequently, the Governor issued a State Disaster Proclamation on December 12, 2013 and submitted a letter to the President of the United States requesting a Presidential Disaster Declaration (Appendix 4) for the State of Texas. On December 20, 2013, a major disaster declaration FEMA-4159-DR (Appendix 6) authorized Public Assistance for Caldwell, Hays, and Travis Counties and Hazard Mitigation statewide.

It is important to note that during the activation of the EOC for this flooding incident, HSEM and TCOEM staff, along with other EOC responders managed the second Formula 1 United States Grand Prix™ with approximately 113,000 attendees and just under 100,000 attendees at Darrell K. Royal-Texas Memorial Stadium for the University of Texas Longhorn vs. Oklahoma State Cowboys football game the weekend of 15-17 November.

The EOC transitioned to regular business hours on Monday, November 18, 2013. Additionally, HSEM continued to conduct daily conference calls with Departments and agencies with representatives at the Flood Assistance Center (FAC) and agencies providing services in the affected area. Based on the decline in requests for assistance, the FAC was formally closed on Wednesday, December 18, 2013 although long-term recovery efforts are still on-going. During this period the EOC produced 29 separate Situation Reports (SitReps) and Incident Action Plans (IAPs) covering approximately 18 operational periods.

The support, time and attention provided by our elected officials and policy makers during this event are greatly appreciated. Their support ranged from quick passage of resolutions that allowed the City/County to seek state and federal assistance, to on-site trips to the impacted areas. They also provided and arranged for tours for residents and helped us share information with people during the event. Their assistance was extremely valuable and the following ways to better interact with them in future events have been identified:

1. Organize a process for meeting and briefing policy makers early in an incident.
2. Provide training to keep policy makers up-to-date on how they can access information and staff operational procedures.
3. Establish and communicate to policy makers clear points of contact for them during an event.

4. Ensure that there are organized plans to guarantee officials and policy makers have access to impacted sites.
5. Develop a process for ensuring policy makers have current and consistent information to share with the community.

2.0 After Action Report (AAR) Development

2.1 *Methodology*

The Halloween Flood was a significant incident, which impacted not only City and County residents but also City and County operations. Following any event it is a prudent practice to conduct an After Action Review (Review). Due to the size of this incident, conducting this City/County-wide Review was a sizable undertaking. In preparation of the City/County-wide Review, each department/agency that participated in the Halloween Flood was required to conduct an internal review and specifically analyze how their department/agency responded to the incident. Austin HSEM and TCOEM, conducted a review of the operations of the Austin/Travis County EOC and that Review will be attached to this City/County-wide After Action Report (AAR).

Additionally, on Monday, January 6, 2014, HSEM provided a copy of a procedure and After Action Report template to each department/agency which outlined a process for conducting and documenting their Review. All departments/agencies were required to provide a copy of their internal review to HSEM, no later than Friday, January 31, 2014. Those individual department/agency Reviews have been attached to the City/County-wide AAR.

All of the information collected during these reviews was used to develop this City/County-wide AAR for the Halloween Flood incident.

In preparation for the City/County-wide Review, HSEM collected the results of each individual department/agency's review and developed the City/County-wide focus areas. The focus areas were discussed during the City/County-wide meeting that was held on Monday, February 24, 2014 from 9 a.m. to 4 p.m. in the Austin/Travis County Emergency Operations Center located in the Combined Transportation, Emergency & Communications Center (CTECC), at 5010 Old Manor Road.

At the meeting on Monday February 24, 2014, each department/agency was allocated 5 to 15 minutes to present their findings to the larger group. In the interest of time, they were asked to summarize their department/agency findings to the greatest extent possible. They were also asked to spend the majority of the time focusing on those areas with a City/County-wide impact or those areas where issues crossed departmental responsibilities.

There were 92 attendees that participated in the Halloween Flood After Action Review, which included City, County and non-governmental stakeholders.

The following seven (7) City/County Focus Areas emerged from the City/County-wide meeting and will be discussed in Section 3 of this report:

- Notifications
- Communications
- Emergency Operation Center (EOC)
- Flood Assistance Center (FAC)
- Volunteers (Recruitment, Management, and Safety)
- Field Operations (Response, Sheltering, Debris Management, and Recovery)
- Plans and Procedures

3.0 AAR Focus Areas

This section includes the seven (7) focus areas that were identified from the departments/agencies AARs and discussed during the meeting on February 24, 2014. Listed under each focus area are: (1) What worked well, (2) What needs improvement, and (3) What didn't work. From the items that did not work or need improvement, a Corrective Action Plan (CAP) was developed and included as Appendix 1.

It is important to note that in any AAR, findings can occur that may appear to be in conflict. That is, there may be a finding stating that an item 'worked well' and then later on in the report another comment may indicate that the same item either 'needs improvement' or 'didn't work.' This is not uncommon, particularly for an AAR covering an especially large or pro-longed incident. This is especially common in cases similar to this incident where individual departments/agencies conducted an AAR related to their own response to the incident (and found something that worked well) while another department/agency may find that in their particular response a similar item either needs improvement or did not work.

The end result is that items that worked well will be sustained and utilized in future incidents while those items identified as needing improvement or not working will be addressed either by individual departments or City/County-wide, as appropriate.

3.1 Notifications

The main issues raised under the Notifications Focus Area revolved around the need to improve early notification and the call-back process for EOC activations. The City of Austin is part of a region-wide paging system, the Austin Warning and Communications System (AWACS). The AWACS paging system is the primary notification mechanism for EOC activations. All personnel that should be notified for EOC activations must carry a pager and have their pager programed with the appropriate cap codes (EOC Activation Groups 1-4) to be notified when there are EOC activations. More than 10,000 pagers serve the City of Austin, Travis County, The University of Texas, Austin Independent School District (AISD), news media and other regional partners. This system includes a variety of activation codes (cap codes) that allow the City, County, region, and the various departments to simultaneously notify groups of users. The system provides instant notification to individuals and groups, and does not depend on the public switched telephone network or the Internet.

Additionally, this focus area addressed the use of a notification system that can be used to provide information to appropriate groups using systems like e-mail, text messaging, smart phones, etc. The system that will be used to address this issue is a Regional Notification System (RNS).

- 3.1.1 What Worked Well
  - Austin Police Department's implementation of the Unified Tactical Response Plan, ALPHA/BRAVO staffing, and timely activation of their Department Operations Center (DOC).
  - Notice from the City Manager's Office on November 1 alerted the Law Department to the current status of the incident and the extent of damage, and allowed attorneys to anticipate the need for preparation of emergency documents.
  - The Purchasing Office, Financial Services Department, maintained office phone lists that were accurate and available when needed.

- 3.1.2 What Needs Improvement
  - Clarify to all City, County and Regional stakeholders that the AWACS paging system is, and will remain, the primary notification of EOC activations.
  - Develop a notification group in FirstCall, the new regional notification system, that can be used to provide City/County management and leadership, elected officials, regional stakeholders, volunteers and responders with updated incident information.
  - Travis County Constables should have a representative at the EOC to coordinate response from the 5 offices.
  - When EOC activation occurs, the Law Department needs to be included to allow for participation in the Response Phase. With an earlier presence at the EOC the department would have been able to assist other departments in crafting a consistent policy for dissemination to employees in the field.
  - Ensure all necessary agencies are included in the appropriate pager groups for EOC activations, i.e. City of Austin Purchasing.

- 3.1.3 What Didn't Work
  - AISD, CPIO, Law, Animal Services Office, Austin 3-1-1, the Travis County Medical Examiner and Travis County Constables reported they did not receive an EOC activation page.
  - AISD was not notified prior to APD helicopters landing on their southeast bus terminal grounds.

3.2 Communications

The Communications Focus Area included issues associated with providing timely and accurate information to the maximum number of citizens enabling them to take appropriate protective actions in order to minimize life and property losses. It includes the processes for the management and release of information to media outlets and the general public.

Figure 3 - Annex B, Communications

In this incident, messaging was handled through a Joint Information Center (JIC) which included Public Information Officers (PIOs) from local government departments, other levels of government, volunteer agencies, and the private sector to help ensure message consistency.

In addition, the goal was to facilitate emergency communications within and among all agencies. All departments are required to maintain their existing equipment and procedures to communicate with their field operations units. Departments are responsible to address communications issues in Standard Operating Procedures, Standard Operating Guidelines, Departmental Policies, or through other methods as appropriate.

- 3.2.1 What Worked Well
  - Distributed critical information to residents about resources and services available to them.
  - Pushing flood safety awareness and preparedness tips via social media.
  - Informational flyers placed on every door in the affected areas worked well. This allowed residents to receive updated information as needed, especially when access to media and technology was limited.
  - Staff were able to produce some translated material (specifically flyers) for distribution fairly quickly and on-the-fly.
  - In less than a four-hour period, HRD was able to create communications from the City Manager's office and execute a citywide request for volunteers.
  - Regional radio system allowed for two-way communications between departments. Radio communications and technology between all responders and command and general staff personnel was reliable, robust and dependable.
  - Austin Resource Recovery's communications with vendors to extend working hours.
  - FEWS on call staff activated well in advance of the storm the afternoon of October 30th based on weather reports from the NWS.
  - Effective coordination between attorneys and personnel from various departments allowed preparation of a fee-waiver ordinance that addressed immediate recovery needs.

- Austin Energy's (AE) Energy Control Center provided great internal communication on outage progress.
- AE Customer Care was able to staff the Customer Outreach Centers post storm to provide information to affected customers.
- Austin 3-1-1 experienced double the normal call volume at times and was able to maintain satisfactory call center service levels.
- Small Business Development Program (SBDP) disseminated information to a diverse geographic population via multiple communication channels, including a newsletter sent out to 18,000 SBDP email contacts and use of social media outlets.
- SBDP utilized non-traditional means of finding small business owners, i.e. utilizing the registered vendors list housed in Central Purchasing to identify potentially affected businesses. Additionally, SBDP ensured that other City of Austin departments working in the FAC were aware of the services offered.
- Lessons learned from the Bastrop Area fires resulted in the development of a website, www.austinsmallbiz.com/getbackinbusiness, which now is permanently hosted on the main website with up-to-date information on each of the five topics: Normal Business Operations Pre-Disaster Planning, What to do After a Disaster checklist, List of Co-working Organizations in Austin, Federal and State of Texas Resources, and City of Austin Resources.
- The Department of Aviation was able to monitor water levels and correctly analyze the impacts to the airport as well as keep certain areas of the campus informed.
- Travis County Emergency Services began issuing National Weather Service flood watch information via social media (Twitter and Facebook) early on the afternoon of October 30, the day before the flood, reinforcing weather forecast information and relaying it to the media and public. Just after midnight on October 31, Travis County Emergency Services also posted on social media about ongoing STAR Flight flood rescues and sent STAR Flight rescue video to local media the following morning.

3.2.2 What Needs Improvement

- Some stakeholder organizations reported receiving "unclear or misinformed guidance," "conflicting information," or "lacked points of contact."
- Need the earlier creation, distribution and use of a communications plan, Form ICS 205 for all responder agencies and organizations.
- Some staff had to use their personal cell phones for response activities and others reported limited cellular coverage in the affected area.
- Shorter "stubby" antennas on some portable radios encountered limited coverage issues.
- The City and County need to improve the ability to timely communicate with and disseminate information to the affected public, including information to non-English speaking populations.

- The City and County need to improve the multi-lingual social media outreach this needs to be broadened beyond Spanish. Asian languages will be a key area of need.
- The City needs to develop specific messaging targeting flood related topics including, but not limited to: rebuilding process (demolition, cleaning, permitting requirements) & buyouts.
- The Joint Information Center (JIC) needs to improve their proficiency with EOC related equipment and tools and needs to pre-identify key information that may be needed during an activation including training in ICS.
- Continue to improve public outreach/public education efforts, to include specific education on the response to a large scale incident.
- Implement a community outreach plan to educate the community on public safety action plans at water-related events and provide the public information on actions they can take.
- Community information meetings should be held according to standard operating procedures.
- AE field crews were having issues with piggy backing on other calls. Radio Communications during the incident were having issues with the repeaters.
- The NWS flood stage definitions on their Web site do not reflect current conditions.
- Radio transmissions from the rain gauge network were at times delayed up to an hour, decreasing accuracy of FEWS flood forecast computer models.
- There is a need for a combined Austin/Travis County press release template with a header that includes both Austin and Travis County seals and contact information.
- Any employee, who has contact with the public in person, via the phone or online, should have information to answer frequently-asked questions or at least know to whom the person should be referred.
- The City and County should provide handouts with information needed by residents as soon as it's safe to enter impacted communities.
- Travis County provided recovery information to the public via the county website. The County should ensure that all necessary information is included and updated.
- SBDP did not have a sustainable plan for maintaining the information on the Get Back in Business website, and had to quickly verify and update the referenced links.
- Residents were confused about the types of placards that were placed on their homes and the terms used to determine habitability. They did not know what the placards meant or what it required them to do.
- Many of the street signs washed away which limited directional capability. Another type of signage should have been installed to assist field crews that were unfamiliar with the area.
- Public Information Officers (PIO) and the JIC need greater access to subject matter experts and designated on-camera/on the record representatives for media interviews.

- Work with departments to ensure they have enough trained, fluent Spanish speaking staff onsite.
- The City and County need to develop a network of grassroots community contacts to help disseminate critical information and collaborate with other community volunteer organizations to ensure consistency for communication to residents.
- Departmental Human Resource (HR) staff was responsible for coordinating volunteers, but they did not receive the information until after Department Directors were notified. This resulted in segmented communication that created an increased amount of questions and confusion.
- The Finance Section Chief needs to be provided access to the citywide financial and payroll staff distribution lists to facilitate better communications.
- Utilize FirstCall to provide the public with emergency information such as evacuations, shelter in place, etc.
- Consider use of Austin/Travis County Amateur Radio Emergency Services (ARES) for situational awareness.

3.2.3 What Didn't Work

- The early warning system for Onion Creek did not work.
- Travis County neighborhood of Bluff Springs was not receiving information being disseminated from the FAC due to a lack of County representation at the FAC.
- FEWS staff did not receive reports of flood-related 911 calls directly and could only rely on reports from their Field Operations staff. Therefore, geographic locations of 911 calls in addition to observations from AFD, EMS, and APD were not known to FEWS during the storm incident.
- There was not an effective way to communicate directly with residents in the affected areas in English and in Spanish concerning the flood, especially as it relates to providing citizens with an enhanced awareness that conditions were worsening.
- Effectively promoting the SBDP website was more difficult because information was not up-to-date, physical handouts did not exist, and website URL was confusing to access for end users.
- The Department of Aviation received very little information on the rising waters from external sources. Most conditions were self-identified by Aviation staff.

3.3 EOC Operations

Figure 4 - Austin/Travis County Emergency Operations Center

The City and County EOC Directors manage EOC resources and operations according to the Austin/Travis County EOC SOG and Position Checklists Plan. They ensure situational awareness for the incident is being conducted. This task involves the collection, evaluation, display, and dissemination of information about the emergency situation to help support the response operations. Information collection sources include, but are not limited to: WebEOC, a web-based software program, used for the purpose of automating the collection, consolidation, and distribution of information related to an incident. WebEOC is also used to provide situational awareness to first responders and EOC representatives.

- 3.3.1 What Worked Well
  - Use of WebEOC by a majority of department EOC representatives.
  - WebEOC has never been used more than with this incident. Strong Planning Section Chief and Leadership embraced the use of WebEOC.
  - Timely situation reports were issued.
  - Providing maps for agencies to identify the affected areas.
  - GIS Emergency Response Team (ERT) was given permissions to the folders on the EOC network so that work could be done remotely.
  - Having a GIS team in place and meeting regularly before the incident.
  - Assigning a CTM technician to the EOC during initial activation with continued support while activated: This allows EOC staff to concentrate on managing the incident without being distracted by technical issues.
  - A regular maintenance schedule to make certain that all of the EOC laptops are updated and working properly.
  - HSEM and TCOEM staff performed above and beyond expectations during this incident. Including a limited number of staff members working long hours over an extended period of time.
  - CERT volunteers provided much needed assistance, especially in the EOC, during this prolonged incident.

- The use of public safety personnel to staff the EOC during overnight hours was very beneficial.
- For the first time PDRD was included in EOC operations which allowed greater communications and coordination between departments and the opportunity to build better relationships and understanding of the operations of other departments and their needs.
- Experienced Public Works Staff responded quickly to the EOC, Street and Bridge field Staff were "called back" to work, and expeditiously positioned barricades at low water crossings and other troublesome areas.
- The Purchasing Office, Financial Services Department, had staff that was prepared to assume their duties and was able to rapidly respond to logistics needs.
- CPIO was able to staff both the EOC and FAC, any gaps in staffing were infrequent and generally all shifts were filled.
- Austin 3-1-1 coordinated the creation of a service request in support of the EOC.
- The EOC should continue to provide fresh fruit and other healthy snacks during activations.
- A/TCHHSD staff members provided representation in the EOC, activated their DOC, conducted the CASPER and provided case management to residents impacted by the incident at the FAC.

♦ 3.3.2 What Needs Improvement

- The use of WebEOC during this activation by EOC representatives, DOCs, and the FAC should be continued. The areas needing improvement include: CTM support, user proficiency, just-in-time training, and resolution of technical issues related to Logistics and Mission Tasking.
- Additional CTM staff should be trained to assist with WebEOC (access privileges, log-ins, passwords, troubleshooting, etc.) when HSEM staff is not available.
- WebEOC accounts should not be created during an EOC activation except for those stakeholders in the EOC itself who need assistance.
- For events requiring a significant GIS involvement, a GIS supervisor should be appointed and charged with: developing GIS staffing, prioritizing requests and assisting requestors.
- Need to conduct training for EOC representatives on: GIS resources and capabilities, limitations and processes.
- Agencies and organizations with representatives in the EOC did not consistently report key operational components of the agency/organization and any anticipated impact from the incident during regular situational briefings or enter the information that was provided into WebEOC.
- Key metrics must be identified that can be reported and monitored throughout an event.
- All Emergency Support Function (ESF) 8 responsibilities will be coordinated through the EOC in compliance with Annex H – Health & Medical.

- Case management Strike Teams and the triggers for activation need to be established.
- EOC representatives must have the authority to make decisions for their agency, staff the work station assigned to their agency and remain at the EOC until relieved or the EOC is demobilized.
- All computers in the EOC should have the same configuration and increased functionality should be explored.
- Additional City employees need to be identified to assist in the EOC during prolonged activations.
- Expand ICS training to non-uniformed staff that may be utilized during a large scale incident. This includes logistics and support staff.
- The City and County need to develop local Incident Management Teams (IMTs) capable of operating field/remote locations or supporting EOC operations.
- Some City utility facilities were adversely impacted by the incident.
- The timing of situational briefings caused conflicts with DOCs and FAC.
- Travis County Constables were having difficulty communicating with EOC staff.
- Need to develop a staffing plan for the key positions needed in the EOC when activated.
- The Logistics Section needs to have a consistent staff to maintain operational awareness. Logistics staff should remain in the EOC up until deactivation for demobilization purposes.
- The City Corporate Safety representatives should be more closely aligned with HSEM operations and EOC activations.
- The Finance Section Chief should have been activated earlier.
- Identify more members to serve on the GIS team to allow for coverage of multiple operational periods.
- Improve scheduling of GIS personnel to the greatest extent possible.

♦ 3.3.3 What Didn't Work

- City utilities were not able to access certain facilities due to denial of access by law enforcement.
- City utilities were not able to access certain facilities due to limited road access.
- An air operations branch was not set up in the EOC.
- Clear tracking of road closures was not available.
- Technology limitations prevented a field situational awareness.
- The EOC should have been fully activated sooner for this incident.
- USGS Stream Level Gauge at Twin Creeks was washed out and USGS Stream Level Gauge at 183 temporarily stopped functioning properly.
- The FEWS flood forecast models rely on radar-based precipitation estimates from the NWS and gauge-adjusted radar rainfall estimates from a private vendor.
- The Logistics Section was unable to use WebEOC due to technical issues.

- Too many users were unfamiliar with WebEOC due to a lack of use.
- GIS staff was overwhelmed by the requests for information associated with the damage assessment teams.

3.4 Flood Assistance Center (FAC)

Figure 5, Dove Springs Recreation Center, 5801 Ainez Dr.

This Local Assistance Center (LAC) was activated and named Flood Assistance Center (FAC) for this incident to provide assistance to the affected community. This FAC provided a centralized location for services and programs, disaster information, and resource referrals for unmet needs following this disaster. In addition, sheltering operations were established at the FAC.

3.4.1 What Worked Well

- The Recreation Center staff provision of overnight shelter management for the Dove Springs Shelter for the duration of the incident.
- Using a facility that had access to the Internet and electric power.
- Having laptops available from an emergency cache and inter-agency assistance with tents, vehicles and staffing.
- Establishing a case management approach to providing services to citizens.
- Red Cross providing meals for citizens and staff at the FAC.
- Establishing a volunteer coordinator to manage/coordinate volunteers from all sources.
- Operating under the Incident Command System for all agencies and non-government organizations.
- PIO's onsite to work with the media.
- Staff from CTM, PARD, Austin/Travis County Health and Human Services (A/TCHHSD) and EMS stepping up quickly and taking on the organization of the FAC and providing needed resources and technology.
- Having knowledgeable staff present during the installation of the Flood Assistance Center was a success.

- Effective community partnerships facilitated in providing critical support services ranging from case management to food assistance, from housing vouchers to bill assistance.
- Setting up fully functional laptop computers that were fully connected with normal AMANDA System to enable onsite permitting.
- Having staff on site at Dove Springs and at the EOC with access to senior management of PDRD and Watershed Protection focused attention early on the need of an interim policy to deal with life safety building permits.
- NHCD through its existing contractual services and business partnerships with nonprofit agencies, to include affordable housing providers, was able to connect residents with services in a relatively short amount of time.
- Co-locating critical departments at the FAC enhanced coordination which expedited service delivery to residents particularly as it relates to identifying single and multifamily housing.
- Regional and local response equipment was utilized for temporary command post and resource shelter areas. This included assets from the City of Austin, Travis County Sheriff's Office and the Round Rock Police Department.
- Issuance and use of radios to communicate at the FAC.
- Shower Trailer set up and preparation. Building Services Department (BSD) had the shower trailers set up and ready for operation within 12 hours of EOC request to deploy.
- BSD staff supported the administrative and logistical needs during the hours of Shower Trailer operations. Also the BSD Trades provided on-going checks, services and maintenance to ensure reliability of trailer systems.
- Community Services staff responded to the FAC to provide case management, which was the most labor intensive service provided by A/TCHHSD. In addition to staff members who normally work as case managers and social workers, other staff members with no case management experience were called in to assist.
- While the FAC closed on November 15th, as of the date of this report, case management continues to be provided to residents affected by the flood.

3.4.2 What Needs Improvement

- The City needs to improve its ability to rapidly set-up and operate a remote assistance center including: the early identification of the center location, pre-positioned furnishing and equipment, IMT staffing, security, appropriate agency staffing and pro-longed operations.
- Need pre-identified shelter setup kits with technologies, hardware, tents, tables, office equipment, etc.
- Need lifecycle replacement of laptops, printers and network equipment that is designated for emergencies. The existing equipment was grant funded and is reaching end of life.
- Engaging Information Technology (IT) experts to design a database that can be used in future events to track client information.

- Although NHCD can skillfully develop housing options for individuals in search of housing options, staff is not trained in the very specific role as housing navigator. This type of expertise is needed on-site to assist in future disaster response operations.
- Need support from other City IT departments during major emergencies to provide additional staffing and resources.
- At sites like the FAC, need to establish an IT lead to report to the Logistics Chief. The IT lead should attend command briefings to better understand needs and set expectations.
- An awareness of what equipment and supplies might be available from other City departments would reduce the need for emergency "spot" purchases, saving time and money. Items such as printers, network cables and additional laptops
- A daily Incident Action Plan (IAP) should be implemented on day one.
- Need to have participating agencies report activity (citizen counts, referrals, permits, etc.) starting from day one.
- Need to improve the information provided to the EOC about the operations of the FAC and various DOC's
- Difficulty of department field FAC representatives having to be physically present in the EOC each morning for briefings and at the same time having operational responsibilities at the FAC that needed attention at the same time.
- The inconsistent availability of or access to volunteers overworked PARD and other City staff at the FAC.
- Standardized situational information for each City Department will be identified and reported to: 1) the EOC if activated, or 2) the HSEM Duty Officer if it indicates a potential change to their normal operations.
- All DOCs, the FAC, etc., must prepare Situation Reports (SitReps). All SitReps must include metrics that are identified at the start of an incident and maintained in each report. The Planning Section should develop from these SitReps, as needed, reports that are maintained with the most updated information.
- Compile a list of A/TCHHSD staff skills/credentials and create case management strike teams.

♦ 3.4.3 What Didn't Work

- Staff was forced to rely too heavily on personal cell phones for communications.
- Food arrangements for remote staff were not well thought through, requiring some staff members to have to leave Dove Springs to procure food and return daily.
- According to NHCD, a significant challenge was the inability of the nonprofits to take on additional cases that required intense case management even if funding could be identified.
- Inventory Control: There was no initial inventory control when equipment was deployed.

- The Flood Assistance Center and Sheltering Operations should be in separate facilities.
- Signs directing people to specific areas on the FAC complex were either non-existent or non-effective.
- Visual Situational awareness was non-existent. Consider the deployment of remote cameras in the future as technology is refreshed.
- Establish triggers that activate A/TCHHSD Memorandums of Understanding with community partners.
- Develop a single intake process for case management and referrals to social services.

3.5 Volunteers (Recruitment, Management, and Safety)

Departments within the City of Austin (COA) utilize a web-based, online Volunteer Management System (VMS) called Volgistics to recruit, manage, track, and coordinate volunteers who support the departments' activities and efforts.

Volgistics supports the daily operations of City departments as well as the City's response to disasters and emergencies. The system allows administrators to recruit and schedule volunteers and to maintain accurate records of services provided by volunteers. The interactive system also allows volunteers to sign up for tasks and to record the time worked online.

Figure 6 - Volunteer Management Plan

3.5.1 What Worked Well

- Safety training and equipment provided to all employees at the beginning of each shift.
- Neon safety vests along with other precautionary and safety equipment (bug spray, sunscreen, water, etc.) was available.
- Organizers ensured that everyone was well briefed and had the Personal Protective equipment necessary. Safety ranked high on the priority list.
- Volunteer groups were able to travel into affected areas to provide information, deliver food, dispense water and cleaning supplies, etc.
- Efficient and cooperative response from departmental staff in coordinating recruitment of volunteers. High response of employees willing to volunteer in bad weather conditions.
- HRD identified employees with bilingual communication skills and provided orientation to each shift of volunteers consisting of clear directions and duties.
- Leadership "on the ground" was organized and worked well together, having employees contact information available, supplying maps of affected areas and establishing a staging area at a City park for volunteer coordination and resources.

- Code Compliance staff was available to help determine if areas were safe to enter.

- 3.5.2 What Needs Improvement
  - The recruitment of volunteers to assist with this response did not fully follow the EOC SOG or make effective use of Volgistics.
  - The management and training of volunteers did not fully follow the City of Austin Volunteer Management SOP.
  - Corporate Safety representatives were not fully utilized with volunteers or field operations.
  - Improve the management of and communications to volunteers assisting with an incident.
  - Improve the training and scheduling of volunteers using Volgistics, the software used by the City for volunteer management.
  - Volunteer coordination: Since many of the organizations providing services at the FAC also had volunteers in the affected area, there should have been a decision earlier in the process to add incident command staff to coordinate all the volunteers.
  - Due to the nature of the emergency and unforeseen needs, volunteers were unaware of the specifics of their assignments prior to the first shift.
  - Providing departments' better notice when seeking volunteers.
  - Utilize volunteer psychologists and/or social workers to be part of the teams going into affected areas.
  - Develop groups of employees within departments that have already agreed to respond to disasters or other serious incidents instead of trying to locate those employees when the need is critical.
  - Providing a tent at the staging location to adequately provide support, equipment and materials.
  - Having a megaphone to facilitate delivery of orientation information to large groups.
  - Too much time was spent mobilizing which impacted actual productive work.
  - Some groups became separated and it was difficult to reconnect. In addition, some teams overlapped in certain areas.

- 3.5.3 What Didn't Work
  - Contacting non-government organizations such as Volunteer Organizations Active in Disaster (VOAD), the Austin Disaster Relief Network (ADRN), and other national volunteer organizations after they did damage assessment on their own, made it difficult to coordinate volunteer efforts, since many of these organizations covered the same area. Need to make contact with them on day one, before they deploy resources to the affected area.
  - There was only one shift that was requested to assist in moving items and debris from front doors to curbside. Fire and non-sworn employees were not provided masks. This created a safety concern that caused coordinators to end such work immediately.

- Some non-emergency responders were emotionally distraught from the experience.
- It was difficult to hear instructions at initial meeting site.
- Requiring employees to perform labor-related duties without an appropriate assessment of physical conditions.

3.6 Field Operations (Response, Sheltering, Debris Management, Recovery)

The Field Operations focus area encompasses those specific actions related to the sheltering of displaced persons, the management of debris resulting from the incident and the recovery activities associated with the return to normal operations for residents, responder agencies as well as critical infrastructure. Additionally, this focus area includes certain response activities undertaken by certain departments/agencies.

Figure 7 - Debris Removal

3.6.1 What Worked Well

- Proper and functional rescue equipment for swift water and flood operations.
- Having proper equipment deployed at the right time and right place, and utilized in an efficient manner.
- Austin Energy personnel demonstrated great effort and resourcefulness in re-routing electricity from the Bergstrom Substation to restore service to the South Austin Regional Wastewater Treatment Plant (SAR).
- Public Works Department demonstrated great dedication quickly to make Fallwell Lane safe for vehicular traffic.
- Attitude of the crews, working in adverse conditions with a solid team approach to accomplish the mission.
- Departments working together to share equipment and operators. Proper utilization of skill sets of personnel on task assignments.
- Despite the hazardous conditions and long work hours, AWU personnel worked injury-free throughout the flood response.
- The rapid relocation of rescue resources by field command staff in response to a rapidly evolving situation.
- Deployment procedures resulting from continued discussions between public safety agencies within the City and County.

- Animal Services Office field services and shelter staff were available to respond. The Austin Humane Society (AHS) provided a large animal transport vehicle to move animals from the scene to the shelter site at AHS.
- Supplies and protocol for standing up animal shelters at remote human sheltering locations is proven and deployed smoothly. Pet sheltering volunteers are well trained.
- Volunteers at pet shelter location ensured pets were well cared for so victims could focus on recovery. Officers "delivered" pets back to their owners as needed to accommodate for lack of personal transportation of owners.
- APD quickly established a Command Post within a few blocks of the affected area where command staff could deploy visible police patrols and restricted access until the resident re-entry phase began.
- APD negotiated with its contracted towing company to reduce, and in some cases, eliminate the cost of storage fees for vehicle owners.
- The APD two-phase traffic control re-entry plan was created to control pedestrian and vehicular re-entry by residents and representatives into the affected area. Procedures were implemented to check and record identification/credentials of all persons entering the area.
- Fleet Services Department (FSD) expanded operating hours at four different FSD facilities to meet additional service demands.
- FSD dispatched Field Repair Support Teams and mobile fueling assets to respond to support department requests.
- PWD Infrastructure Management Division staff assessed the condition of roads and bridges impacted by the flood to determine their sustainability.
- The berm around Sand Hill Energy Center (SHEC) prevented flooding issues at the Plant itself.
- All AE personnel were able to maintain communication and work safely during the incident.
- Watershed Protection Department FEWS on-call staff activated well in advance of the storm the afternoon of October 30 based on weather reports from the NWS. Up until midnight, the FEWs forecast models worked well.
- Gate arms and warning lights at low water crossings functioned properly.
- Travis County Purchasing Office's open contract with Grainger allowed Travis County Constables to quickly obtain needed supplies and equipment.
- STAR Flight Aircraft and Equipment worked well. Onsite STAR Flight management provided logistical support to crews and created a beneficial buffer between crews and communications when there were multiple requests to the same locations (Spicewood Springs) or high priority calls.
- CCD's utilization of all-terrain vehicles (ATV's) assisting with rescues, navigating the area etc.
- Austin Fire Department's establishment of Unified Command allowed for multi-agency communication and organization of the incident.
- The AFD Operations Division Chief separated incidents throughout the city of Austin and Travis County Authority Having Jurisdiction (AHJ) into five

major incidents geographically with divisions which made the activities much more manageable.

- Austin 3-1-1 provided bilingual staffing at the FAC.
- Daily teleconference calls were held to assure successful communications and to schedule staffing as needed.
- All units had and utilized swift water personal protective equipment.
- Disease surveillance and infection control conducted at the FAC shelter.
- The ability to provide 313 immunizations quickly, including TDaP, Adult Hepatitis A, and Influenza.
- The ability of the Office of Vital Records to provide 229 free birth certificates.
- Public education materials were readily available in Spanish as well as Spanish-speaking staff.
- The implementation of a CASPER (Community Assessment for Public Health Emergency Response).
- The notification of TNR After Hours Response Teams (ART) crews and the response provided by TNR crews to re-open and repair roadways. TNR had the necessary materials, equipment and human resources to make the roadway repairs in the shortest time possible.

3.6.2 What Needs Improvement

- Numerous issues with debris removal were identified, including: Better communication (briefing/debriefing) with field crews; issuance of appropriate Personal Protective Equipment; better traffic (vehicle and pedestrian) control; and, assign areas slated for clean-up clearly and ahead of crew deployment.
- Sheltering operations did not fully follow Annex C – Shelter & Mass Care or EOC SOG.
- The City needs to develop a process to provide additional: transportation, fueling operations and qualified drivers during a large scale event.
- A number of difficulties were encountered with the removal of animal carcasses.
- Numerous challenges in the identification and acquisition of alternate housing options for impacted residents were encountered.
- Field operations involving multiple departments or agencies should be better managed and coordinated.
- City Departments serving on the Debris Removal Planning Task Force did not fully implement the operational concepts in Annex X – Debris Removal.
- APD field command post lacked computer access in the early stages of deployment and therefore did not have the ability to monitor, access, or update WebEOC.
- APD air support units unable to assist with rescues or evacuations because they are not equipped for such operations.
- Fleet Services has identified the need to train and license additional HAZMAT qualified drivers from other city departments to assist during emergencies.

- ARR experienced difficulties in maintaining the same level of service in all affected areas, including the ability of private contractors to meet City needs.
- Keeping spectators and scavengers out of the affected area.
- Shower operations could be better managed by providing tents, chairs and tables that would allow staff to receive customers, issue supplies and provide seating while in the queue for the showers.
- Early coordination by FAC with Red Cross to provide shower supplies to the shower operations staff for distribution to people using the shower trailers.
- CCD Inspectors need equipment to protect themselves from aggressive dogs.
- The FEWS Onion Creek flood forecast model uses several of the USGS gauges as boundary conditions. For instance, USGS gauges in Williamson Creek, Slaughter Creek, and Onion Creek are all used as inputs into the forecast model for lower Onion Creek.
- Starting just after midnight on October 31, the FEWS flood forecast mapping computer server stopped functioning properly.
- Animal Services is not clear on their scope of authority in a first responder situation; better coordination and clearer communication is needed with public safety agencies. Support is needed from APD, specifically in this case by assisting with horse trailers and tack.
- Choosing Capital Areas Shelter Hub Plan (CASH-P) approved sheltering sites would be better than ad hoc churches and recreation centers. Parker Lane and Dove Springs were not vetted, and not ideal, for pet sheltering.
- Process for notification of and request for regional and state water rescue assets.
- Conduct additional joint swift water training.
- Travis County needs to develop a policy to address private property clean-up and funding should be appropriated to address disaster events.

♦ 3.6.3 What Didn't Work

- Fleet Services is not staffed or equipped to provide transportation assets with drivers in these types of incidents. FSD managers were required to act as drivers during this emergency which was an inappropriate application of staff.
- Alternative methods of accessing Sand Hill and Onion Creek substation need to be reviewed and implemented to increase accessibility options during emergencies.
- The flooding of Onion Creek took out the Onion Creek electrical substation, cutting off all electrical power to South Austin Regional Wastewater Treatment Plant (SAR).
- Establish an alternate access roadway into SAR. The flooding and subsequent damage to Fallwell Lane isolated the plant from needed resources.
- Lack of field facilities for crews. A mobile crew support trailer would have been helpful for field responders to eat, drink water, and charge cell phones.
- Workers assigned to debris response should receive vaccinations against diseases that they may come into contact with during the response.
- Household Hazardous Waste was not separated from regular garbage.

- Water rescue 911 calls were not all triaged correctly. Specialized resources (boats and helicopters) were dispatched to calls that were a low priority and would not have warranted a boat or helicopter response.
- The current AMANDA system used by CCD for case management was not designed for emergency response and caused significant case management problems.
- Communication about shelter location transition from Parker Lane to Dove Springs failed. Transition from Parker Lane to Dove Springs was very rough; people and pets arrived at Dove Springs before the animal sheltering area was set up.

3.7 Plans and Procedures

Figure 8 - City of Austin Recovery Plan

The City of Austin Recovery Plan (Annex J) defines responsibilities, establishes a recovery organization, defines lines of communications, and is designed to be part of the City of Austin Emergency Management Program. This plan will be updated with information from this incident, and information obtained from the Federal Emergency Management Agency (FEMA) Austin/Travis County Community Specific Integrated Emergency Management Course conducted in Emmitsburg, Maryland. Additionally, the EOC Standard Operations Guidelines (SOG) Plan will be updated as a result of information obtained from this incident.

♦ 3.7.1 What Worked Well

- NHCD and HHSD implemented a social services/case management response procedure model to address emergency events. The model requires that all intake activity be channeled through the A/TCHHSD case management intake process so that a comprehensive assessment can be administered for each resident.
- Through coordination with 3-1-1, a disaster relief referral process was implemented so that residents in need of social services were directed to the A/TCHHSD case management phone number by calling 3-1-1.
- The Law Department exhibited good working familiarity with the City's Emergency Operations Plan (Basic Plan), specifically the department's

responsibility to carry out enumerated functions; and exhibited good working familiarity with the departmental policies and procedures.
- Having CCD Officers accompany FEMA teams throughout the affected area.

- 3.7.2 What Needs Improvement
  - All plans, procedures and annexes cited in this AAR or used in this response should be reviewed, revised and updated as appropriate.
  - All Departments should submit for legal review their policies and procedures related to long-term recovery issues, prior to dissemination to the public.
  - Annex E – Evacuations and Appendix F – Re-entry of Annex J should be revised and updated as needed.
  - Departments should review and implement FEMA guidelines and procedures where applicable.
  - A policy and process needs to be developed and implemented which establishes a badging system to identify and authorize mission critical responders to enter areas that are restricted but don't pose an immediate danger to life and health.
  - Develop and implement a policy and process for use of air resources during EOC activations.
  - CCD's damage assessment criteria did not coincide with FEMA's criteria.
  - All Departments need to ensure that COOP plans are updated and exercised regularly to ensure that contact information, "go kits", etc. are ready at a moment's notice.
  - Update the EOC SOG plan and use it for all EOC activations.
  - Update the Recovery plan with information from this incident, and information obtained from the FEMA Austin/Travis County Community Specific Integrated Emergency Management Course conducted in Emmitsburg, Maryland.
  - Have a Recovery Coordinator on staff before the FEMA Kickoff Meeting.
  - Create a planning group to put together some procedures related to how to trigger a mandatory evacuation as well as re-entry procedures.
  - City needs to assess the need for calculating the long-term cost of disasters.
  - Develop Timelines/Gantt Charts and additional training for implementing the Disaster Recovery Plan.
  - AFD will implement a proactive staffing plan for water related events that would allow AFD to pre-position water resources in opportune areas based on finite metrics provided by weather forecasting, command level experience, and situational awareness of affected communities.

- 3.7.3 What Didn't Work
  - Need to develop a policy to deal with life safety building permits.
  - The Austin Financial Services Department needs to develop a policy to address the reimbursement of departments that serve as Logistics Section Chief in the EOC and use their Procard to make purchases.

- The Austin Financial Services Department needs to identify and assign the appropriate management staff to be trained and serve as Finance Section Chief during EOC activations.
- CCD did not have an emergency response plan to address large scale emergency events that require mass damage assessments.
- There is no plan in place to evacuate or perform search and rescue for horses and other livestock.

4.0 Conclusion and Next Steps

This was a major incident for all responder agencies, many Austin/Travis County residents and the City and County as a whole. Recovery will take years. It has taken a toll on all those impacted.

The Austin/Travis County Health and Human Services Department (A/TCHHSD) was concerned about the potential ongoing public health impact of the flooding. To address that concern, a community assessment was conducted approximately two weeks after the start of the heavy rains/flooding with residents living in the most heavily impacted areas. The objectives of the assessment were to determine current and long-term public health needs, community concerns, and to provide local officials with situational awareness.

To accomplish the assessment objectives, A/TCHHSD utilized a Community Assessment for Public Health Emergency and Response (CASPER) methodology. CASPER is an epidemiologic technique designed to provide household-based information about an affected community's needs after a disaster and with minimal resources. The sample survey is designed to represent a cross-section of the affected community and includes responses from residents who had minor and major damage to their homes. These are door-to-door household surveys. The survey results provide information that is shared with the disaster response and community officials to improve service delivery and response actions.

Several issues were noted as the result of the survey.

- Although the community is well on the way to recovery, individual households and individuals still require assistance for such basic necessities as food and shelter.
- The lack of "official" evacuation notification was a significant issue in the community.
- Several households noted the need for more consistent guidance from the City of Austin regarding permit requirements, as was the need for an explanation of the red and yellow tags placed on damaged houses early in the structural assessment process.
- The safe use of generators and gas/charcoal stoves remains a challenge in every disaster.
- Consistent messaging is vital. The variety of information sources used by residents in the affected area creates a challenge for those providing the information to both coordinate the message(s) and to ensure the correct messages are sent through a variety of methods and reach a dispersed population. Messages must also be provided in multiple languages.

- Based on comments from the survey, there was confusion among some residents as to whether they should have boiled their drinking water after the flood and/or whether an official boil water notice had been issued.
- Using community groups and home owner associations can be an invaluable resource for distributing information and providing insight into the community they serve.
- The interruption of mail service affected the delivery of medication for one household.
- The community was very complimentary of the debris removal services to date. Several households, however, were not sure how long the services would be available and asked for more information.
- The community was also very complimentary of the volunteer response.
- While many of the surveys were completed without requiring language translation, the use of a language translation service via the telephone proved to be a viable resource in the absence of a Spanish-speaking surveyor in this assessment effort.
- Residents noted pets as one of the challenges during evacuation. One resident chose not to evacuate because of pets.

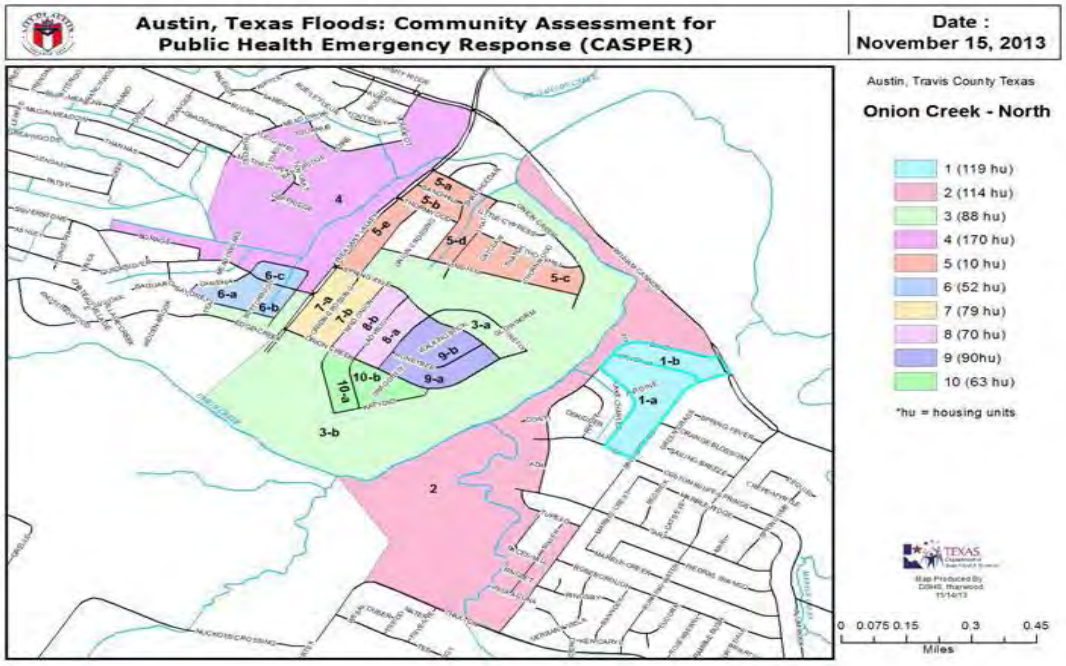


Figure 9, Map of CASPER Survey Area, Onion Creek

Public Health Recommendations

1. The City and County need an effective, urgent, and accurate evacuation notification system for high risk areas, with back-up plans and alternate methods of notification.
2. Consistent and coordinated health and safety messages across government and volunteer organizations.
3. Consistent and sustained communication from the City of Austin regarding debris removal schedules and the permitting process for rebuilding and renovation.

4. Consistent and sustained communication regarding the potential buy-out of homes in the affected area.
5. Increased awareness of the multiple methods currently used to receive medications (mail delivery).
6. Community health assessments should be coordinated through a single ESF- 8 contact. Although the residents appreciated the number of volunteers and contacts that were made over the past two weeks, coordinating community services among agencies and volunteer organizations would maximize limited resources, decrease the likelihood of duplicative efforts, and ensure the broadest range of information would be shared among response groups. This would help focus and prioritize relief efforts. To help coordinate assessments in future disaster response, ESF 8 may consider, in working with agencies and volunteer organizations, developing an inventory of agencies that conducted assessments, the objectives of these assessments, and when those assessments are typically done.
7. Early and sustained engagement with community groups for community needs assessments.
8. Enhanced sharing of GIS information across public health agencies. Work toward shared access of critical information prior to the next disaster.
9. Encourage all households with pets to develop an emergency plan for the pets and include that in their family emergency plan.

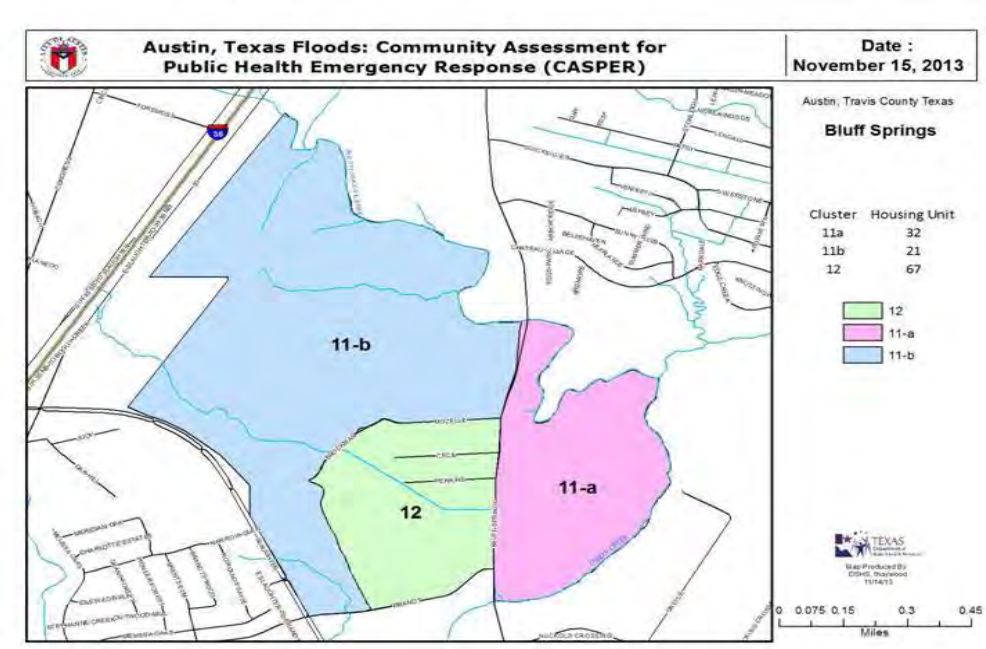


Figure 10, Map of CASPER Survey Area, Bluff Springs

Austin Fire Department's (AFD) analysis of the Halloween Flood identified four areas of service delivery enhancement which are already in the planning, beginning, or implementation stages:

1. Implement a proactive staffing plan for water-related events, including boat resources and location.
2. Implement a community outreach plan to educate the community on AFD action plans at water-related events.
3. Vet information from the Emergency Operations Center and the Department Operations Center prior to dissemination to the field.
4. Implement an area command at large-scale incidents followed by formal notification through the chain of command.

Figure 11, Map of AFD Incident Command along Onion Creek

In response to some of the challenges faced during the Halloween Flood, the Austin Police Department (APD) recently revised its DOC Standard Operating Procedures in order to ensure the following:

- Clear command and control for incidents.
- Enhanced communications technology introduced to allow faster decision making by the Incident Commander.
- Required IAPs for each operational period to ensure objectives meet real-time needs.
- Clear Command staff rotation to ensure a timely response to incidents.

As a result of this incident and others, APD Command Staff and their support officers' use of WebEOC has grown exponentially.

Summary of USGS "hardening" Work

FEWS staff is working with the USGS to "harden" USGS gauges that provide data to the flood warning group. The goal of gauge hardening is to make the gauges more flood resistant so they

continue to operate under more extreme flooding conditions. However, gauges have to monitor water levels and that means that equipment has to be installed at the bottom of the creeks. This makes them susceptible to damage from flood debris and bridge failures even in extreme storm events.

The USGS and City of Austin have a long-term contractual agreement to have the USGS provide full range rating stations (flow and depth monitoring gauges) as well as perform water quality sampling at specified locations within the City. After the Halloween Flood, when the Twin Creeks gauge was damaged and the US 183 gauge stopped reporting, the City entered into a single purchase contract with the USGS to provide "hardening" to four of its gauges. The "hardening" of gauges means the following:

- There will be two types of monitoring equipment installed in the creek. This will include bubbler lines and a pressure transducer (used to determine water depth by measuring pressure). One bubbler line will be down in the channel specifically to measure water depths for low flow situations. A second bubbler line will be up higher and in a more secure location. This line will ensure water depth measurements at high levels even if debris damages the lower bubbler line. A pressure transducer will be installed at the bottom of the creek channel for redundancy in the event the lower bubbler line is washed out.
- The gauge housing (metal box with equipment) will be elevated at least to the 100-year flood level and also above the bridge deck. This will ensure that the equipment in the housing (the data logger and communication equipment) will be less susceptible to high flood levels, even if flood waters overtop the bridge deck.
- The data logging equipment inside the housing will be connected to two different types of communication equipment to provide redundancy in transmitting data. The two types of equipment are radios (communicates every 5 minutes) or by satellite (every hour).
- The USGS will update their gauge Web site for these gauges to include a line on the graph at the elevation of the gauge equipment. In the event the water level graph is shown above the elevation of the equipment, then users of the data will be aware that the data provided by the gauge might be erroneous.

The four gauges to be "hardened" under the current contract include: Onion Creek at US Highway 183; Onion Creek at Twin Creeks Road; Williamson Creek at Manchaca; and Shoal Creek at 12th Street.

FEWS and USGS will assess the additional "hardening" of existing gauges and placement of new USGS gauges during the scoping process with the USGS for the next long-term service agreement. It is anticipated that the new service agreement will be prepared for review by Council towards the end of this fiscal year.

Summary of Home Buyout Program

The Watershed Protection Department (WPD) has partnered with the U.S. Army Corps of Engineers (Corps) since 1999 to find solutions to flooding in the Onion Creek watershed. A joint

study ultimately recommended a project to buyout 483 homes in the 25-year floodplain within the Onion Creek Forest, Onion Creek Plantation, and Yarrabee Bend neighborhoods; restore the riparian woodland habitat along Onion Creek; and convert the area to a park. The study selected the homes due to their high risk of flooding. These neighborhoods were evacuated in 1998, 2001, and again in the Halloween Flood of 2013.

The Corps project designated funding to be shared 35% locally and 65% federally. The latest draft cost estimate reflects a cost share for the City of $25.5 million and a federal share of $44.3 million. The U.S. Congress authorized the project in 2007 but, until recently, funding had not been approved for this project in the annual federal budget. In March 2014, $11.8 million of funding was approved for the Corps project in Austin and Travis County. The details of the partnership agreement with the Corps and the division of funds between the City and the County will be worked out in the coming months.

At the time of the Halloween Flood, the City had already purchased 323 homes in the Corps project area and relocated their occupants to homes safe from flooding. This greatly reduced the number of people and homes at risk during the recent flood. The total cost of these buyouts was approximately $36.5 million, exceeding the City's cost share for the project. Funding came from a $7.8 million FEMA grant, the Drainage Utility Fee, the Regional Stormwater Management Program, and the 1998 and 2006 Bond Programs.

The neighborhoods of Onion Creek Forest, Onion Creek Plantation, Yarrabee Bend and Silverstone sustained the most damage during the Halloween Flood and are the areas with the most significant flood risk in the City of Austin. There are 531 residences at risk of flooding in the 100-year floodplain in these neighborhoods, and WPD plans to relocate all of the residents to homes safe from flooding. Immediately after the 2013 Halloween Flood, WPD put together the Recovery Buyout Program to purchase 116 homes to avert the rebuilding of homes within the Corps project area that were substantially damaged or destroyed during that flood. Funding for the emergency buyouts came from cost savings from completed projects and reprioritization of a small number of Capital Improvement Projects (CIP). As of March 5, 2014, appraisals have been completed for 112 homes; 88 offers have been made on the appraised homes, 65 offers have been accepted and the City has closed on nine homes. WPD anticipates making all offers by early April 2014.

In addition to the 116 homes in the recovery buyout area, there are an additional 44 homes in the Corps project area for which buyouts are currently unfunded. The City's share of the new Corps funding may be used to begin the acquisition process for those remaining properties in the Corps project area.

Outside of the Corps project area, there are 371 homes remaining in the 100-year floodplain within the Onion Creek Forest, Onion Creek Plantation, Yarrabee Bend and Silverstone neighborhoods. Many of them sustained heavy damage. WPD has recently submitted a Hazard Mitigation Grant Program (HMGP) grant application to request funding to purchase up to 37 homes outside the Corps of Engineers buyout area. The scope of this application is based on the availability of HMGP funds that FEMA has released due to the presidential disaster declaration

for the Halloween Flood. WPD also continues to explore other opportunities for funding buyouts for these homes.

Travis County has purchased 124 homes in the Timber Creek neighborhood since the 1998 floods. From 1999 - 2005 the County used FEMA grant funds through the HMGP and the Pre-Disaster Mitigation program (PDM) for buyouts. In 2005, the County began buyouts in Timber Creek in partnership with the U.S. Army Corps of Engineers (USACE) and the City of Austin. The USACE projects were designed to address the recommendations made by the USACE in its study of the Onion Creek Watershed. In addition to federal grants, Travis County voters approved $6.0 million in bond funds for buyouts in 2005 and another $2.75 million in 2011, to purchase properties in Timber Creek, Thoroughbred Farms, and Quiette Drive. Since the Halloween Floods, the County has received 74 applications for flood-related buyout. Offers have now been made to all property owners who sustained major damage in the Halloween Flood. An application for FEMA grant funds to buy the remaining residential buyout applicants is being prepared for submittal to the Texas Division of Emergency Management this Spring 2014.

Long-Term Recovery

Austin/Travis County Health & Human Services Department's (A/TCHHSD) case managers are providing case management to 40 families affected by the flood. These families have various needs including housing, legal issues, health and mental health concerns, utility assistance, furniture and food assistance. Families also identified a need for assistance to navigate the complex processes involved in the buyout of some properties, mortgage deferment, and other issues. Neighborhood Housing & Community Development (NHCD) continues to work closely with A/TCHHSD social services case management staff to serve as a resource to address housing assistance identified by impacted residents in the City of Austin.

NHCD continues to work with community partners and entities involved in the long-term recovery planning discussions. The department is working with VOAD to explore how best to provide services in the more comprehensive community dialogue underway to identify a long-term framework. In addition, the department is working within its existing programs to address the needs in the Dove Springs area. Funding in the amount of $1 million has been dedicated through the GO Repair! Program, which will help to alleviate risk to life, health or safety for eligible homeowners and their families.

Following the flood incident, the City of Austin approved the issuance of a minimum life-safety building permit to allow for minimum standards repairs which included the replacement of pre-existing interior sheetrock, insulation, electrical wall plugs, doors, water heaters, and heating and cooling units. The permits also included repair and/or replacement of pre-existing exterior heating, ventilation & air conditioning (HVAC) components and front and/or rear doors.

Travis County Health and Human Services & Veterans Service (TCHHS/VS) also staffed the Flood Assistance Center. After the FAC closure, the TCHHS/VS social workers then provided services to those families who were deemed eligible for other basic needs services at our Emergency Assistance Centers.

NHCD is committed to the long-term recovery efforts underway and will continue to seek ways to bring available resources to the Dove Spring neighborhood.

WPD staff continues to work with FEMA regarding debris removal, grant funding for home buyouts, and floodplain permitting requirements.

Following the Presidentially Declared Disaster for Public Assistance, WPD has been working with HSEM, other departments, and FEMA to establish the process for debris cleanup along the City's creek system as a result of the Halloween Flood.

The Watershed Engineering Division, in coordination with HSEM, has applied for a Hazard Mitigation Grant from FEMA to provide money to expand the City's home buyout program beyond the existing Corps project area. However, even if this grant is awarded, hundreds of homes will still remain at significant risk for flooding in the Onion Creek area.

In addition, WPD staff is working with FEMA to ensure that the City's permitting process for flood damaged homes is in accordance with the City's and FEMA's floodplain regulations.

HSEM is directing long-term recovery activities for the City through the Recovery Coordinator. An employee has been hired to assume the responsibilities of the Recovery Coordinator. The Recovery Coordinator is working under the direction of the Director of HSEM. The specific responsibilities of HSEM and the Recovery Coordinator during the long-term include, but are not limited to:

- Serving as the liaison between departments/agencies and all State and Federal disaster recovery agencies;
- Ensuring all documentation gathered by each department on expenditures and damage is in the proper format for review by the State and Federal inspectors;
- Coordinating with the Departmental Point of Contact concerning site inspections by the State and Federal disaster recovery inspectors;
- Reviewing all Project Worksheets prepared by the State and Federal inspectors for accuracy, either concurring with their recommendations or generating a letter of non-concurrence;
- Maintaining accurate records of project sites, including copies of the Project Worksheets, applicable photographs and other documentation;
- Archiving all disaster recovery files with the appropriate department following the conclusion of the disaster period; and
- Managing the State or Federal single audit of the disaster.

5.0 Corrective Action Plan (CAP)

Those items listed on the CAP Spreadsheet in Appendix 1 have been assigned to the appropriate personnel within HSEM, TCOEM, and other departments/agencies for necessary action and/or will be called upon to assist with the correction of the identified deficiency.

A due date along with a primary contact has also been identified for each item. The correction of the items contained on the spreadsheet in Appendix 1 will encompass a wide assortment of actions ranging from simple changes to existing policies or procedures, to major expenditures for budgetary considerations.

Even in the best managed incidents there are always lessons to be learned and areas where professionals can concentrate on improving their response capabilities. This incident is not any different. Based on the comments received during the AAR, a Corrective Action Plan (CAP) has been created. This CAP includes the most prominent issues identified as needing attention in the AAR. The CAP has assigned appropriate personnel/agencies to address these issues, along with a timeline. The implementation of the issues identified in the CAP will be monitored and tracked by HSEM and TCOEM. The Directors of HSEM and TCOEM will ultimately be responsible for ensuring the items in the CAP are addressed.

Appendix 1 – Corrective Action Plan (CAP)

Action #	Action Description	Due Date	Assigned Dept	Contact	Status
Notifications					
1.1	Clarify to all City, County and Regional stakeholders that the AWACS paging system is, and will remain, the primary notification of EOC activations.	11/07/2014	HSEM/TCOEM	Latin/Baldwin	
1.2	Develop a notification group in FirstCall, the new regional notification system, that can be used to provide City/County management and leadership, elected officials, regional stakeholders, volunteers and responders with updated incident information.	11/07/2014	HSEM/TCOEM	Latin/Cummings/ Guajardo	
1.3	Travis County Constables should have a representative at the EOC to coordinate response from the 5 offices.	11/07/2014	TCOEM	Baldwin	
1.4	No notification of the EOC activation was received by AISD, CPIO, Law, Animal Services Office, Purchasing, the Travis County Medical Examiner or Travis County Constables.	11/07/2014	HSEM/TCOEM	Swearengin/ Guajardo	
1.5	AISD was not notified prior to helicopters landing on their southeast bus terminal grounds.	11/07/2014	EOC Directors/AISD/APD	Latin/Baldwin/Gaete/ Robledo	

Communications					
2.1	Some stakeholder organizations reported receiving "unclear or misinformed guidance," conflicting information," or "lacked points of contact."	11/07/2014	HSEM/VOAD/Tx Gas Service/Red Cross/AISD	Dirr/Appropriate agency reps	
2.2	Need the earlier creation, distribution and use of a communications plan, Form ICS 205 for all responder agencies and organizations.	11/07/2014	EOC Directors	Latin/Baldwin	
2.3	Some staff had to use their personal cell phones for response activities and others reported limited cellular coverage in the affected area.	11/07/2014	Wireless/PDRD/ Purchasing/HRD	Brotherton/Guernsey/ Walsh/Hayes	
2.4	Shorter "stubby" antennas on some portable radios encountered limited coverage issues.	11/07/2014	CTM	Hopingardner	
2.5	The City and County need to improve the ability to timely communicate with and disseminate information to the affected public, including information to non-English speaking populations.	11/07/2014	HSEM/TCOEM/ CPIO/TCPIO	Dirr/Block	
2.6	The City and County need to improve the multi-lingual social media outreach (this needs to be broadened beyond Spanish. Asian languages will be a key area of need).	11/07/2014	HSEM/TCOEM/ CPIO/TCPIO	Dirr/Block	
2.7	The City needs to develop specific messaging targeting flood related topics including, but not limited to: rebuilding process (demolition, cleaning, permitting requirements) & buyouts.	11/07/2014	FEWS/CCD/PDRD/ A/TCHHSD	Shunk/Cooper/ Guernsey/Pichette	

Communications					
2.8	The JIC needs to improve their proficiency with EOC related equipment and tools and needs to pre-identify key information that may be needed during an activation including training in ICS.	11/07/2014	HSEM/CPIO/TCPIO	Dirr/Florance/ Block	
2.9	Continue to improve public outreach/public education efforts, to include specific education on the response to a large scale incident.	11/07/2014	HSEM/TCOEM/ CPIO/TCPIO	Dirr/Guarjado/ Florance/ Block	
2.10	Implement a community outreach plan to educate the community on public safety action plans at water-related events and provide the public information on actions they can take.	11/07/2014	AFD, APD, EMS, TCSO	Evans/Munguia/ Shamard/Hemby	
2.11	Community information meetings should be held according to standard operating procedures.	11/07/2014	HSEM/CPIO	Dirr/Florance	
2.12	Austin Energy field crews were having issues with piggy backing on other calls. Radio Communications during the incident were having issues with the repeaters.	11/07/2014	AE/Wireless	McAfee/ Brotherton	
2.13	The National Weather Service (NWS) flood stage definitions on their Web site do not reflect current conditions.	11/07/2014	WPD/NWS	Shunk	
2.14	Radio transmissions from the rain gauge network were at times delayed up to an hour, decreasing accuracy of FEWS flood forecast computer models.	11/07/2014	WPD	Shunk	

Communications					
2.15	There is a need for a combined Austin/Travis County press release template with a header that includes both Austin and Travis County seals and contact information.	11/07/2014	HSEM/TCPIO	Dirr/Block	
2.16	Any employee, who has contact with the public in person, via the phone or online, should have information to answer frequently-asked questions or at least know to whom the person should be referred.	11/07/2014	HSEM/TCPIO/HRD/ 3-1-1	Dirr/Block/Harry/ Mendoza	
2.17	The City and County should provide handouts with information needed by residents as soon as it's safe to enter impacted communities.	11/07/2014	HSEM/TCOEM/ HRD	Goodman/ Dunn/Harry	
2.18	Travis County provided recovery information to the public via the county website. The County should ensure that all necessary information is included and updated.	11/07/2014	TCOEM/TCPIO	Baldwin/Block	
2.19	SBDP did not have a sustainable plan for maintaining the information on the Get Back in Business website, and had to quickly verify and update the referenced links.	11/07/2014	EDD	Miller	
2.20	Residents were confused about the types of placards that were placed on their homes and the terms used to determine habitability. They did not know what the placards meant or what it required them to do.	11/07/2014	CCD	Cooper	

Communications					
2.21	Many of the street signs washed away which limited directional capability. Another type of signage should have been installed to assist field crews that were unfamiliar with the area.	11/07/2014	ATD	Schatz	
2.22	Public Information Officers (PIO) and the JIC need greater access to subject matter experts and designated on-camera/on the record representatives for media interviews.	11/07/2014	HSEM/CPIO/TCPIO	Dirr/Florance/ Block	
2.23	Work with departments to ensure they have enough trained, fluent Spanish speaking staff onsite.	11/07/2014	HRD	Hayes	
2.24	The City and County need to develop a network of grassroots community contacts to help disseminate critical information and collaborate with other community volunteer organizations to ensure consistency for communication to residents.	11/07/2014	HSEM/HRD/ TCOEM	Goodman/Harry/ Guajardo	
2.25	Departmental Human Resource (HR) staff was responsible for coordinating volunteers, but they did not receive the information until after Department Directors were notified. This resulted in segmented communication that created an increased amount of questions and confusion.	11/07/2014	HRD	Hayes	
2.26	The Finance Section Chief needs to be provided access to the citywide financial and payroll staff distribution lists to facilitate better communications.	11/07/2014	HSEM/Finance Department	Longmore/Hart	

Communications					
2.27	Utilize FirstCall to provide the public with emergency information such as evacuations, shelter in place, etc.	11/07/2014	HSEM/TCOEM/ CAPCOG	Latin/Cummings/ Baldwin/ Henderson	
2.28	Consider use of Austin/Travis County Amateur Radio Emergency Services (ARES) for situational awareness.	11/07/2014	HSEM/TCOEM	Swearengin/Doege	
2.29	The early warning system for Onion Creek did not work.	11/07/2014	HSEM/WPD/AFD	Latin/Cummings/ Shunk/Evans	
2.30	Travis County neighborhood of Bluff Springs was not receiving information being disseminated from the FAC due to a lack of County representation at the FAC.	11/07/2014	TCOEM	Baldwin	
2.31	FEWS staff did not receive reports of flood-related 911 calls directly and could only rely on reports from their Field Operations staff. Therefore, geographic locations of 911 calls in addition to observations from AFD, EMS, and APD were not known to FEWS during the storm incident.	11/07/2014	HSEM/WPD/AFD/ APD/EMS	Latin/Shunk/Evans /Robledo/Shamard	
2.32	There was not an effective way to communicate directly with residents in the affected areas in English and in Spanish concerning the flood, especially as it relates to providing citizens with an enhanced awareness that conditions were worsening.	11/07/2014	HSEM/WPD/AFD	Latin/Shunk/Evans	

Communications					
2.34	Effectively promoting the website www.austinsmallbiz.com/getbackinbusiness was more difficult because information was not up-to-date, physical handouts did not exist, and website URL was confusing to access for end users.	11/07/2014	EDD	Miller	
2.35	The Department of Aviation received very little information on the rising waters from external sources. Most conditions were self-identified by Aviation staff.	11/07/2014	Aviation/HSEM	Madole/Hawkins	
2.36	Establish and communicate to policy makers clear points of contact for them during an event.	11/07/2014	Deputy City Manager/Executive Manager, Emergency Services	Michael McDonald/Danny Hobby	
2.37	Develop a process for ensuring policy makers have current and consistent information to share with the community.	11/07/2014	Deputy City Manager/Executive Manager, Emergency Services	Michael McDonald/Danny Hobby	

Emergency Operations Center (EOC)					
3.1	The use of WebEOC during this activation by EOC representatives, DOCs, and the FAC should be continued. The areas needing improvement include: CTM support, user proficiency, just-in-time training, and resolution of technical issues related to Logistics and Mission Tasking.	11/07/2014	HSEM/CTM/ CAPCOG	Hunt/Cummings/ Warren/Henderson	
3.2	Additional CTM staff should be trained to assist with WebEOC (access privileges, log-ins, passwords, troubleshooting, etc.) when HSEM staff is not available.	11/07/2014	CTM	Warren	
3.3	WebEOC accounts should not be created during an EOC activation except for those stakeholders in the EOC itself who need assistance.	11/07/2014	HSEM/TCOEM	Hawkins/Guajardo	
3.4	For events requiring a significant GIS involvement, a GIS supervisor should be appointed and charged with: developing GIS staffing, prioritizing requests and assisting requestors.	11/07/2014	HSEM/GIS ERT	Hunt/Clark	
3.5	Need to conduct training for EOC representatives on: GIS resources and capabilities, limitations and processes.	11/07/2014	HSEM/GIS ERT	Hunt/Clark	

Emergency Operations Center (EOC)					
3.6	Agencies and organizations with representatives in the EOC did not consistently report key operational components of the agency/organization and any anticipated impact from the incident during regular situational briefings or enter the information that was provided into WebEOC.	11/07/2014	HSEM/TCOEM/PSC /Dept & Orgs as needed.	Latin/Baldwin/Atkins /Reps as needed	
3.7	Key metrics must be identified that can be reported and monitored throughout an event.	11/07/2014	PSC/EOC reps as needed	Atkins/Reps as needed	
3.8	All Emergency Support Function (ESF) 8 responsibilities will be coordinated through the EOC incompliance with Annex H – Health & Medical.	11/07/2014	EOC Directors/ A/TCHHSD	Latin/Baldwin/ Pichette	
3.9	Case management Strike Teams and the triggers for activation need to be established.	11/07/2014	A/TCHHSD	Pichette	
3.10	EOC representatives must have the authority to make decisions for their agency, staff the work station assigned to their agency and remain at the EOC until relieved or the EOC is demobilized.	11/07/2014	EOC Directors	Latin/Baldwin	
3.11	All computers in the EOC should have the same configuration and increased functionality should be explored.	11/07/2014	CTM	Warren	
3.12	Additional City employees need to be identified to assist in the EOC during prolonged activations.	11/07/2014	HSEM and all City Departments	Atkins/Hunt/ Reps as needed	

Emergency Operations Center (EOC)					
3.13	Expand ICS training to non-uniformed staff that may be utilized during a large scale incident. This includes logistics and support staff.	11/07/2014	HSEM/TCOEM	Hawkins/Guajardo	
3.14	The City and County need to develop local Incident Management Teams (IMTs) capable of operating field/remote locations or supporting EOC operations.	11/07/2014	HSEM/TCOEM	Latin/Baldwin	
3.15	Some City utility facilities were adversely impacted by the incident.	11/07/2014	AE/AWU	McAfee/Kennedy	
3.16	The timing of situational briefings caused conflicts with DOCs and FAC.	11/07/2014	HSEM/CTM	Swearengin/ Hopingardner	
3.17	Travis County Constables were having difficulty communicating with EOC staff.	11/07/2014	TCOEM	Baldwin	
3.18	Need to develop a staffing plan for the key positions needed in the EOC when activated.	11/07/2014	HSEM/TCOEM	Latin/Baldwin	
3.19	The Logistics Section needs to have a consistent staff to maintain operational awareness. Logistics staff should remain in the EOC up until deactivation for demobilization purposes.	11/07/2014	HSEM/TCOEM	Latin/Baldwin	
3.20	City Corporate Safety representatives were not fully integrated into EOC operations and activations.	11/07/2014	HSEM/HRD	Atkins/Land	
3.21	The Finance Section Chief should have been activated earlier.	11/07/2014	HSEM/TCOEM	Latin/Baldwin	

Emergency Operations Center (EOC)					
3.22	Identify more members to serve on the GIS team to allow for coverage of multiple operational periods.	11/07/2014	CTM	Hopingardner	
3.23	Improve scheduling of GIS personnel to the greatest extent possible.	11/07/2014	CTM	Jensen	
3.24	City utilities were not able to access certain facilities due to denial of access by law enforcement.	11/07/2014	HSEM/TCOEM/ AWU	Latin/Baldwin/ Kennedy	
3.25	City utilities were not able to access certain facilities due to limited road access.	11/07/2014	AWU/AE/PW	Kennedy/McAfee/ Magana	
3.26	An air operations branch was not set up in the EOC.	11/07/2014	EOC Directors/Aviation/ APD/StarFlight	Latin/Baldwin/ Madole/Munguia/ Ping	
3.27	Clear tracking of road closures was not available.	11/07/2014	HSEM/FEWS/PW/ TNR/CAPCOG	Hunt/Shunk/Magana/ Ward/Henderson	
3.28	Technology limitations prevented a field situational awareness.	11/07/2014	HSEM/CTM/APD	Swearengin/ Hopingardner/ Munguia	
3.29	The EOC should have been fully activated sooner for this incident.	11/07/2014	HSEM	Latin	
3.30	USGS Stream Level Gauge at Twin Creeks was washed out and USGS Stream Level Gauge at 183 temporarily stopped functioning properly.	11/07/2014	WPD	Shunk	

Emergency Operations Center (EOC)					
3.31	The FEWS flood forecast models rely on radar-based precipitation estimates from the NWS and gauge-adjusted radar rainfall estimates from a private vendor.	11/07/2014	WPD	Shunk	
3.32	The Logistics Section was unable to use WebEOC due to technical issues.	11/07/2014	HSEM/CAPCOG	Hunt/Cummings /Henderson	
3.33	Too many users were unfamiliar with WebEOC due to a lack of use.	11/07/2014	HSEM/CAPCOG	Hunt/Henderson	
3.34	GIS staff was overwhelmed by the requests for information associated with the damage assessment teams.	11/07/2014	CTM	Jensen	
Flood Assistance Center (FAC)					
4.1	The City needs to improve its ability to rapidly set-up and operate a remote assistance center including: the early identification of the center location, pre-positioned furnishing and equipment, IMT staffing, security, appropriate agency staffing and pro-longed operations.	11/07/2014	HSEM/CTM/PARD	Shepard/ Hopingardner/Fuller	
4.2	Need pre-identified shelter setup kits with technologies, hardware, tents, tables, office equipment, etc.	11/07/2014	HSEM/CTM/BSD	Shepard/ Hopingardner/Dean	

Flood Assistance Center (FAC)					
4.3	Need lifecycle replacement of laptops, printers and network equipment that is designated for emergencies. The existing equipment was grant funded and is reaching end of life.	11/07/2014	CTM	Hopingardner/ Newman	
4.4	Engaging Information Technology (IT) experts to design a database that can be used in future events to track client information.	11/07/2014	CTM/NHCD	Hopingardner/Giello	
4.5	Although NHCD can skillfully develop housing options for individuals in search of housing options, staff is not trained in the very specific role as housing navigator. This type of expertise is needed on-site to assist in future disaster response operations.	11/07/2014	NHCD	Giello	
4.6	Need support from other City IT departments during major emergencies to provide additional staffing and resources.	11/07/2014	CTM/Departments as needed	Hopingardner	
4.7	At sites like the FAC, need to establish an IT lead to report to the Logistics Chief. The IT lead should attend command briefings to better understand needs and set expectations.	11/07/2014	HSEM/CTM	Shepard/ Hopingardner	
4.8	An awareness of what equipment and supplies might be available from other City departments would reduce the need for emergency “spot” purchases, saving time and money. Items such as printers, network cables and additional laptops	11/07/2014	HSEM/CTM	Shepard/ Hopingardner/ Newman	

Flood Assistance Center (FAC)					
4.9	A daily Incident Action Plan (IAP) should be implemented on day one.	11/07/2014	HSEM	Shepard	
4.10	Need to have participating agencies report activity (citizen counts, referrals, permits, etc.) starting from day one.	11/07/2014	HSEM/Departments as needed	Atkins	
4.11	Need to improve the information provided to the EOC about the operations of the FAC and various DOC's.	11/07/2014	HSEM	Shepard	
4.12	Difficulty of department field FAC representatives having to be physically present in the EOC each morning for briefings and at the same time having operational responsibilities at the FAC that needed attention at the same time.	11/07/2014	HSEM	Latin/Hawkins/ Shepard	
4.13	The inconsistent availability of or access to volunteers overworked PARD and other City staff at the FAC.	11/07/2014	HSEM/HRD/PARD	Goodman/Harry/ Fuller	
4.14	Standardized situational information for each City Department will be identified and reported to: 1) the EOC if activated, or 2) the HSEM Duty Officer if it indicates a potential change to their normal operations.	11/07/2014	HSEM/Departments as needed	Atkins	

Flood Assistance Center (FAC)					
4.15	All DOCs, the FAC, etc., must prepare Situation Reports (SitReps). All SitReps must include metrics that are identified at the start of an incident and maintained in each report. The Planning Section should develop from these SitReps, as needed, reports that are maintained with the most updated information.	11/07/2014	HSEM	Atkins	
4.16	Compile a list of A/TCHHSD staff skills/credentials and create case management strike teams.	11/07/2014	A/TCHHSD	Pichette	
4.17	Staff was forced to rely too heavily on personal cell phones for communications.	11/07/2014	HRD/Purchasing	Hayes/Walsh	
4.18	Food arrangements for remote staff were not well thought through, requiring some staff members to have to leave Dove Springs to procure food and return daily.	11/07/2014	PDRD/HSEM	Guernsey/Shepard	
4.19	According to NHCD, a significant challenge was the inability of the nonprofits to take on additional cases that required intense case management even if funding could be identified.	11/07/2014	NHCD	Giello	
4.20	Inventory Control: There was no initial inventory control when equipment was deployed.	11/07/2014	HSEM	Shepard	
4.21	The Flood Assistance Center and Sheltering Operations should be in separate facilities.	11/07/2014	HSEM	Shepard	

Flood Assistance Center (FAC)					
4.22	Signs directing people to specific areas on the FAC complex were either non-existent or non-effective.	11/07/2014	HSEM/PWD	Shepard/Magana	
4.23	Visual Situational awareness was non-existent. Consider the deployment of remote cameras in the future as technology is refreshed.	11/07/2014	HSEM	Hawkins	
4.24	Establish triggers that activate A/TCHHSD Memorandums of Understanding with community partners.	11/07/2014	A/TCHHSD	Pichette	
4.25	Develop a single intake process for case management and referrals to social services.	11/07/2014	A/TCHHSD/ NHCD	Pichette/Giello	
Volunteers (Recruitment, Management, and Safety)					
5.1	The recruitment of volunteers to assist with this response did not fully follow the EOC SOG or make effective use of Volgistics.	11/07/2014	HSEM/HRD	Goodman/Hayes	
5.2	The management and training of volunteers did not fully follow the City of Austin Volunteer Management SOP.	11/07/2014	HSEM	Goodman	
5.3	Corporate Safety representatives were not fully utilized with volunteers or field operations.	11/07/2014	HSEM/HRD	Goodman/Atkins/ Land	
5.4	Improve the management of and communications to volunteers assisting with an incident.	11/07/2014	HSEM/HRD	Goodman/Harry	

Volunteers (Recruitment, Management, and Safety)					
5.5	Improve the training and scheduling of volunteers using Volgistics, the software used by the City for volunteer management.	11/07/2014	HSEM/HRD	Goodman/Harry	
5.6	Volunteer coordination: Since many of the organizations providing services at the FAC also had volunteers in the affected area, there should have been a decision earlier in the process to add incident command staff to coordinate all the volunteers.	11/07/2014	HSEM/HRD	Shepard/Goodman/ Harry	
5.7	Due to the nature of the emergency and unforeseen needs, volunteers were unaware of the specifics of their assignments prior to the first shift.	11/07/2014	HRD	Hayes	
5.8	Providing departments' better notice when seeking volunteers.	11/07/2014	HSEM/HRD	Goodman/Hayes	
5.9	Utilize volunteer psychologists and/or social workers to be part of the teams going into affected areas.	11/07/2014	HRD/ A/TCHHSD	Hayes/Pichette	
5.10	Develop groups of employees within departments that have already agreed to respond to disasters or other serious incidents instead of trying to locate those employees when the need is critical.	11/07/2014	HRD	Hayes	
5.11	Providing a tent at the staging location to adequately provide support, equipment and materials.	11/07/2014	BSD	Dean	
5.12	Having a megaphone to facilitate delivery of orientation information to large groups.	11/07/2014	HRD	Harry	

Volunteers (Recruitment, Management, and Safety)					
5.13	Too much time was spent mobilizing which impacted actual productive work.	11/07/2014	HRD	Hayes	
5.14	Some groups became separated and it was difficult to reconnect. In addition, some teams overlapped in certain areas.	11/07/2014	HSEM/HRD	Goodman/Hayes	
5.15	Contacting non-government organizations such as Volunteer Organizations Active in Disaster (VOAD), the Austin Disaster Relief Network (ADRN), and other national volunteer organizations after they did damage assessment on their own, made it difficult to coordinate volunteer efforts, since many of these organizations covered the same area. Need to make contact with them on day one, before they deploy resources to the affected area.	11/07/2014	HSEM	Shepard/Goodman	
5.16	There was only one shift that was requested to assist in moving items and debris from front doors to curbside. Fire and non-sworn employees were not provided masks. This created a safety concern that caused coordinators to end such work immediately.	11/07/2014	HRD	Land	
5.17	Some non-emergency responders were emotionally distraught from the experience.	11/07/2014	HRD	Land	
5.18	It was difficult to hear instructions at initial meeting site.	11/07/2014	HRD	Harry	

Volunteers (Recruitment, Management, and Safety)					
5.19	Requiring employees to perform labor-related duties without an appropriate assessment of physical conditions.	11/07/2014	HRD	Land	
Field Operations (Response, Sheltering, Debris Management, and Recovery)					
6.1	Numerous issues with debris removal were identified, including: Better communication (briefing/debriefing) with field crews; issuance of appropriate Personal Protective Equipment; better traffic (vehicle and pedestrian) control; and, assign areas slated for clean-up clearly and ahead of crew deployment.	11/07/2014	ARR/Debris Removal Task Force	Angoori	
6.2	Sheltering operations did not fully follow Annex C – Shelter & Mass Care or EOC SOG.	11/07/2014	HSEM	Swearengin	
6.3	The City needs to develop a process to provide additional: transportation, fueling operations and qualified drivers during a large scale event.	11/07/2014	Fleet/Depts as needed	Walls	
6.4	A number of difficulties were encountered with the removal of animal carcasses.	11/07/2014	ASO/HSEM/APD/ TCOEM	Nobles/Hawkins/ Munguia/Guajardo/ Dunn	
6.5	Numerous challenges in the identification and acquisition of alternate housing options for impacted residents were encountered.	11/07/2014	NHCD/PDRD/WPD/ A/TCHHSD	Giello/Guernsey/ Shunk/Pichette	
6.6	Field operations involving multiple departments or agencies should be better managed and coordinated.	11/07/2014	ARR/Debris Removal Planning Task Force	Angoori	

Field Operations (Response, Sheltering, Debris Management, and Recovery)					
6.7	City Departments serving on the Debris Removal Planning Task Force did not fully implement the operational concepts in Annex X – Debris Removal.	11/07/2014	ARR/Debris Removal Planning Task Force	Angoori	
6.8	APD field command post lacked computer access in the early stages of deployment and therefore did not have the ability to monitor, access, or update WebEOC.	11/07/2014	APD/CTM	Munguia/ Hopingardner	
6.9	APD air support units unable to assist with rescues or evacuations because they are not equipped for such operations.	11/07/2014	APD	Munguia	
6.10	Fleet Services has identified the need to train and license additional HAZMAT qualified drivers from other city departments to assist during emergencies.	11/07/2014	Fleet/Depts as needed	Walls	
6.11	ARR experienced difficulties in maintaining the same level of service in all affected areas, including the ability of private contractors to meet city needs.	11/07/2014	ARR	Angoori	
6.12	Keeping spectators and scavengers out of the affected area.	11/07/2014	APD/TCSO	Robledo/Hemby	
6.13	Shower operations could be better managed by providing tents, chairs and tables that would allow staff to receive customers, issue supplies and provide seating while in the queue for the showers.	11/07/2014	BSD	Dean	

Field Operations (Response, Sheltering, Debris Management, and Recovery)					
6.14	Early coordination by FAC with Red Cross to provide shower supplies to the shower operations staff for distribution to people using the shower trailers.	11/07/2014	HSEM	Shepard	
6.15	CCD Inspectors need equipment to protect themselves from aggressive dogs.	11/07/2014	CCD/ASO	Cooper/Nobles	
6.16	The FEWS Onion Creek flood forecast model uses several of the USGS gauges as boundary conditions. For instance, USGS gauges in Williamson Creek, Slaughter Creek, and Onion Creek are all used as inputs into the forecast model for lower Onion Creek.	11/07/2014	WPD	Shunk	
6.17	Starting just after midnight on October 31, the FEWS flood forecast mapping computer server stopped functioning properly.	11/07/2014	WPD	Shunk	
6.18	Animal Services is not clear on their scope of authority in a first responder situation; better coordination and clearer communication is needed with public safety agencies. Support is needed from APD, specifically in this case by assisting with horse trailers and tack.	11/07/2014	ASO/APD	Nobles/Munguia	
6.19	Choosing Capital Areas Shelter Hub Plan (CASH-P) approved sheltering sites would be better than ad hoc churches and recreation centers. Parker Lane and Dove Springs were not vetted, and not ideal, for pet sheltering.	11/07/2014	HSEM	Hawkins/Shepard	

Field Operations (Response, Sheltering, Debris Management, and Recovery)					
6.20	Process for notification of and request for regional and state water rescue assets.	11/07/2014	EOC Directors	Latin/Baldwin	
6.21	Conduct additional joint swift water training.	11/07/2014	AFD/APD/EMS/ TCSO	Evans/Munguia/ Shamard/Hemby	
6.22	Travis County needs to develop a policy to address private property clean-up and funding should be appropriated to address disaster events.	11/07/2014	TCOEM/TNR	Baldwin/Ward	
6.23	Fleet Services is not staffed or equipped to provide transportation assets with drivers in these types of events. FSD managers were required to act as drivers during this emergency which was an inappropriate application of staff.	11/07/2014	FSD/Depts as needed	Walls	
6.24	Alternative methods of accessing Sand Hill and Onion Creek substation need to be reviewed and implemented to increase accessibility options during emergencies.	11/07/2014	AE/AWU	McAfee/Kennedy	
6.25	The flooding of Onion Creek took out the Onion Creek electrical substation, cutting off all electrical power to South Austin Regional Wastewater Treatment Plant (SAR).	11/07/2014	AE/AWU	McAfee/Kennedy	
6.26	Establish an alternate access roadway into SAR. The flooding and subsequent damage to Fallwell Lane isolated the plant from needed resources.	11/07/2014	AE/AWU/PWD	McAfee/Kennedy/ Magana	

Field Operations (Response, Sheltering, Debris Management, and Recovery)					
6.27	Lack of field facilities for crews. A mobile crew support trailer would have been helpful for field responders to eat, drink water, and charge cell phones.	11/07/2014	BSD/Fleet/PARD	Dean/Walls/Fuller	
6.28	Workers assigned to debris response should receive vaccinations against diseases that they may come into contact with during the response.	11/07/2014	HRD/ A/TCHHSD	Land/Pichette	
6.29	Household Hazardous Waste was not separated from regular garbage.	11/07/2014	ARR	Angoori	
6.30	Water rescue 911 calls were not all triaged correctly. Specialized resources (boats and helicopters) were dispatched to calls that were a low priority and would not have warranted a boat or helicopter response.	11/07/2014	AFD/EMS/STAR Flight/EOC Directors	Evans/Shamard/Ping/ Latin/Baldwin	
6.31	The current AMANDA system used by CCD for case management was not designed for emergency response and caused significant case management problems.	11/07/2014	CCD/CTM	Cardenas/ Hopingardner	
6.32	Communication about shelter location transition from Parker Lane to Dove Springs failed. Transition from Parker Lane to Dove Springs was very rough; people and pets arrived at Dove Springs before the animal sheltering area was set up.	11/07/2014	HSEM	Shepard	

Plans and Procedures					
7.1	All plans, procedures and annexes cited in this AAR or used in this response should be reviewed, revised and updated as appropriate.	11/07/2014	HSEM/TCOEM/All departments	Latin/Baldwin/Dept Directors	
7.2	All Departments should submit for legal review their policies and procedures related to long-term recovery issues, prior to dissemination to the public.	11/07/2014	Law/WPD/ PDRD/Depts as needed	Morgan/Shunk/ Guernsey	
7.3	Annex E – Evacuations and Appendix F – Re-entry of Annex J should be revised and updated as needed.	11/07/2014	HSEM/Depts as needed	Hawkins/Atkins	
7.4	Departments should review and implement FEMA guidelines and procedures where applicable.	11/07/2014	CCD/WPD/Finance/ Depts as needed	Cooper/Shunk/ Herring	
7.5	A policy and process needs to be developed and implemented which establishes a badging system to identify and authorize mission critical responders to enter areas that are restricted but don't pose an immediate danger to life and health.	11/07/2014	AWU/AE/HSEM/ TCOEM	Kennedy/McAfee/ Latin/Baldwin	
7.6	CCD's damage assessment criteria did not coincide with FEMA's criteria.	11/07/2014	CCD	Cooper	
7.7	All Departments need to ensure that COOP plans are updated and exercised regularly to ensure that contact information, "go kits", etc. are ready at a moment's notice.	11/07/2014	HSEM/All departments	Atkins/COOP planners	
7.8	Update the EOC SOG plan and use it for all EOC activations.	11/07/2014	HSEM/TCOEM	Swearengin/ Guajardo	

Plans and Procedures					
7.9	Update the Recovery plan with information from this incident, and information obtained from the FEMA Austin/Travis County Community Specific Integrated Emergency Management Course conducted in Emmitsburg, Maryland.	11/07/2014	HSEM	Atkins/Latin/ Swearengin	
7.10	Have a Recovery Coordinator on staff before the FEMA Kickoff Meeting.	11/07/2014	HSEM	Latin	
7.11	Create a planning group to put together some procedures related to how to trigger a mandatory evacuation as well as reentry procedures.	11/07/2014	HSEM/APD	Shepard/Robledo	
7.12	City needs to assess the need for calculating the long-term cost of disasters.	11/07/2014	HSEM/Finance	Longmore/Thomas	
7.13	Develop Timelines/Gantt Charts and additional training for implementing the Disaster Recovery Plan.	11/07/2014	HSEM	Latin/Kelly	
7.14	AFD will implement a proactive staffing plan for water related events that would allow AFD to pre-position water resources in opportune areas based on finite metrics provided by weather forecasting, command level experience, and situational awareness of affected communities.	11/07/2014	AFD	Evans	
7.15	Need to develop a policy to deal with life safety building permits.	11/07/2014	WPD/PDRD/CCD	Shunk/Guernsey/ Cooper	

Plans and Procedures					
7.16	The Austin Financial Services Department needs to develop a policy to address the reimbursement of departments that serve as Logistics Section Chief in the EOC and use their Procard to make purchases.	11/07/2014	Finance	Hart	
7.17	The Austin Financial Services Department needs to identify and assign the appropriate management staff to be trained and serve as Finance Section Chief during EOC activations.	11/07/2014	Finance	Hart	
7.18	CCD did not have an emergency response plan to address large scale emergency events that require mass damage assessments.	11/07/2014	CCD	Cooper	
7.19	There is no plan in place to evacuate or perform search and rescue for horses and other livestock.	11/07/2014	ASO	Nobles	
7.20	Organize a process for meeting and briefing policy makers early in an incident.		Deputy City Manager/Executive Manager, Emergency Services	Michael McDonald/Danny Hobby	
7.21	Provide training to keep policy makers up-to-date on how they can access information and staff operational procedures.		Deputy City Manager/Executive Manager, Emergency Services	Michael McDonald/Danny Hobby	
7.22	Ensure that there are organized plans to guarantee officials and policy makers have access to impacted sites.		Deputy City Manager/Executive Manager, Emergency Services	Michael McDonald/Danny Hobby	

Appendix 2 – Mayor's Letter to Governor and Declaration of Local State of Disaster

City of Austin
Founded by Congress, Republic of Texas, 1839
P.O. Box 1088, Austin, Texas 78767

November 4, 2013

The Honorable Rick Perry
Governor of Texas
c/o State Coordinator
Division of Emergency Management
P.O. Box 4087
Austin, Texas 78773-0001

Dear Governor Perry:

On October 31, 2013, the City of Austin was severely impacted by a rain event that produced record amounts of rainfall. The hardest hit areas in Travis County were along Onion Creek. The flooding has damaged homes, government facilities and roadway infrastructure. Over 1,000 homes have been impacted. Numerous roads, bridges and drainage culverts have sustained damage due to flood waters. Efforts are underway to get an accurate assessment of costs associated with the losses. The City of Austin expects to incur significant costs associated with debris removal once the water starts to recede.

While recovery efforts are underway, it is my belief the damage to homes and business due to the rain constitutes a potential public health and safety hazard. I have determined that this incident is of such severity and magnitude that an effective response is beyond the City of Austin's capability to recover without supplementary State and/or Federal assistance. Additionally, I certify that the City of Austin does not have local funding available to make the needed repairs and to provide these citizens with effective relief.

Your assistance in this emergency matter, as it affects the safety and health needs of our citizens would be appreciated.

Sincerely,

Lee Leffingwell, Mayor of Austin

The City of Austin is committed to compliance with the Americans with Disabilities Act. Reasonable modifications and equal access to communications will be provided upon request.

OFFICE OF THE MAYOR
OF
THE CITY OF AUSTIN

DECLARATION OF LOCAL STATE OF DISASTER

BE IT KNOWN:

WHEREAS, on October 31, 2013 residents of the City of Austin incurred significant business and personal losses due to torrential rains and widespread flooding; and

WHEREAS, businesses were damaged and hundreds of residents displaced by widespread and severe flooding and high winds; and

WHEREAS, the City of Austin government is incurring extraordinary expenses associated with responding to the flooding and severe weather; and

WHEREAS, immediate and concerted actions and funding are required to begin rehabilitation and recovery efforts to return businesses and public facilities to normal operations and persons to homes and living quarters; **NOW, THEREFORE,**

By virtue of the authority vested in me by the City Charter, as the presiding officer of the governing body and under Government Code, Section 418.108, I DECLARE a local state of disaster within the City to continue until November 11, 2013, a period of seven days, subject to continuation or renewal by consent of the City Council.

I further proclaim activation of the City of Austin, Emergency Operations Plan and the activation of all other Charter, statutory, and ordinance powers vested in me and all officers of the City of Austin to act in this local state of disaster.

The City Clerk is directed to give prompt and general publicity of the issuance of this DECLARATION.

DECLARED this 4th day of November, 2013, in the City of Austin, Travis County, Texas in witness whereof I subscribe my name and cause to be affixed the seal of the City of Austin.

Lee Leffingwell
Mayor

Filed with me, City Clerk of the City of Austin this 4th day of November, 2013, by Mayor Lee Leffingwell whose signature I hereby give my hand and the seal of the City of Austin.

City Clerk

FILED IN THE OFFICE OF CITY CLERK
ON 4th DAY OF Nov 2013
AT 11:40AM
CITY CLERK

Appendix 3 – Travis County Judge's Letter to Governor and Flooding Disaster Declaration

SAMUEL T. BISCOE
COUNTY JUDGE

TRAVIS COUNTY ADMINISTRATION BUILDING
700 LAVACA ST., SUITE 2.700
P.O. BOX 1748 AUSTIN, TEXAS 78767
(512) 854-9555

November 4, 2013

The Honorable Rick Perry
Governor of Texas
c/o State Coordinator
Division of Emergency Management
P.O. Box 4087
Austin, Texas 78773-0001

Dear Governor Perry:

On October 31, 2013, Travis County was severely impacted by a rain event that produced record amounts of rainfall. The hardest hit areas in Travis County were along Onion Creek and impacted homes, government facilities and damaged roadway infrastructure. Travis County has recorded three fatalities as a result of the flooding and over 1000 homes have been impacted. Numerous roads, bridges and drainage culverts have sustained damage due to flood waters. Efforts are underway to get an accurate assessment of costs associated with the losses. Travis County and jurisdictions within Travis County expect to incur significant costs associated with debris removal once the water starts to recede.

While recovery efforts are underway, it is my belief the damage to homes and businesses due to the rain constitutes a potential public health and safety hazard. I have determined that this incident is of such severity and magnitude that an effective response is beyond Travis County's capability to recover without supplementary State and/or Federal assistance. Additionally, I certify that Travis County does not have local funding available to make the needed repairs and to provide these citizens with effective relief.

Your assistance in this emergency matter, as it affects the safety and health needs of our citizens would be appreciated.

Sincerely,

Samuel T. Biscoe

Samuel T. Biscoe,
Travis County Judge

Return:

INTER-OFFICE -- HON. SAM T. BISCOE
TRAVIS COUNTY COMMISSIONER'S COURT

FILED AND RECORDED
OFFICIAL PUBLIC RECORDS
Dana DeBeauvoir
Nov 04, 2013 10:08 AM 2013199329
FEE: $0.00
Dana DeBeauvoir, County Clerk
Travis County TEXAS

TRV 2013199329
2 PGS

ORIGINAL FILED FOR RECORD

TRAVIS COUNTY
FLOODING DISASTER DECLARATION

WHEREAS, the County of Travis on the 31th day of October, 2013, suffered fatalities, severe damage, and loss of property resulting from a significant rainfall event; and

WHEREAS, after an extensive survey, the Judge of the County of Travis has determined that extraordinary measures must be taken to alleviate the suffering of people and to rehabilitate property;

NOW, THEREFORE, BE IT PROCLAIMED BY THE JUDGE OF THE COUNTY OF TRAVIS:

Section 1. That a state of disaster is declared for the County of Travis.

Section 2. That the County's Emergency Management Plan has been implemented.

Section 3. That the state of disaster shall continue for a period of not more than seven days of the date hereof, unless the same is continued by consent of the Commissioners' Court of the County of Travis, Texas.

Section 4. That this proclamation shall take effect immediately from and after its issuance.

ORDERED this 4th day of November, 2013.

Samuel T. Biscoe
Samuel T. Biscoe, County Judge
County of Travis, Texas

FILED IN THE OFFICE OF
THE TRAVIS COUNTY CLERK
Dana DeBeauvoir
Dana DeBeauvoir, County Clerk
Date: Nov. 4, 2013

Appendix 4 – Governor's Request for Presidential Disaster Declaration

OFFICE OF THE GOVERNOR

RICK PERRY
GOVERNOR

December 12, 2013

The Honorable Barack Obama
President of the United States
The White House
1600 Pennsylvania Avenue, NW
Washington, D.C. 20500

Through: Regional Administrator Tony Robinson
FEMA Region 6
Denton, Texas

RE: **REQUEST FOR PRESIDENTIAL DISASTER DECLARATION**

Dear Mr. President:

Under the provisions of Section 401 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. §§5121-5207 and implemented by 44 CFR §206.35 and §206.36, I request that you declare a major disaster for the State of Texas as a result of excessive flooding in Caldwell, Hays and Travis counties, beginning on October 30, 2013 and continuing through November 16, 2013.

I issued a state disaster proclamation on December 12, 2013.

On October 30, 2013, an upper level disturbance, a cold front and deep tropical moisture converged over south central Texas. The heavy rain threat was enhanced by remnants of weakening Tropical Storm Raymond in the Eastern Pacific. Severe thunderstorms flooded watersheds in Caldwell, Hays and Travis counties.

In less than 24 hours, rainfall totals in the three-county area reached more than 12 inches, causing watershed basins to overflow and dumping massive amounts of water into creeks in the area. Rainfall amounts exacerbated the situation as a similar storm two weeks earlier had saturated soils in the area.

Various creeks and rivers overflowed, including: the Blanco River, Wood Creek, Onion Creek, Bull Creek, Williamson Creek, Slaughter Creek, Walnut Creek, the Colorado River and the San Marcos River. There were other minor flooding events across central and eastern Texas.

This incident caused six confirmed fatalities and numerous injuries. Flooding caused widespread damage to homes, businesses and public infrastructure across the state, resulting in the need for significant debris removal operations, which continue today.

POST OFFICE BOX 12428 AUSTIN, TEXAS 78711 (512) 463-2000 (VOICE)/DIAL 7-1-1 FOR RELAY SERVICES
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Extensive search and rescue operations began early October 31 and continued for several days. The last missing person was recovered from a submerged vehicle on November 12. Although authorities knew the victim's location, waters in the river were too treacherous to attempt recovery until November 12.

The majority of residential and commercial damage centered in the Onion Creek area of the City of Austin in Travis County. Onion Creek reached an historic crest at 40 feet, overflowing and causing severe damage to entire neighborhoods. The previous record was set in 1869 and 1921 at 38 feet. The last major flood in this area was in 2001 when the creek reached 36.5 feet.

Flood gauges were damaged by raging waters, causing limited warning and catching residents and officials off guard. Some flooding occurred outside the normal floodplain and the rapid rise in the creek occurred overnight when most residents were asleep. Residents were cut off from evacuation routes by rapidly rising water. Most evacuations occurred after flooding caused significant damage to homes and vehicles. Many residents were rescued from roofs and cars tops.

The Onion Creek area consists of working families who, according to a Census Bureau report, have a median household income under $40,000 — well below the state and national average. There was also damage in rural areas of Hays and Caldwell counties. In addition to being an area with lower household income, residents in this area are severely underinsured and uninsured.

Travis County EMS evacuated 625 homes. Several shelters opened for flood victims and remained open until November 15, the same day the Austin Police Department was able to return to normal activities in the affected neighborhoods.

Several elementary schools closed due to impassable roads and power outages. More than 3,800 homes experienced power outages.

Local Individual Assistance (IA) damage assessments were conducted for Caldwell, Hays and Travis counties. Results from these assessments initiated a request for a joint state/FEMA/Small Business Administration (SBA) IA damage assessment, which was conducted in the same counties November 8-10, 2013. This joint IA damage assessment for homes in Travis, Caldwell and Hays counties resulted in a finding that 858 homes were impacted as tabulated in the enclosure. This includes 82 affected, 169 with minor damage, 469 with major damage and 138 destroyed.

While only 287 of the 607 homes that were destroyed or incurred major damage were uninsured, interviews with the homeowners indicated that a significant number of those with flood insurance did not carry contents insurance. In addition, about 20 percent of the area consists of rental homes. Most of these are not insured for contents.

We believe that the number of underinsured homes that were destroyed or withstood major damage, including those that were uninsured, is more than 400. In addition, there were more than 75 private businesses/nonprofit entities that sustained damage, with more than 25 of these having damages classified as major or destroyed. It is also noted that 70 recreational vehicles (RV) were destroyed in an RV park in Caldwell County.

Long-term recovery planning started with initial meetings on November 13. Both the City of Austin and Travis County have indicated they will attempt to implement a limited buyout program, dependent on available funding, for the hardest-hit areas. This could be further limited by the amount of infrastructure damage sustained.

Critical infrastructure facilities, such as water treatment plants, roads and bridges, were also damaged. Public water systems, including lift stations, were offline due to water line damage for which personnel rerouted systems to restore service.

Several roads and bridges were temporarily closed due to damage and the River Road Plantation Bridge in Travis County will remain closed until extensive repairs can be made to the infrastructure.

Significant debris removal operations have been and continue to be necessary. This includes curbside removal of damaged housing materials and contents, as well as vegetative debris removal, carcass removal and vehicle recovery. Debris located in the watershed will hamper drainage and could result in additional flooding.

State and local Public Assistance damage assessments were conducted on November 19–26, 2013, for Caldwell, Hays and Travis counties. The results of these initiated a request for a joint state/FEMA damage assessment, which was conducted in the same counties December 3–5, 2013. Preliminary estimates of damages to public infrastructure and the amount of assistance needed for debris removal and emergency protective measures under the Stafford Act indicate damages in excess of $48 million and are tabulated in the enclosure.

A summary of the types of damages surveyed is found below.

Travis County

- Roads and bridges: 10 roads, 9 bridges and culverts - $11.6M
    - River Plantation Bridge remains closed indefinitely for repairs
- Utilities: 10 sites, include lift stations, manholes, etc. - $28.4M
- Parks, rec other: 16 locations, include public golf courses, hike and bike trails and parks - $1.1M
- Buildings and equipment: $563k
- Debris: 25 sites - $3M

Hays County

- Emergency protective measures: $37.6k
- Roads and bridges: 88 roads - $327.7k
- Public utilities: 1 lift station - $647k
- Parks, rec other: 11 playgrounds, 2 trails - $108k
- Buildings: 2 – fire department and an elementary school - $725k
- Debris: 4 sites noted with significant debris - $22k

Caldwell County

- Roads and bridges: 32 sites - $748k
- Water control facility: 1 site - $10k
- Parks, rec other: 1 - $355k
- Debris: 18 significant sites noted - $98k

Several other counties experienced flooding, storm damage and tornadoes (touchdown in Bridge City, Texas). Either Preliminary Damage Assessments (PDA's) have not yet been done or the counties did not meet their threshold for damages during preliminary assessments.

The Salvation Army (TSA) opened three shelters, one of which remained open for approximately two weeks. Several canteens were set up to feed victims and responders. A laundry unit was provided for affected residents in Austin.

The American Red Cross (ARC) engaged with sheltering, feeding and mobile bulk food distribution. Mobile feeding continues in Caldwell, Hays, Travis and Williamson counties. There has been a large response from the Voluntary Organizations Active in Disaster (VOAD) community and other charitable organizations. This event received little media coverage nationally or regionally. While the Austin area is well known across the world and is ranked by the Census Bureau as the nation's 35th largest metropolitan area behind San Jose and Indianapolis, it is not a major television market. As a result, the VOADs are reporting limited donations.

The following information is furnished on the nature and amount of state and local government resources that have been used to alleviate the conditions of this disaster:

- Texas Search and Rescue (TEXSAR), a nonprofit search and rescue and disaster response team, mobilized in Caldwell County to assist in search and rescue and incident management duties, coordinating resource requests and obtaining technical specialists for specific operational guidance.

- The Texas Department of Public Safety (DPS) provided an aircraft to assist in one hoist rescue. DPS deployed a mobile disaster unit to central Texas to issue replacement Texas

driver's licenses and identification cards to victims who lost those documents in the floods. State Troopers continue to assist in impacted areas.

- Texas Military Forces (TMF) provided seven high-profile vehicles (HPVs) with 18 personnel to support flooding in central Texas. They activated two UH60 helicopters with hoists. An additional Transportation Force Package consisting of 10 HPVs and 32 personnel was activated by the governor to respond to flooding in southeast Texas.

- The Texas Animal Health Commission (TAHC) provided two personnel to assist with deceased domestic animals and provided information on disposal locations to the public.

- 2-1-1 Texas, a program managed by the Texas Health and Human Services Commission providing information and referral services in Texas, monitored school openings and closures and continues to provide information to callers as needed.

- The Texas Department of Transportation (TxDOT) provided crews from the Austin District to assist Caldwell County with repairs to a washed out culvert. TxDOT crews continue with clean-up operations in Waco, Austin, San Antonio, Houston and Beaumont.

Over the past 12 months Texas has experienced numerous events requiring response activities, including:

- October 23, 2012: A local state of disaster declared for Concho County for excessive rain and flooding. A Public Assistance (PA) damage assessment for the county was $62,894.68.

- November 12, 2012: A local state of disaster declared for the City of Marlin resulting from a failure of the local water system. The water production rate diminished to approximately 25 percent of normal capacity.

- December 25, 2012: A local state of disaster declared for Houston County for tornado activity and severe thunderstorms. Six structures were affected. A PA damage assessment for the county showed approximately $135,000 in damages to the local utility co-op.

- April 17, 2013: A Presidential Disaster declared (DR and EM) for the West Fertilizer Plant explosion. PDAs are in excess of $35 million. Project worksheet (PW) coordination is ongoing.

- May 15, 2013: A local state of disaster declared in North Texas for a severe outbreak of tornadoes, resulting in numerous fatalities and damage to over 100 homes and businesses. PA damages exceeded $1.4 million.

- May 23, 2013: A local state of disaster declared in Kent County for severe storms with large hail damaging five homes.

- May 25–27, 2013: A local state of disaster declared for the City of San Antonio and Bexar County for severe flooding damaging more than 200 homes and three businesses with an estimate of more than $7 million in damage to infrastructure.

- June 14–15, 2013: A local state of disaster declared for the City of Eagle Pass and Maverick County for severe flooding damaging more than 300 homes and causing more than $6 million in damage to local infrastructure.

- July 14–16, 2013: A local state of disaster declared for Callahan County for severe flooding causing more than $500,000 in infrastructure damage.

- July 14–17 2013: A local state of disaster declared for Eastland County for severe flooding causing more than $80,000 in infrastructure damage.

- September 11–13, 2013: A local state of disaster declared for the City of El Paso and El Paso County for severe flooding damaging 37 homes and causing more than $1.3 million in infrastructure damage.

- October 13, 2013: A local state of emergency declared for the City of Turkey and Hall County for severe flooding causing extensive damage to roads and bridges.

- Ongoing: The Governor of Texas continues to renew a Statewide Drought Proclamation in effect for the past 36 months. The proclamation states that drought conditions have reached historic levels and continue to pose an imminent threat to public health, property and the economy. The April 2013 proclamation included 240 of the 254 counties in Texas. These 240 counties have a combined population of 24,637,554 and cover a total of 255,689 square miles.

- Ongoing: The United States Department of Agriculture (USDA) has issued multiple agricultural drought declarations over the last 24 months including all 254 Texas counties.

In addition to these recent events, Texas is still recovering from the 2011 wildfires, the worst in Texas history, receiving two presidentially declared disasters (DR 4029 and DR 1999) and

The Honorable Barack Obama
December 12, 2013
Page 7

devastating wildfires at Livermore Ranch in West Texas for which they received a Fire Management Assistance Grant (FMAG) in 2012.

The following information provides detailed information on the impacted population.

	Average of Persons Below Poverty Level**	Median Household Income**	Percent Elderly**	Percent Pre-Disaster Unemployment*
National Average	14.3%	$52,762	13.7%	7.4%
State Average	15.8%	$48,259	10.5%	6.4%
Caldwell County	20.7%	$43,136	12.6%	7.7%
Hays County	16.4%	$58,247	9.2%	5.7%
Travis County	16.6%	$55,452	7.8%	5.4%
Williamson County	6.3%	$71,346	9.6%	5.6%

** Bureau of Labor Statistics*
***Census Bureau*

Pursuant to 44 CFR §206.35 and §206.36, this incident is of such magnitude and severity that effective response is beyond state and local capabilities and supplementary federal assistance is necessary to save lives, protect property, public health and safety, and lessen the impact of the disaster.

As a result of this disaster, the State of Texas is specifically requesting a major disaster declaration for Individuals and Households Programs (IA), Other Needs Assistance (ONA), Crisis Counseling, Disaster Unemployment Assistance, Disaster Legal Assistance, Disaster Case Management, Public Assistance and Hazard Mitigation to support the citizens of the State of Texas.

Sincerely,

Rick Perry

Rick Perry
Governor

RP:dzk

Enclosures

Appendix 5 – U.S. Small Business Administration Declaration

DISASTER NEWS

Loans for Homeowners, Renters and Businesses of All Sizes

Release Date: November 22, 2013
Release Number: TX 13823-01
Media Contact: Richard Jenkins
Phone: (916) 735-1500

SBA Offers Disaster Assistance to Texas Residents and Businesses Affected by the Severe Flooding

SACRAMENTO, Calif. – Low-interest federal disaster loans are available to Texas residents and business owners affected by the severe storms and flooding that occurred from October 30 - 31, 2013, U. S. Small Business Administration (SBA) Acting Administrator Jeanne Hulit announced today. SBA acted under its own authority to declare a disaster in response to a request SBA received from Gov. Rick Perry on November 20, 2013.

The disaster declaration makes SBA assistance available in the primary Texas counties of Caldwell, Hays and Travis and the neighboring counties of Bastrop, Blanco, Burnet, Comal, Fayette, Gonzales, Guadalupe and Williamson.

"The U. S. Small Business Administration is strongly committed to providing Texas with the most effective and customer-focused response possible, and we will be there to provide access to federal disaster loans to help finance recovery for residents and businesses affected by the disaster," said Hulit. "Getting our businesses and communities up and running after a disaster is our highest priority at SBA."

"Low-interest federal disaster loans are available to homeowners, renters, businesses of all sizes and private, nonprofit organizations whose property was damaged or destroyed by this disaster," said SBA's San Antonio District Director Pamela Sapia. "Beginning Monday, November 25, SBA representatives will be on hand at the following Disaster Loan Outreach Centers to answer questions about SBA's disaster loan program, explain the application process and help each individual complete their application," Sapia continued. The centers will be open on the days and times indicated until further notice. No appointment is necessary.

CALDWELL COUNTY
Disaster Loan Outreach Center
Caldwell County Scott Annex
Caldwell County Office of
Emergency Services
1403 Blackjack Street, Suite E
Lockhart, TX 78644

HAYS COUNTY
Disaster Loan Outreach Center
Hays County Precinct 2 Office
5458 FM 2770
Kyle, TX 78640
(corner of Crystal Meadow Drive
across from Barton Middle School)

TRAVIS COUNTY
Disaster Loan Outreach Center
Dove Springs Recreation Center
5801 Ainez Drive
Austin, TX 78744

Opens Thursday, December 5 at 9 am	***Opens Tuesday, December 3 at 9 am***	***Opens Monday, Nov. 25***
Thursdays & Fridays, 9 am – 6 pm	Mondays - Wednesdays, 9 am – 6 pm	Mon. Nov. 25, 12 pm – 6 pm Tues. Nov. 26, 9 am – 6 pm
Closes Thurs., Dec. 12	***Closes Wed., Dec. 11***	Wed., Nov. 27, 9 am – 12 pm ***(closed Thanksgiving weekend)***
		Re-opens Tuesday, Dec. 3 at 9 am Mondays – Fridays, 9 am – 6 pm *until further notice*

Disaster loans up to $200,000 are available to homeowners to repair or replace damaged or destroyed real estate. Homeowners and renters are eligible for up to $40,000 to repair or replace damaged or destroyed personal property.

Businesses of any size and private, nonprofit organizations may borrow up to $2 million to repair or replace damaged or destroyed real estate, machinery and equipment, inventory, and other business assets. SBA can also lend additional funds to homeowners and businesses to help with the cost of making improvements that protect, prevent or minimize the same type of disaster damage from occurring in the future.

For small businesses, small agricultural cooperatives, small businesses engaged in aquaculture, and most private, nonprofit organizations of any size, SBA offers Economic Injury Disaster Loans (EIDLs) to help meet working capital needs caused by the disaster. EIDL assistance is available regardless of whether the business suffered any property damage.

Interest rates can be as low as 2.25 percent for homeowners and renters, 2.625 percent for private, nonprofit organizations and 4 percent for businesses, with terms up to 30 years. Loan amounts and terms are set by SBA and are based on each applicant's financial condition.

Applicants may apply online using the Electronic Loan Application (ELA) via SBA's secure Web site at *https://disasterloan.sba.gov/ela*.

Disaster loan information and application forms are also available from SBA's Customer Service Center by calling (800) 659-2955 or e-mailing *disastercustomerservice@sba.gov*. Individuals who are deaf or hard-of-hearing may call (800) 877-8339. For more information about SBA's disaster assistance programs, visit *http://www.sba.gov/disaster*.

The filing deadline to return applications for property damage is **January 21, 2014**. The deadline to return economic injury applications is **August 22, 2014**.

SBA Field Operations Center - West, P.O. Box 419004, Sacramento, CA 95841

Appendix 6 – Texas Severe Storms and Flooding FEMA-4159-DR

Texas – Severe Storms and Flooding FEMA-4159-DR

Declared December 20, 2013

On December 12, 2013, Governor Rick Perry requested a major disaster declaration as a result of severe storms and flooding during the period of October 30-31, 2013. The Governor requested a declaration Individual Assistance and Public Assistance for three counties and Hazard Mitigation statewide. During the period of November 8-10, 2013 and December 3-6, 2013, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.

1 The Preliminary Damage Assessment (PDA) process is a mechanism used to determine the impact and magnitude of damage and resulting needs of individuals, businesses, public sector, and community as a whole. Information collected is used by the State as a basis for the Governor's request for a major disaster or emergency declaration, and by the President in determining a response to the Governor's request (44 CFR § 206.33).
2 When a Governor's request for major disaster assistance under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (Stafford Act) is under review, a number of primary factors are considered to determine whether assistance is warranted. These factors are outlined in FEMA's regulations (44 CFR § 206.48). The President has ultimate discretion and decision making authority to declare major disasters and emergencies under the Stafford Act (42 U.S.C. § 5170 and § 5191).
3 Degree of damage to impacted residences: Destroyed – total loss of structure, structure is not economically feasible to repair, or complete failure to major structural components (e.g., collapse of basement walls/foundation, walls or roof); Major Damage – substantial failure to structural elements of residence (e.g., walls, floors, foundation), or damage that will take more than 30 days to repair; Minor Damage – home is damaged and uninhabitable, but may be made habitable in short period of time with repairs; and Affected – some damage to the structure and contents, but still habitable.
4 By law, Federal disaster assistance cannot duplicate insurance coverage (44 CFR § 206.48(b)(5)).
5 Special populations, such as low-income, the elderly, or the unemployed may indicate a greater need for assistance (44 CFR § 206.48(b)(3)).
6 Ibid (44 CFR § 206.48(b)(3)).
7 Based on State population in the 2010 Census.
8 Statewide Per Capita Impact Indicator for FY14, *Federal Register*, October 1, 2013.
9 Countywide Per Capita Impact Indicator for FY14, *Federal Register*, October 1, 2013.

On December 20, 2013, President Obama declared that a major disaster exists in the State of Texas. This declaration made Public Assistance requested by the Governor available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms and flooding in Caldwell, Hays, and Travis Counties. This declaration also made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.[2]

Summary of Damage Assessment Information Used in Determining Whether to Declare a Major Disaster

Individual Assistance

☐Total Number of Residences Impacted: 858

Destroyed - 138
Major Damage - 469
Minor Damage - 169
Affected - 82

☐Percentage of insured residences: 51%
☐Percentage of low income households: 12%
☐Percentage of elderly households: 9.1%
☐Total Individual Assistance cost estimate: $1,098,519

Public Assistance -

☐Primary Impact: Damage to Utilities
☐Total Public Assistance cost estimate: $48,459,113
☐Statewide per capita impact: $1.93
☐Statewide per capita impact indicator: $1.39
☐Countywide per capita impact: Caldwell County ($31.84), Hays County ($11.89), Travis County ($44.30).
☐Countywide per capita impact indicator: $3.50

Appendix 7 – FEMA 4159-DR Individual Assistance Denial Letter

U.S. Department of Homeland Security
500 C Street, SW
Washington, DC 20472

FEMA

December 26, 2013

The Honorable Rick Perry
Governor of Texas
P.O. Box 12428
Austin, Texas 78711

Dear Governor Perry:

This is in response to your December 12, 2013, request for a major disaster declaration for the State of Texas due to damage resulting from severe storms and flooding during the period of October 30-31, 2013. You specifically requested Individual Assistance and Public Assistance for three counties and Hazard Mitigation statewide.

The December 20, 2013, major disaster declaration FEMA-4159-DR authorized Public Assistance for Caldwell, Hays, and Travis Counties and Hazard Mitigation statewide.

The damage to the infrastructure was significant in the areas designated for Public Assistance. However, based on our review of all of the information available, including the results of the joint federal, state, and local government Preliminary Damage Assessment, it has been determined that the damage to the dwellings from this event was not of such severity and magnitude to warrant the designation of Individual Assistance under FEMA-4159-DR. Therefore, your request for Individual Assistance for Caldwell, Hays, and Travis Counties is denied.

This denial may be appealed within 30 days after the date of this letter. Any appeal pursuant to 44 CFR § 206.46, along with additional information justifying the appeal, should be submitted to me through George A. Robinson, Regional Administrator, FEMA Region VI, located at:

800 North Loop 288
Denton, Texas 76209-3698

FEMA has notified the Small Business Administration (SBA) of your request for disaster loan assistance. As a means of expediting assistance to states affected by disasters, SBA will consider your request for disaster loan assistance under SBA authorities without regard to whether a Stafford Act declaration decision has been appealed.

Sincerely,

Joseph L. Nimmich
Associate Administrator
Office of Response and Recovery

www.fema.gov

Appendix 8 – FEMA 4159-DR Individual Assistance Appeal Denial Letter

U.S. Department of Homeland Security
500 C Street, SW
Washington, DC 20472

FEMA

FEB - 5 2014

The Honorable Rick Perry
Governor of Texas
P.O. Box 12428
Austin, Texas 78711

Dear Governor Perry:

This is in response to your January 25, 2014, letter appealing the denial of Individual Assistance for Caldwell, Hays, and Travis Counties under major disaster declaration FEMA-4159-DR.

After thorough review and careful consideration of all of the information included in your initial request and appeal, we reaffirm our original finding that the damage to the dwellings from this event was not of such severity and magnitude to warrant the designation of Individual Assistance under FEMA-4159-DR. Therefore, your appeal for Individual Assistance for Caldwell, Hays, and Travis Counties is denied.

Sincerely,

Elizabeth A. Zimmerman
Deputy Associate Administrator
Office of Response and Recovery

www.fema.gov

RESOLUTION NO. 20140515-064

WHEREAS, the City of Austin has a responsibility to ensure the public health and safety of its residents and is committed to establishing policies that protect the long-term well-being and viability of our community; and

WHEREAS, there are 65 watersheds that are either wholly or partially within the city limits of Austin and all are susceptible to recurring flash flooding; and

WHEREAS, according to the National Climatic Data Center, Texas leads the nation in flash flood fatalities and between 1959 and 2008 had three times the number of fatalities as the next leading state and approximately 77% of all fatalities occurred in vehicles; and

WHEREAS, flooding is the most common hazard for the Central Texas area and 60 people have died in flash flooding in Travis County since 1960; and

WHEREAS, the City of Austin's commitment to addressing watershed conditions goes back to 1974 when the City Council adopted the Waterway Development Ordinance that limited development in the 25-year floodplain and required new developments to identify appropriate erosion controls; and

WHEREAS, after the Memorial Day flood of 1981, which was responsible for 13 deaths and significant property damage, the City of Austin implemented a new drainage fee to provide funding for an expanded storm water management program; and

WHEREAS, strong public support for flood and erosion proposals was demonstrated as City of Austin voters approved bond packages totaling $75 million for capital improvement projects between 1981 and 1984; and

WHEREAS, the predecessor to the Watershed Protection Department was created in 1996 with the merger of the flood and erosion programs of the Public Works Department with the water quality protection programs of the Environmental and Conservation Services Department, and has the mission to reduce the impact of flooding, erosion and water pollution in our community in order to protect lives, property and the environment; and

WHEREAS, shortly after its formation, the Watershed Protection Department initiated a Watershed Master Plan to better prioritize service needs and refine program direction; and

WHEREAS, the Watershed Master Plan (Master Plan) was approved in June 2001 and identifies opportunities for optimizing existing resources through improved prioritization, mission integration and a renewed commitment to the use of environmentally responsible, cost-effective and sustainable solutions; and

WHEREAS, as a means of developing options for capital infrastructure projects, operational program enhancements and regulatory modifications, the Master Plan inventoried existing watershed problems and gauged the impact of future urbanization in 17 watersheds, but did not include the Onion Creek watershed which was intended for future phases of study; and

WHEREAS, the Master Plan states that within those 17 watersheds in 2001, the number of inhabited structures at risk from a 100- year flood within

the City of Austin was estimated at that time to be 8,000 buildings, putting as many as 20,000 people at risk of high flood waters; and

WHEREAS, the Onion Creek Watershed has experienced severe flooding in 1998, 2001 and most recently in a storm event that began on October 30, 2013, causing a disaster in Central Texas that included the deaths of 5 individuals, the displacement of hundreds of families and the damage or destruction of millions of dollars in property; and

WHEREAS, the Halloween Flood of 2013 raised water levels above the banks of Walnut Creek, Shoal Creek, Williamson Creek and Bull Creek, in addition to Onion Creek, where levels exceeded the record stage and flow at the United States Geological Service gauge located in the area, and estimates indicate a rise of 40.15 feet, which broke the previous record of 38.00 feet measured during a September 9, 1921 storm; and

WHEREAS, the City of Austin has partnered with the U.S. Army Corps of Engineers since 1999 to find solutions to flooding in the Onion Creek Watershed which contains many homes built before current watershed protection ordinances or updated flood maps were adopted; and

WHEREAS, the City of Austin, Travis County, and the U.S. Army Corps of Engineers recommended a buyout program for the approximately 483 homes in the City of Austin 25-year floodplain which was estimated in 2006 to cost $76 million and was designated to be shared 35% locally and 65% federally; and

WHEREAS, the City of Austin started to fund and purchase homes beginning with a $2.4 million bond approved in 1998 and a $28 million bond

that voters supported in 2006 and which collectively removed 323 homes before the Halloween Floods occurred; and

WHEREAS, the U.S. Congress authorized the Onion Creek buy out project in 2007, but no funding was granted until March 2014 when $11.8 million was appropriated to the City of Austin and Travis County; and

WHEREAS, it has been noted by those with familiarity with the program that this initial appropriation improves the likelihood of continuing project support; and

WHEREAS, one of the other means of federal assistance for flood prone areas is the National Flood Insurance Program (NFIP) created by Congress in 1968 and administered by the Federal Emergency Management Agency (FEMA) to help provide a means for property owners to financially protect themselves from losses and as an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods; and

WHEREAS, the NFIP was created in response to the unaffordability and exclusion of coverage for floods in the private insurance market that began in the 1950s, and also as a way for the federal government to incentivize flood risk management practices in local communities; and

WHEREAS, the NFIP offers flood insurance to homeowners, renters, and business owners if their community participates in the NFIP by agreeing to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding, which the City of Austin did in 1981; and

WHEREAS, FEMA determines a community's flood risk in a flood insurance study that includes statistical data for river flow, hydrologic analyses, and rainfall and topographic surveys to create flood hazard maps that outline a community's different risk areas; and

WHEREAS, as a part of the Flood Disaster Protection Act of 1973, Congress mandated that federally regulated or insured mortgage lenders require flood insurance on properties that are located in a Special Flood Hazard Area (SFHA) that are at a high risk of flooding and, additionally, a private lender can require flood insurance even if it is not federally mandated; and

WHEREAS, FEMA has instituted a Community Rating System (CRS) as a voluntary program to provide incentives in the form of premium discounts of between 5% and 45% for policy holders in communities that go beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding; and

WHEREAS, the CRS grades communities into one of 10 classes with class 1 receiving the greatest discount and class 10 receiving no discount at all; and

WHEREAS, Austin, Texas is currently classified as a 6 in the CRS ranking, making residents eligible for a 20% discount in the SFHA and a 10% discount in non-SFHA areas; and

WHEREAS, the Flood Insurance Rate Map (FIRM) for Austin was first issued in 1981 and substantially updated in 1993, showing a rise in the 100-year floodplain by approximately 10 feet along Onion Creek which put several hundred homes in the Onion Creek Forest, Yarabee Bend, Onion

Creek Plantation, Silverstone and Timber Creek communities into the floodplain for the first time; and

WHEREAS, flood risks can and do change over time and FEMA is currently updating and modernizing the nation's FIRMs and in 2012 submitted preliminary maps for the Austin area that are projected to become effective August 18, 2014; and

WHEREAS, as of April 2012, the NFIP program had a national risk pool that insured 5.5 million homes and, while the program was meant to be self-supporting, a Government Accountability Office audit reported that the program was not actuarially sound and needed to raise rates to avoid continued borrowing brought on by Hurricane Katrina; and

WHEREAS, on July 6, 2012 Congress passed the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12) which sought to extend the NFIP while requiring significant reform and moving to full risk-based premiums to cover rising costs; and

WHEREAS, BW-12 resulted in steep increases in premiums that in some categories went up as much as 10-fold, and had an impact on low income households and the roughly 19% of policy holders that previously received a grandfathered or artificially low rate; and

WHEREAS, out of concern for the affordability impact of mandatory premiums and the risks associated with declining enrollment, the Homeowner Flood Insurance Affordability Act of 2014 was signed into law on March 21, 2014 and effective May 1, 2014 repealed and amended certain provisions of BW-12, including certain rate increases and reinstated the use of October 1, 2013 subsidized rates for certain eligible properties; and

WHEREAS, in addition to extending the phase-in of increased premiums, the Homeowners Flood Insurance Affordability Act of 2014 also made changes to grandfathering rules, established a flood insurance advocate for the fair treatment of policy holders, and requires a draft affordability framework be delivered to Congress within 18 months; and

WHEREAS, in developing the affordability framework, FEMA was directed to consider:

- accurate communication to customers of flood risks,
- targeted assistance based on financial ability to pay,
- individual and community actions to mitigate flood risk or lower cost of flood insurance,
- the impact of increases in premium rates on participation in NFIP,
- the impact of mapping updates on affordability of flood insurance,
- proposals for regulations to ensure flood insurance affordability and accessibility among low-income populations; and

WHEREAS, after Hurricane Sandy, issues of increasing premiums, an expanded floodplain risk area and low insurance take up rates, prompted New York City to commission a plan on climate change resiliency measures and a study on how to address the rising cost of flood insurance specifically; and

WHEREAS, the resulting report from the Rand Corporation on flood insurance impacts recommended policymakers consider a multi-layered

approach to mitigation and protection by providing assistance programs based on financial need for the cost of flood insurance, and to work to ensure that mitigation efforts are accurately and timely reflected in NFIP rates; and

WHEREAS, in an effort to both plan and proactively respond to Austin's own vulnerability to long-term changes in climate and major weather events, the City Council passed Resolution No. 20131121-060, directing the City Manager to explore ways to improve the resilience of our community and to conduct department level assessments and plans for city-wide disaster and emergency preparedness; and

WHEREAS, as of May 1, 2014, no detailed options for budget consideration have been provided in response to Resolution No 20131121-060; **NOW THEREFORE,**

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The City Manager is directed to bring forward options as a part of the fiscal year 2014-15 budget no later than July 15, 2014, for investment in flood prevention, protection and preparedness for properties city-wide.

Options should include, but are not limited to:

- early warning infrastructure and emergency communication systems,
- items addressing the rising costs of flood insurance appropriate to Austin such as a deductible sharing program or local flood insurance voucher or tax credit program for low-income households,
- public education efforts regarding flood risks and flood prevention as well as mitigation and insurance programs available, and

- improved road signage and warnings at low water crossings and other driver education efforts.

BE IT FURTHER RESOLVED:

The City Manager is directed to prepare a report no later than June 16, 2014, identifying gaps in current flood insurance enrollment city-wide, a history of changes to the Flood Insurance Rate Map for Travis County, a summary of the local impact of federal legislation amending the National Flood Insurance Act, and opportunities for improving Austin's Community Rating System classification.

BE IT FURTHER RESOLVED:

The City Manager is directed to analyze the impacts of pursuing local options for flood prevention and recovery efforts on the eligibility for federal buyout assistance and report back by June 16, 2014

ADOPTED: May 15 , 2014 **ATTEST:**

Jannette S. Goodall
City Clerk