



Flood Hazard News

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Inside this issue

Ken's Column

Master Planning Program

Floodplain Management Program

Information Services and Flood Warning Program

Design Construction and Maintenance Program

Stormwater Quality and Permitting Activities

Maintenance Eligibility Program

Professional Activities of District Staff

Surfing in Colorado... Really?

By

Laura Kroeger, P.E., UDFCD

When the idea to incorporate a standing surf wave into a river improvement project on the South Platte River, was first posed to me I was taken aback. *River surfing in Colorado?* Truth be told, I didn't even know river surfing was a "thing." After asking a few questions, I quickly saw the potential and became excited about being a part of bringing this up-and-coming sport to the Denver area.

Has anyone else experienced this type of great idea moment? Most of us get really excited about an innovative, creative opportunity and the possibilities of what it could become. Then, once you start discussing your thoughts with peers, the challenges of tackling an "out-of-the box design" come to light and a heavy dose of reality sets in. The barrage of questions and the unknowns soon start to kill the buzz. Questions regarding managing safety concerns, long-term maintenance, city council approval, permitting, funding (the list goes on, but you get the idea) - can take their toll. Unfortunately, many great ideas end up in the innovation graveyard once they come to this crossroad. It's not that this line of questioning is wrong, in fact, it's quite necessary; however, these questions need to be asked at the right time in order to keep the innovation process from stalling out. Over the years, the Urban Drainage and Flood Control District has attempted many exciting and innovative approaches pitched



Ben Nielsen, Merrick and Co. Project Manager, surfing the South Platte River.

Protecting people, property, and the environment
through preservation, mitigation, and education.

by creative design teams. It's typical that the idea wins the job, then we all aid in putting it to a slow and disappointing death. Fortunately, we can learn from our missteps. The common themes of why innovative ideas were not realized are summed up in the following three observations:

- Lack of commitment and clarity of the vision.
- Not having the right team of experts at the right time to be effective.
- Not managing expectations of stakeholders, specifically related to risk.

By identifying what the stumbling blocks were on previous projects we were able to develop a strategic project guidance plan that is referred to as **V2P**. The implementation of this plan successfully enabled the River Run Improvement Project to incorporate an innovative idea to create a standing wave in the low flow water conditions of the South Platte River.

have a good sense of what it is or does. Vision can create the confidence to let go of the old or the status quo, and move onto something better. The more visual the message, the easier it will be to communicate, especially with a wide audience.

For the River Run project a computer generated model of the proposed project was used to provide better imagery of the Vision of the improvements. The existing photo compared to the proposed made for an easy sales pitch.

Early on, the project partners of River Run worked



Looking Downstream, Existing Conditions of the South Platte River at Oxford Avenue City of Sheridan, Colorado.



Looking Downstream, Computer generated rendering of the proposed River Run project at the same location.



What does **V2P** mean? Innovation through a clear and engaging **V**ision, a driving **P**assion to break down barriers and the creation of strong **P**artnerships. These three elements enable innovative concepts to be realized by providing the mechanism to **M**anage Risks associated with doing something new and the continued need to **S**ell the Vision to a broad audience to sustain support.

The approach is not linear; rather all three elements are used simultaneously. V2P are intertwined and when they complement each other they build the consistency, confidence and trust required to accomplish innovative goals.



Vision – Clear, visual and simply messaged ideas provide the guiding inspiration to the innovation process. Embracing something new is difficult in general; especially if you don't

diligently to shape the message of a park and river improvements that would engage a wide range of users. The messaging was fine-tuned throughout the project based on feedback and responses from elected officials and the public. The time spent *Selling the Vision* was valuable in that it not only promoted the project goals, but it also provided an opportunity to gain valuable feedback that further supported the innovative process.

The concept stage imagery of the Vision for the River Run Improvements project didn't specifically advertise river surfing. Even though the design team had the idea in hand, we used the Selling the Vision process to slowly introduce the concept and gain support before making it a focal point of the

project. The vision to “Create a Unique Regional Park Experience that Celebrates the River” never changed but simply grew to include river surfing.

It’s worth noting that the process of Selling the Vision can be just as enriching as the excitement experienced while first developing the innovative idea. This is largely due to the growth in energy that comes from expanding the vision to a larger group of people. Innovative projects can’t happen without the support gained from doing a good job at Selling the Vision, but much of the heavy lifting is in Managing the Risks. Once you have the initial buy in to move ahead, the “project vision” can be used to inspire the project partners to deliver by properly Managing the Risks.



Passion – Vision alone is not enough to get past all the No(s)... We’ve never done it that way before... or the You can’t do that! It’s the driving passion of the project partners who want to see the vision realized that is able to clear the hurdles and gain support at all levels.

Ben Nielsen, the project manager with Merrick & Company and resident surfer, was confident that river surfing would take off based on his experience designing projects in other land locked areas, and also through his network of local Colorado water recreation users. His passion and conviction helped excite the sponsors to want to provide the community with this high value recreational experience. Ben was able to Sell the Vision and also rely on past project successes to Manage the Risks associated with creating a standing wave in low-water conditions. Standing adjustable waves have been built, but to the team's knowledge not at low water conditions of 150 cubic feet per second. The drive and passion to achieve something new led the design team to spend countless hours in the hydraulics laboratory at Colorado State University. The hydraulic obstacles of creating a standing wave in low water conditions were proving to be significant, and on many occasions, the design team could have closed shop and declared the approach too difficult to achieve. The team’s reluctance to not let go of the Vision and



River Run Vision Statement

maintain a passion for success is what kept the project moving forward.

Like most things, too much of a good thing can become a problem, so there has to be some balance maintained with a driving passion. For example, passion can become counterproductive if it leads to having blinders on and not recognizing and/or giving credit to genuine concerns. Ultimately, this will erode confidence and trust between partners as well as stakeholders. Keep the driving passion focused on overcoming hurdles by first seeing them and then using partnerships to manage them.



Partnerships – The vision and the passion are encompassed by partnerships. The trust, expertise and commitment a solid partnership provides is instrumental to success. Developing a core team as early as possible will aid in the development of the vision and will most likely be the

individuals who exhibit the driving passion. As mentioned earlier, sharing new ideas too early and with the wrong audience can end up sending worthy ideas to the graveyard. Start with a few trusted individuals who will be curious, ask good questions, and be open to exploration. The purpose of this small group is three fold:

- Perform initial vetting of the idea to gain a broader perspective.
- Outline a plan to grow the partnership by identifying individuals with expertise and influence to advance the vision and help manage the risks. Also consider including a non-technical member on the team, like an artist or educator. These types of individuals tend to ask challenging and insightful questions that can provide a fresh approach.
- Develop a sales pitch in a safe environment.

The purpose of the partnerships is to sell the vision and manage the risks, which is why a diverse team of experts and people of influence is needed. The River Run core partners started with the traditional design team, but added the contractor as well. Having Naranjo Civil Constructors on board during design was key to value engineering and risk management. For example, one of the identified risks for River Run was in the fabrication of the wave shaper. The traditional approach would have involved several different sub-contractors working on the different components, which would open up the possibility of error in the final assembly. To mitigate this potential risk, the lead design consultant, Merrick & Company, contacted Obermeyer Hydro a provider of hydropower and water-control equipment, who they had worked with on larger projects in the past. Due to their past partnership and Obermeyer Hydro's interest in the innovative vision, they agreed to take on this small job and build the wave shaper as a unit for the project.

The River Run project partners grew to include elected officials, who were instrumental in keeping this project a funding priority through several election cycles. Another targeted partner was the local media. As public works agencies, we often avoid anything to do with being in the news. On the River Run project, we took a proactive approach to the media and promoted the amenities the project would provide as a means to reach the broader community.

One final factor a partnership brings to the table is the mindset that "We're all in this together." This allows the partners the confidence to go out on a limb because they know they have the needed support behind them. A good example of this was in the early stages of River Run when maintenance was first discussed., the idea of managing an adjustable wave on a daily basis was daunting. Who had the staff, the knowledge, or willingness to take on potential safety issues associated with a standing wave? Finally, one of the project partners stepped up and volunteered to do the

daily physical adjustments needed to respond to variable flow conditions. Shortly after, another partner pledged funds for future operational costs, then another for post project vegetation maintenance and so on. It was as if a contagious cooperative spirit had taken over the group and had created a culture to work together to make the vision a reality.

Summary - **V2P** is an approach that identifies the key performance elements needed in order to overcome the risks associated with innovation, and to continually sell the vision to a broad audience in order to gain and sustain the required support to successfully implement an innovative or non-traditional project. The River Run project incorporated the exciting idea of bringing river surfing to the Denver area by creating a standing wave in the South Platte River



Looking upstream before construction.



Looking upstream after construction.

A Note from the Executive Director

By Ken MacKenzie



In the fall of 2016, Paul Hindman retired after eight years as our leader and I entered into a contract with the UDFCD Board of Directors as the District's fifth executive director. I competed for this job with four close friends within our ranks and would have proudly served under any one of them had the outcome been different. I am humbled and grateful to work among so many high caliber, driven professionals and I am very excited at the tremendous potential our future holds.

In 2015 we began a strategic planning process and have made very good progress in 2016. This effort started with an all-staff retreat focusing on an analysis of our areas of strength and weakness, and led to the development of our strategic plan, which the Board of Directors accepted at our December 2016 board meeting. In our strategic plan we focused on four strategic priorities:

- **Culture**
- **Organization**
- **Customers**
- **Results**

One of the goals we identified under the **Culture** strategic priority was to *"Implement a succession plan that has clear documentation of competencies required for each position so individuals desiring leadership roles can seek training and education to be ready to fill those roles in the future."* The District's first succession plan was put into place in 2001. This plan focused solely on how we would replace the executive director (at the time the same executive director had been running the organization for 29 years), and how we would replace the finance manager. It was assumed at that time that plenty of qualified candidates for all other positions would be available in the local community, if not within the organization itself. In the past decade we have lost significant institutional knowledge as several of our senior staff retired and we now realize that we must focus an increased effort toward transferring knowledge and providing career development and personal growth opportunities wherever we can, and in better preparing the next generation to lead UDFCD into the future.

A goal we identified under the **Organization** strategic priority was to *"review organizational structure to better align resources and expertise that increases efficiency, improves internal communication, better distributes the workload, and is resilient to staff changes."* A weakness identified by staff through the strategic planning process was the very structure of our organization. For decades the District supported five independent technical programs

(Floodplain Management, Master Planning, Design and Construction, Maintenance, and South Platte River).

Typically, each program consisted of a manager and one or two staff members, creating a lean, responsive team of highly qualified experts in each domain. While this structure served us exceptionally well in the 1980s and 1990s, we were slow to realize that as our staff grew to meet the ever-increasing needs of our customers in the 2000s, the same organizational structure that had served us so well in the past became a limiting factor. Senior leaders managed larger staffs while still carrying out many of the same duties, and junior staffs were left with fewer opportunities for advancement and growth.

In 2008 we merged the Design and Construction Program, the Maintenance Program, and the South Platte River Program into a single program we call the Design, Construction, and Maintenance (DCM) Program. Feedback from the 2015 all-staff retreat indicated overall satisfaction with this previous merger and a strong desire to break down the siloes among the remaining three technical programs. To that end, we are now merging the Floodplain Management Program and Master Planning Program into a single new program we are calling our Watershed Services Program. My ultimate goal is to have the minimum number of program managers necessary to provide adequate resources and support to a substantially larger staff of project managers and construction managers, empowering the project managers and construction managers to be the leaders, and not the helpers of the program managers.

Under the **Customer** strategic priority, two of the goals identified were:

- *Expand feedback from customers and local governments to improve the customer experience and ensure the services we provide are the services needed.*
- *Develop and practice a flood response plan to be prepared for a flood event.*

In the last days of 2016 I sent out an expanded customer feedback survey to our local government contacts at all 40 of the local governments we serve, asking questions about our performance in four key areas. The feedback received will be used to focus our resources better on those areas where we most need improvement.

While we are not an emergency response agency, we do have a flood response standard operating procedure and the floods of 2013 taught us that we needed to expand, refine, and practice that plan so we can assist in a timely and effective manner those communities who need it most.

Under the **Results** strategic priority, one of the goals we identified was to “*Re-evaluate Maintenance Eligibility Program to improve process and work product.*” We have assembled a committee with members from each of the technical program areas to formulate a plan to make our Maintenance Eligibility Program more efficient, more effective, and more sustainable. This is my top priority in 2017 and we will be reaching out to our partners in the community development programs across the District for help in this area.

One of the many great things that came out of the strategic planning process was the articulation of our core values, which are:

- **Advocate for public safety** by reducing flood damage, by increasing community awareness of flood risk, and through responsible design and development.
- **Utilize public funds responsibly** through flexible and efficient processes and by leveraging resources to maximize community and environmental benefit.
- **Be stewards of watersheds and streams** by promoting natural and beneficial functions of floodplains and responsible watershed management.
- **Support local governments** by building partnerships, influencing responsible practices, and promoting community welfare.

- **Advance the practice** of science, engineering, and management of watersheds and streams through research, innovation, and education.

These core values, along with our newly combined mission and vision statement “*Protecting People, Property, and the Environment through Preservation, Mitigation, and Education*” are to be the beacons that will guide us through the rest of the process, including additional training and programmatic reorganization. We intend that, in going forward, we will test every decision we make for alignment with our mission, vision, and these five core values.

In 2016 many of us also committed to an intensive 360-review process, whereby we were able to give and receive feedback to our supervisors, peers, and staff. During this process we also solicited input from many of our colleagues in the local stormwater management community. The 360-review was followed by the opportunity to work on specific workplace behaviors with a professional development coach through the Mountain States Employer’s Council. Eleven employees then volunteered to attend a 40-hour leadership academy, also offered by MSEC. The result of all this work is apparent to me in a happier, stronger, and more collaborative team, and I recommend this exercise to any organization wanting to create a more collaborative workplace.

Next year, 2017, is going to be a year of growth and big changes at UDFCD and I will be looking forward to reporting back next year on the progress we have made.

The CRA Stream Academy

By Barb Chongtoua, P.E., CFM, Project Manager

With increasing regulation on urban streams, rising capital and O&M costs of traditional flood control projects and the ever-increasing demand for environmental stewardship, water resources professionals are challenged to lead stream projects incorporating softer stabilization measures and place-making elements. The CRA Stream Academy was developed to provide water resources professionals with a continuing education curriculum focused on watershed and stream functions that should be elements of any urban stream project.

Sponsored by the Colorado Riparian Association (CRA) and supported by the Colorado Association of Flood and Stormwater Managers and the UDFCD, the second year of the Stream Academy launches in fall 2017.

Topics:

- Anatomy of watersheds and stream systems
- The specific order and hierarchy of functions that are necessary to reduce capital and O&M costs
- Planning and engineering techniques

Logistics:

- 8 classes held once a month at the UDFCD
- October 2017 – May 2018
- \$600 Tuition

Who:

- Public Works Professionals
- Water Resources Engineers
- Land Development Engineers
- Landscape Architects
- Environmental Scientists

Learning Outcomes:

- **Understand** the watershed and stream **systems**.
- **Influence** a multidiscipline team.
- **Understand** the key hydrologic, hydraulic, geomorphic **principles, order, and hierarchy**.

Anyone interested in further information about the upcoming academy may contact Barb Chongtoua at bchongtoua@udfcd.org.

Floodplain Management Program

David Mallory, PE, CFM, Program Manager

The Floodplain Management Program has matured since its creation in 1974 to a potent and nationally recognized advocate for sound floodplain management policy and public safety. The regional floods of September 2013 proved that 40 years of mitigation works! That legacy was the result of strong leadership and solid participation from all the communities that make up the UDFCD service area. My long-time mentor and friend, Bill DeGroot led the Floodplain Management Program for 40 years. I am proud to have served for the past 19 years as project manager and eventually program manager.

Paul Hindman retired in September of this year and Ken MacKenzie was appointed Executive Director. Ken's vision was to merge his Master Planning Program and the Floodplain Management Program to create the new Watershed Services Program, known inside these walls as the "Shed". I fully support this reorganization to improve service to our communities. The downside is the loss of the Floodplain Management Program. It's appropriate this year to catalog the incredible legacy of the Floodplain Management Program and its impact on the quality of life and public safety in the Denver Metropolitan Area.

A brief Look back at the program

In 1973, the UDFCD Board of Directors adopted a two-pronged approach of fixing existing problems while working to prevent new problems from being created. This led to the creation of the Floodplain Management (FPM) and Design and Construction Programs.

One of the FPM's earliest efforts was to begin a flood hazard area delineation (FHAD) effort to map the 100-year floodplains of drainageways that were mostly undeveloped, using future watershed conditions hydrology, to get out in front of development. The FHAD effort continues, although the focus has shifted to revising previously mapped floodplains as the metro area has developed.

Another early effort was to review and comment on drainage studies for new developments at the request of local governments. All drainage reports were voluntarily submitted by the local governments. By the late 1970's it had become apparent to the UDFCD that in many cases the approved plans were not being adequately implemented in the field, resulting in the premature degradation of drainage facilities. In 1981, after the UDFCD had received authorization from the legislature for a maintenance program, the Board of Directors established a Maintenance Eligibility Program (MEP) for projects constructed by others.

The MEP was intended to ensure that projects constructed by developers or by local governments would be maintainable at a reasonable cost to the UDFCD maintenance program. The MEP requires that the UDFCD review and approve construction drawings, observe construction in the field and accept the final construction for any project to be eligible for UDFCD maintenance assistance. In my view the program has prevented the construction of many projects that would have quickly become maintenance nightmares, and has saved the UDFCD and local governments an untold amount of maintenance expense.

FPM also teamed with the Federal Insurance and Mitigation Administration (FIMA) to work with local governments to join the National Flood Insurance Program (NFIP); and to adopt adequate floodplain regulations. This cooperation has continued after the NFIP was transferred to FEMA (see below).

The 1976 Big Thompson flood was the catalyst for developing a flood warning system for Boulder Creek. Over the years, the system grew until it was spun off as its own program in 2005 (now Information Services and Flood Warning Program).

The National Flood Insurance Reform Act of 1994 created the first Technical Mapping Advisory Council (TMAC) to the Federal Emergency Management Agency (FEMA). Bill DeGroot was a Technical Advisor to the TMAC representing local governments. The TMAC sunset in 2000.

FEMA established its Cooperating Technical Partners (CTP) effort in 1999 to more fully engage its local partners in various aspects of the National Flood Insurance Program. The UDFCD, acting through the FPM, became the first CTP in the nation on May 17, 1999. The terms of the initial agreement set forth the framework for cooperation between UDFCD and FEMA. Subsequent agreements have included activities such as UDFCD review of Letters of Map Change, also first in the nation, which has been performed continuously since July 1, 2001; and updates of the DFIRMs for Broomfield, Denver, Douglas and Jefferson counties.

The second Technical Mapping Advisory Council (TMAC) was mandated as part of Biggert-Waters Flood Insurance Reform Act of 2012 (BW12) and modified by the Homeowner Flood Insurance Affordability Act of 2014 (HFIAA). Congress mandated a specific list of activities for the TMAC to work on and a specific makeup of the council ([TMAC page](#)). I was honored to receive a 2-year appointment to the TMAC (2014-2016) as one of two representatives of local CTPs. The other local CTP representative is from New York City. In all, the

council has 20 members from federal, state, local and private sector organizations. In the first two years, TMAC produced four reports that included nearly 100 recommendations for FEMA to consider. Many of the recommendations were administrative in nature. However, there were several recommendations that are, in my view, transformative:

- Flood hazard identification should be based on accurate, high resolution ground elevation data. This generally means LiDAR at QR2 resolution. This is based on the USGS National Map Initiative, also known as 3-Dimensional Elevation Program (3DEP).
- Transition from the 1% annual chance floodplain delineation and flood elevation to structure-specific flood hazard and flood risk analysis. Implicit in this recommendation is partnership with local communities to collect first floor elevations for every structure. This is essential to effective flood risk communication. We must change the perception that if I am just on the other side of the 100-year flood line, I am safe.
- Transition to a dynamic, queried display of data, models, maps and risk assessments. The way we communicate as a nation is changing and we need to create a more robust database that enables data to be dynamically queried and displayed in a webpage.
- Prepare the nation for hazard and risk analysis based on future conditions and actionable science related to climate change. We have advocated for and published flood maps based on future conditions hydrology for many years.
- Reinstatement of a five-year rolling plan that allows the leveraging of local and state funds. The Multi-Year Flood Hazard Identification Plan (MHIP), developed during Map Modernization, established an enterprise wide approach to maximize the return on federal investment.
- Prepare the nation for the future. With respect to riverine flood risk, this means future conditions hydrology. Not only must we consider the future for land occupation projects, but data acquisition and computational methods must be responsive and nimble to the changing landscape. New studies need to be completed faster to be credible.

The National Flood Insurance Program must be reauthorized by Congress in 2017. The reauthorization will likely produce many program changes so watch this space through any of the professional organizations you're active in.

In 2014 FPM negotiated an agreement with FEMA Region 8 to put together a timeframe of when DFHADs will be completed so that they can be scheduled by the region for Physical Map Revision (PMR) funding as they are completed.

This helps get the DFHADs into the DFIRM database and onto the National Flood Hazard Layer quicker. The first two PMRs, consisting of seven DFHADs, are now effective FEMA FIRM maps. There are four more projects, consisting of eleven FHADs, all in the post-preliminary phase.

Following is a summary of FPM activities in 2016.

Floodplain Mapping and Risk Identification

We have twelve DFHAD's underway; **Upper Westerly Creek** in Denver and Aurora; **Big Dry Creek** in Englewood, Cherry Hills Village, Greenwood Village, Centennial and Arapahoe County; **Little Dry Creek** in Arvada, Westminster, and Adams County; **Second Creek** in Brighton, Commerce City, Aurora, Denver (DEN) and Adams County; **Niver Creek** in Federal Heights, Thornton and Adams County; Plum Creek in Douglas County; **Harvard Gulch** in Denver and Englewood; **Grange Hall Creek** in Northglenn, Thornton and Adams County; **Sloans Lake** in Denver, Edgewater, Wheat Ridge and Lakewood; **Third Creek** in Brighton and Adams County; **South Plate River** from Fort Lupton to Chatfield Dam; **Clear Creek** from the confluence to SH 6; **Weaver Creek** in Lakewood and Jefferson County; and peer reviews for Boulder studies of **Skunk Creek**, and **Bluebell and Kings Gulches**

These studies are compatible with FEMA's DFIRM specifications, and will be provided to FEMA for incorporation into the appropriate DFIRMs. Terri Fead is our program lead and continues to do an excellent job of assuring that the DFHADs are done to our standards and FEMA's. The review work load has increased to the point where we have engaged several consultants to review the work of the study consultants. Terri is a superb manager who gets it right.

We are starting to see a lot of community interest in outreach workshops. We participated in the planning, preparation and presentation at several workshops hosted by SEMSWA.

LOMC Review Partnership

This is a new name for LOMC Delegation. Turns out the federal government can't delegate authority so we have another example of how this program continually evolves. LOMC reviews have very stringent timelines. Somewhere between Terri, me and our program consultants we get it done. The continued robust pace of development in the Denver metro area (discussed below) also affects the LOMC case load. The LOMC review program continues to be of great benefit to anyone engaged in projects in and around stream corridors.

DFIRM projects

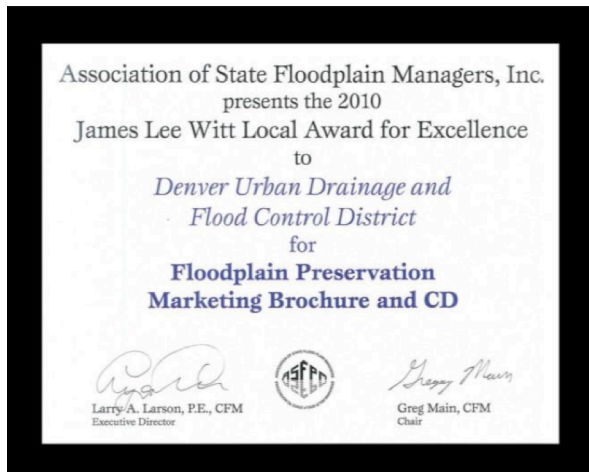
In 2009 we received four grants from FEMA to update existing DFIRMs for the City and County of Broomfield, City and County of Denver, Jefferson County and Douglas County. The last project, Douglas County, went effective on March 16, 2016.

FasTracks Coordination

Our involvement in the metro area's major transit project has slowed. Mike Sarmento is working to close out the various construction projects that make up the Eagle P3 phase. We continue to work with RTD and their contracting group on the North Metro line through Thornton and Northglenn. The focus is on collaboration that most effectively leverages public resources to address the sometimes-competing transit and stream corridor agendas. The FPM Program has been a part of the FasTracks stakeholder group since 2004. I believe we have conducted principled negotiations that result in mutually beneficial outcomes.

Maintenance Eligibility Program

Let me be clear: UDFCD supports and encourages good, sound and safe development. We have published the Floodplain Preservation [Brochure](#) (see photo) and the *Floodplains as a Community Asset* [video](#), which recognize the legitimate profit motive of private sector development and the growth aspirations of communities while at the same time occupying the land in such a way that brings value to the community. Stream and riparian corridors are community assets that, when thoughtfully developed, encourage healthy stream functions, provide recreational opportunities and promote public safety.



Teresa Paterson is responsible for the Maintenance Eligibility Program (see her column elsewhere in this publication). Teresa, along with John Pflaum, Mike Sarmento, and Doron Levary (FPM's first student intern) worked through a very large caseload as the resurgence of land development activities continued through 2016. We had several long staff absences through the year. Joanna Czarnecka was engaged to fill in for Mike during his absence and Holly Piza was our substitute Teresa during her absence. I'm very proud and grateful of how the FPM staff pulled together to get the work done. I'm very honored and humbled to have worked with

such a talented, dedicated and downright good human beings over the last many years. They say change is inevitable and so it is that I say goodbye and at the same time we all say hello to the "Shed". Be good and stay out of harms way.

UDFCD Awards in 2016

Greenway Foundation Award

The UDFCD was the recipient of the Greenway Foundation's Hero of the River Award, which was presented at the 2016 Gala on the Bridge event in September. The gala is held annually on the historic 19th Street bridge over the South Platte River, and is the Greenway's major fund raising event each year.

Excellence in Financial Achievement

The UDFCD received the Government Finance Officers Association (GFOA) *Certificate of Achievement For Excellence in Financial Reporting* again in 2016. The certificate is presented to government units whose comprehensive annual reports achieve the highest standards in government accounting and financial reporting. Congratulations to Terry Schaeffer, Manager of Finance and Accounting, and Wanda Salazar, account, for their efforts in providing outstanding financial management to the UDFCD.

UDFCD receives award from Colorado Chapter of APWA

In 2014, the UDFCD and the Southeast Metro Stormwater Authority (SEMSWA) initiated a stream stabilization project for a reach of Willow Creek between Englewood Dam and Arapahoe Road (see story in the Design, Construction and Maintenance column elsewhere in this issue). The project received the attention of the Colorado Chapter of the American Public Works Association (APWA) due to its innovative water quality enhancements, and was awarded the APWA Colorado Environmental Award.

Dan Olsen, Director of Maintenance and Inspections Division and Lanae Raymond, Director of the Environmental Resources Division for SEMSWA, and Rich Borchardt, UDFCD Project Manager, were all in attendance to receive this prestigious award.

Information Services and Flood Warning Program

Kevin Stewart, PE, Program Manager

UDFCD's IS/FW program continued to strengthen services in 2016. Highlights this year include early flood detection enhancements for Thornton; an improved high-resolution precipitation forecast tool; better web map services; E-records management and processing upgrades; and planning for future IT security and growth.



New rain/stream gage on Big Dry Creek at Thorncreek Golf Course in Thornton

Julia Bailey is in her seventh year at the District where she manages the OnBase™ project, directs internal GIS activities, improves web map capabilities, and continues to make E-documents easier to find. She also assists with UDFCD's Internet and satellite data communications connected with the flood warning program. Be sure to read Julia's article in this issue of *Flood Hazard News* to learn about recent developments and planning activities that she leads.

Derrick Schauer is UDFCD's network administrator and is entering his tenth year of full-time employment. IT systems security and continuity of operations remain high priorities for Derrick as well as website administration. As E-records and E-accounting practices continue to evolve, IT grows increasing critical to daily operations at the District.

2016 Flood Season Recap

After three record-breaking years for tallying the number of days with flood potential, UDFCD's flood warning program finally had a slight reprieve with the threat day count for 2016 being just slightly above normal. The flood problems were also considerably less than preceding years.

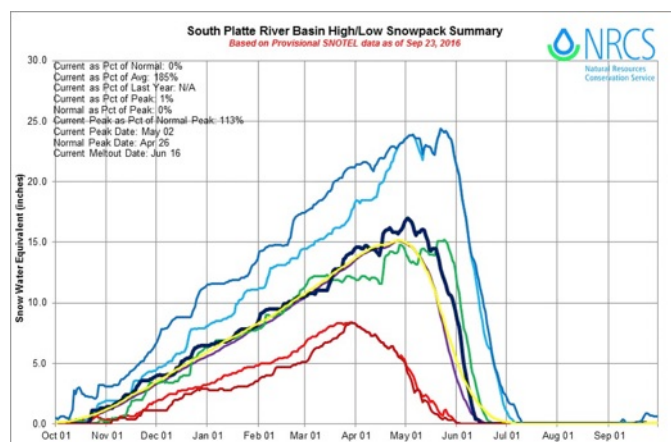
This past year the ALERT System generated rainfall rate alarms on only 21 days compared to 31 the previous year. The following table pinpoints the specific alarm dates for 2016 and designates the days that the National Weather Service issued flash flood watches and warnings.

42 days with flood potential in 2016

May	7, 10, 16, 24, 26, 31	6
June	6, 7, 9, 12, 13, 19, 20, 23, 24, 25, 28, 29, 30	13
July	1, 2, 8, 15, 18, 19, 20, 22, 24, 28	10
August	2, 3, 6, 7, 8, 16, 18, 19, 25, 29, 30	11
Sept	1, 3	2

Red dates are when automated rain gauges exceeded alarm thresholds. Yellow highlighted dates indicate heavy rainfall only affected areas outside UDFCD's main area of concern such as the Hayman Burn Area in SW Douglas County and watersheds in northern Boulder County. Blue boxes are when a NWS flash flood watch was the highest threat level reached and red designates a flash flood warning.

Only one ALERT rain gauge measured over 3 inches in 24-hours during 2016. This occurred on August 30 at the Betasso Filter Plant in Boulder County during an intense thunderstorm that lasted about 80 minutes. Radar precipitation estimates suggest that the Denver region may have experienced as many as four other days (May 26, June 6, 13 & 20) with rainfall totals nearing the 3-inch mark while no CoCoRaHS observations in the region exceeded this threshold. A [storm summary table](#) is available that lists peak rain totals for every day in 2016 having flood potential.



The 2016 snowpack for the South Platte River basin (dark blue line above) tracked close to average (yellow line) providing northeast Colorado farmers with another good water year. Cooler than normal temperatures in May delayed runoff slightly, but this did not result in any unusual flooding being reported.

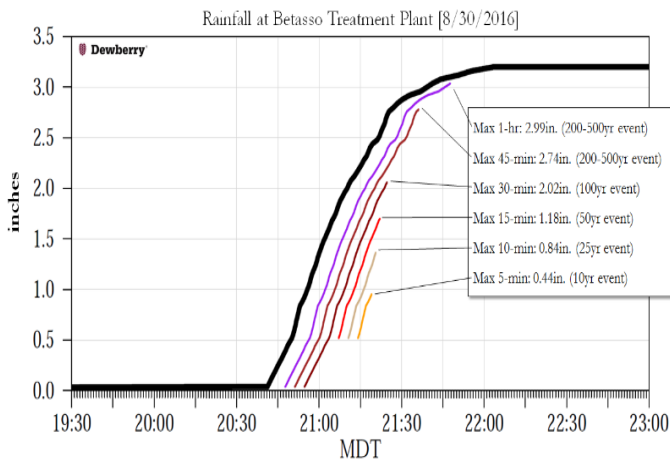


Cherry Creek flooding near Speer Blvd. and Stout Street on June 24, 2015

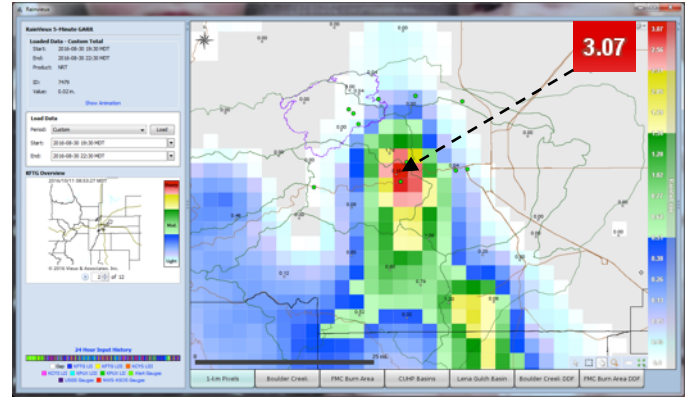
CORRECTION: Last year's Flood Hazard News reported a peak discharge of 2,000 cfs for the June 24, 2015 event on Cherry Creek through downtown Denver. Subsequent reviews suggested that the actual peak was considerably higher. The USGS agreed and recently updated their stage/discharge rating with the corresponding revised flood peak of 3350 cfs.

Rainfall Exceeds 100-Year Return Period Yet Again

In 2015 three days recorded rainfall intensities that exceeded the 100-year threshold (1% AEP-annual exceedance probability) according to NOAA Atlas 14. This past year only one day achieved this "rare" status—that day being Tuesday, **August 30, 2016**. The ALERT rain gage at the Betasso Water Treatment Plant in Boulder County recorded a storm rainfall total of 3.15" between 8:40PM and 10PM. The maximum 30-, 45- and 60-minute intensities exceeded the 1% AEP values for that location. The plot below suggests that the maximum rainfall return period (or frequency) was between a 200 and 500-year event. Due to the small footprint of that storm, the impacts from the runoff were minimal, attracting little attention.



Cumulative rainfall plot of August 30, 2016 storm with corresponding NOAA-14 precipitation frequency values



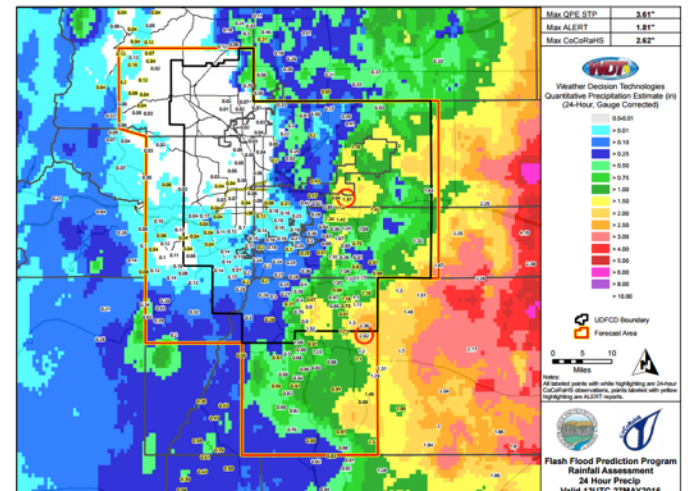
Gage Adjusted Radar Rainfall (GARR) estimates for the August 30, 2016 storm located over Boulder Creek about 2 miles west of Boulder

Other Noteworthy Events of 2016

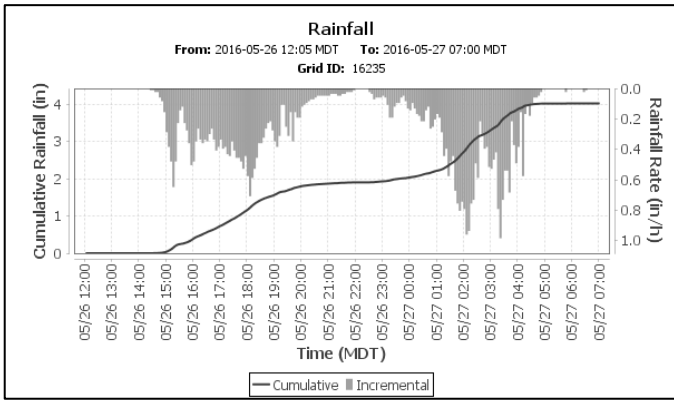
This past year the Denver region experienced 28 days with daily rainfall exceeding one-inch. The following dates characterize the more significant happenings:

Saturday, **May 7** was the first 'Message Day' of the year delivering short-lived heavy rainfall during the early afternoon hours. Due to the fast storm movement, rain accumulations remained low (< 1-inch) resulting in some minor street flooding. High winds and hail accompanied some storms with one tornado warning being issued for central Arapahoe County and NW Elbert County at 1:29 PM.

Thursday PM to Friday AM, **May 26-27** brought 24-hour rain totals close to 3 inches near the eastern District border with rain intensities on the low side. It is remarkable that no alarms occurred from any of the 203 rain gages in the ALERT network. Areas further east may have received over 6 inches of rain according to some radar estimates (see map below). A CoCoRaHS observer near Deer Trail in eastern Arapahoe County reported 4.58 inches, a 50- to 100-year event according to NOAA Atlas 14. The time series plot below the map is from a radar-precipitation grid point in Elbert County. It shows precisely when the rain fell as well as the storm's intensity in 5-minute increments.



24-hour radar-rainfall estimates and rain gauge totals for May 26-27, 2016



Time-series plot of 5-minute radar-rainfall estimates

On Monday, **June 6**, the primary target was Highlands Ranch in northern Douglas County where rainfall amounts approached 3-inches from two waves of storm activity in the late afternoon and late evening hours. The ALERT gage on Big Dry Creek at the Heritage Regional Park recorded a rainfall total of 2.44” with bursts occurring from 4:30 to 5:50PM and from 11:30PM to 12:15AM with a maximum 10-minute intensity of 4.0 in/hr at 5:05PM. A nearby CoCoRaHS observer reported the maximum 24-hour amount for the day of 2.81 inches. The most intense rainfall measurement occurred further north at a new ALERT station along Weir Gulch in Denver where the rain total there was just under an inch with a 5-minute downpour at 5:16PM averaging an impressive 7.1 inches per hour. The streamgage at that location measured its high water maximum for the year at 5:30PM with a 3.8-foot rise occurring in just 15 minutes and a corresponding flow rate change from 2 cfs to about 300 cfs.

The ALERT streamgage on Big Dry Creek at Heritage Regional Park came within 0.04-feet of tying a previous high water record set in 2012 with the creek rising nearly 10-feet in just over an hour and cresting at 6PM with a peak flow of 830 cfs. Coincidentally, the 2012 storm also occurred on D-Day (June 6) of that year. The station has only been in operation since June of 2011.



ALERT, CoCoRaHS & Radar-estimated rain amounts for June 6, 2016

Another heavy downpour on June 6 occurred near Brighton reminding us once again that our “dense” network of rain gages does not catch everything that happens. Gerald Blackler with Engenuity Engineering Solutions was asked by the City of Brighton to analyze this storm in detail. According to radar-rainfall estimates, this event produced nearly 2.5-inches in less than 2-hours while nearby rain gages measured

far less. The [engineer’s report](#) contains other interesting information including a video of their 2D rainfall/runoff model to visualize the flooding.

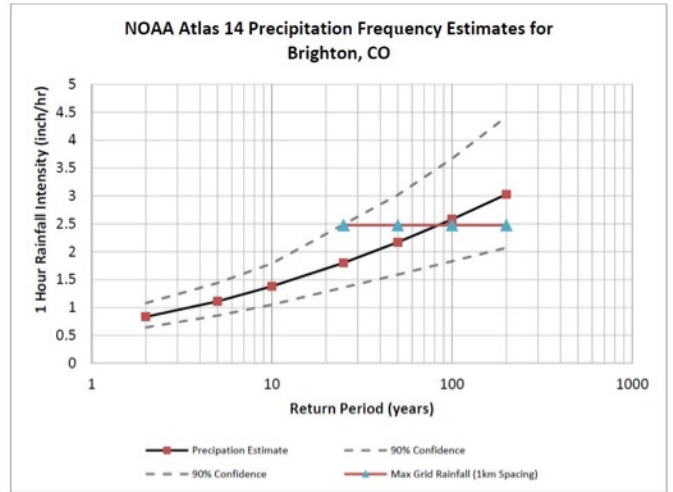


Figure from Engenuity report on Brighton event of June 6, 2016

One week later on Monday, **June 13**, rainfall again approached the 2.5-inch threshold with the highest totals occurring in Parker. The Lakewood and Morrison areas of Jefferson County also experienced rain amounts close to 2 inches. Large hail, heavy rainfall and gusty winds accompanied the storms.

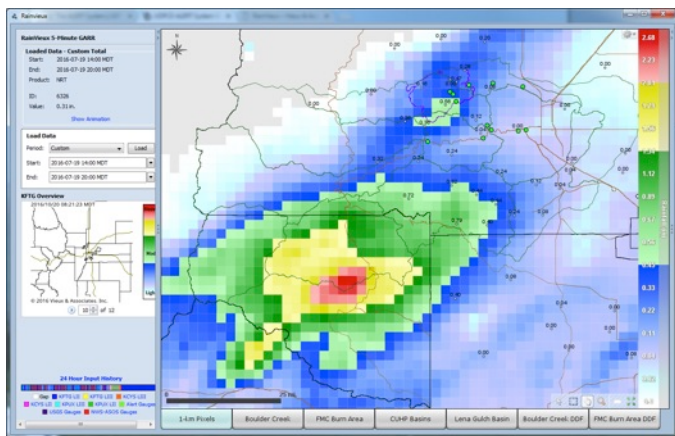
Maple Grove Reservoir on Lena Gulch in Lakewood reached its spill level just after midnight and continued overflowing for 3 days. The spillway flows were small however and no flooding resulted.

Tuesday, **June 28**, brought hail and very intense rainfall to the central part of the metro area with peak rainfall rates approaching the 6 inch-per-hour mark in downtown Denver around 6:45PM, while storm totals remained on the low side—less than 2 inches. Similar rain intensities also occurred a short time earlier in Arvada and Wheat Ridge. High water maximums for the year were set this day for Ralston, Leyden and Van Bibber Creeks in Arvada; on Little Dry Creek in Adams County; and on Lakewood Gulch, Cherry Creek and the South Platte River in Denver. A [video](#) of Ralston Creek was shot at the crest of the “flood” in Hoskinson Park along Brooks Drive near the Carr Street crossing.



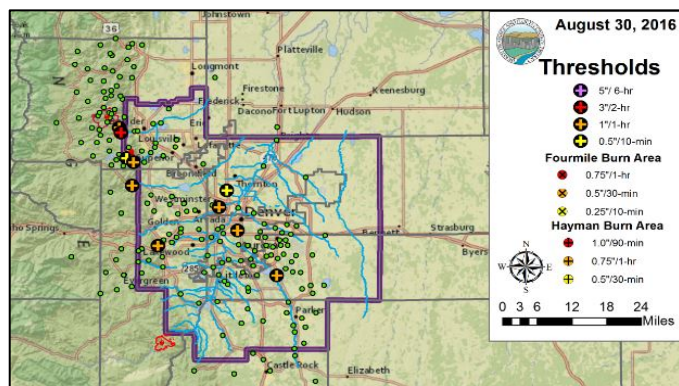
Ralston Creek near Carr Street at 7:50PM on June 28, 2016

After an extended 2-week period of unusually dry weather and rising fire danger, the Colorado monsoon—that normally debuts around Independence Day—finally arrived on July 17 with heavy rainfall in eastern Adams County prompting the NWS to issue a flash flood warning while the metro area continued its dry spell. The following day more intense storms began threatening the District on the east and south sides but once again with little consequence. By Tuesday, **July 19**, the urban landscape began feeling the monsoon when intense downpours dropped 1 to 1.5 inches just south of downtown Denver with peak rain rates exceeding 5 inches/hour. A number of stage gauges recorded their annual maximums of this day on Harvard Gulch, Sanderson Gulch, Cherry Creek, the South Platte River, and a few other locations. Another interesting observation this day was the large storm that occurred in the mountains over Gilpin County that produced over 2.5 inches according to radar rainfall estimates. Fortunately, this storm missed the Fourmile Burn Area (*fire in 2010*) while the little rain that did fall there caused the highest flow of the year from the FMBA, albeit small.



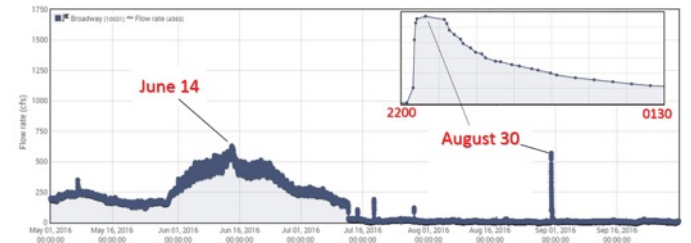
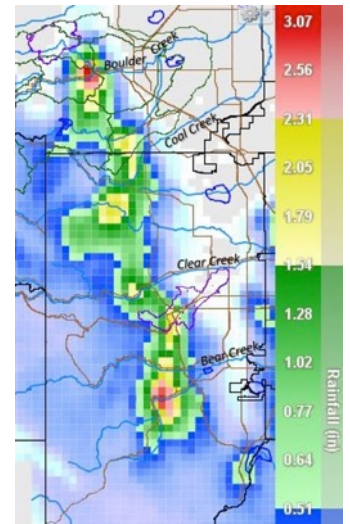
July 19, 2016 rainstorm over Gilpin County

The cloudburst during the evening hours of Tuesday, **August 30** has the illustrious honor of being the year’s most unusual event, with one point in Boulder County having a return period between 200 and 500-years according to NOAA-14 (*see previous discussion and data plot for the Betasso Filter Plant ALERT gage*).



Rainfall Rate Alarms for August 30, 2016

While the point rainfall from this storm is statistically rare, it did not result in the maximum peak flow of the year on Boulder Creek due to its small footprint. That record was set on June 14 from seasonal mountain snowmelt (*see plot below*), plus a little help from a much smaller rainstorm than what happened on August 30. The 8/30 runoff is remarkable, however, especially when comparing the storm runoff to the extended two-week high water period in June. Both flow peaks were nearly identical but the August event caused Boulder Creek to rise from 5 cfs to over 500 cfs in just 15 minutes. Compared to the “September-to- Remember” flood of 2013, this Boulder Creek peak was quite small (*the 2013 peak was about 5,000 cfs*), but the 8/30 event does clearly illustrate why flash floods are so dangerous, happening quickly, sometimes with little or no warning.



Boulder Creek flows at Boulder from May 1 to September 30, 2016

Fortunately, an early warning issued for this mini flash flood gave first responders in Boulder plenty of lead-time and the rapid rise occurred during a less busy time of day, just after 10PM. Prior to this the first rain alarm from the Betasso Filter Plant occurred at 8:50PM. Next an automated streamgage in the canyon just west of Boulder detected a 500 cfs increase between 9PM and 9:35PM prompting the NWS to issue their flash flood warning at 9:25PM. Earlier notifications concerning the heavy rain threat went out before 6PM. The earliest indication of a more serious flood potential may have been the QPFMAX product at 12:38PM (*see later discussion*) suggesting that 1-hour rainfall amounts could reach the 2.5-inch threshold during the evening hours. As it was in 2013, emergency managers in Boulder were once again ready well ahead of what ensued this day.

Meteorological Support

UDFCD’s Flash Flood Prediction Program, a.k.a. F2P2, operates from April 15 through September 30 in close partnership with the National Weather Service, focusing primarily on intense rainfall events that threaten local

jurisdictions within the District. This long-running program has been serving the region since 1979.

Skyview Weather provided the flood prediction and notification services for 2016. Forecast products include daily heavy precipitation outlooks, quantitative precipitation forecasts (QPF), storm track maps, and jurisdiction-specific 'messages' concerning flood threats (see example below). Skyview's president Tim Tonge has participated in the program for the past 11 years. Project manager Brad Simmons is a 10-year veteran of the F2P2. Bryan Rapport, a 23-year veteran with Genesis Weather Solutions, served as Skyview's senior operational and consulting meteorologist. Other meteorological support staff included 4-year veteran Alan Smith along with Justin Brooks, Nick Barlow and Ryan Matoush, who all just completed their rookie season of flood forecasting for the F2P2.

Sent: Tuesday, August 30, 2016 7:52 PM
To: message-jefferson-sms@lists.udfcd.org
Subject: M-1 Low Impact Flooding Update

Heavy Rainfall Likely for Jefferson County from Current to 915 PM
<http://udfcd.org/gmap>

An [annual report](#) and a complete [archive](#) of F2P2 products are available.

CoCoRaHS Update

UDFCD has been a proud sponsor of the Community Collaborative Rain, Hail & Snow Network, a.k.a. CoCoRaHS, since 2001. This large network of about 21,000 volunteer observers covers all 50 states, Canada, Puerto Rico, the U.S. Virgin Islands and the Bahamas—just added in 2016. Funding of CoCoRaHS currently relies on sponsorships and contributions by individuals. Consequently, this unique non-profit organization continues to seek new financial partners. To donate or to become a volunteer observer visit the [CoCoRaHS website](#).

ALERT System News

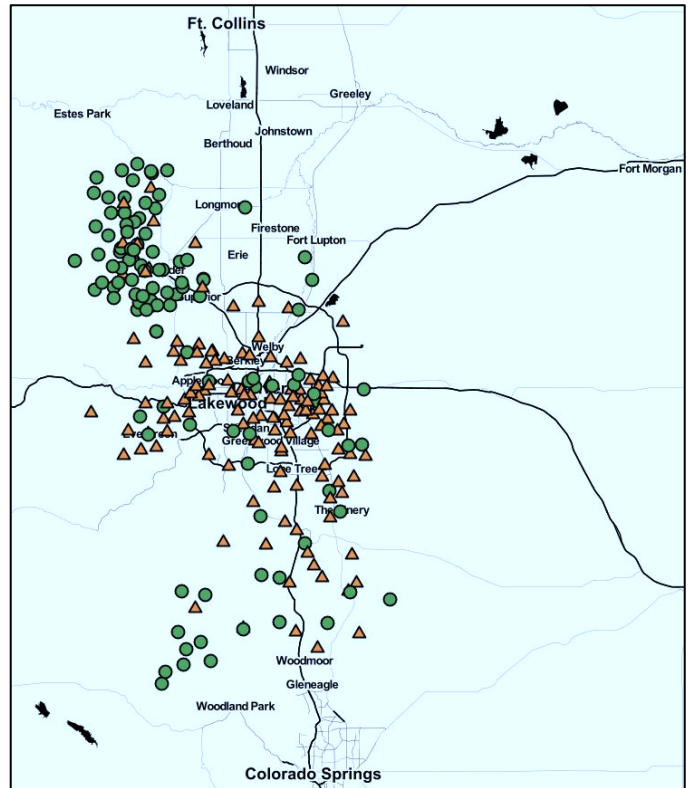


Weir Gulch at Julian Street in Denver

The ALERT system operated by UDFCD covers an extensive regional area with 232 gaging stations that monitor rainfall, water levels and weather conditions in real-time. Two new stations installed

in January of 2017 will measure rainfall and water levels on Big Dry Creek at the Thorncreek Golf Course and on Brantner Gulch near Quebec Street this coming year. Both stations are located in the City of Thornton. Last March, Denver had a

new gaging station installed on Weir Gulch at Julian Street to monitor both rainfall and streamflow.

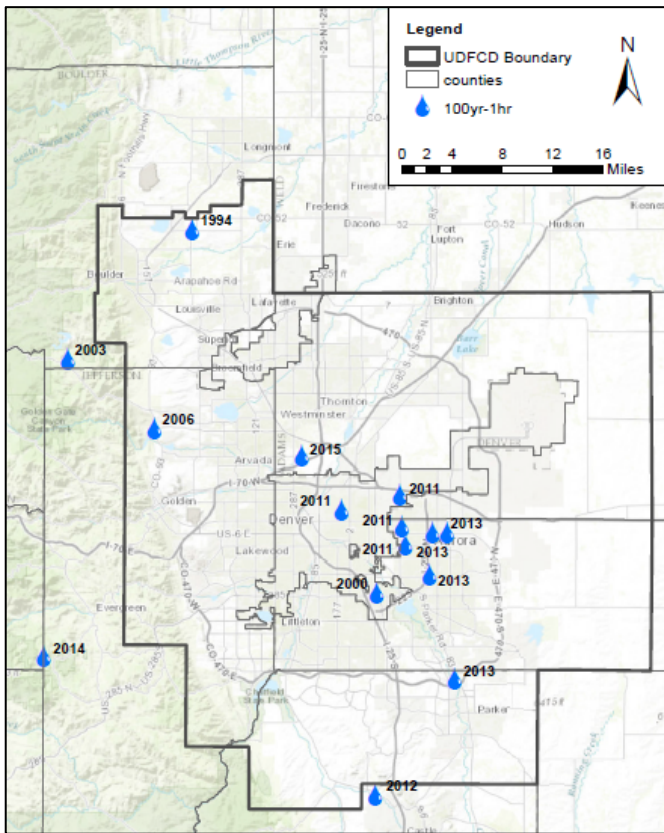


2016 ALERT System Coverage

OneRain and Water & Earth Technologies (WET) provided routine preventative maintenance and unscheduled repair services for 2016, enabling successful data collection of 13.1 million ALERT data reports. The [Resources](#) box at end of this article contains links to annual reports and other pertinent documents.

A [MS-Excel™ workbook](#) is available that summarizes the annual peaks and maximums for the period of record for every ALERT streamgauge in the network including discontinued stations and those temporarily out-of-service. The corresponding data includes the date, time, gage height/stage and flow rate. Appropriate notes are also included as cell-specific comments where data is missing, questionable, or supplemented by other measurements.

Similarly, monthly rainfall data is analyzed and tabulated using Excel to provide summaries for various peak rainfall periods ranging from 5-minutes to 24-hours. The data at the top of the each worksheet represents the maximums for each month. Highlighted cells indicate that a pre-defined alarm threshold was exceeded for the respective time period. Subsequent analysis permits comparison with NOAA-14 intensity/duration/frequency (IDF) values for each gaging station location. A recent long-term records analysis by WET lead to the production of the following map that shows the location and corresponding year when 1-hour rainfall measurements exceeded the 100-year (1% AEP) threshold.

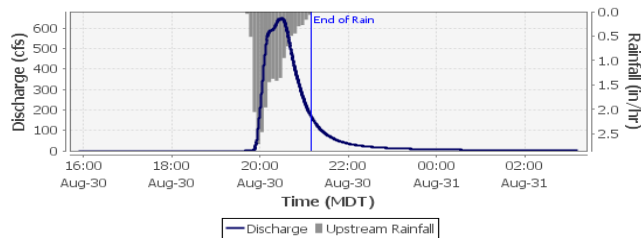


Locations and corresponding years when a 1-hour rainfall event exceeded the 100-year (1% annual chance) threshold

UDFCD supports two primary websites that provide access to ALERT data. OneRain maintains the public website linked to from UDFCD's [flood safety page](#). Links to the F2P2 and Twitter websites are also on this page. The 'alerts5' website is the starting point for most flood warning program partner agencies.

Real-Time Hydromodel Experience from 2016

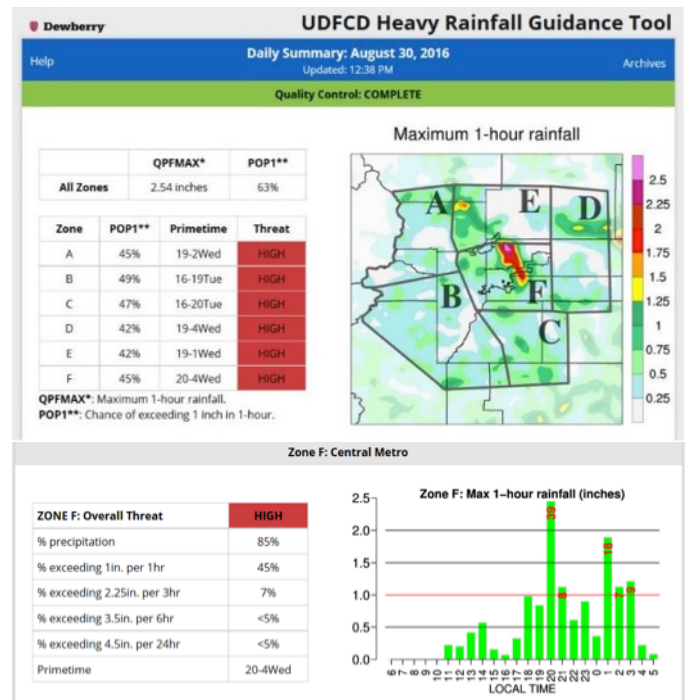
This past flood season provided few opportunities to evaluate RT-hydromodel performance. One good occasion was **August 30** when Lena Gulch in Jefferson County recorded its annual peak from a storm in the foothills near Golden where just over 2-inches of rain fell in about 90-minutes. This storm was less intense than the Boulder County storm that same day (*see previous discussion*), but the runoff response was impressive and good lessons were learned about the complexities of running hydromodels in real-time. A detailed [report](#) by Vieux, Inc. exposes some of the challenges.



Vflo hydromodel output near Heritage Square in Golden

High-Resolution QPF Enhancements

In 2015, Dewberry built a web-based precipitation forecast tool for UDFCD to address four crucial questions regarding potential flood threats from heavy rainfall: 1) timing, 2) location, 3) intensity and 4) confidence. The tool, named "QPFMAX", relies on an ensemble of high-resolution weather models that directly simulates thunderstorm rainfall. The original 2015 operational version used raw model data. In 2016, a [technical memo](#) documenting 2015 performance noted, among other things, that a noticeable "overconfidence" bias existed where predicted heavy rainfall had a higher probability than the observations implied. Thus, a significant processing step added in 2016 reduced this bias. A [recent report](#) prepared by Dewberry describes the performance of QPFMAX (v.2) during 2016 and comments on the potential for future refinement.



QPFMAX from August 30, 2016

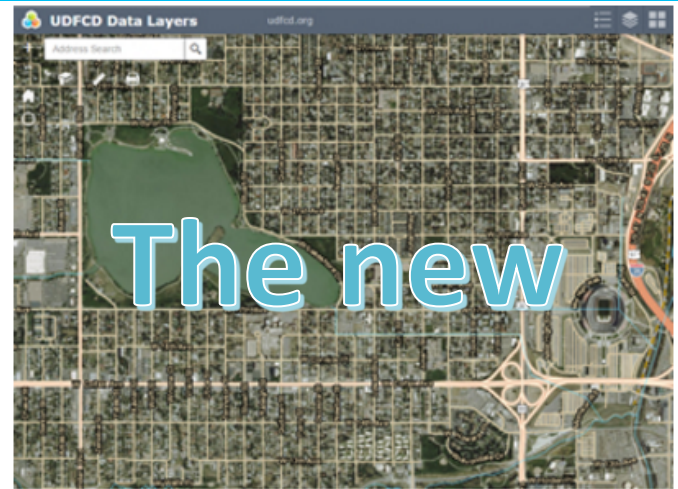
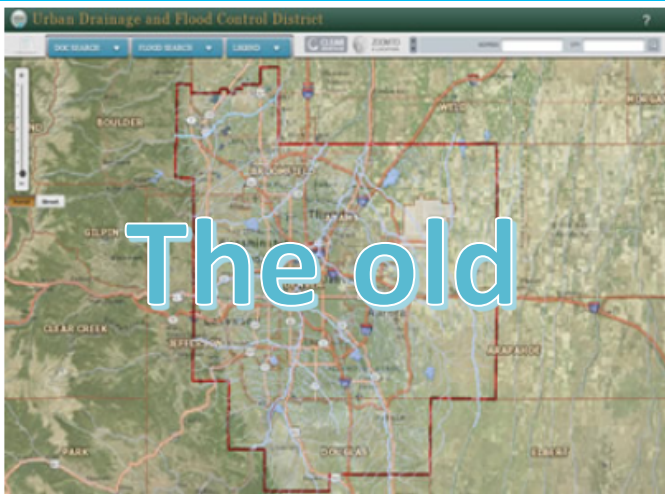
In closing, the 2016 flood season was thankfully a year of low impact flooding for UDFCD but as usual, flood forecasting continues to be a challenging experience that provides many learning opportunities for us all. Please share your ideas on how we may better serve your needs knowing that future floods are certain to come.

Resources

A complete archive of daily forecasts, flood threat notifications, storm track predictions, storm summary maps, and other products are available at the [F2P2 website](#). A MS-Excel workbook containing [annual and record stream levels and peak flows](#) measured by the ALERT System along with detailed annual reports concerning [ALERT System maintenance activities](#) and [F2P2 operations](#) are also available.

Public Access to Maps and Documents

Julia Bailey, Information Services Engineer, Information Services and Flood Warning Program



Announcement

Let's start with the bad news. On July 1st 2017, the web application tool known as the EDM (Electronic Data Management) will no longer be accessible. The good news is that new tools are coming!

Brief History

The EDM was first released in 2009. It is a multifunctional tool used to view GIS data layers such as floodplains, UDFCD projects, and other information. It is also the only public access available for certain publications like masterplans and as-built drawings. The application was built using the Adobe Flex software development kit for rich Internet applications based on the Adobe Flash platform. This technology is outdated. It can be slow to load and subject to security issues. A few users have contacted the UDFCD because their IT department has blocked Flash applications and they cannot access the EDM. With new technology available today, it is time to move forward.

Vision

With a clear deadline, the UDFCD plans to make a smooth transition away from the EDM. The objective will be continued public access to mapping and document retrieval. The new tools and figures will leverage technology that is configurable as opposed to fully customized applications with large amounts of written code.

What's Next?

The plan to replace EDM functionality consists of three parts. The first component will provide access to mapping through an application created with ArcGIS Web App Builder. The map is available on our website udfcd.org/mapping. Map layers are available for download as well. The map does not currently support document search functionality.

Map layers are available for download at udfcd.org/mapping

The second component is a new addition to our website. The new page will provide for public retrieval of documents. The public access site is integrated with our internal electronic content management system, OnBase™. Document retrieval will be by keyword and text-based search. Users will enter information to retrieve related documents. The document search webpage is expected late February 2017. The combination of this tool and the simple webmap provide most of the functionality that is currently available on the EDM except that users will not yet be able to retrieve documents by clicking related map features.

The final component is the addition of an OnBase widget that will be accessible in a webmap application. The OnBase widget enables public retrieval of documents through a mapping interface. This capability utilizes the ESRI integration for the OnBase module. Document search from the mapping interface will be available by early May.

Mobile Access

The EDM was intended to be a web-based desktop application. It was never accessible on Apple devices and was not accessible on Android after Flash support was discontinued. The new mapping tools from ArcGIS Web App Builder are mobile friendly.

Feedback

We look forward to your feedback on the new tools and functionality coming in 2017. Please send comments to Jbailey@udfcd.org.

Master Planning Program

Shea Thomas, Project Manager and Holly Piza, Project Manager

Master Planning Projects

We completed eight planning studies and one flood hazard area delineation study in 2016 with twenty-four additional studies under way; and we plan to begin eight new planning studies in 2017.

To date UDFCD has completed a total of 113 major drainageway planning (MDP) studies, 94 outfall system planning (OSP) studies, and 101 flood hazard area delineation (FHAD) studies, which includes many updates to studies completed in the past.

Urban Storm Drainage Criteria Manual

After the release of the Urban Storm Drainage Criteria Manual Volumes 1 and 2 rewrite in January 2016, UDFCD provided several workshops to local communities covering the changes. UDFCD also started the process of adopting NOAA Atlas 14 data and released several updates to the USDCM in early 2017.

UDFCD Software

You may download the UDFCD unit hydrograph program *Colorado Urban Hydrograph Procedure (CUHP 2.0)*, and other free software, and design aid workbooks from our website www.udfcd.org. Several of the design aid workbooks have undergone major revisions based on the USDCM update, recalibration of CUHP, and the adoption of NOAA Atlas 14.

UDFCD Annual Seminar

At our 2016 annual seminar we had over 330 participants. The proceedings are available at: <http://udfcd.org/presentations>.

On April 4, 2017 we will have our next annual seminar. This one-day program will be at the Omni Interlocken in Broomfield. Register soon and join us to find out what is going on regionally and nationally in drainage, stormwater quality, and floodplain management. Registration information is currently on our website.

STATUS OF PLANNING PROJECTS

Project	Sponsors	Consultant	Status
54 th & Pecos OSP	Adams Co	CH2M	20% Complete
Airport Creek US36 to UPRR Alternatives	Broomfield	Olsson	100% Complete
Bear Canyon Creek Mitigation Plan	Boulder	AMEC	100% Complete
Bear Creek at Sheridan Alternatives	Denver	Michael Baker	100% Complete
Big Dry Creek FHAD	SEMSWA, Greenwood Village, Englewood	RESPEC	70% Complete
Brighton OSP	Brighton	Enginuity	70% Complete
Clear Creek FHAD	Adams Co, Denver, Arvada, Wheat Ridge, Jefferson Co, Golden	ICON	20% Complete
Dry Gulch OSP Update	Lakewood, Denver	ICON	95% Complete
Goose Creek, Twomile Canyon Creek Mitigation Plan	Boulder	ICON	0% Complete
Grange Hall Creek MDP & FHAD	Thornton, Northglenn, Adams Co	RESPEC	75% Complete
Harvard Gulch MDP & FHAD	Denver, Englewood	Matrix	100% Complete
Lee Gulch in Centennial Alternatives	SEMSWA	ICON	100% Complete
Little Dry Creek MDP & FHAD	Arvada, Westminster, Adams Co	Olsson	25% Complete
McIntyre Gulch & Tributaries FHAD	Lakewood	Enginuity	0% Complete
Montclair Basin OSP	Denver	Enginuity	50% Complete
Niver Creek MDP	Thornton, Federal Heights, Adams Co	CH2M Hill	100% Complete
Niver Creek FHAD	Thornton, Federal Heights, Adams Co	CH2M Hill	70% Complete
North Dry Gulch OSP	Lakewood	Muller	95% Complete
Plum Creek MDP	Douglas Co	Enginuity	100% Complete
Plum Creek FHAD	Douglas Co	Enginuity	70% Complete
Quincy, Shop, Meadowood Creeks OSP	Aurora	Michael Baker	40% Complete
Sand Creek Right Bank Tributaries OSP	Aurora, SEMSWA	Merrick	100% Complete
Second Creek MDP & FHAD	Aurora, DIA, Adams Co, Commerce City, Brighton	RESPEC	5% Complete
Skunk, Blubell Canyon, King's Mitigation Plan	Boulder	ICON	0% Complete
Sloan's Lake Drainageway MDP & FHAD	Denver, Edgewater, Lakewood, Wheat Ridge	Matrix	60% Complete
South Platte River FHAD	12 communities	Olsson	25% Complete
Sulphur Creek FHAD	Parker	Merrick	0% Complete
Third Creek MDP & FHAD	Brighton, Commerce City, Adams Co, Aurora	Matrix	60% Complete
Weaver Creek MDP & FHAD	Jefferson Co, Lakewood	Olsson	55% Complete
Weir Gulch MDP & FHAD	Denver	Michael Baker Jr.	75% Complete
Westerly Creek (Upper) FHAD	Aurora, Denver	CH2M Hill	95% Complete
Westerly Creek (Lower) FHAD	Aurora, Denver	Matrix	10% Complete

Stormwater Quality & Permitting Support Activities

Holly Piza, Project Manager

UDFCD continued to be active in the stormwater quality arena in 2016, with commitments to the following activities and organizations:

UDFCD BMP Monitoring Program:

UDFCD has been monitoring stormwater BMPs since the late 1990's. This year UDFCD continued monitoring influent and effluent water quality for three stormwater research sites. Information for each is available on our website. Sites monitored as part of this program:

- a green roof at Denver Botanic Gardens,
- a rain garden located in the right-of-way of Lakewood, and
- a rainwater harvesting system located at a public school in Denver.

Two new research sites were also constructed in 2016 and will be monitored beginning in April 2017. At a new rain garden located within the Broken Tee golf course, UDFCD will monitor a suite of stormwater constituents to include E. Coli and also record volume reduction. The second project, Industry, located in the RINO district of Denver is a new permeable interlocking concrete pavement (PICP) project that will separately monitor untreated runoff, effluent from a PICP section with a sand layer, and effluent from a PICP section without a sand layer.

Special Studies and Projects:

Pathogens Toolbox

The 2016 303(d) list includes 35 E. Coli impaired stream segments with 38 more segments listed for monitoring and evaluation for potential impairment. These numbers have almost doubled in the past eight years. In 2016 UDFCD completed a pathogens toolbox document that outlines an approach to help communities begin to look closer at specific watersheds and address this issue. Our website hosts this document. In 2017 we will develop a number of additional resources on this topic.

Nationwide Stormwater Treatment Costs and Maintenance Needs

UDFCD is leading a team of communities across the nation to further evaluate the whole life cycle costs and long-term maintenance and operation of distributed stormwater quality treatment infrastructure. This work is through a partnership with the Environmental and Water Resource Institute (EWRI) Municipal Water Infrastructure Council (MWIC). In 2016 UDFCD and EWRI collaborated to complete a nationwide

survey pertaining to the cost of maintaining green infrastructure. This document is complete and will be available through the ASCE library. UDFCD is also using this data to update BMP-REALCOST and inform revisions to the Maintenance chapter of Volume 3.

Senate Bill 15-212

In early 2016 UDFCD worked with the State to help clarify notification requirements for water detention facilities designed to mitigate adverse effects of stormwater runoff. Our website provides a summary memorandum.

Colorado MS4 Permit Assistance:

As a Phase I MS4 permit requirement, Denver, Aurora, and Lakewood must each monitor in-stream water quality during runoff-producing events. UDFCD has assisted these communities in complying with the requirement since 1998 by co-funding and managing the data collection, analysis, and reporting activities. Together with our partners, UDFCD has collected 19 consecutive years of wet-weather in-stream data at five locations within the UDFCD boundary. On April 1, 2017 UDFCD will deliver the third Wet Weather Water Quality Monitoring Trends Analysis report to the State.

UDFCD also continues to host and actively participate in the general assembly and legislative committee meetings for the Colorado Stormwater Council, an MS4 permittee-only group comprising 98% of all permit holders in Colorado. The District also hosts a quarterly MS4 meeting with the Division and other interested parties.



A crew at Industry washes filter media into the structural base of this permeable pavement section. In the distance a second section will be constructed without filter media. Both sections will be monitored for water quality.

Maintenance Eligibility Program

Teresa L. Patterson, P.E., CFM, Project Manager, Floodplain Management Program

MEP Case Numbers Continue to Rise

As witnessed by all of the activity on the skyline throughout the Denver area, construction activity in the UDFCD continues to rise. In 2016 we logged 740 submittal applications for our review for flood safety considerations and compliance with current stream design standards. At any given time, we are tracking the construction progress of roughly 50 projects in varying stages of construction across the Denver Metro area. In general, design and construction activity related to major stormwater infrastructure has increased by 25% since 2015.

I am also happy to report that we had a significant increase in MEP approvals and acceptance of finalized projects to the program. The local government staffs and the consulting engineering community have risen to the challenge of making this year so fruitful. We greatly appreciate their cooperation in the implementation of mitigation efforts across our region to protect our environment and the investments to public infrastructure.

MEP Workshops – Outreach and Education

In 2015 we began offering half-day MEP Workshops to our local governments in an effort to strengthen the relationships with our community counterparts. The workshops cover the services provided by UDFCD, focusing mainly on maintenance needs and how the MEP process bridges the UDFCD programs. The content of each workshop is tailored to the specific community needs and their familiarity with the MEP. Workshops are hosted at the community's facilities to maximize attendance and permit more flexibility with attendees' schedules.

In 2016 we presented two workshops – one with Commerce City and the other with Thornton. Each workshop

was co-presented by Mike Sarmento, the MEP Construction Manager and myself, with additional participation from other UDFCD staff members. The workshops have been well received and we can't be more grateful to the attendees for taking time out of their busy schedules to help us understand how we can assist them better.

MEP Projects

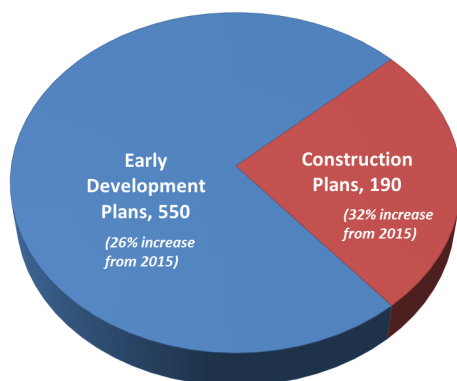
Project sizes varied widely again this year, from large-scale developments to single pipe outfall projects along existing streams. The following highlights two site-challenged projects that implemented proposed improvements from UDFCD master plans.

Baranmor Ditch Reach 4-5

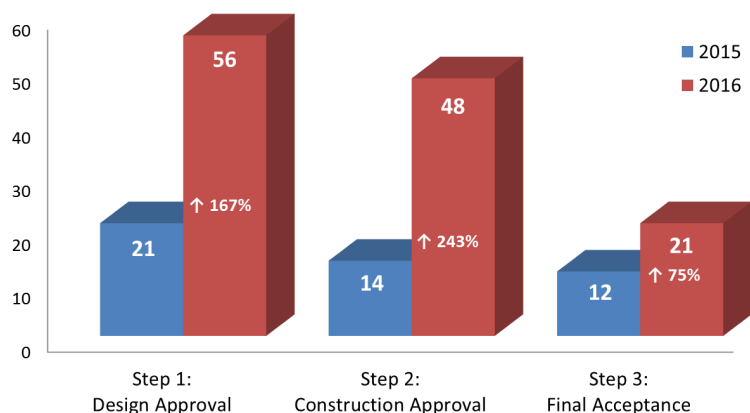
The Baranmor Ditch Reach 4-5 project is final improvement for a reach of Baranmor Ditch, a Sand Creek tributary in Aurora. Baranmor Ditch is a flood control channel along the north side of Baranmor Parkway. Since publishing the 2010 UDFCD *Baranmor Ditch Watershed Outfall Systems Plan*, the City of Aurora has undertaken several major channel improvement projects along Baranmor Ditch to fully contain the 100-year peak flow event. The downstream section under Peoria was constructed in 2012 followed by the upstream section from Scranton Street to Smith Road in 2013.

One of the most challenging aspects of Baranmor Ditch Reach 4-5 was the very limited right of way and the existing channel's close proximity to existing buildings. The design team utilized block retaining walls and short rock walls to create the capacity that was lacking in the original channel. The project also replaced three culvert crossings to connect Reach 6 at Scranton to the downstream Peoria crossing.

MEP SUBMITTAL REVIEWS COMPLETED IN 2016



MEP APPROVALS IN 2015 & 2016



Flatiron Meadows Regional Detention Basin

The Flatiron Meadows Regional Detention Basin project again was the implementation of regional improvements laid out in a UDFCD master plan, the 2014 *Town of Erie Outfall Systems Plan, West of Coal Creek*. The project is located in Erie adjacent to Erie Parkway along the Prince Tributary and downstream of Prince Lake No. 2. The master plan called for Regional Detention Basin 1029 between Erie Parkway and the Leyner Cottonwood Irrigation Ditch.

The Flatiron Meadows design team had several challenges with this particular site. Flow from Prince Tributary had to bypass the Leyner Cottonwood Ditch before dropping into the detention basin. The team analyzed the flood wave inundation from a potential dam breach from Prince Lake No. 2 and made accommodations in the design of Prince Tributary, the detention basin, and the Erie Parkway crossing to minimize damages and ensure that homes would not be inundated if such an event occurred.



Challenging site constraints with limited right of way for Baranmor Ditch channel improvements. Above-channel before construction; below-improved channel section utilizing block walls to support the added sidewalk on the left and short rock wall on the right to preserve the building access.



Prince Tributary enters the detention basin over a grouted boulder drop structure protecting the Leyner Cottonwood Ditch.



Design, Construction & Maintenance Program

David Bennetts, PE, CFM, Program Manager and Laura Kroeger, PE, Assistant Program Manager

Capital Improvement Plan and Work Plan

The DCM program is funded by three different legislative authorizations; the Construction Fund, the Maintenance Fund, and the South Platte River Fund. Each year the District prepares a work plan for each of the funds. The 5-year Capital Improvement Plan (CIP) lists capital construction projects by county for the Construction and South Platte River funds. The CIP shows the UDFCD's financial participation, which will be matched by the participating local governments, for a 5-year window of time. This allows both the UDFCD and local government partners to plan funding levels into the future.

The Stream Management Plan lists projects for the Maintenance and South Platte River funds. County, category of work, the local government where the work is located, project location, description of work, and the estimated cost are all listed in this plan. Stream management work is entirely funded by the District. Development of both the 5-year CIP and Stream Management Plans are based on prioritized project requests from local governments. Copies of both of these plans are available on the UDFCD's website: <http://udfcd.org/design-construction-maintenance/>.

Design and Construction Projects

Design and construction projects implement master planned improvements. Generally, the UDFCD manages final designs prepared by consulting engineers. The local governments are involved in all aspects of the design process, and usually acquire any necessary ROW. UDFCD projects are constructed utilizing our Project Partner process, or in some cases, are publically bid. In 2016, the UDFCD authorized approximately \$11,270,000 for construction projects.

Stream Management

Stream management provides basic flood control maintenance along the major drainageways within the UDFCD. Services typically performed include mowing, trash and debris removal, weed management, and tree thinning. The UDFCD is currently managing over 350 drainageways and spent \$690,000 in 2016 for Stream Management. Private contractors are hired each year to perform the work on a unit price basis. The UDFCD's website has maps of the routine work broken down by county, major drainageway and reach.

Restoration Maintenance

Restoration work is site-specific construction work to address isolated drainageway problems that are eligible for maintenance. This work often mitigates the need for more costly improvements in the future. Types of restoration activities include: sediment removal, local erosion repair and bank protection, drop structure repair, and channel grading, stabilization, and revegetation. All of this work is

accomplished using private contractors through a pre-qualified contractor selection process. In 2016, the UDFCD completed almost \$9,000,000 in restoration work.

Below is a brief outline of a few capital and maintenance projects that are in progress or have been recently completed.

Adams County

Little Dry Creek. Major improvements are underway in the Little Dry Creek corridor from Federal Boulevard to Lowell Boulevard, including a formalized regional stormwater detention basin, creek reconstruction, and a formal park. This is a joint project between the UDFCD, the City of Westminster, and Adams County. The new Westminster commuter rail station opened in the center of the project area in July 2016, the only station on the new B Line, with direct service from Westminster to Union Station.

The project site has historically supported industrial uses and has been a frequent dumping ground for various types of waste disposal. Several dozen homes adjacent to the creek are within the 100-year floodplain, with several of the homes being actively threatened by stream bank erosion along the south side of the channel. The project will lower the floodplain by five feet, reconstruct the creek to move it away from the homes, and will reconstruct and improve the regional trail system.



An example of the creek threatening homes.

A previous phase of the project included re-alignment of utilities under the 40-foot tall Federal Boulevard embankment, which involved 30-inch, 54-inch, and 108-inch tunnels and two water line relocations. Another phase included lowering the channel downstream of Federal Boulevard, extension of the existing 10-foot by 14-foot box



View of nearly completed Little Dry Creek, looking east toward Federal Boulevard. The Westminster Station is on the Left.

culvert on both sides, and removal of two sanitary sewer lines that were running within the bottom of the box culvert.

In 2016 we constructed a new lake, relocated the creek, rebuilt most of the regional trail, constructed a 165-foot center span bridge, constructed two low water crossings, and constructed 60% of a new road called Creekside Drive along the south side of the project area. Completion of Creekside Drive and the regional trail is planned for summer of 2017, with formal park improvements including a nature play area near Lowell Boulevard planned for construction later in 2017.

Kenwood Outfall. Over the course of the past 20 years, the UDFCD has been partnering with Adams County to construct a regional storm drainage system throughout parts of unincorporated Adams County in the area of 77th Avenue and Highway 85. This project originally started with the Dahlia Outfall project, which was constructed in many phases over several years to create an outfall from west of I-76 to the South Platte River along Dahlia Street.



Flooding Along Kenwood Street in 2013.

The Kenwood Outfall storm sewer discharges to the Dahlia Pond near 78th Avenue and Highway 85, which in turn discharges to the Dahlia Outfall storm sewer. Previous phases of the Kenwood Outfall have included tunneling under the O’Brian Canal, open cut construction along the west Frontage Road of Highway 85, tunneling under Highway 85, and tunneling under the Union Pacific Railroad (UPRR) east of Kenwood Street, with pipe sizes ranging from 60-inch to 84-inch.

The last remaining phase to complete the storm sewer outfall from the UPRR to Highway 85 started construction

in October 2016. This will extend the storm sewer outfall west along 76th Street, north along Kenwood Street, and west along 77th Avenue to connect with the previously constructed tunnel under Highway 85. This new storm drain system will provide sorely needed flood protection for an area that has seen flood damage on a yearly basis. Construction is planned to be complete by the spring of 2017.



Final Phase of Kenwood Outfall Shown in Red.

Brantner Gulch. Brantner Gulch crosses Riverdale Road just north of 128th Avenue in the City of Thornton and unincorporated Adams County. The existing culvert under 128th Avenue was a 48-inch corrugated metal pipe that was significantly undersized; such that the road had been overtopped by flooding once or twice per year for the past several years. A new box culvert was constructed to pass the 100-year flood under Riverdale Road; this new structure is a triple 16-foot by 12-foot box culvert. The box culvert was designed such that one cell could be retrofitted and used as a trail underpass should one be desired in the future.

A shoofly was constructed to route Riverdale Road around the box culvert excavation, so the road could remain completely open during construction. Water control was a big concern during construction, as the new culvert was being



Completed Brantner Gulch crossing structure.

excavated nearly 10 feet lower than the existing 48-inch culvert. The day we were set to pour the bottom slab of the structure, rain moved in and the creek overtopped the protecting berm, flooding our excavation. Luckily when the excavation was pumped dry the steel and formwork were intact. Construction was completed in spring of 2016.

Arapahoe County

Piney Creek. The UDFCD, the Southeast Metro Stormwater Authority (SEMSWA), and the Cherry Creek Basin Water Quality Basin completed construction of a capital project on Piney Creek through the Ranches, located north of



Piney Creek before.

the intersection of Arapahoe Road and Euclid Drive. This project represents a breakthrough approach integrating traditional engineering techniques and natural stream design. The



Piney Creek after construction.

upstream watershed has been about 90% developed and the creek has had several years to adjust to the change in hydrology.

Stable channel sections were identified and used as reference reaches to help determine stream geometry in the unstable reaches. Traditional engineering methods were used as counter-measures to project constraints or where not all of the natural stream design elements could be met. The traditional engineering practices used were grouted boulder drop, riffle, and boulder check structures. The natural stream approaches help to shape the bank-full channel geometry and riffle, glide, pool series for frequent flows. The project provides stream stability and improves water quality.

Willow Creek maintenance. The UDFCD and SEMSWA completed a maintenance project on Willow Creek upstream of Arapahoe Road located southeast of the intersection of Arapahoe Road and Holly Street. Willow Creek had experienced head cutting and bank erosion through the project reach, and willows had completely over-taken the channel. A combination of techniques was used to help stabilize the creek. Soil wraps and void-filled riprap allowed the stream restoration work to be performed while preserving much of the existing tree canopy. Several storm sewer outfalls to the creek were upgraded to improve their function and provide water quality treatment. A combination of plantings including seed, plugs, shrubs, and trees helped to stabilize the creek while returning the stream to previous roughness characteristics in order to maintain the floodplain and function of the stream.

Boulder County

Louisville-Lafayette Boundary Area Drainage

Improvements. Topography in the City of Louisville generally slopes from west to east, towards Coal Creek. The BNSF Railroad tracks along the east side of downtown Louisville sit on top of a 5-foot embankment, which impounds runoff trying to reach Coal Creek. This has resulted in a mapped 100-year floodplain over much of the downtown area. The Cities of Louisville and Lafayette, Boulder County, and the UDFCD partnered to construct improvements to install a 100-year outfall system to capture the 100-year flood and route it underneath the railroad tracks.

A 72-inch pipe was tunneled under the railroad tracks from a new 100-year storm drain system installed throughout downtown Louisville. Construction in the downtown area was completed just in time to avoid impacts to summer farmer's markets and other festivities.

East of the BNSF Railroad tracks the new outfalls drain to the Harney Lastoka Open Space. New outfall channels were constructed to drain flows through the open space and to Coal Creek. The regional trail system was expanded and improved, including three new pedestrian crossings of the outfall channels.



New Pedestrian Crossing and Outfall Channel

Wonderland Creek. Hundreds of multi-family homes currently lie within the Wonderland Creek 100-year floodplain along a one-mile reach from Winding Trail Road downstream to Foothills Parkway. The UDFCD partnered with the City of Boulder to design improvements to the creek to reduce the 100-year flood risk such that all of these multi-family homes will no longer be in the 100-year floodplain. The project includes a new bridge and underpass at the crossing of the BNSF Railroad, relocation of the Boulder and White Rock Ditch, six separate road crossing improvements,

and a new trail corridor with underpasses at Kalmia Avenue and at 28th Street.

Construction began in early 2016 and is planned to be complete near the end of 2017. Completed construction includes relocation of the Boulder and White Rock Ditch, a new bridge and trail underpass of the BNSF Railroad, a new 100-year culvert crossing at Spring Creek Place, 100-year channel improvements from Foothills Parkway to 34th Street, and a 100-year culvert crossing at Kalmia Avenue. Construction continues on

the channel from Winding Trail to the Diagonal Highway and the culvert crossings at 28th Street, Winding Trail Drive, 34th Street, and Iris Avenue.

Wonderland Creek. Vegetation had taken over the stream corridor along Wonderland Creek from Foothills Parkway to King's Ridge Boulevard, inhibiting flood conveyance and significantly increasing flood risk for the adjacent neighborhoods. The UDFCD worked with the neighborhood and the City of Boulder to identify appropriate measures to mitigate for this flood risk. The UDFCD worked with Arbor Force to clear woody debris from the channel bottom, trimmed dead and overhanging tree branches, cleared fallen trees, and thinned tree saplings to limit future vegetation overgrowth. The results of this activity can be seen in the photos below.



Spillway at the Boulder and White Rock Ditch.



Channel from 34th to Spring Creek Place.



Wonderland Creek before and after vegetation thinning.



Stream bank erosion at location two.



Finished repairs at location two.

Rock Creek Outfalls. Rock Creek flows through an open space adjacent to a commercial development in the City of Lafayette, north of Horizon Avenue. The creek has become severely incised and the stream banks at two locations were actively migrating towards the commercial properties. The UDFCD with the City to devise a repair to the outfalls and stream banks at these locations to protect the private properties.

City and County of Broomfield

Rock Creek. The UDFCD and the City and County of Broomfield are in the process of replacing deteriorated



New cascading boulder drop structure on Rock Creek.

concrete grade control structures on Rock Creek downstream of US 36. The project goals are to provide natural looking structures, preserve riparian habitat, and protect the area with a public easement along this reach prior to potential adjacent development. Cascading boulder drops were the choice of the design team. Construction will be complete in 2017.

Over the past year, Broomfield has requested and received several sediment removal projects within stream channels and pond embankments that are necessary to preserve flood conveyance and detention that residents and businesses rely on for flood protection. While these projects appear to be simple, construction access and permitting is always challenging.

City and County of Denver

Denver County applied for a Federal Emergency Management Agency (FEMA) disaster declaration in late 2015 from the storms that came through the area in June and July 2015. The UDFCD assisted Denver Parks and Recreation (DPR) throughout the process by engaging with FEMA and contractors to develop the Preliminary Damage Assessment (PDA). The PDA painted a picture of the amount and cost of damage that was a result of constant days of rainfall. Several of the damages identified in the PDA have been addressed throughout the year. Cherry Creek at 11th Street, Cherry Creek at Quebec, Sanderson Gulch at Mexico, and several trail projects are either under contract or construction has begun as a result of the efforts of the UDFCD and DPR.

First Creek. Construction on three CIP projects either continued or began during 2016. UDFCD partnered with Denver Public Works, Denver International Airport, Regional Transportation District, and property owners for the First Creek restoration at 56th Avenue near the Green Valley Ranch



First Creek at 56th Avenue.

subdivision. The project broke ground in September 2015 but most of the construction was completed during 2016. Lawrence Construction, along with many subcontractors, implemented the vision to restore First Creek to its original alignment and stabilize the stream with grade control structures (two grouted boulder, two riffle). In addition to

stream restoration, the project restored the floodplain to the natural stream corridor preventing the flooding of 56th Avenue, a major arterial to DIA and the Green Valley Ranch area. A regional trail from the Rocky Mountain Arsenal National Wildlife Refuge to Tower Road, complete with a pedestrian underpass across 56th Avenue, was also built with the project. ICON Engineering did the design, and construction is nearly complete with only punch list items remaining.

Babi Yar Tributary. UDFCD partnered with DPR for the restoration of Babi Yar Tributary to Cherry Creek south of Yale Avenue through Hentzel Park and the John F. Kennedy Golf Course. Construction began in late 2015 and continued into 2016. Edge Contracting, along with subcontractors, restored the tributary, built a golf cart/maintenance path, and constructed three grouted boulder drop structures - all while dodging golfers teeing off from the fifth tee and approach shots on fourth green on the Creek Nine. Merrick & Company did the design, and construction was completed in July 2016.



Babi Yar Tributary.

Westerly Creek. UDFCD partnered with Denver Public Works (DPW) and DPR for the restoration of Westerly Creek from East 11th Avenue to East 13th Avenue downstream of Kelly Road Dam in the Montclair neighborhood. The project is celebrated because of the partnership of UDFCD, DPR, DPW, and two grants from the Natural Resources District. Construction began in November 2016 by Tezak Heavy Equipment, along with subcontractors, and the scope includes stabilizing Westerly Creek using rock and vegetation. A trail and improved access to the trail will also be constructed. Muller Engineering did the design with construction slated for completion in May 2017.

Douglas County

Cherry Creek. Construction of two CIP projects either continued or began in 2016 in Douglas County. Cherry Creek at Norton Farms in Parker was a partnership between UDFCD and the Town of Parker to complete stream restoration of approximately 3,000 feet of Cherry Creek in the Cottonwood Subdivision of Parker. Contractor 53 Corporation, along with subcontractor Arrowhead Landscape, was given the Notice to Proceed in January 2016. The scope included flattening the slope of Cherry Creek by regrading and installing two riffle



Cherry Creek at Norton Farms.

drop structures, laying back slopes, and providing bank protection and low flow vegetated terraces. Olsson Associates did the design, and construction was completed in September 2016.

Big Dry Creek. The third phase of Big Dry Creek broke ground in late November of 2016. UDFCD partnered with the Highlands Ranch Metro District to complete restoration of approximately 1,500 feet of Big Dry Creek in Cheese Ranch. Naranjo Civil Constructors, along with subcontractors, are constructing five sculpted concrete drop structures, laying back deeply incised banks, and stabilizing the channel by raising the invert of the channel. ICON Engineering did the design, with construction slated for completion in May 2017.

Newlin Gulch. UDFCD collaborated with the Town of Parker to assist with construction observation of the Newlin Gulch East-West Trail project in late 2016. Premier Earthworks & Infrastructure, along with subcontractors, constructed a grouted boulder drop structure, box culvert, and trail between Newlin Meadows and Regency subdivisions in Parker. UDFCD participated by performing construction observation of the grouted boulder drop structure to ensure it was constructed to criteria and specifications.

Jefferson County

West Fork Kenney's Run. The West Fork Kenney's Run project, funded jointly by the UDFCD and the City of Golden, is now complete. This capital project consisted of improving the channel reach from Golden High School to just downstream of 23rd Street to pass 100-year flows safely through the highly confined neighborhood. It incorporated sculpted concrete drops, grouted boulder walls, two box culvert street crossings and a stabilization product called Envirolok[®] vegetated bags. The completed project removed 41 properties from the 100-year flood hazard area within Golden business and residential communities.

Weir Gulch. The UDFCD and the City of Lakewood completed a maintenance project on Weir Gulch adjacent to Belmar Park at Wadsworth Boulevard. The stream banks of Weir Gulch were experiencing vertical and lateral erosion,



Two-Tier sculpted concrete drop structure on West Fork of Kenney's Run at Golden High School.



Alleyway Boulder Wall Channel on West Fork of Kenney's Run - Envirolok® bags on bottom



Weir Gulch before construction.



Post-Construction Void-Filled Riprap on Weir Gulch.

threatening a pedestrian bridge and the recreational trail. The gulch bottom was lined with void-filled riprap at a slope steeper than existing to provide grade control and a more natural looking bottom. The recreation trail was shifted and the vertical banks regraded to flatter slopes.

The vertical banks, while somewhat natural in dynamic stream systems, had become a public safety issue for Lakewood Parks and Recreation. Many social trails had developed on top of these dangerous banks. Bank stabilization projects within natural open-space parks are sometimes controversial. Many nearby residents, especially with children, will ask for bank improvements, while others believe park users should be aware enough to avoid these hazards. Many times the final decision is to be on the safe side in urban areas.

South Platte River

Denver County Update. The Denver reach of the South Platte River saw continued implementation of the Greenway Foundation's River Vision Implementation Plan (RVIP). This plan calls for the implementation of key projects in five different reaches of the river with an estimated value of \$30 million and rehabilitation of 1.25 miles of the river. The five projects include Confluence Park, Johnson Habitat Park, Grant

Frontier/Overland Park Improvements, Weir Gulch at Sun Valley, and River North Park in the RINO area.

Work is continuing on the implementation of the RVIP. In 2016 we saw the completion of Grant Frontier Park, and some additional park related work on Pasquinel's Landing Park. Confluence Park is back under construction after a significant delay requiring redesign and additional funding, and is expected to be completed in the summer of 2017. River North Park in the RINO area in under construction, as are two major outfall projects. The 33rd Street Outfall and the 40th Street Outfall are both under construction; with the 33rd Street Outfall project being done this summer, and the 40th Street Outfall, now called Globeville Landing Outfall (GLO) in 2018.

In addition to the construction projects in Denver, several large planning efforts, working with the U.S. Army Corps of Engineers, are underway. One is a Feasibility Study on three drainageways in Denver, the South Platte River, Harvard Gulch, and Weir Gulch. The Corps' interest in the South Platte River is in ecological restoration and habitat improvements. The study covers the river from 6th Avenue

north to 58th Avenue, and will result in a Chief's Report recommending a list of improvements to receive federal support matched by local dollars. The second effort is an 1135 Reconnaissance Study for the southern part of the river in Denver. This project is underway, and is focused on ecological restoration along the river.

The following DCM staff members contributed to this column: Bryan Kohlenberg, P.E., CFM, Project Manager; David Skuodas, P.E., CFM, LEED AP, Project Manager; Richard Borchardt, P.E., CFM, Project Manager; Barbara Chongtoua, P.E., CFM, Project Manager; Jason Stawski, CFM, Senior Construction Manager; Steve Materkowski, E.I., Senior Construction Manager



Artist renderings of the 33rd Street storm sewer outfall (above) and the Globeville Landing Outfall (below).



2016 Professional Activities of UDFCD Staff

Kevin Stewart, Manager, Information Services and Flood Warning Program

- * Board Member & Past President, National Hydrologic Warning Council (NHWC)
- * Presented *The Colorado Floods of 2013* at NHWC Flood Warning Workshop in Albany, NY
- * Presented *Progress With Recognizing Flood Threats Since the Colorado "September to Remember" Floods of 2013* at the Alert Users Group annual conference in Fish Camp-Yosemite, CA
- * Presented *How to Stress Test a Watershed Model in Preparation of a Flood Warning System* at the annual CASFM conference in Crested Butte, CO
- * Technical advisor to ASFPM and presented *No Adverse Impact How-To Guide for floodplain managers on emergency management*

Ken MacKenzie, Manager, Master Planning Program

- * Board member for NAFSMA
- * Board member for the Urban Watersheds Research Institute (UWRI).
- * Steering Committee Member for the Colorado Stormwater Center.

David Bennetts, Manager, Design, Construction & Maintenance Program

- * Presented *How to Fund Your Project When Money is Tight and Build a Better Project* at the annual conference of the Colorado Chapter of APWA in Denver
- * Attended PWX-North American Conference in Minneapolis, MN
- * Council Member, CU Denver Engineering Leadership Council
- * Board member, CU Denver Construction Engineering and Engineering Management Advisory Board
- * Board Member, Colorado Chapter, American Public Works Association

David Mallory, Manager, Floodplain Management Program

- * Chair of the Floodplain Management Committee for NAFSMA
- * Board Member & Treasurer of the Natural Hazard Mitigation Association (NHMA)
- * Member of FEMA's Technical Mapping Advisory Committee (TMAC) as the CTP local government representative. Attended TMAC meetings in Washington DC, throughout the year
- * Member of Colorado Flood TAP

Laura A. Kroeger, Assistant Manager, Design, Construction & Maintenance Program

- * Presented *Creating Effective Teams* at Rocky Mountain Public Works Institute
- * Presented *Surfing in Colorado . . . Really* at Colorado APWA Annual Conference
- * Presented *A Learning Organization: A Platform for Resiliency* at PWX-North American Conference
- * Committee member for National Donald C. Stone Center Program Council
- * Member of National Leadership and Management Committee
- * Chair of Rocky Mountain Public Works Institute

Shea Thomas, Project Manager, Master Planning Program

- * Chair of CASFM
- * Presented *Adventures in Master Planning* at the UDFCD Annual Conference in Broomfield, CO
- * Presented *Re-Defining Regulatory Hydrology: SPR and Clear Creek Hydrology CLOMRs* at the CASFM Conference in Vail, CO
- * Stormwater Management Committee chair for NAFSMA.

Barbara Chongtoua, Project Manager, Design, Construction and Maintenance Program

- * Presented *Urban Watersheds: A New Frontier for Stream Restoration* at the Rocky Mountain Restoration annual conference in Breckenridge, CO
- * Chair of the Colorado Riparian Association Stream Academy
- * Vice-Chair of the ASCE EWRI Sustainable Stormwater Infrastructure Committee
- * Chair of the ASCE EWRI Watershed Approach for Stormwater Committee
- * Attended ASCE EWRI annual conference in Palm Beach, FL

Rich Borchardt, Project Manager, Design, Construction & Maintenance Program

- * Presented *Building a Better Outfall* at the CASFM annual conference
- * Presented *Design and Maintenance of Detention Basins with Water Quality Features* at a CASFM Lunch and Learn

Holly Piza, Project Manager, Master Planning Program

- * Presented *Post-Construction Stormwater BMP Inspections* at the APWA Colorado Construction Inspection Conference
- * Presented *Developments in Ultra-Urban Green Infrastructure* at a CASFM regional social
- * Presented *What We Can All do to Improve Water Quality* at a Denver Office of Sustainability conference
- * Presented *UDFCD Partnerships and Special Projects* at a NACWA Management Committee meeting
- * Presented *Green Infrastructure Maintenance Cost Research Summary and Routine and Restorative Permeable Pavement Maintenance* at an ASCE EWRI LID conference
- * Presented *Green Infrastructure Maintenance Costs* at the CASFM annual conference
- * Presented *UDFCD Volumes 1 and 2 Revisions-What's New* at the UDFCD annual conference
- * Presented *Watershed Hydrology* at the CRA Stream Academy hosted by UDFCD
- * Chair of the ASCE EWRI committee Sustaining Long-term Commitments to Municipal Stormwater System Infrastructure
- * Chair of the CASFM committee Comprehensive Costs of Implementing and Maintaining Green Infrastructure

Dave Skoudas, Project Manager, Design, Construction & Maintenance Program

- * Instructor for the APWA Public Works Institute
- * Presented *The Remarkable Impact of Being an Effective Client* at a City of Boulder lunch and learn, The CASFM annual conference, PWX-North American Conference, and the APWA Colorado Chapter annual conference
- * Presented *Connecting Vegetation Management to the Mapped Flood Risk* at the UDFCD annual conference and the Colorado Riparian Association (CRA) conference
- * Committee member for the South Platte River Forum annual conference

Terri L. Fead, P.E., CFM, Project Manager, Floodplain Management Program

- * Presented *Denver Metro PPI – Pulverizing Public Ignorance Through a Multi-Jurisdictional Program for Public Information* at the CASFM annual conference and the ASFPM annual conference

Teresa L. Patterson, Project Manager, Floodplain Management Program

- * Presented *Denver Metro PPI – Pulverizing Public Ignorance Through a Multi-Jurisdictional Program for Public Information* at the CASFM annual conference
- * Member of the Floodplain Management, CRS and Colorado Flood TAP committees

Mike Sarmiento, Senior Construction Manager, Floodplain Management Program

- * Presented *MEP Final Acceptance Site Stability and Revegetation* to the UDFCD annual conference
- * Presented *UDFCD's Maintenance Eligibility Program . . . Are You Eligible?* to the APWA annual conference

Steve Materkowski, Senior Construction Manager, Design, Construction & Maintenance Program

- * Presented *Working With FEMA* at the UDFCD annual conference
- * Presented *Public Works role in Emergency Management* at the APWA Public Works Institute
- * APWA liaison to the Colorado Emergency Management Association annual conference
- * Committee member for the APWA 2016 Public Works Expo
- * Member of the State All Hazards Advisory Committee

Joe Williams, Senior Construction Manager, Design, Construction & Maintenance Program

- * Presented *Soil Lift's Top Ten List* at the UDFCD annual conference

Jason Stawski, Senior Construction Manager, Design, Construction & Maintenance Program

- * Presented *Working With FEMA* at the UDFCD annual conference



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