

Flood Hazard News

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Do BMPs Protect Our Receiving Waters?

By

Ben R. Urbonas, P.E., Chief, and John T. Doerfer, Project Hydrologist, Master Planning Program

Is What We Are Using Appropriate to Protect Receiving Waters?

Do the stormwater best management practices (BMPs) we are using help mitigate the impacts of urbanization on our receiving waters? This is the question that is not asked often enough. Throughout the United States, BMPs are typically chosen from a list specified in local or state criteria, rules, regulations, or ordinances. Often these lists have been developed without regard to what may be appropriate for the local meteorology, climate, geologic conditions or the receiving waters that are supposedly being protected. At the same time, when local criteria are not clear, BMPs may be selected because a vendor has convinced a local reviewer that their product will meet the regulatory requirements. Either approach is like having your mechanic chose from a list of very expensive parts to put in your car without first knowing why the engine will not run.

The Urban Drainage and Flood Control District (District), with the help of many professionals and local municipalities, has spent much time and effort to screen a number of BMPs and has selected the ones that appear to have the greatest potential to mitigate the known impacts of urbanization on the receiving waters in the eastern plains of Colorado. Nevertheless, there remain many questions that need to be answered before we can quantify the degree of mitigation provided by these BMPs.

The United States is on the verge of a massive structural and non-structural BMP deployment in Phase I and II municipalities. This will be done in

many communities without questioning which BMPs are really needed to protect their receiving waters. This has been occurring and will now accelerate as the U.S. EPA, states and the local jurisdictions respond to the 1987 provisions of the Clean Water Act.

Emerging Themes at the Engineering Foundation Conference in 2001

A number of excellent papers by leading experts were presented on this topic at a conference held August 19 - 24, 2001 in Snowmass, Colorado. The American Society of Civil Engineers (ASCE) will publish its proceedings early in 2002. One theme that emerged is that BMPs need to mitigate flow rates and volumes to the maximum extent practicable in order to have a chance in reducing the geomorphic changes and the accompanying aquatic habitat changes that occur as areas urbanize. Another theme that emerged was the need to use BMPs (i.e., treatment devices) that have the greatest potential for reducing concentrations of small sediment particles, even ones smaller than 10 microns. Yet another theme that is gaining considerable notice is that in-stream stabilization and habitat enhancement measures need to occur in parallel with BMPs as areas urbanize.

Initial evidence presented by several presenters, some from outside the United States, shows that the use of extended detention-type BMPs can have a measurable mitigating effect on impacts of urbanization to the aquatic biota in the streams. It was also concluded at this conference that much more work and research is still needed before we can quantify the relationships

between the types of BMP systems in a watershed, their design parameters, and their effectiveness in mitigating impacts of urbanization. In the meantime, we will need to continue to draw on the emerging information and do our best job at selecting and using what we believe to be the most effective BMPs. As a side note, all of the BMPs recommended in the District's *Urban Storm Drainage Criteria Manual (USDCM)* provide the performance features emerging as needed for mitigating receiving impacts.

Recent Examples of District's Design Guidance Effectiveness

The Urban Drainage and Flood Control District (District) attempted, in its latest version of the *USDCM*, to address a significant number of design, nuisance, maintenance, and performance problems; and to better quantify the needed water quality capture volume and emptying times for different BMPs. It also includes new outlet design details for extended detention basins, retention ponds and wetland basins. Figure 1 shows an outlet with a micro-pool and a properly sized stainless steel well-screen type trash rack. The perforated riser plate that controls the emptying time is mounted behind the trash rack. This is from an installation at Grant Ranch that the District, in cooperation with the Grant Ranch Metropolitan District, retrofitted into an existing extended detention basin that originally had an older type perforated riser pipe outlet and no micro-pool.

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South Platte River Program Notes

by
Ben Urbonas, P.E., Chief, South Platte River Program

South Platte River Program's 15-Year Anniversary

In 1986 the Colorado Legislature created a special revenue fund for the District for the maintenance and improvements of the South Platte River within its boundaries. Except for jurisdictions within Boulder County, because they are within the Boulder Creek watershed, all properties within the District contribute funds to support this program. In response, the District's Board adopted policies that established the way the program operates along functional lines. There are three primary sub-programs: (1) Maintenance, (2) Capital and (3) Co-operative.

Maintenance activities can be paid for 100% by the District and are divided into two categories: routine and restorative. Routine maintenance assists local jurisdictions with activities such as trash pickup within the river's channel and immediate overbanks, weed and noxious plant control, dead and invasive tree removal and replacement with native species, revegetation of the corridor with native species of grasses and shrubs, repair of minor erosion problems and other types of routine maintenance activities.

Restorative maintenance includes more structural efforts such as restoration and stabilization of trashed out or eroded banks, installation of low (i.e., boater and fish passage friendly) grade control structures when evidence shows a need for them, buttressing of utilities where the river channel has degraded and threatens their loss, repair of recreational trails that also serve as maintenance access, etc.

Capital projects help local governments with major river improvements and with the acquisition of the floodplain to preserve open spaces along the river. District will pay up to 75% of these project costs when funds are available.

The co-operative program helps private property owners with the river

restoration activities, similar to what the District does with restorative maintenance for local governments. It does require a minimum of a 25% match of the total project cost by the property owner, but will credit the owner for the value of a flowage and maintenance easement turned over to the District as part of the project.

Since the program's inception, most of the District resources have been spent on routine and restorative maintenance. In recent years, however, a few capital projects have required considerable attention and funding. They included the widening of the river's corridor adjacent to Elitch Gardens; the reconstruction of Confluence Park including a much-improved whitewater boating and fish passage/aquatic habitat facility; restored river banks and enhanced terrestrial and aquatic habitat through the Globeville neighborhood; and the currently on-going Corps of Engineers projects. The District could not have been involved with them without the initiative of our local government partners.

The last 15 years have been very productive and much has been accomplished. Although it is not possible to fully restore the river to what it was before urbanization occurred in this region, much has been done to improve its ecology and functions.

Maintenance Activities

Routine Maintenance

In 2001 the South Platte River routine maintenance included an equivalent of

- 9.1 miles of tree trimming and pruning along the river trail,
- 3.6 acres of string trimming at access ramps and rest areas,
- 78 miles of trail edge mowing, and
- 192 miles of trash and debris pickup and removal along the river.

A total of 170 truckloads of trash and debris were removed from the river and taken to landfills. We continue to study statistical data pertaining to trash and debris accumulation patterns gathered

over the past five years, and in 2002 we will further tailor our removal program to maximize results.

For the fifth consecutive year we participated in the Greenway Foundation's annual NIMBY Fest volunteer trash pickup, during which an additional 51 cubic yards of trash were removed. In addition, government personnel and volunteer groups picked up and removed trash from the river corridor throughout the year. Unfortunately, we do not have an estimate of the volume removed by them. Trash is also regularly removed from trash receptacles maintained by park personnel along recreational trails.

Routine maintenance continues to be the most cost effective program in terms of environmental enhancement and public service. Without it, the trash along and in the river would accumulate. Since its inception under the South Platte River Program, the Routine Maintenance Program now handles more than twice the number of trash pickups, trail mowings and invasive weed control activities than we did 15 years ago. At this level of activity we find the river corridor needs are addressed quite well.

Removal of Undesirable Plant Species.

In 2001 the Routine Maintenance Program continued to work with local government agencies to control infestations of non-native and undesirable tree species along the river. In the City of Brighton's Morgan Smith nature area we removed 100 Russian Olive trees and planted 200 shrubs and bushes. Working with the South Suburban Park and Recreation District and the City of Littleton, we removed 200 Russian Olives from the riverbanks in South Platte Park. In addition, we removed 160 Siberian Elms and Russian Olives in Denver County. The removal of invasive non-native trees provides the opportunity for native cottonwoods, box elders, willows, and others to become established. These natives in turn

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Tucker-Talk

by L. Scott Tucker

Timely Comment from the District's Executive Director



Three years ago in this column I discussed the evolution of multiuse drainage and flood control thinking from the early 1970's to 1990's. It was noted that the focus in the late 1990's was on water quality and preservation of stream corridors. The direction of drainage and flood control is still heading that way with subtle changes continuing to occur. A concern of the public in Colorado and elsewhere recently has been growth control. Some people simply do not want any more growth, others recognize a certain inevitability but want to somehow control its impacts, while others are willing to let things take their natural course with as little governmental control as possible. Drainage and flood control is a subset of the growth control issue as it is growth that drives the need for housing, roads, shopping malls, etc. which have such an impact on the environment including the drainageways.

The pressure for little or no impact of urbanization on the nation's water bodies continues to build. It is becoming more and more obvious, however, that it is very difficult or impossible to have development without impacts. Negative impacts can be mitigated to some extent, but the attainment of zero impact is virtually impossible. As an agency it has not been the District's role to weigh in on growth, such as whether to have more or less and where it should be directed. We have taken the position, however, that development should not take place in such a way as to be damaged by floods up to the 100-year event. Development in floodplains has been controlled for the past thirty plus years through regulations which have worked very well to keep new development out of the path of 100-year floods.

However, regulation does not prevent development from occurring in

floodplain areas. The developer can provide a 100-year channel to reduce portions of the floodplains. This is not the best solution and the District has encouraged developers to stay out of defined 100-year floodplains. While this can be encouraged it cannot be required. The public today is beginning to recognize the value of riparian areas, and stream corridors are becoming popular areas for urban dwellers to hike, bike and get a little closer to nature. Some developers are responding to this in a market sense by preserving floodplains and integrating them into their developments as assets and they market them as such. I did say some and not all, but at least the recognition of the value of riparian corridors is beginning to be noticed. There are many developers, however, that still have the objective of developing the maximum amount of their property as possible and the space needed for drainage is an issue to them. This is particularly true in the areas where property values are very high.

It just seems to be good public policy when looking at the long term to preserve our natural drainage systems. However, such preservation has to take place in the context of private property rights. We still live in a democracy in which private property rights are important and protected. That is why we cannot prevent through regulation all development in floodplains. One way to address this issue is through the acquisition of floodplain properties when there is a willing seller. There is strong public support for open space acquisition in the Denver area and the District has worked with local governments to acquire floodplain areas, sometimes as part of the acquisition of larger parcels. In this way we can guarantee the long term preservation of floodplains. The District annually budgets monies for the purchase of

floodplains that may unexpectedly become available during the course of the year. The District usually requires matching funds from local government which helps our money to go further. The District can also include right-of-way purchases for projects in its Capital Improvement Program that can include acquisition of floodplain areas.

Our focus is still on multiple use of drainageways, but that is shifting to more natural approaches. We must still pay attention to flood control, but that becomes just one consideration along with water quality, restoration, hiker/biker trails, flood storage, erosion control, habitat preservation and open space. To accomplish this vision of open natural like drainageways one must have patience to persist over a long period of time along with the availability of several important ingredients such as consistent long term funding, ability to buy floodplains, ability to plan and implement on a multiuse basis, ability to address water quality, ability to maintain, and ability to regulate.

The control of growth is a very difficult issue. It is difficult to see how growth itself can be controlled. Some cities in the Denver area have placed restrictions on the amount of new housing that can be built in a year, but this only pushes the new people that have moved here somewhere else. It has not controlled the growth into the metro area. Growth is basically a people issue. How can we stop people from moving to the Denver area? The issue that really is being addressed is how can we manage growth, and that too has a wide range of answers depending on one's philosophy. It is a political question and will not be decided by the District. How much do we force on people in terms of how they live? Do we require cluster type developments with high densities but

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Design and Construction Program Notes

By

David W. Lloyd, P.E., Chief, Design and Construction Program

The year 2001 saw us committing over \$8 million to design and construction projects by year-end. Most of this funding has gone toward the construction of several new projects as well as the continuation of projects started in past years. One notable change to the Design and Construction Program was the addition of Ken MacKenzie as Project Engineer effective February of this year. After several years of trying to manage 80 to 90 projects each year, Paul and I are grateful for the assistance that Ken is now giving us. We are currently working toward dividing the District by county with Paul responsible for Douglas and Arapahoe Counties, Ken for Denver and Jefferson Counties and myself for Adams and Boulder Counties. We thought it advantageous to have local governments dealing with only one point of contact for capital projects.

A number of unique projects were constructed this past year including some which had been many years in the planning and design process. The Little Dry Creek Railroad Culverts project in Adams County was completed this year. Design of this project was initiated in the early 1980s and it took several years of negotiations with the Burlington Northern Santa Fe Railroad before final agreement was reached in late 2000. Hats off to Adams County for their persistence in bringing this project to fruition. Adequate conveyance is now available to carry 100-year flows between Federal Boulevard and Clear Creek; and a much needed trail connection is now in place along Little Dry Creek from Arvada and Westminster to the Clear Creek trail corridor.

Acquisition and construction of improvements to Leyden Reservoir were also completed in 2001. This was a joint project with the Cities of Arvada and Westminster. Acquisition of the property and the commitment of funding for the improvements took a yeoman effort on the part of the City Managers

STATUS OF DISTRICT DESIGN PROJECTS

Project	Participating Jurisdiction(s)	Status
North Tributary of Massey Draw	Jefferson County	Complete
Lakewood Gulch @ Welchester Park	Jefferson County	Complete
Drainageway G	Jefferson County	Complete
Cottonwood Creek	Arapahoe County	Complete
Happy Canyon Creek	Douglas County	Complete
Brookridge/Grant Outfall	Arapahoe County	Complete
Cherry Crest West Outfall	Arapahoe County	Complete
Erie Drainage	Erie	Complete
Leyden Dam	Arvada	Complete
McKay Outfall	Adams County	95% Complete
Pinehurst & Academy Park Tribs	Denver	95% Complete
Plaster Reservoir Detention	Broomfield	90% Complete
South Lakewood Gulch	Lakewood	50% Complete
Kalcevic Reservoir	Adams County	35% Complete
Lena Gulch @ Mountain Side	Jefferson County	30% Complete
Parker/Jewell Outfall	Arapahoe County	25% Complete
Arvada Channel	Arvada	20% Complete
Little Willow Creek	Douglas County	10% Complete
Sand Creek Stapleton to Toll Gate	Aurora	5% Complete
Sulpher Gulch	Parker	5% Complete

STATUS OF DISTRICT CONSTRUCTION PROJECTS

Project	Jurisdiction(s)	Cost	Status
Westerly Creek @ Expo Park	Aurora	\$3,400,000	Complete
Meadowood Creek	Aurora	3,204,000	Complete
Cherry Creek Drops	Glendale	700,000	Complete
Grange Hall Creek Phase 2/3	Northglenn	1,506,000	Complete
Weaver Creek @ Simms	Jefferson County	1,020,000	Complete
South Trib. Slaughterhouse Gulch	Littleton	837,000	Complete
Twenty Mile Detention	Parker	795,000	Complete
Lakewood Gulch @ Perry	Denver	1,136,900	Complete
Big Dry Creek Trail	Littleton, Englewood	715,000	Complete
Virginia Village Outfall Phase 1	Denver	1,230,000	Complete
Valley Club Outfall	Arapahoe County	1,400,000	Complete
Pleasantview Tributary	Jefferson County	281,000	Complete
Shaw Heights Trib. Phase II	Westminster	638,000	Complete
Goose Creek	Boulder	3,803,000	95% Complete
Bear Creek Maintenance Access	Morrison	817,300	95% Complete
Leyden Dam	Arvada	1,604,000	95% Complete
Little Dry Creek RR Culverts	Adams County	3,200,000	95% Complete
Niver Trib. M Outfall	Federal Heights	172,000	95% Complete
Marcy Gulch	Highlands Ranch	1,800,000	90% Complete
Lemon Gulch	Douglas County	815,000	90% Complete
Cottonwood Creek	ArapCo. Greenwood	1,360,200	85% Complete
Dad Clark Gulch	Highlands Ranch	523,000	80% Complete
Wonderland Creek	Boulder	575,000	80% Complete
Indiana St. Outfall	Lakewood	950,000	75% Complete
Virginia Village Phase II	Denver	789,000	50% Complete

of Arvada and Westminster, as well as the Jefferson County Administrator. The improvements consisted of construction of a 380-foot wide spillway over the top of the existing 40-foot high dam. The new spillway is capable of safely passing 75% of the Probable Maximum Flood. Unique to this project was the use of roller compacted concrete to construct the spillway. Leyden Dam will now fully detain the 100-year event cutting approximately

2,000 cfs from the previous master plan release of approximately 2,200 cfs. We are just now starting the Letter of Map Revision process for what we anticipate to be significant impacts to the downstream floodplain along Leyden and Ralston Creeks.

The third and final phase of Grange Hall Creek was completed this past year in the City of Northglenn. The uniqueness of this project was in the nineteen drop



Looking upstream at the new Perry Street bridge along Lakewood Gulch.

structures constructed along Grange Hall Creek and its North Tributary. These two and four foot drops were constructed of concrete utilizing a reinforced concrete substructure with a colored shotcrete covering. After application of the shotcrete, the finished surface was sculpted to give the appearance of a rock outcrop. These “feaux” rock structures have been getting considerable attention in the metropolitan area and we anticipate using them on other projects. The Grange Hall Creek Project received the Grand Award at this year’s Annual Conference of the Colorado Association of Stormwater and Floodplain Managers. Congratulations to the City of Northglenn and Muller Engineering for their fine work on this project.



Goose Creek form liner detail.

Yet another phase of Goose Creek in the City of Boulder was completed this past year. Unique to this project was the use of a very intricate form liner, which gives the appearance of a rock wall. Coloration was added to the individual “concrete” rocks to enhance the appearance of the wall. The final phase of the Goose Creek channel improvements was bid by the City of Boulder in late 2001 and should be starting early in 2002. This will conclude a multi-year multi-phase project that was initiated in the mid-1980s. The resultant 100-year channel improvements will remove a number of properties from the floodplain.



Constructing a soil cement drop structure on Marcy Gulch.

The year 2002 looks to be very busy with funding identified in the 5-Year Capital Improvement Program for 40 new or existing projects.

Floodplain Management Program Notes

By

Bill DeGroot, P.E., Chief, Floodplain Management Program

Pilot project

On July 1 we began a one-year pilot project with FEMA to assume the responsibility to review requests for Conditional Letters of Map Revision (CLOMRs) and Letters of Map Revision (LOMRs) for the 32 communities within the District that are participating in the National Flood Insurance Program (NFIP). The project is funded by a \$100,000 grant administered through Region 8. We have retained ICON Engineering, Inc. to assist us in the technical reviews of these requests.

It would probably not be appropriate for me to discuss too many details about our experiences to date, at least not until we have our six-month progress review with FEMA, which is now scheduled for February. I will say that 5 ½ months into this effort our experience has been about as good as I could have imagined or hoped for. I'll have a lot more to say at the conclusion of this effort.

It is not too early, however, to recognize Mike Buckley, Matt Miller, Mike Grimm and Sally Magee at FEMA Washington for taking this step and for allowing us to do the work. I also want to thank Dan Carlson at FEMA Region 8 for helping me with the paperwork, and Tom Smith and his colleagues at Michael Baker, Jr. for all of their assistance.

Future floodplains on FIRMs

As I reported in this space last year, one of the first and best policy decisions of the District was to delineate and regulate 100-year floodplains based on projected future development of the watershed. This belief was reinforced when the 2000 census numbers were released and we found that Colorado had added a million people over the last ten years, with most of them landing in the District's area.

We have had a running battle with FEMA, and before them the Federal Insurance Administration, about this issue. They insisted on using existing conditions floodplains on their FIRMs,

and, of course, we wanted to use the future conditions floodplains. A couple of years ago the FEMA staff began to take a look at how they could accommodate those of us who wanted to use the future conditions floodplains.

That effort was headed up by Mike Grimm, who worked for Fort Collins before heading to Washington. Mike's efforts culminated on November 27, when FEMA published a rule that allows future conditions hydrology floodplains to be shown on FIRMs, for informational purposes, at the request of the community. This approach allows FEMA to continue to require flood insurance based on the present risk, while helping progressive communities to plan for the future by recognizing the future flood hazard. My thanks to Mike for a job well done.

FEMA funding breakthrough

For the first time in many years FEMA's budget includes money (\$25 million) from the general fund for mapping. For the last several years mapping costs have been funded by a fee charged to flood insurance purchasers only. It is too early to know how FEMA will utilize this new source of funds

During Congress's deliberations regarding this funding, a remarkable coalition of organizations came together to support it, including National Association of Counties, National League of Cities, National Association of Development Organizations, Coastal States Organization, National Emergency Management Association, Association of State Floodplain Managers, Association of State Wetland Managers, National Association of Flood and Stormwater Management Agencies, American Congress of Surveying and Mapping, American Planning Association, American Public Works Association, National Association of Home Builders, National Association of Realtors, National Lenders Insurance Council, and American Society of Civil Engineers.

Susan Gilson from NAFSMA played a key role in assembling this coalition.

FEMA really needs this money to upgrade their maps. I hope this is the start of many years of increasing levels of funding.

The year in review

We continue to be just about maxed out on development referrals, and it is a constant struggle to assure that new development doesn't increase the flood hazard potential within the District.

Our maintenance eligibility program continues to flourish under David Mallory's direction. He currently has over 200 separate projects somewhere in the process between design review and final acceptance of construction. See David's column elsewhere in this issue.

Kevin Stewart continues to assure that we have the best possible flood detection system, and he continues to be in demand as an expert in this field (see his list of professional activities on page 20 and his column in this issue). If you check out our web site at www.udfcd.org you will also see Kevin's handiwork.

Implementation efforts

Implementation of portions of our master plans, particularly regional detention facilities, is always a challenge. We continue to have some successes that I would like to highlight.

The E-470 Public Highway Authority has constructed a major detention facility, which also served as a borrow area, on Third Creek. They also constructed another detention pond/borrow area on the Buffalo Run Tributary to Third Creek.

Last year I reported that we had negotiated an intergovernmental agreement (IGA) with Aurora, Denver, Gateway Regional Metro District and Town Center Metro District (Oakwood Homes) for implementation of the

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Flood Warning Program Activities

by
Kevin G. Stewart, P.E., Information Systems Manager, Floodplain Management Program

After reviewing an interesting collection of state and local flood-related news stories for the past year, it is the author's opinion that the events that attracted the most media attention were the historic accounts and memorial activities marking the 25th anniversary of the Big Thompson Canyon flash flood. This historic flood occurred during the late evening hours of 31 July 1976, when 12 to 14 inches of rain fell in the canyon area downstream of Estes Park. Considered by many to be Colorado's worst disaster, the flood devastated nearly everything in the canyon and claimed 144 lives. The Big Thompson flood is credited with providing the motive for many local flood warning systems that are in place today, both in this region and elsewhere.

While the District was fortunate to avoid flood disaster once again, the 2001 flood season was not without problems. The District's 23-year-old flash flood prediction program (a.k.a. F2P2) experienced an above average number of "message days" with 42, compared to an average of 36, a record high of 52 in 1996, and a low of 23 in 2000. The National Weather Service issued flash flood watches affecting the District on 13 days in July and August, setting a record. Flash flood warnings were issued for 3 days, during the same week in July. Eleven straight days of flood potential occurred from July 5-15, setting another District record for most consecutive "message days." Brief descriptions for a few notable events are provided later.

Meteorological Support

HDR Engineering, Inc. provided the F2P2 forecast services during 2001. John Henz, former president of Henz Meteorological Services, acted as HDR's senior project manager. Bryan Rappolt served as lead meteorologist. John and Bryan are both veterans of the program. This is the first year in the program's history that an engineering firm was selected as the meteorological support provider. With HDR being one of the District's more experienced

hydrologic/engineering consultants, this new role for them may open the door for other professional engineering firms to consider offering operational hydro-meteorological services. The F2P2 provides forecast and notification services directly to District local governments from mid-April through mid-September each year.

Flood Warning Research

Dr. Eve Gruntfest and Kim Carsell with the University of Colorado at Colorado Springs are working with the District to evaluate the effectiveness of Boulder's local flood warning program. The Boulder/Boulder County Office of Emergency Management is the local sponsor of this research project. The study is using the latest findings and lessons from recent Colorado and U.S. flood disasters to assess the effectiveness of Boulder's program and recommend ways to improve it. Successful aspects of other well-known local flood warning programs are being identified. A community survey was conducted to learn what floodplain residents understand about their community's flood threat, the warning process, and personal flood safety. The final report will be completed by next spring and made available to interested parties. Eve was also involved with the behavioral science research conducted by CU-Boulder for the District after the Big Thompson flood.

GIS Flood Threat Recognition

The District began efforts to develop its Geographic Information Systems (GIS) capabilities in 1998 and recently initiated a project that applies this technology to recognizing flood threats. Bruce Rindahl, project manager for Brown and Caldwell, assisted the District in 2001 by developing a GIS interface that processes real-time radar and lightning data from the District's satellite downlink and from the ALERT system. The radar data interface relies on software from Meteorlogix (formerly Kavouras) to convert data to a standard GIS format used by ArcView™. Kavouras has been providing radar data

to the District since 1979. The Internet was used to establish the ALERT data interface, making integration of other useful data sets possible. The next logical step will be to link site-specific flash flood guidance and decision aids contained in basin flood warning plans with GIS and build quantitative forecasting capabilities for use in the F2P2. This work is expected to begin in January and will be operationally tested during 2002. Eventually, GIS products will be disseminated to local governments and made available on the Internet with the expectation that flood threats will become easier to recognize, thereby enabling more timely and specific flood warnings.

Self Help Gets Noticed

What can individuals, families, and businesses do to protect themselves from floods? By choosing to better understand the risk, learn some safety rules, write a simple plan, and spend a few dollars to protect personal property—much can be done to keep damages to a minimum and prevent loss of life when the next big flood hits. Boulder and Denver, with assistance from the District, are developing flood protection handbooks and web pages to help citizens help themselves. The publications will be completed by the 2002 flood season, but the real success of this effort will be determined by the willingness of individuals to act. Marketing this idea will take some creative thinking and it will be interesting to observe this process. We hope it will not take a flood disaster to generate public interest, but it may.

ALERT System News

The ALERT system continues to provide valuable early flood detection and decision support for the District. It now includes 148 gaging stations that provide 134 real-time rain measurements, stream and reservoir water levels for 68 locations, and weather data from 16 mesonet stations.

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Maintenance Program Activities

by

Mark R. Hunter, P.E., Chief, Maintenance Program

Routine Maintenance

Through the routine maintenance program \$687,600 was spent in 2001 for mowing and debris pickups. This work was done on approximately 240 different sections of urban drainageways within the District boundaries. This equates to a total of over 100 miles of drainageways in the Denver area on which we performed scheduled mowing and debris pickup maintenance.

Many of the more urban drainageways now receive four or five mowings and seven or eight debris pickups per year. In the early 1980s the sole purpose of the routine program was to pick up large debris that could otherwise contribute to blockages and flooding problems. These days urban drainageway corridors are prized as neighborhood amenities. Along with that outlook comes the community desire for a level of drainageway maintenance that goes beyond our original flood control debris pickups. Three or four debris pickups per year is now inadequate on the more urban drainageways that we maintain.

All of our routine work is done on structured schedules by private contractors. We are not set up to carry out landscape maintenance, on-call work, or emergency services. In the past we have participated with other agencies by splitting maintenance duties along drainageways through improved parks. We have seldom been pleased with our performance in these areas. Recognizing this, we will resume our initial policy of not providing mowing and debris pickup on irrigated drainageway corridors.

For the year 2001 we awarded eight separate contracts for routine work. All eight contracts were awarded through a direct competitive bid process. This was the first year all routine contracts were competitively bid. Over the last four years we have been transitioning away from awarding routine contracts based on an internal review of contractor proposals and toward awarding them based on the competitive

bid process. For the year 2002 we will add a provision to the routine contracts that will allow us to negotiate contract renewals for 2003 if we are satisfied with the contractor's work.

Restoration Maintenance

In 2001 the restoration program completed \$1,887,000 of work. Restoration projects typically address isolated drainage problems where the solution involves small-scale construction. Eighty-seven individual activities were completed during the year. A major advantage of the restoration program is the ability to use it to react quickly to local drainage needs.

The topography in the Denver area is generally steep enough that stream erosion is a rapid and visible element of the hydrologic cycle. When development occurs streams are often confined to inflexible corridors. If the stream corridor is narrow little room is available for the common episodes of erosion. A frequent method of controlling vertical stream erosion is to install drop structures to dissipate the energy. A drop structure must be stout in order to withstand the erosive power of a stream.

To borrow a football cliché, only three things can happen to a drop structure and two of them are bad. In the first case, drops can fail when water flows through, under, or around them due to an inadequate cutoff wall. In the second case, they can be damaged when the structure itself is not robust enough to withstand and dissipate the stream's energy. Only if all goes well with the design and construction will the drop structure provide years of stable and durable grade control.

Our restoration program repaired several drop structures that suffered the first type of failure. The drop structures on **Greenwood Gulch** in Greenwood Village were built in 1998, but three of them were showing signs of water flowing around the sides of the

structures. These were originally built as low-flow drops with grouted boulders as the cutoff wall. We repaired them by driving a ten-foot deep sheet pile wall on their upstream edge and grouting the connection from the sheet pile to the existing boulders.

A drop structure of concrete rubble and grout had been in place for years on **Harvard Gulch** just upstream of Madison Street in Denver. This facility had no cutoff wall and had been undermined by the stream. Our approach was to trench and pour a concrete wall for the cutoff and to use grouted boulders for the sloping face of the structure.

It is common to have utility lines cross streams. Many of them end up with concrete encasements to protect the utility from the stream. On **Massey Draw, North Tributary** in Jefferson County the stream eroded both under and around one end of a sewer line encasement. With the financial assistance of the sewer district we poured a concrete cutoff wall and placed grouted boulders for the drop structure face.

We also repaired several facilities that suffered from the second type of drop structure damage. A Capital Program project from the 1970s on **Sanderson Gulch** in west Denver included drop structures made of gabion baskets. The high bed load of sediment and vandalism combined to limit the service life of the gabions. The gabion drop on the east side of Federal Boulevard had been repaired in the past with sprayed-on concrete, but that was now deteriorating. We replaced that structure with a trenched and poured concrete cutoff wall with grouted boulders for the sloping face. We will continue replacing the old drop structures on Sanderson Gulch as funds are available.

Just south of C-470 in Douglas County **Willow Creek** flows through an undeveloped area. Similarly, in

Brighton, **Line A**, also called **North Urban Channel**, discharges to the South Platte River after flowing through a rural area. The structures on both these creeks shared a similar history in that they suffered from increased flows due to upstream development and the downstream channel was degrading resulting in undermining of the facilities. For both these structures we drove sheet pile to establish the cutoff wall and installed grouted boulders to create the face of the drop. We realize that since there is no grade control downstream of these structures they will still be vulnerable to vertical erosion in the downstream channel.

Stream-rounded boulders were used over the years by the City of Boulder to establish a dozen drop structures on **Boulder Creek**. These drops are two to three feet tall and have no concrete and no cutoff wall. The original boulders were locked into an arch shape through careful placement, but, eventually, in the cobble-bedded stream some of the rounded boulders became displaced. We imported some angular boulders and re-established an arched grade wall bedded in the cobbles. The rounded boulders were then placed downstream of the grade wall to give a sloping face to the structure.

Rehabilitation Maintenance

Twenty-four projects were at various stages of design or construction during 2001. Those projects are listed in the accompanying table titled “STATUS OF MAINTENANCE REHABILITATION PROJECTS”. Rehabilitation projects usually take the form of consultant-designed repairs that are intended to address severe problems that have occurred on a previously improved urban drainageway. By the end of 2001 the District will have spent about \$2,559,300 on rehabilitative design and construction for the year. A few of the unique projects are discussed below.

We are always doing something on **Cherry Creek**. In southeast Denver where the Highline Canal crosses the creek there is a massive 12 foot tall drop structure composed of dumped concrete rubble. As the creek bed downstream has degraded the structure has evolved

STATUS OF MAINTENANCE REHABILITATION PROJECTS

Project	Jurisdiction		Cost	Status
ADAMS COUNTY				
Clear Creek – S. Platte R. to York St. Build drops to control grade.	Adams County	Design	\$72,700	25%
		Const.	0	0%
Little Dry Ck., Shaw Heights. – South of 80 th . Repair bank erosion, partic.	Westminster	Design	65,000	100%
		Const.	600,000	100%
Niver Ck, Trib M – N.E. of Huron St. & 88 th Ave. Drops & repair bank erosion.	Thornton	Design	43,600	100%
		Const.	263,400	5%
ARAPAHOE COUNTY				
Big Dry Creek – East of University Blvd Repair to channel and trails	Arapahoe County	Design	83,950	100%
		Const.	296,850	100%
East Toll Gate Trb. – Along Uravan Av Drops and channel repair	Aurora	Design	104,064	100%
		Const.	152,208	5%
Lee Gulch – West of Prince Street. Remove sediment from lake, partic.	Littleton	Design	By others	100%
		Const.	10,000	25%
Little Dry Ck – Quincy to Belleview Av Grade control at sewer crossings partic.	Cherry Hills Village	Design	By others	100%
		Const.	100,000	100%
S.J.C.D. North – East of Sheridan Blvd. Repair low flow channel and drops.	Arapahoe County	Design	68,857	100%
		Const.	354,206	100%
BOULDER COUNTY				
No Changes in 2001				
DENVER COUNTY				
Cherry Creek – Highline canal crossing. Repair drop structure, participation	Denver	Design	Included	100%
		Const.	437,550	0%
Goldsmith Gulch, - North of Hampden Channel and bank repair.	Denver	Design	54,000	0%
		Const.	Next year	0%
Harvard Gulch – Through DeBoer Park Rebuild trickle channel	Denver	Design	77,683	100%
		Const.	278,526	100%
Lakewood Gulch – Federal to Knox Channel erosion repair	Denver	Design	86,185	100%
		Const.	420,393	100%
South Platte River, West Side Trib. - N.E. of 6 th and I-25. Concrete channel.	Denver	Design	85,779	100%
		Const.	379,423	100%
DOUGLAS COUNTY				
Big Dry Creek – In Heritage Park Drops and repair steep banks, partic.	Douglas County	Design	By others	100%
		Const.	100,000	0%
Big Dry Creek – Crest Hill Tributary Drops and repair steep banks, partic.	Douglas County	Design	By others	100%
		Const.	100,000	100%
Sulphur Gulch – W. of Hwy #83. Rebuild drop structure	Parker	Design	77,940	100%
		Const.	291,307	100%
JEFFERSON COUNTY				
Bear Creek – Through Morrison Access trail, participation.	Morrison	Design	By others	100%
		Const.	50,000	100%
Coon Creek – West of Sheridan Blvd Drops and repair eroding channel.	Jefferson County	Design	30,200	20%
		Const.	Next year	0%
Dutch Ck – NE. of Pierce & Coal Mine Repair eroding channel.	Jefferson County	Design	76,558	100%
		Const.	464,702	100%
Lena Gulch – Colfax at Heritage Road Drops and repair channel, participation.	Golden	Design	20,000	10%
		Const.	Next year	0%
Lilley Gulch – Wadsworth to Estes Repair channel and trail.	Jefferson County	Design	62,515	100%
		Const.	268,762	0%
McIntyre Gulch – West of Holland St. Repair channel banks, participation.	Lakewood	Design	Included	100%
		Const.	265,000	0%
McIntyre Gulch – Union at Alameda Pk Repair erosion and drops, participation	Lakewood	Design	63,910	100%
		Const.	300,000	100%
S.J.C.D. North – West of Sheridan Blvd Floodplain determination.	Jefferson County	Design	11,134	70%
		Const.	No const.	0%

into a drop that protects the Highline Canal siphon that crosses under Cherry Creek. Erosion has now exposed the siphon and the rubble appears inadequate to resist a major flood event. Several regional and local governments are participating with us in rebuilding this substantial structure including trail

and park improvements for the large open space area.

Niver detention pond is a large regional facility located west of I-25 at 88th Avenue. **Tributary M to Niver Creek** joins Niver Creek just upstream of the dam. The dam provides some grade
(Continued on page 23)

Master Planning Program Notes

by
Ben Urbonas, P.E., Chief, Master Planning Program

Planning Projects

As listed in "Status of Planning Projects" table, we completed five master planning projects in 2001; 13 projects are in progress and vary in completion from 5% to 90%; five have mapping completed or are being mapped, awaiting the start of engineering studies; and four we hope to begin in 2002. The planning activities with our city and county partners continue to be vigorous and challenging.

We now have a total of over 110 watershed-level major drainageway and outfall system plans in our inventory. And, as you can see, we will be adding another 29 within the next two to three years. These master plans help guide the District's capital projects and land development activities by the cities and counties within the District. They also serve as a resource of information about each of the watersheds and drainageways that were investigated and can provide local governments and the private sector with vital information on drainage and major drainageway (i.e., receiving water) system condition and needs.

In addition, all of the newer outfall system plans contain specific recommendations for stormwater water quality facilities and stream stability. They help to continue this region's national leadership in addressing the important question of how to mitigate the impacts of urbanization on receiving waters.

Release of the Updated Urban Storm Drainage Criteria Manual

The effort we began in 2000 to update Volumes 1 and 2 of our *Urban Storm Drainage Criteria Manual (Manual)* was completed in June of this year. Wright Water Engineers, Inc., under the leadership of Jonathan E. Jones, P.E., was the lead consultant that helped us to totally update and modernize these two volumes.

STATUS OF PLANNING PROJECTS

Project	Sponsor(s)	Consultant	Status
Cottonwood Area Catchment OSP	Parker & Douglas Co.	Farnsworth & Polk	Completed in 2001
Holly Hills Trib. To Harvard Gulch	Arapahoe Co. & Denver	SEC	Completed in 2001
Lower Box Elder OSP	Adams Co. & Denver	Wright Water	Completed in 2001
Sulphur & Tallman Gulches Outfall Plan	Douglas Co. & Parker	Kiowa	Completed in 2001
Town of Erie OSP	Town of Erie	Love & Associates	Completed in 2001
Broomfield & Vicinity MP Update	Broomfield & Westminster	Kiowa	90% Complete
Lower First Cr. OSP Update	Adams County & Commerce City	Turner Collie & Braden	90% Complete
Basin 4100, DFA 0054 & 0056 Update	Thornton & Adams Co.	Kiowa	75% Complete
Four Mile Canyon Cr.	Boulder & Boulder Co.	Love & Associates	75% Complete
Plum Creek OSP - FHAD	Douglas Co.	WRC	75% Complete
Todd Creek & DFA0052	Adams Co. & Thornton	Kiowa	60% Complete
Applewood OSP	Jefferson Co.	Kiowa	50% Complete
Upper Piney Cr. & Tribs	Aurora	Kiowa	50% Complete
Unnamed Tributary to W. Toll Gate Creek	Arapahoe Co., ECCV & Aurora	Kiowa	50% Complete
Oak Gulch & Stroh Ranch	Parker & Douglas Co.	Knight Piésold	50% Complete
Horse Creek OSP	Adams County & Aurora	n/a	35% Complete
RMA 815 & Adj. Areas	Commerce City, Adams Co.	Love & Assoc.	5% Complete
Second Creek (Lower) MP Update	Adams Co., Brighton & Commerce City	Kiowa	5% Complete
Fairmount Area OSP	Jefferson Co., Golden	n/a	Mapping Done
NE Sheridan OSP	City of Sheridan	n/a	Mapping Done
High Line Canal – Marcy G. to Mississippi Ave.	Denver WD & WMD, Greenwood Village, S. Suburban Park & Rec. Dist. Littleton, Cherry Hills Village, Arapahoe Co.	n/a	Mapping Under Way, Start Engineering in 2002
Cherry Creek MDP u/s of Cherry Cr. Reservoir	Parker, Douglas Co., Arapahoe Co.	n/a	Mapping RFP Out
Rocky Mtn Ditch	Denver & Lakewood	n/a	Mapping RFP Out
Kinney Creek & Foster Draw	Douglas Co.	n/a	Start in 2002
Third Creek (Lower) MP Updates	Adams Co., Commerce City, Brighton	n/a	Start in 2002
Preble & Sack Creek Updates	Broomfield	n/a	Start in 2002
Lower Brantner Gulch Update	Adams County, Thornton	n/a	Start in 2002

This was a major effort that included the participation and assistance from practically every community within the District and some local governments outside our District boundaries. We also received valuable comments from the State of Colorado, U.S. EPA and the U.S. Corps of Engineers. The *Manual's* development process included eight

meetings with the Working Group and four meetings with the Milestones Group of the Stormwater Manual Advisory Committee. A seminar attended by 230 was held in March to introduce this document to the public and to take comments before it was finalized.

The full list of those that served on the *Manual's* Advisory Committee and others that provided materials or helped by review of this document is in the Acknowledgements section of the document. Our sincerest and heartfelt thanks go to all of these people. It was a truly cooperative effort by the majority of the municipalities along the front range of Colorado.

The updated Manual is in two volumes, both in printed form and on a CD. The CD contains a number of spreadsheets

to assist engineers with many of the calculations, several software packages that do the same and a number of AutoCAD™ details. Order forms for its purchase may be downloaded from our web page at www.Udfcd.org/usdcm_orders.htm.

We will also continue to update the Manual and the software, spreadsheets and design details that help the users with its technical aspects. You can help to improve this document by reporting to us about any errors you find and by

making suggestions on how to improve this package. All future updates and errata to the *Manual* will be accessible through the District's web site. They will be posted under "Software, Drawings, Specifications, etc." button or the "Downloads" note on our home page at www.udfcd.org. We will not be sending out any of these updates to manual owners and will rely on their initiative to visit our web page to stay current.

District Software News

By Ben Urbonas, P.E.

CUHP & UDSWM Software

We have been struggling for over a year to convert the District's supported software to run under the Windows operating system. Student interns are doing much of the programming work under the guidance of an experienced software developer, John O'Brian, author of several DOS versions of the District's supported software; Dr. C.Y. Guo; and myself. Initially, each package was been posted on our web page as a beta test version and as a final version when ready. All the District's supported software is available to download, free of charge, from our web page www.udfcd.org.

By the time you read this article, we hope to have a much more stable and friendly final beta test version of the *CUHP* software and a final version out by early in 2002. After its final release we will continue to work on improving its "friendliness" features.

This has not been a trouble-free effort. We encountered more problems than anticipated, which was frustrating for us and for the users. However, the *UDSWM* software is now sufficiently stable for release as Version 1.0.

UDSEWER & UDPOND Software

John-Michael O'Brian has rewritten, also under the guidance of the above-mentioned team, *UDPOND* and *UDSEWER* in Visual Basic. The latter will be known as *NeoUDSEWER*. It has the same math engine as the original

UDSEWER and provides virtually identical answers. It also has a graphical interface with drop-down forms for data entry and can import input data from the old version. Until recently it was available as a test version, but should be posted on our web page as Version 1.0 by the time you read this article. We also hope to release Version 1.1 in 2002 that will plot, at the user's request, sewer and hydraulic grade-line profiles.

UDPOND is a totally rewritten detention basin sizing program. Although it is based on the same mathematics as the old software, its math engine is new, very stable and offers users choices of how precise they want the calculations to be.

The user can chose to pre-size the detention volume using the Rational Formula-based modified FAA method. For final design purposes it requires an input hydrograph and uses the modified Puls method with reduced time steps to develop the outflow hydrograph. It permits the user to input as many outlet control elements (i.e., vertical and horizontal orifices, weirs and spillways) as needed for final design, or to input known composite stage-storage and stage-discharge curves. *UDPOND* is available as a beta test version at this time and we hope to have it ready for final release in spring of 2002.

Future Plans

Over the next six months we hope to have a graphical interface developed for

the *UDSWM* package so that the users can assemble and code the drainageway system (i.e., pipes, gutters, channels, etc.) and then input each element's parameters via drop-down forms. This should significantly reduce errors in the coding of drainageway system connectivities.

In time we hope to integrate the *CUHP* and *UDSWM* into a single package with a continuous simulation option. In addition, we hope to integrate the *UDPOND* input features into the consolidated *CUHP-UDSWM*. That will take another year of development time.

New staff member

Steve Materkowski has joined the District as an Engineering Inspector in the South Platte River Program. A student intern with us since early 2000, Steve is currently finishing his senior year at the University of Colorado, Denver. He is majoring in Civil Engineering with a minor in Economics. Steve is also a member of the Golden Key International Honor Society. Steve's prior experience includes 10 years as an Environmental Control Technician for the U.S. Postal Service and an enlistment in the United States Navy as a Nuclear Power Technician/Electrician's Mate. Steve is a native of Northern Michigan but has lived in Colorado since the late 80's.

Warning (from page 7)

The District's ALERT web server had the desired effect this past year by logging more than 1.7 million individual requests for products. In addition, over 170,000 real-time data tables were automatically sent to a NWS server in Boulder where the data is processed and subsequently disseminated to other systems for use in research, education, and other purposes.

Prior to developing the website, ALERT users had to either connect directly to the District's system by modem or request data from District staff. Now, only a handful of requests for data and remote access privileges are received annually. Due to an increasing demand for historic data, the District recently added archive data retrieval capabilities to the website. Users can now obtain data online back to August 21, 1985.

ALERT system expansion in 2001 consisted of four stations: 1) Urban Farm at Stapleton weather station; 2) Third Creek at DIA rain/stream gage; 3) Hidden Lake rain/stream gage; and 4) Little Dry Creek at 64th rain/stream gage. Funding agreements with Denver and Aurora were signed in December allowing further network expansion in 2002. One project will cover Marston Lake area in southwest Denver and the other will involve the Upper Sand Creek basin. New weather stations will be installed at Marston Lake and Aurora Reservoir. DIAD Incorporated may install a third weather station at their Longmont offices to facilitate testing of sensors and new equipment designs. DIAD provided the 2001 ALERT maintenance services for the District and Boulder County. More stations also appear to be on the horizon. Within the past month the City of Boulder expressed the desire to install at least two new rain/stream gages along South Boulder Creek downstream of Eldorado Springs. With such a high level of interest by so many, it is difficult to predict just how big the network will grow.

The 2001 Flood Season

The 2001 flood season may be remembered most for one week of particularly wet weather at a time of the

year when hot and dry tends to be the norm. The week ending July 14 had flash flood warnings on three days (8,10,13), flash flood watches for three others and a mid-week break with only marginal flood potential. July 8, without question, produced the worst flooding of the year for the District. Fortunately, the storm happened on a Sunday or it would have affected many Denver area commuters and the consequences might have been worse. The following briefly describes some of the year's more notable events:

May 3-5

Three days of steady upslope rain saturated soils along the Front Range. Rainfall amounts totaled 2 to 3 inches over much of the District causing some minor street flooding while larger streams like Cherry Creek and the South Platte River rose above normal. Two reservoirs monitored by the ALERT system recorded their annual peaks on May 5 (see table). No rainfall rate alarms occurred during this period.

Wednesday, June 20

At 7:20 p.m., heavy rain and damaging hail struck DIA causing more than \$49 million in damage. That estimate did not include undisclosed damages sustained by the airlines at DIA. Between 40 and 50 mobile homes were also damaged in the Watkins area. Messages concerning the possibility for storms were issued for the entire District at 4:10 p.m. No major flooding was reported.

Thursday, July 5

Fast-moving storms accompanied by high winds dropped 1.85 inches in less than an hour over Aurora during the rush hour. Rainfall rate alarms occurred at four ALERT gages in the general vicinity of I-225 and Sand Creek. Annual peaks were recorded for three stream gages in the same area. This day marked the beginning of 11 straight days of flood potential for the District and a 45-day siege of monsoon storms for the region.

Sunday, July 8

Serious street and stream flooding hit Denver hard between 4 and 6 p.m. The storms were accompanied by high winds and small hail. Damage to the Cherry Creek Arts Festival was a major news

Days having flood potential

April	None	0
May	2-5,27-28,30	7
June	7,13-14,20-21,26	6
July	5-15,23-26,31	16
August	1-2,6-9,13-15,22,30	11
September	14-15	2

story where one person was taken to the hospital after being struck by blowing debris from street displays. Flash flooding was observed on Harvard Gulch, Goldsmith Gulch, Cherry Creek, the South Platte River, and along I-25 where the infamous "Lake Logan" (Logan St./I-25 underpass) once again stopped traffic. The Harvard Gulch at Jackson Street rain gage measured the heaviest rainfall of 0.67" in 5 minutes and 2.48" in an hour. Additional reports of flash flooding were noted in Centennial and Englewood.

This was the main record-setting day for the ALERT system with rainfall rate alarms occurring at 17 stations. Annual peaks were recorded by 16 stream gages with 5 breaking their historic marks. The District and affected local governments were made aware of this day's flood potential before noon, thanks to the forecasting talent of Bryan Rappolt. In the morning the NWS did not believe the threat warranted a flash flood watch, but as conditions worsened in the afternoon appropriate flash flood warnings were issued.

A reconstitution of the storm performed by HDR Engineering showed that rainfall totals might have exceeded 4 inches along Colorado Blvd. between I-25 and Evans. The Harvard Gulch rain gage mentioned above is in this area and may have experienced considerable undercatch due to high winds—a well-known accuracy problem for ALERT rain gages. Harvard Gulch did experience a record flood, but it is somewhat unclear why the extent of flooding wasn't worse with much of the upper basin receiving more than 3 inches of rain according to the HDR study. Further study will be needed to answer this question.

2001 Peak Flows. Some notable peaks measured by the ALERT system.

Date/Time	Location	Peak in cfs
May 5 11:15	Maple Grove Res. on Lena Gulch	20 (Elev. 5527.1)
May 5 20:21	Englewood Dam	* 156 (Depth 17.6')
June 9 03:45	Boulder Creek near Orodell	** 630
July 5 19:46	Westerly Creek at Montview Blvd.	500
July 5 20:06	Havana Park Detention	350 (Depth 7.6')
July 8 04:44	South Platte River at Henderson	7,160
July 8 17:13	Goldsmith Gulch at Eastman Avenue	2,030
July 8 17:15	Harvard Gulch at Jackson Street	820
July 8 17:16	Harvard Gulch Park at Logan Street	* 2,080
July 8 17:25	Goldsmith Gulch at DTC/Temple Pond	640 * (Depth 14.5')
July 8 17:27	South Platte River at Dartmouth Ave.	2,730
July 8 18:24	South Platte River at 19th Street	9,220
July 8 18:27	Holly Dam	* 138 (Depth 19.8')
July 8 19:02	Cherry Creek at Steele Street	* 2,240
July 8 19:30	Cherry Creek at Champa Street	* 3,230
July 10 20:57	Niver Creek Detention	60 (Depth 13.4')
July 13 19:02	Ralston Creek at Carr Street	1,020
July 23 16:49	Slaughterhouse Gulch Detention at Grant St.	120 (Depth 7.0')
July 23 16:44	South Platte River at Union Avenue	1,540

* New record ** Peak due to snowmelt
Visit alert.udfcd.org for a complete listing of record

This event came very close to causing much greater property damage. More serious consequences were avoided for two main reasons: 1) existing flood control and drainage improvements prevented major damages; and 2) the rain stopped before the capacity of these facilities was exceeded. Another inch of rain and it would have been different.

Tuesday, July 10

A fast developing storm formed over central Jefferson County dropping 1.5 inches in 35 minutes while a second foothills storm hit the Evergreen area with similar amounts. A flash flood warning was issued by the NWS for upper reaches of Bear Creek above Evergreen where one-hour radar rainfall estimates exceeded 3 inches. Rain rate alarms occurred at 8 stations and 4 annual peaks were recorded.

Friday, July 13

Dual “Friday the 13th” storms deluged Arvada and Aurora. Radar-estimated rainfall of 2 to 3.5 inches was noted in northern Arvada over Little Dry Creek. An observed 1.7 inches in less than an hour caused heavy runoff in the Toll Gate Creek basin and along Sand Creek in Aurora. Rain rate alarms occurred at 9 stations and 10 stream gages record annual peaks.

Saturday, July 14

A long track multi-cell storm complex developed over the northwestern Jefferson County foothills about 3 p.m. The storm produced severe weather in the form of damaging hail and high winds across the foothills north of Golden, Rocky Flats, Broomfield and west-central Adams County. A Thornton official reported the heaviest rainfall amount of 3.7 inches, which caused serious street flooding. High winds and heavy rain produced street flooding problems in northern Aurora, near Barr Lake, and at DIA. Intense rainfall was also measured by the ALERT system in the Parker area.

Monday, July 23

A highly localized storm impacted rush hour traffic around the Denver Tech Center. Hail, wind and

rainfall amounts exceeding 1.2 inches in 30 minutes slowed travel on I-25 and I-225. Funnel clouds were also reported. The South Platte River gage at Union Avenue recorded its record flow for the year, as did the Slaughterhouse Gulch detention basin at Grant Street. Rainfall rate alarms occurred once again in the Goldsmith and Harvard Gulch basins, but the flooding was not nearly as severe as July 8.

Thursday, August 9

The “final” big storm day of 2001 hit the Boulder and Jefferson County foothills with four active storms dropping more than one inch in 30 minutes. The heaviest rainfall was noted over Morrison (1.61”), Turkey Creek (1.50”), and South Boulder Creek (1.34”). Rain rate alarms were triggered by 6 ALERT gages and 2 stream gages in the Bear Creek basin recorded their annual peaks. Very active lightning accompanied these storms.

For more information...

A more comprehensive version of the above article can be found at udfcd.org. The web page contains related photos, figures, links and other information that could not be included in this printed edition of *Flood Hazard News* due to space limitations. One link to check out is the PowerPoint™ presentation of the July 8 flood that was presented by Bill DeGroot at the 2001 CASFM conference in Steamboat Springs.



Goldsmith Gulch upstream of Mexico Avenue on July 8, 2001. Many more during and after photographs can be seen on the District’s web page at udfcd.org.

South Platte (from page 2)

provide better habitat for wildlife native to this region. After removal of undesirable species, we replant these areas with the species mentioned above.

An area of growing concern is invasive noxious weeds. These weeds threaten habitat, decrease the value of infested lands and hamper public use. With the adoption of an integrated approach to noxious weed management, the Routine Maintenance Program is better equipped to deal with invasive weed species. Our methods include weed mowing, hand pulling and selective use of approved herbicides. Our relationship with various county weed managers allows us to coordinate our efforts in order to maximize the public benefit from our activities.

Restoration Maintenance

In 2001, the Restoration Maintenance Program had a busy year. In addition to typical stabilizing, rehabilitating, and revegetating riverbanks, the District continued to assist local governments with maintaining the recreation trail used by the District for maintenance access. This year, over 3000 feet of badly eroded riverbanks were restored and stabilized with buried riprap. The slopes were revegetated with native grass, shrubs, willows, and cottonwood trees. Over the years we have found this type of combined hard and soft treatment to be very successful in both urban and rural areas. In most instances there is little or no evidence of underlying riprap once the vegetation matures and it does add to the aquatic habitat diversity when it is under the water surface.

One project of special note involved a breached river levee in Adams County. On Saturday, May 5th, a flow of approximately 6,500 cubic feet per second breached a riverbank levee adjacent to a sand and gravel operation near 120th Avenue extended. The breach was first reported to the District on Monday morning. An assessment was made later that day and on Tuesday, a District restoration contractor was mobilized to repair the breach. Thanks to the watchful eye of river property

owners, and the ability for the District to hire on-call contractors, potentially major river degradation and bank erosion was prevented.

Unfortunately the over-bank side channel area downstream of the breach experienced severe vertical and lateral erosion resulting in the loss of wetlands and other valuable wildlife habitat features within and adjacent to conservation areas. The District is now working with property owners, Adams County Parks, Commerce City, U.S. Army Corps of Engineers, LaFarge/Mobile Premix Concrete Company, Denver Water Department and others to restore and stabilize the damaged areas.

In 2002 the program will include the following rehabilitative projects:

- Reconstruction of the Gardener's Diversion Dam just upstream of the York Street bridge in Adams County.
- Construction of a boulder grade control structure upstream of 120th Avenue.
- Construction of a boulder grade control structure at the Henderson flow gauge near 123rd Avenue.
- Extension of the river recreation/maintenance trail northward below 104th Avenue.
- Construction of a boulder grade control structure and old bridge pier removal at 16th Street in Denver.

Cooperative Projects with Private Property Owners

Cooperative projects are constructed on flowage and maintenance access easements dedicated to the District by private property owners adjacent to the river in exchange for river restoration work. To date almost 550 acres of these easements have been dedicated, resulting in over 22 bank stabilization and riparian revegetation projects on these properties since 1988. In most cases, the local park departments use these easements for the construction of recreation trails which double as river maintenance access. No new cooperative projects were constructed this year, however, work leading to the acceptance of three more easement dedications was completed. Aggregate Industries, Inc. and Asphalt

Specialties, Inc. have both expressed an interest to work with the District in order to fulfill their bank restoration and stabilization requirements for mining within the South Platte River 100-year floodplain in Adams County.

The McIntosh Farm Company would like to clean up and stabilize the eroded bank along their property. This property was recently protected by a conservation easement held by Adams County. This easement will ensure the farm's 245 acres can never be developed, while allowing the family to retain ownership and maintain its dairy operation. We hope to complete these bank rehabilitations during 2002.

Capital Improvement Projects

Upper Central Platte Valley Project

The U.S. Army Corps of Engineers has completed a Feasibility Study of a river restoration project for the Sun Valley and Zuni Reaches, 12th Avenue to upstream of 8th Avenue. These two reaches are immediately upstream of the Colfax Reach (I-25 to 12th Avenue). Work should begin on final design this fiscal year. The District is assisting Denver, who is the official local sponsor, to fund the local match and is hopeful the U.S. Congress approves funds for the 2/3 Federal share to construct this \$15,000,000 project.

At this time the Corps is busy completing the river restoration improvements to the Colfax Reach of the river. This \$4,000,000 project has widened the river corridor through the acquisition of additional right-of-way and the demolition of one small building. When completed, river bank slopes will be much flatter (i.e., 3H:1V) than the 1.5H:1V before work began, creating significantly more terrestrial wildlife habitat. In addition, features such as small flow diversion jetties will provide for an improved aquatic habitat. We will be completed by March, 2002. In addition to improved aquatic and terrestrial habitat, other benefits of the Corps projects will include an improved flood carrying capacity, a trail that will no longer have a street level crossing, an open confluence with Weir Gulch

(currently it is blocked by a railroad spur embankment and a culvert) and a much improved river access for the Sun Valley neighborhood residents. This project has moved at a rate not seen for Corps projects in the past. The Omaha team, and especially the project manager Patrick Addison, have to be congratulated for this. They have

exhibited a phenomenal ability to get this project under way, to include all aspects of local participation in its design and to help get the needed Corps funding and approvals.

Adams County Master Plan Update

This project, completed by CDM, to update the South Platte River Major

Drainageway Master Plan through Adams County, is now completed. Adams County, the cities of Brighton, Thornton, Commerce City, South Adams County Water and Sanitation District and the Denver Water Department were the local sponsors.

Stormwater Permit Activities

by

John T. Doerfer, Project Hydrologist, Master Planning Program

On March 10, 2003, all of the cities, counties, and special districts in Colorado that operate what are defined by regulation as “small municipal separate storm sewer systems” (Small MS4s) will be required to submit permit applications for coverage under the Colorado Discharge Permit System. There are about 40 cities, towns, and counties in the state with less than 100,000 population located within Census-defined “Urbanized areas.” Many of these municipalities are located within the UDFCD. In addition, there are a number of special districts within these jurisdictions that have drainage responsibilities (*i.e.* metropolitan districts; drainage districts; water and sanitation districts; etc.) also defined as small MS4s. Collectively, these entities are referred to as “Phase II” of EPA’s municipal stormwater control program. The District assisted its member governments in 2001 to prepare for Phase II permit applications, and will continue to do so as the March 2003 deadline approaches.

Phase II Regulations. EPA published the federal regulations for Phase II on December 8, 1999. The six (6) management programs (called “minimum control measures”) that must be implemented by an MS4 are: (1) Public education and outreach; (2) Public involvement/participation; (3) Illicit discharge detection and elimination; (4) Construction site runoff control; (5) Post-construction runoff management in new development and redevelopment; and, (6) Pollution prevention/good housekeeping for municipal operations. The EPA regulations also included additional “guidance” that was recommended for consideration by municipalities when

developing a proposed program. The state’s Attorney General determined that if this guidance was included in the Colorado regulations, it would be mandatory rather than discretionary. So, the guidance provisions were not included in the Colorado Discharge Permit System Regulations (5 CCR 1002-61) for Phase II adopted on January 8, 2001.

Guidance Document. A Municipal Workgroup of the Colorado Stormwater Task Force, chaired by UDFCD with participation by many of its member governments, decided that a separate guidance document published by the state would be helpful for preparing permit applications. The guidance has been customized for Colorado and includes descriptions of potential management program elements and methodologies. About 50 volunteers from around the state began in February 2001 to write this document, and it was completed in November and is posted on the Water Quality Control Division’s (WQCD) website at: www.cdphe.state.co.us/wq/PermitsUnit/wqcdpmt.html

General Permit. The next activity that will take place during 2002 will be development of general permits. The state plans to use two of these for Phase II. The first will be completed by July for construction sites between 1 and 5 acres, defined as an industrial category of stormwater discharges (sites greater than 5 acres have been regulated since 1992). The second is for small MS4s, planned for completion by December 2002. Cities and counties within the District will want to pay attention to these general permits, and participate in their development if possible, because

they will affect the ultimate outcome of permit application submittal requirements and compliance issues. The District will participate, and sponsor a number of meetings among member governments during the year to discuss these general permits, elements of management programs and the “measurable goals” that must be proposed in the MS4 general permit applications.

Phase I Municipalities. The cities of Denver, Aurora, and Lakewood are classified as “Phase I” MS4s and were issued permits by the WQCD in 1996. Their permits were for a 5-year permit term and expired on April 30, 2001. The three cities submitted permit renewal applications in October 2000, but as of the current date have not yet been reissued permits for a second term. In accordance with state regulations, they continue implementation under previous permit conditions.

The Phase I cities have fully implemented all of their permit requirements. These include those generally described above for Phase II, as well as an industrial inspection program and monitoring requirements. Arapahoe County, although required to submit a Phase I application in July 1997, received notice this year it will instead be permitted under Phase II. The District has coordinated a regional water-quality monitoring program on behalf of Denver, Aurora, Lakewood, and Arapahoe County. Under a cooperative agreement with the U.S. Geological Survey, a total of five sites have been sampled during runoff events for four years. The program is intended to assess long-term trends, and will also provide data for watershed planning.

Tucker (continued from page 3)

space between clusters? Do we force people out of their cars and into mass transit? Do we prevent development outside defined growth areas? Do we require more dense infill development? Do we require sales taxes to be collected on a metro basis instead of by local governments, thereby removing the

competitive nature of sales tax producing developments? Etc., etc. These are questions that policy makers will have to face.

In the meantime the District will continue to try to keep development out of floodplains, to preserve floodplains to the extent possible, continue to do projects that solve existing problems,

continue to maintain the drainage facilities, continue to work on water quality improvements, and continue restoration efforts. Such efforts should provide future generations with drainageway corridors that are assets and not liabilities.

CoCo RaHS Coming to District

by Nolan Doesken, Assistant State Climatologist, CSU Colorado Climate Center

What is CoCo RaHS? CoCo RaHS is an acronym for the "Community Collaborative Rain and Hail Study". This is a community-based research and education project designed to involve local citizens of all ages in helping scientists study the fascinating and remarkably localized rain and hail patterns from spring and summer thunderstorms. With the help of the Urban Drainage and Flood Control District, CoCo RaHS will be starting up in the Denver area during the spring and summer of 2002. Detailed precipitation maps will be produced for every day of the year to help examine rainfall patterns in the region.

CoCo RaHS was initiated by the Colorado Climate Center at Colorado State University following the devastating flash flood that struck Fort Collins in July 1997. At that time, hundreds of local citizens in Fort Collins and Larimer County assisted the Colorado Climate Center in documenting storm rainfall patterns. With the help of nearly 300 rain gauge reports, precise details of the storm were identified and mapped. The heaviest core of that storm was shown to be only about one mile across and centered over extreme southwest Fort Collins where 14.5 inches of rainfall was measured. This was the heaviest rain ever documented over an urbanized area in Colorado. Just three miles to the east, rainfall decreased to less than two inches and many citizens of Fort Collins had no idea that a raging flood was in progress. Local observations also showed another rainfall core of over 12 inches just northwest of Fort Collins near the town of Laporte.

Since that storm, the Colorado Climate Center has worked together with teachers, students, local utilities, the National Weather Service, and various other organizations to put together a network of hundreds of volunteers that measure rainfall and hail on a daily basis. High school students from Fort Collins created a webpage that allows volunteers to submit their daily observations over the Internet. Rainfall and hail maps are immediately created and displayed that show the data from all volunteers.

Project scientists and sponsors utilize these precipitation maps to help understand the localized nature of storms and their impacts. The maps also are proving to be a wonderful resource for students and teachers in learning about weather patterns here in Colorado. In Fort Collins, where CoCo RaHS has been active for only four years, a monitoring network of more than one station per square mile covers nearly the entire city and surrounding areas. This allows scientists and water managers to truly understand local rainfall patterns and their implications.

CoCo RaHS is becoming a huge help to the Colorado Climate Center, whose job is to accurately monitor Colorado's climate. The Climate Center has done well with only a few weather stations per county across the state, but has always known that precipitation patterns are highly variable and that statewide precipitation estimates have been crude. Since CoCo RaHS started, several hundred precipitation stations are now reporting routinely from northern Colorado and precipitation assessments are getting much better.

Measuring rainfall seems easy, but there is more to it than meets the eye. All volunteers will be equipped with high capacity rain gauges that meet National Weather Service accuracy requirements. The Climate Center will provide excellent training on where and how to set up rain gauges to get accurate readings, while trying to make this a fun and exciting educational experience for all participants regardless of age or background.

CoCo RaHS expansion into the District will begin this spring. A student intern from Metropolitan State College Department of Earth and Atmospheric Sciences will play an important role in the project. Efforts will begin immediately to recruit volunteers, equip them with quality rain gauges and hail measuring devices called "CoCo RaHS Hail Pads", and provide training to all volunteers.

The goal for 2002 will be 150 new volunteers in the Denver metropolitan area to supplement the existing network of over 130 automated rain gauges operated by UDFCD. Together, this should provide a greatly improved ability to track and understand local storms.

It only takes five minutes per day to be a CoCo RaHS volunteer. If you would like to help with this project, please contact the Colorado Climate Center, Department of Atmospheric Science, CSU, Fort Collins, CO 80523, phone: 970-491-8545, fax: 970-491-8449, email: nolan@atmos.colostate.edu.

To learn more about CoCo RaHS, a link has been provided to the website from alert.udfcd.org.

Floodplain (from page 4)

regional detention facilities called for in the upper First Creek master plan, including cost sharing for the Green Valley Ranch Golf Course Pond and the Blue Grama Pond. The IGA called for Town Center to construct the Green Valley Ranch pond in conjunction with golf course construction and to be reimbursed by the other parties. That pond has been built and paid for.

Floodplain delineation

This year we added approximately 84 miles of newly identified 100-year floodplains to our inventory in two major studies that were completed in conjunction with Outfall Planning Studies. The first was *Flood Hazard*

Area Delineation for Lower Box Elder Creek Watershed, September, 2001, by Wright Water Engineers (53 miles); followed by *Flood Hazard Area Delineation, Plum Creek & Tributaries*, November, 2001, by WRC Engineering, Inc. (31 miles).

We have modified our scope of work for these studies to have the flood data prepared in digital form which should be compatible with FEMA's Digital Flood Insurance Rate Map (DFIRM) specifications. Our hope is that it will be easier to add these floodplains to the DFIRMs by having them in digital form.

Master planning efforts

As I reported last year I somehow ended up managing two difficult master planning projects, even though the District has a separate Master Planning Program. We have almost completed the final report for the lower portion of the First Creek watershed. It should have a December or January date.

Our recommended plan for South Boulder Creek was accepted by the University of Colorado but rejected by both Boulder and Boulder County. This was the District's third attempt (my second and last) to prepare a plan that had a chance to be implemented.

Please see Ben Urbonas for any of your future master planning needs.

Two District projects win CASFM awards

Two projects sponsored in part by the District won awards at the annual conference of the Colorado Association of Stormwater and Floodplain Managers (CASFM) held in Steamboat Springs in September. Brief descriptions of the projects are given below.

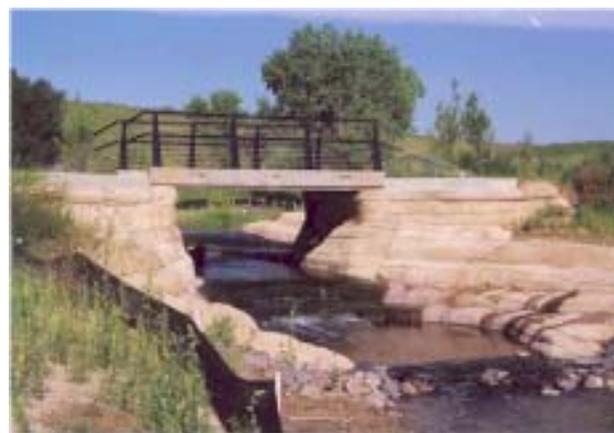
The winner of the Grand Award was the Grange Hall Creek Channel Improvements. Local sponsors were the City of Northglenn Public Works and Parks and Recreation Departments. The lead consultant was Muller Engineering Company, Inc. with Wenk Associates.

A 6,000-foot length of channel in Northglenn was stabilized through the use of sculpted and colored concrete drop structures. Existing 15- to 25-foot vertical banks were filled and laid back while preserving trees and wetlands. A wildlife habitat island was created in one location, and a portion of vertical bank was retained for nesting birds. A water-quality pond and a sedimentation basin were built on the North Tributary. A trail bridge-crossing was designed/built similar in appearance to the drops. The project was constructed from May 1999 to April 2001.

The Jewell Wetlands project received an Honor Award at the same conference. Local sponsors were the City of Aurora Utilities and Parks and Open Space

Departments. The lead consultant was ICON Engineering, Inc. with Design Concepts.

A 57-acre natural area was preserved and enhanced in Aurora. Drainage and flood-control protection was provided to a residential area and downstream city-owned facilities through construction of channel stabilization and a flood-control dam/reservoir. Wetland and upland-area educational opportunities were included through the use of a boardwalk and interpretive signs. A hummingbird viewing area was created. Volunteer efforts, including schools and citizen participation, were extensive as was fundraising involving multiple partners.



Two of the Grange Hall Creek sculpted structures.

Design was initiated in 1997 and construction was completed in 2000.

BMPs (from page 1)

The pre-retrofit basin was experiencing outlet clogging problems and its bottom became a soggy, unusable, nuisance to the neighborhood. The District will collect data on rainfall, flow rates and water quality at this installation over the next two to three years to see how well the recommended design performs. We observed that this design virtually eliminated clogging and sediment accumulation problems at the outlet. Two other extended detention basins nearby were observed last summer to not empty properly, while the retrofit basin had its water quality capture volume empty within the 40-hour design period of time.

Another design that the District introduced in its *USDCM* is a sand filter basin, and an example is shown in Figure 2. It provides for a water quality capture volume above the filter's surface and flood routing above the overflow outlet. We expect these filter basins will operate well, provide significant peak flow attenuation and require reasonable maintenance to stay in operation. AutoCAD™ details for these designs are available for download at the District's web page www.udfcd.org.

Need for a Nationwide Research Program

The universal use of BMPs can be very expensive. Many BMPs require the dedicated use of expensive land areas, and their ongoing operation and maintenance have a significant price tag. If the selected BMPs provide a level of protection for the receiving waters, the price may be worth it. However, if they do not, then much money is being spent building facilities for naught. The only way to answer whether what we are installing and maintaining in our communities is effective is to have the Federal Government, states, and local jurisdictions commit to a long-term national program of basic research. The research being suggested would help quantify the linkages between urban stormwater BMPs and their ability to mitigate the impacts of urbanization on receiving waters.



Figure 1. Extended detention outlet installed June 2001 in operation in August - 18 hours after storm's end. Note the partially submerged well-screen type trash rack, the debris line that is near the bottom of the 10-year control orifice and the 100-year overflow on top.



Figure 2. Sand filter with water quality capture volume above it, installed late 1980s. Note two inlet pipes and an overflow for larger storms. Volumes below the overflow are filtered and, because site conditions permit, infiltrated into the ground.

To assist with these research needs, the Water Environment Research Foundation has launched a stormwater research program. It will fund this effort by seeking Federal and other grants and through subscriptions by municipalities

(i.e., cities, counties, special districts, stormwater utilities, etc.). Subscribers will have access to advance information that will not be available to the public until research projects are fully completed. The authors encourage all

municipalities to become subscribers. The research that will be needed is very expensive and no single entity will be able to afford it. By joining forces and funds, there is a chance that we will be seeing answers to some of the questions that still need to be answered.

There are sufficient data and observations in place today that show urbanization does change the nature, quality and quantity of surface runoff and groundwater flows reaching the nation's receiving waters. These include changes in the rates, volumes, frequency, and quality of the surface runoff. All of these are attributed to the observed physical, chemical, and biological changes of the receiving water systems. There also have been several reported efforts to compile information on the effects of urbanization and impacts on receiving water. Many of these studies, although good to excellent in their own right, either did not follow consistent protocols or attempted to couple data from various sources to develop linkages between observed effects and impacts. Namely, reporting that the Rapid Bio-assessment Index showed degradation between upstream and downstream reaches of an urban area does not tie these degradations to specific effects of urbanization.

There were only a very few attempts to link the performance of stormwater BMPs with their ability to mitigate the observed impacts of urbanization (e.g., State of Maryland; King County, Washington; Austin, Texas). Although studies by Maxted (1999) and Maxted and Shaver (1997) looked at the ability of retention basins and Horner, et. al. (expected publication in late 2001) looked at extended detention basins to mitigate the impacts of urbanization on aquatic biota, none of those studies attempted to link specific BMP design parameters (i.e., various types, surface areas, and capture volumes relative to local mean runoff volume, release rates, etc.) to their effectiveness. None of them looked at entire systems of municipal BMPs that thoroughly cover the watershed and can operate simultaneously.

There is a clear need to establish an approach to develop a nationwide quantitative evaluation of BMPs and their ability to mitigate impacts. We need an effort that will attempt to link the performance of various types of BMPs and their design parameters such as type, size, volume, surface area, flow release rates, potential for infiltration, etc. To be credible a research effort that addresses and quantifies the linkages between BMPs and their ability, as part of a total municipal system, to mitigate impacts of urbanization on receiving water will need to: Involve the scientific and engineering community from many disciplines, Identify issues and complexities that will need to be dealt with to achieve stated goals, Identify the data and other information needs, Develop protocols for research, data acquisition and their evaluation, Whenever possible, quantify the relationships discovered, and Point out the observed or suspected relationships that cannot be quantified. This effort will need to be aimed at defining which physical (i.e., hydrologic, geomorphic, stream power, sedimentation, erosion, etc.), chemical (i.e., toxicity, oxygen availability, etc.) and biological (i.e., numbers and types of species of flora and fauna, habitat, eutrophication, etc.) processes are at work and what may be achievable through the use of individual BMPs and systems of BMPs in urban areas to mitigate the effects of urbanization.

Summary and Conclusions

The universal use of structural BMPs (i.e., treatment facilities) is very expensive and unless they provide a realistic level of protection for the receiving waters, their use could be a total waste of the investment for this nation. What is needed is a nationwide research effort, funded to a large extent by the Federal government, to quantify the linkages between urban stormwater systems of BMPs and their ability to mitigate the impacts of urbanization on receiving waters.

This scientific effort has a good start through the availability of the ASCE BMP database. In other words, some of the tools needed to begin the above-stated research effort are now in place.

A follow-up program can start with this database, build on it, and add to it a set of receiving water parameters. It will need to link, by geographic regions, BMP designs and systems of BMPs to observe in-stream; in-lake; in-wetland; and in-estuary impacts provided by each. Comparisons will need to be made using areas not yet urbanized, urbanized areas without BMPs, and areas with BMPs. In addition, isolated tests are also needed to identify the effectiveness of a specific BMP design's ability to mitigate the impacts of urbanization. All of these field research studies have to be designed in order to minimize the influences of a very large number of confounding variables.

By selecting BMPs that help reduce flow rates; volumes of runoff; and concentrations of very fine suspended solids, we have the greatest chance of mitigating some of the impacts of urbanization on our receiving streams. Thus, while the sciences improve, lets be discriminatory in our choices; using the goal of mitigating the physical and biological impacts of urbanization as our goal. On the other hand, choosing BMPs without regard to this goal is misguided and probably a monumental waste of fiscal resources.

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Maintenance Eligibility Notes

By

David Mallory, P.E., Project Engineer, Floodplain Management Program

Robust development pace continues

Everyone involved with land development design, construction and oversight is well aware that the 2001 recession has missed, or at worst, scored an indirect hit on metropolitan Denver's housing industry. We have seen some slowing in long range planning and a modest slow down in construction plan submittals. None-the-less, we processed 220 construction plan submittals in 2001, a 25% reduction from the 300 submittals reviewed last year.

Some of the reduction in plan submittals can be attributed to fewer review cycles necessary to achieve plan approval. One of our goals with the maintenance eligibility program is to reduce and streamline the process of approving construction projects. We issued 60 design approval letters for 220 submittals during the last 12 months, meaning each approved design took an average of 3.5 review cycles. Three cycles or less seems a reasonable target. Based on past experience we can offer the following strategies for shortening design review times:

Review the basin master plan. The District has prepared nearly 100 master plans for the metropolitan area. Some master plans are outdated, but they all provide a solid starting point.

Review District design criteria. Our criteria manual has been recently updated. Several new items have been added (storm sewer outlet treatments for example) and some old standbys have been altered or deleted. Make sure the area set aside for regional drainage facilities will accommodate approvable channel sections.

Check the web site for updated construction details and software downloads. We are continually developing design aids in order to streamline the approval process.

Review flood hazard data. Check for FEMA and District floodplain mapping.

Read the Guidelines for Maintenance Eligibility. The latest guidelines were issued in September

2000, and contain lots of helpful information.

Meet with us. After completing the research and conceptual planning, ask for a pre-submittal meeting. A number of consultants are taking advantage of this service to the benefit of their projects. The sooner we are involved in project reviews, the less time will be spent in reworking ill-fated concepts.

Use standard designs. The criteria manual has a full array of pre-designed hydraulic elements. Unique designs must have complete engineering backup. Thus, a unique design takes more time and effort to review and will likely result in added review time.

Meet with us again. During the design phase a lot of unexpected issues come up from scheduling to aesthetics, permitting and local issues. The District is also in an excellent position to offer advice relative to the preparation of FEMA submittals.

We are also available by e-mail, fax or telephone to answer questions on design criteria or the maintenance eligibility program. A new feature for 2002 will be online access to the District's maintenance eligibility database, updated monthly.

In the field

An integral part the maintenance eligibility process is construction oversight. If anything, construction activity has increased this year over past years. We typically have 100 to 130 projects approved for construction at any given moment. During 2001, we completed 120 construction observation site visits. Over 50 current projects were completed and recommended for construction acceptance. Another 16 previously approved projects were re-inspected for vegetative cover and given final approval.

Boyle Engineering, Inc. has provided some added horsepower to the field program. We brought them onboard during the last quarter of 2001 to help with the elevated construction observation requests.

The FEMA connection

On July 1, 2001, we began a new relationship with FEMA. We are now providing technical review of FEMA floodplain submittals (see Bill's article). Besides the several advantages of reviewing these documents locally, there is also a connection to the District's maintenance eligibility program. When a request is made to change a community's floodplain map, FEMA requires that community to assure the maintenance of the facility responsible for the map change. Having District maintenance assistance for flood control facilities helps local governments fulfill federal responsibilities and eases the approval process for developers.

Projects that are eligible for District maintenance assistance have been receiving speedy reviews in the LOMR process. We become familiar with project details through design review and construction observation. We know a floodplain map revision will eventually be necessary and help the consultant plan for that phase. The result is a streamlined map revision process.

Consider, for example, The Haven at York Street subdivision in the City of Thornton. The major drainageway involved is Wadley South from the UP Railroad to its confluence with Big Dry Creek. Improvements included an engineered channel, drop structures and a roadway crossing. A downstream developer also cooperated with right-of-way and project funding. Benik Consulting Services provided design and construction observation for the project. We approved the construction plans on July 31, 2000, and construction commenced in the spring of 2001. The final punch list was prepared the end of July and we accepted construction the end of August. The LOMR request was submitted on the 8th of August. We acknowledged receipt of all materials necessary for review on August 29, 2001 (coinciding with construction



Two views of the Wadley South Channel at The Haven at York

acceptance). FEMA issued the LOMR on September 25, 2001. We think that's remarkable considering the national disaster and attendant upheaval that occurred during the review period.

In summary, projects that follow the strategies outlined above, receive District plan approval and are built according to the approved plans can

expect a swift and relatively painless floodplain map revision.

District news briefs

Governor Owens Appoints Ben Urbonas to the CCBWQA Board

Governor Bill Owens appointed Ben Urbonas to the Board of Directors of the Cherry Creek Basin Water Quality Authority. Last year the State legislature redefined the Board's structure to have members from each of the five tributary municipalities, one special district representative and six citizens appointed by the Governor. The Board has to have two members with water quality expertise, two to represent recreational interests and two to represent environmental interests. Ben was appointed to a two-year term to represent water quality expertise.

District Licenses CUHP to XP Software

The District has entered into an agreement with XP Software, the developers of XP-SWMM™. This agreement grants XP Software a nonexclusive right to incorporate the CUHP software into the XP-SWMM™ software. This was done in response to requests from several consultants and municipalities. The District does not

support or endorse this or any other commercial product. We are pleased, however, that this arrangement will permit the municipalities and consultants using this package to now use the CUHP runoff model option to generate the stormwater runoff hydrographs for tributary catchments.

Paul Hindman wins APWA Award

Paul Hindman was the 2001 winner of the APWA Colorado Chapter's William E. Korbitz Award. Paul has served the Colorado Chapter in many ways. He served as the Chapter treasurer. He was the Chapter President in 2000 and led the Chapter's Strategic Planning effort, which provides a roadmap for the 21st Century.

Paul implemented the Horizon's Scholarship Program providing funding for deserving high school students. He also created a pool tournament to fund the scholarships. Paul also worked tirelessly as volunteer coordinator for the 1999 National Congress when it was in Denver, devoting countless hours to the task.

Paul is the second District employee to receive this award. Scott Tucker was the 1999 recipient.

Intern wins scholarship

Jennifer Lien, student intern in the Maintenance Program, won an APWA Jim Murray Scholarship this year. Jennifer is a senior Civil Engineering student at Colorado School of Mines.

District Wins Accounting Award

For the thirteenth year in a row the District has received a "Certificate of Achievement for Excellence in Financial Reporting" from the Government Finance Officers Association of the United States and Canada. The certificate is presented to government units whose comprehensive annual financial reports achieve the highest standards in government accounting and financial reporting. Congratulations to Frank Dobbins, Chief of Finance and Accounting, for continuing this string of awards.

2001 Professional Activities of District Staff

Scott Tucker, Executive Director

- *Lecturer, Department of Earth and Atmospheric Science, Metropolitan State College, Denver, in April.
- *Speaker on Overview of Site-specific Streamgaging Activities in Colorado, Colorado Streamgaging Symposium, Breckenridge, CO, in May.
- *Session Chair, Session on Zero and Deminimus Impact Policy Issues, Engineering Foundation Conference on Linking Stormwater BMP Designs and Performance to Receiving Water Impacts Mitigation, Snowmass, CO, in August.
- *Chaired Workshop session at National Association of Flood and Stormwater Management Agencies (NAFSMA) annual conference, in Charlotte, NC, in November.
- *Participant in Stormwater Managers Roundtable Meeting, Johnson County Kansas Stormwater Management Program, Overland Park, KS, in November.
- *Member of Board of Directors and Co-Chairman of the Stormwater Management Committee of NAFSMA.
- *Member of Board of Directors, Chairman of Future Programs Committee, member of Executive Committee of the Metro Wastewater Reclamation District.
- *Member of American Public Works Association, American Society of Civil Engineers, and Water and Environment Federation.

Bill DeGroot, Chief, Floodplain Management Program

- *Chair of the Floodplain Management Committee of the National Association of Flood and Stormwater Management Agencies (NAFSMA), and chaired a session on Floodplain Management Issues at NAFSMA's annual meeting in Charlotte in Nov.
- *Co-authored, with David Lloyd, Bryan Kohlenberg, and Mark Hunter, "Mitigating Stream Erosion in the Denver Metropolitan Area."
- *Presented a slide show on the District's 2001 flood experience at the Colorado Association of Stormwater and Floodplain Managers (CASFM) annual conference in Steamboat Springs in Sept.

Kevin Stewart, Information Systems Manager, Floodplain Management Program

- *Chair of National Hydrologic Warning Council (NHWC), representing Southwestern Association of ALERT Systems
- *Member of Advisory Committee on Water Information (ACWI), Subcommittee on Hydrology, Washington DC.
- *Co-author with James C. Y. Guo and Ben Urbonas of publication entitled: *Rain Catch under Wind and Vegetal Cover Effects*, ASCE Journal of Hydrologic Engineering, Vol. 6, No. 1, January/February, 2001.
- *Attended Interstate Council of Water Policy (ICWP) Washington Roundtable & USGS Streamgaging Workshop in Washington DC in February.
- *Member of NWS Service Assessment Team responsible for evaluating National Weather Service performance during *Tropical Storm Allison Heavy Rains and Floods, Texas and Louisiana, June 2001*.
- *Attended Colorado Governor's Conference on Emergency Management and annual CEMA meeting in Breckenridge in August.
- *Guest speaker at Environmental Hazards Class, University of Colorado at Denver in November.

Ben Urbonas, Chief, Master Planning & South Platte River Programs

- *Continues as a principal co-investigator (Eric Strecker & Jonathan Jones principal co-investigators) for an EPA funded ASCE effort to develop Nationwide BMP Evaluation Data Management software and to accumulate and evaluate BMP data for performance and their relationships to design parameters.
- *Co-authored with Eric Strecker, Marcus Quigley, Jonathan Jones and Jane Clary, "Determining Urban Storm Water BMP Effectiveness," in the, May/June Issue of ASCE's *Journal of Water Resources Planning and Management*.
- *Co-authored with Jane Clary, Jonathan Jones, Eric Strecker, Marcus Quigley and John O'Brian, "Developing, evaluating and maintaining a standardized stormwater BMP effectiveness database," on the EPA-sponsored ASCE-BMP database project for the Novatech 2001 conference in Lyon, France.
- *Co-authored, with John Doerfer, and presented "Testing of an Underground Stormwater Treatment Vault in Denver, Colorado, USA," at Novatech 2001 in Lyon, France.
- *Authored a paper, "Protecting Our Receiving Waters With BMPs," in the *Water Resources IMPACTS*, Published by AWRA, November Issue.
- *Presented at a "BMP Effectiveness Seminar" at NAFSMA conference in Charlotte, NC in November.
- *Organized, served as chairman and edited proceedings of a United Engineering Foundation conference on *Linking Stormwater BMP Designs and Performance to Receiving Water Impact Mitigation*, held in Snowmass, Colorado, August 19-24, 2001.
- *Appointed by Governor Bill Owens to a two-year term on the Board of Directors of the Cherry Creek Basin Water Quality Authority.
- *Appointed by the Water Resources Research Foundation Board of Directors to the inaugural Stormwater Technical Advisory Committee.

Dave Lloyd, Chief, Design and Construction Program

- *Co-authored, with Bryan Kohlenberg, Bill DeGroot, and Mark Hunter, and presented "Mitigating Stream Erosion in the Denver Metropolitan Area" at the Engineering Foundation conference in Snowmass in August.

Cindy Thrush, Project Engineer, Maintenance Program

- *Vice-Chair of the Board of Directors for the Colorado Association of Stormwater and Floodplain Managers (CASFM).
- *Editor of the CASFM newsletter.

Ken A. MacKenzie, Project Engineer, Design and Construction Program

- *Presenter at the 12th annual conference of the Colorado Association of Stormwater and Floodplain Managers (CASFM).
- *Presenter at *Urban Storm Drainage Criteria Manual Volumes 1 and 2* Update Seminar.
- *Developed spreadsheet-based design aid software with Dr. James C.Y. Guo, department of Civil Engineering, University of Colorado at Denver, and Wright Water Engineers.
- *Developed AutoCAD™ details for the *Urban Storm Drainage Criteria Manual Volumes 1 and 2*.

Bryan Kohlenberg, Project Engineer, South Platte River Program

- *Co-authored, with David Lloyd, Bill DeGroot, and Mark Hunter, “Mitigating Stream Erosion in the Denver Metropolitan Area.”
- *Continued as NSPE’s scoring coordinator for the Jefferson Chapter and Colorado State MATHCOUNTS competitions for 7th and 8th graders.

Paul Hindman, Project Engineer, Design and Construction Program

- *Member of site selection committee for APWA’s 2008 Congress and Exposition.

John Doerfer, Project Hydrologist, Master Planning Program

- *Chairman of Awards Committee, Colorado Association of Stormwater and Floodplain Managers, 2001 Annual Conference.
- *Chairman of Municipal Workgroup, Colorado Stormwater Task Force.
- *Speaker on construction-site sediment control measures and enforcement procedures at International Erosion Control Association Mini-Conference, June 5-6, in Denver.
- *Co-authored paper with Ben Urbonas, “Testing of an Underground Stormwater Treatment Vault in Denver, Colorado, USA,” NOVATECH 2001 conference, June 25-27, in Lyon, France.
- *Co-authored article with Matt Gavin, Wright Water Engineers, “Retrofit of an Extended Detention Basin in Denver, Colorado,” Water Resources IMPACT, Journal of American Water Resources Association, Vol. 3, No. 6, November.

Mark Hunter, Chief, Maintenance Program

- *Committee member for the IECA-Mountain States Chapter.
- *Member of IECA Technical Review Committee and Awards Committee.
- *Co-authored, with David Lloyd, Bill DeGroot, and Bryan Kohlenberg, “Mitigating Stream Erosion in the Denver Metropolitan Area.”

David Bennetts, Project Engineer, Maintenance Program

- *Guided a field trip on riparian zone plant species, with Deb Kemmerer at the 12th Annual CASFM Conference in Steamboat Springs in September.

Maintenance (from page 9)

control, but by the time Tributary M reaches Huron Street the erosion is severe with 12 to 15 foot tall vertical banks and a headcut undermining the Huron Street culvert. Our project will include five drop structures and extensive bank reshaping.

One of this year's projects includes the elimination of an 18-inch diameter trickle flow/underdrain pipe. The **East Toll Gate Tributary** in Aurora has several grouted rock drop structures with deep stilling basins that drain into the 18-inch trickle flow pipe. The pipe is damaged or plugged in several areas. The drops are deteriorated and have become a safety problem because of the deep stilling basins. Rebuilding the drop structures and regrading the channel will allow all runoff to flow on the surface through the improved corridor. Aurora plans to upgrade the site to an irrigated bluegrass park.

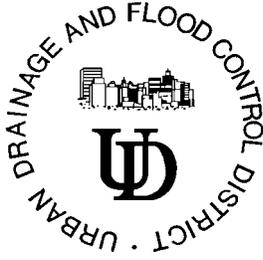
The City of Denver also had a channel with a troublesome underdrain pipe. **Harvard Gulch** flows through DeBoer Park in south Denver. The underdrain was connected to multiple surface inlets with the intent of keeping the area dry during low flow periods. The thin slope-paved concrete of the trickle channel through the park had become displaced and broken-up to the extent that the trickle flows went under or around the inlets and never made it to the underdrain pipe. With the coordination of Denver Parks the five-foot wide concrete trickle channel was replaced with a boulder-edged low flow channel that varies from 10 to 15 feet wide.

With the acquisition, by Foothills Park District, of a parcel of land west of Wadsworth Boulevard a final link was made in the **Lilley Gulch** corridor in Jefferson County. The additional public land allowed us to incorporate a re-aligned trail, streambank protection, and several

areas of wetlands. Four drop structures will also be built to control the grade through this new open space park.



DeBoer Park low flow channel before and after.



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