VIRTUAL BUFFALO CREEK: A TOOL TO EDUCATE CITIZENS AND STUDENTS ON ISSUES IN A WATERSHED WITH SYMPTOMS OF URBAN STREAM SYNDROME IN NORTHEASTERN ILLINOIS

BY

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SPECIAL PROJECT

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ABSTRACT

Around the world, urban streams share a set of symptoms which include “flashier hydrograph, elevated concentrations of nutrients and contaminants, altered channel morphology and stability, and reduced biotic richness, with increased dominance of tolerant species” (Walsh et al. 2005). Urban stream syndrome is characterized by symptoms that are consistent across a number of categories – hydrology, water chemistry, stream channel characteristics, aquatic habitats, plant and animal life and ecosystem processes.

The causes of urban stream syndrome are complex but are ultimately related to impacts from human population growth. It is therefore up to humans to mitigate the causes or conditions they have created in order to reduce flooding and erosion, improve water quality and restore environmental health at the watershed level.

Broad understanding and multiple strategies are required to address these conditions. According to the Committee on Reducing Stormwater Discharge Contributions to Water Pollution of the National Research Council, urban stream syndrome “reflects a multitude of effects caused by altered hydrology in urban streams, altered habitat, and polluted runoff. Focusing on only one of these factors is not an effective management strategy.”

Urban stream syndrome is also an apt diagnosis of the health of the Buffalo Creek ecosystem. This tributary to the Des Plainer River drains approximately 27 square miles and is inhabited by nearly 80,000 residents in the northwest suburbs of Chicago. It flows through two counties and nine municipalities before it discharges into the Des Plaines River near Wheeling, Illinois.

Through the lens of urban stream syndrome, it becomes apparent how the issues that affect local watersheds in the Chicago suburbs also impact heavily-populated watersheds globally. Because the stream flows across political boundaries, there is no one governmental unit responsible for the full range of issues – flooding, erosion and sedimentation, and habitat degradation across the watershed. The Buffalo Creek Clean Water Partnership (Partnership) was formed in 2012 by concerned citizens to understand and address these issues, bridge jurisdictional lines and increase citizen awareness and engagement. Because of the commonality of these issues, it is possible to look to other groups in other watersheds for success stories and lessons learned.

The Virtual Buffalo Creek website is a vehicle to promote watershed education and outreach. The centerpiece of Virtual Buffalo Creek is the six modules intended to engage and inform visitors about the local impacts and potential remedies for urban stream syndrome.

ACKNOWLEDGMENTS

I would especially like to thank UIUC faculty and staff. Professor Robert Hudson provided the spark and generous support throughout this project. He first proposed the virtual watershed project and enlisted the involvement of Jim Knoblauch and his team at ACES Information Technology and Communication Services for filming, voiceovers and editing the Virtual Buffalo Creek videos. Renee Gracon provided encouragement and comments on project documents. Professor Timothy Ellsworth provided encouragement in the early days, and Professors Jeffrey Dawson and Bethany Cutts provided valuable feedback and suggestions. Their input is greatly appreciated.

Tom Murphy, professor emeritus of Environmental Chemistry at DePaul University, has been an invaluable collaborator and mentor. Tom agreed to serve on the Buffalo Creek Clean Water Partnership's technical committee and became a regular commuter to Buffalo Creek to monitor stream flows and paddle as bow man on frequent lake monitoring expeditions. He downloaded historical data, developed flow diagrams, rounded up instruments and supplies, and collaborated patiently in preparing and reviewing many versions of the Water Quality Report and other project documents.

Marcy Knysz was the first member of the Buffalo Creek Clean Water Partnership and has served as watershed coordinator, meeting organizer and tireless collaborator. She is a wildlife biologist and consultant at Cardno JF New. Without her, our watershed partnership would have never gotten its feet wet.

Matt Pomilia was webmaster for our Partnership until the call of the wild lured him to Africa and South America. His many contributions are appreciated.

My wife Martha Weiss has been a constant source of support. She became a RiverWatch citizen-scientist and Partnership secretary, keeping minutes and proofreading my writing.

Chris Harbourt of Waterborne Environmental, Inc. and Jim Montgomery of DePaul University provided instruments and supplies that equipped the Pollutant Monitoring Program.

It has been my pleasure to meet and partner with many professionals at agencies who are working on the issues of stormwater runoff, water pollution and degraded habitats. They include Patty Werner and Jeff Laramy from Lake County Stormwater Management Commission, Kathy Paap and Mike Adam from the Lake County Health Department, John Nelson and Debbie Antlitz from the Lake and Cook County Forest Preserves, Joe Kratzer from the Metropolitan Water Reclamation District of Greater Chicago, Dawn Johnson and Holly Hudson from the Chicago Metropolitan Agency for Planning, Linda Masters from Openlands, Inc. and Jennifer Clarke from the Illinois EPA. Citizen-scientists Debi Moritz and Mark Steuer from the Buffalo Grove Environmental Action Team are some of the Partnership's most reliable volunteers. To them and all the other agency staff and citizens who have contributed to the early success of the Buffalo Creek Clean Water Partnership and this project, I am extremely grateful.

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BACKGROUND

My interest in the following issues motivated me to mobilize residents of the Buffalo Creek watershed:

- Clean water. Buffalo Creek and its three largest impoundments, Lake Albert and the two stormwater storage basins at Buffalo Creek Forest Preserve, are impaired for their intended beneficial uses by excessive nutrients, chlorides, fecal coliform, total suspended solids and low dissolved oxygen, all caused or exacerbated by urban development. (Illinois Environmental Protection Agency 2013)
- Degraded habitats and loss of environmental services. My second professional career involves conducting habitat restoration work across the Chicago region, while my volunteer stewardship and watershed activities are focused on sites close to home and building volunteer groups to care for them.
- Community awareness and environmental action. Human health and enjoyment of life depend upon environmental services, such as clean water, and diverse ecosystems. Many people are simply not aware of our human impacts, their consequences, or what can be done to reduce them. Mobilizing our watershed was a logical extension for the Buffalo Grove Environmental Action Team, which I started in 2009.

An early course that I took in the Natural Resources and Environmental Sciences program was Watershed Hydrology in fall, 2011. For my class project, I researched my local watershed, Buffalo Creek, and developed a plan to form a watershed group. Immediately afterward, I set out to meet with water professionals across Illinois. They were invariably generous with the time they were willing to spend with a newcomer to their field. They encouraged my ambition to organize a new watershed group. When Marcy Knysz joined as watershed coordinator, we launched the Buffalo Creek Clean Water Partnership (Partnership).

In the two years since, we have:

- Formed partnerships with numerous agencies, including the Lake and Cook County stormwater management agencies – Lake County Stormwater Management

Commission (SMC) and the Metropolitan Water Reclamation District of Greater Chicago (MWRD) – Illinois Environmental Protection Agency (IEPA), Lake County Health Department (LCHD), Chicago Metropolitan Agency for Planning (CMAP), the Forest Preserve Districts of Cook (FPDCC) and Lake (LCFPD) County, nine municipalities and four park districts,

- Conducted six public stakeholder meetings and formed a technical committee to assess and address issues at the watershed level,
- Applied for and been awarded grants totaling $114,000:
    - A watershed Assistance Grant for $10,000 from SMC to implement a two year Coordinated Pollutant Monitoring Program (PMP) across the watershed, and
    - A Clean Water Act Section 319 grant for $104,000 to develop a watershed-based plan, which is due to be finalized in 2015,
- Implemented a Pollutant Monitoring Program (PMP) with assistance from LCHD and financial participation by eight communities with Multiple Separate Storm Sewer Systems (MS4s), National Pollutant Discharge Elimination System (NPDES) permits and significant land areas in the watershed,
- Prepared, published and presented a Water Quality Report based on the PMP to the MS4's and other stakeholders,
- Established a website www.buffalocreekcleanwater.org which provides news and information to members, partners and other watershed organizers,
- Sponsored and led volunteer activities, including:
    - RiverWatch stream monitoring (macro-invertebrates) and a fish survey in restored wetlands at Deer Grove East Forest Preserve,
    - Habitat stewardship workdays at various sites, including the wetland mitigation project at Deer Grove East Forest Preserve and stream cleanup at Rylko Park in Buffalo Grove,
    - Illinois Volunteer Lake Monitoring Program (VLMP),
    - Assessments of stream reaches, using the Urban Stream Assessment protocols and forms published by the Center for Watershed Protection, and

- Participated with the Illinois EPA to finalize a Total Maximum Daily Load and implementation plan for the Upper Des Plaines River watershed, which includes Buffalo Creek.

NRES coursework has continued to stimulate my interest and inspire me to dig deeper into these issues. The idea for the Virtual Buffalo Creek website came out of a meeting hosted by Professor Robert Hudson in May 2013. At the time, I was a student in his Watersheds and Water Quality class. Attendees at that meeting included NRES faculty, Illinois State Water Survey staff and ACES Information Technology and Communication Services staff. The goal was to develop interactive learning resources for NRES students. At the meeting, I agreed to develop materials for a suburban stream, Buffalo Creek, which could be used by NRES students as well as for outreach and education by the Partnership. From that meeting sprang Virtual Buffalo Creek.

INTRODUCTION

Virtual Buffalo Creek is primarily a vehicle to promote watershed outreach and education. The six video modules that form the centerpiece of Virtual Buffalo Creek are intended to engage and inform visitors about the issues of urban stream syndrome, which are described in the Discussion section of this paper. The videos are issue-based and focus on local conditions and methods that are used by volunteers and professionals to assess or address them. The overall goals of the Virtual Buffalo Creek site are to:

- Present material containing relevant explanatory information and links to more detailed information located in high quality websites,
- Be visually immersive, i.e., illustrated with video, still photographs and graphics,
- Use GIS tools to create or link to informative maps of stream conditions and areas where “best management practices” may potentially be utilized to manage or mitigate issues such as flooding, erosion, sedimentation, pollution or habitat degradation,
- Present spatially-referenced information from each module via links to an interactive map of the Buffalo Creek watershed, and
- Provide a means for citizens to share photos and thoughts relevant to the health of the watershed and its beneficial uses.

METHODS

Virtual Buffalo Creek is an outreach and training tool for the Buffalo Creek Clean Water Partnership and an educational resource that has already been used in NRES 403, Watersheds and Water Quality. When researching methods for implementing an interactive website, the capabilities of Google Sites and ArcGIS.com were explored based on their strong support for spatial imagery. In investigating the capabilities of those environments, it became apparent that some of the original functionality planned for Virtual Buffalo Creek would require custom development, which exceeded the resources available. Instead, the site was developed on a page within the Partnership's existing website, www.buffalocreekcleanwater.org. This approach allowed the use of available capabilities of Wix.com tools and capabilities and enabled Virtual Buffalo Creek to leverage the Partnership's existing look and feel and content. In the future, the entire site will be redeveloped in the Google Sites environment as additional capabilities and resources become available.

The subjects for the videos were originally discussed and agreed upon with Professor Hudson. Jim Knoblauch from ACES Information Technology and Communication Services provided resources for video recording and support to edit video footage and record voiceovers. I recommended the events and scenes to be filmed, wrote the scripts, provided graphics and additional video footage and integrated them into the Virtual Buffalo Creek page of the Partnership's website.

The videos were recorded at times designed to capture live watershed events:

- RiverWatch monitoring session on June 8, 2013,
- USGS stream gage monitoring on November 7, 2013,
- Native seed sowing at Deer Grove East Forest Preserve on December 27, 2013, and
- A habitat workday at Deer Grove East Forest Preserve on January 12, 2014

These live action video sessions were supplemented with other material such as interviews, video at other sites and a re-enactment of a grab sample collection session. I supplied other materials, including news and other video used with permission of the owners, photos from

watershed meetings, maps from Google Earth and other sources and images taken from presentations at Partnership meetings.

First and final cut videos were produced by Jim Knoblauch, with voiceovers recorded by Martin Booth Hodges on the ACES staff, based on the scripts that I wrote. "First cut" videos were reviewed and revised based on input by Professor Hudson and various Buffalo Creek stakeholders. I uploaded the final videos to YouTube, installed "issue buttons" on the watershed map, and created links from them to the YouTube videos.

Links were created to other sites, including the geo-databases that are being created by SMC to document the stream and basin inventories that they conducted in 2013. These maps, photos and data are accessible to the public, and will be used to target and prioritize future Best Management Practices (BMPs) in our watershed plan.

Other linked documents include:

- The Des Plaines River/Higgins Creek TMDL, which includes Buffalo Creek,
- Buffalo Creek Pollutant Monitoring Program and 2013 Water Quality report,
- USEPA sites on various topics, such as Green Infrastructure, Social Indicators and the Watershed Academy,
- The LCHD Buffalo Creek Reservoir study, and
- Village of Buffalo Grove flood mitigation plan documents.

Future enhancements will be undertaken in order to enrich the site and increase the interactivity with visitors. Planned enhancements include:

- Links to social media sites, especially Facebook and Twitter, to increase visits to the site, and provide the ability for visitors to interact, add photos and comments,
- Creation of a Quick Response (QR) code and signage to be installed at forest preserve and park sites where we are working, in order to promote visits to Virtual Buffalo Creek and publicize our work to visitors at these locations, and
- Opinion and attitude surveys based on the USEPA's social indicators process and tools (USEPA 2013).

DISCUSSION

This section contains a discussion of each of the videos, the underlying goals and science and preliminary ideas for future work to address the issue.

Module 1 - welcome video

One of the requirements of the Section 319 watershed-planning grant is to develop and implement a Public Education and Outreach Plan. When Professor Hudson described his idea for a Virtual Watershed, it became clear that producing a Virtual Buffalo Creek website could be an effective tool to educate the public and help build support for our plan.

The goal of this module is to engage visitors, introduce them to some of the issues of urban stream syndrome and make them feel comfortable navigating the site. It is hoped that the Partnership's vision statement will resonate with visitors to the website and that they will spend time and learn about the issues presented.

However, the EPA's Guidance for Developing Watershed Action Plans states "simply informing and educating the public on the issues is not always enough to produce the behavioral changes necessary for plan implementation." IEPA (2008).

Virtual Buffalo Creek is one component of the Partnership's proposed Outreach and Education Plan. In order to assess current awareness and attitudes and track changes in behavior over time, researchers sponsored by the USEPA have developed a process and tools for assessing and changing these social behaviors (Great Lakes Regional Water Program 2013). As is stated in Social Indicators website "without insight into the awareness, attitudes, constraints, capacity and behaviors of stakeholders involved with water projects, it can be difficult for water resources managers to make informed decisions and implement effective practices that ultimately lead to water quality improvement and protection." (USEPA 2013). As planning proceeds, the Partnership will utilize the social indicators process and tools to measure the current attitudes and awareness of watershed stakeholders and changes over time. In the future, Virtual Buffalo Creek can link visitors to questionnaires in order to collect survey data.

Module 2 - impervious surfaces video

The purpose of the video is to introduce the idea that population growth has led to increased stream flows and related problems – collectively described as urban stream syndrome. USGS technician Shawn Cutshaw is the human subject of this video, and the voiceover describes his work in monitoring the stream gage on Buffalo Creek.

Walsh et al. (2005) described a set of symptoms, which include "flashier hydrograph, elevated concentrations of nutrients and contaminants, altered channel morphology and stability, and reduced biotic richness, with increased dominance of tolerant species." The causes of urban stream syndrome are complex but are ultimately related to impacts from human population growth, especially the increase in impervious surface area.

Buffalo Creek watershed has undergone dramatic change in stream flows since the USGS flow gage became operational and began continuously recording stream flows in 1952. Population, estimated from US Census data and the respective land area of the municipalities within the watershed, has grown from a rural population of 2,000 in 1950 to nearly 80,000 in 2010 (Weiss et al. 2014). Land use changes associated with population growth and urbanization includes the following:

- Draining and filling wetlands and floodplains, which store and slowly release stormwater and increase infiltration into ground water,
- Increasing the amount of impervious surfaces from roads, roofs, driveways, and parking lots, which reduces infiltration of stormwater and snow melt into the ground, and
- Construction of stormwater infrastructure, which channels stormwater water from homes and roads, into sewers where it is conveyed very quickly into streams and rivers.

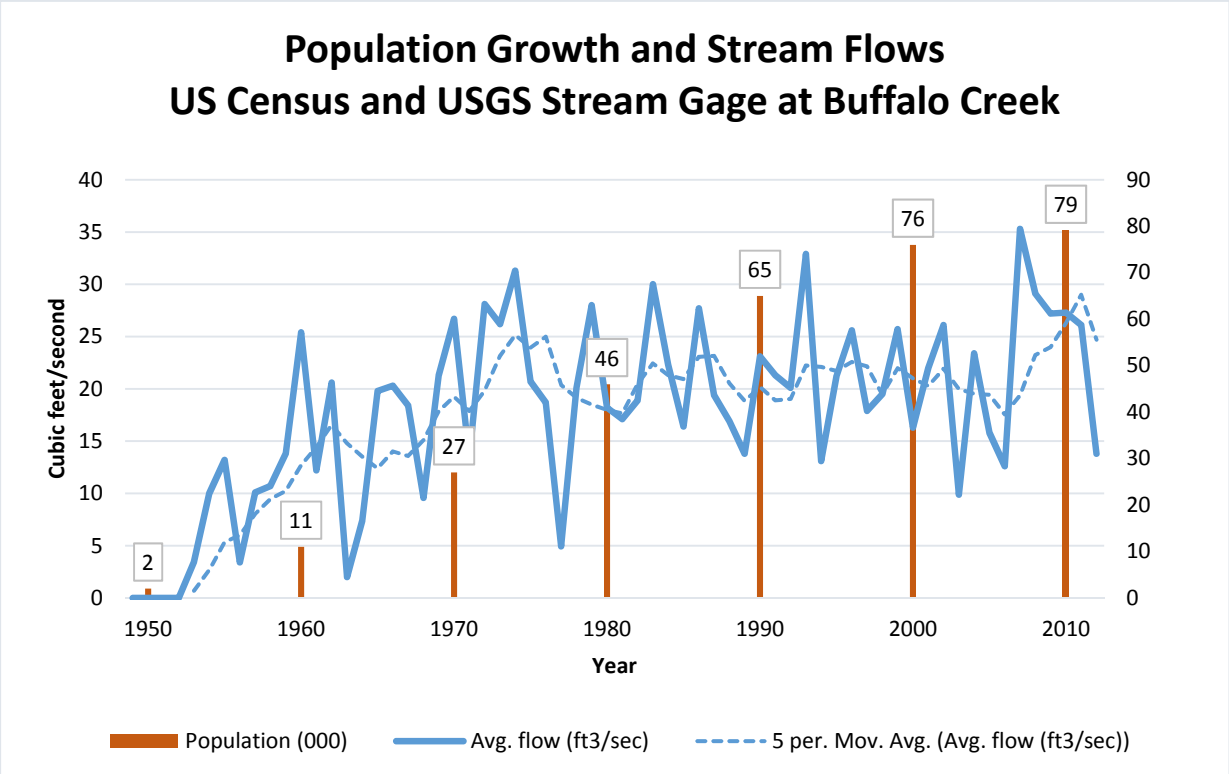
According to the hydrology and hydraulics study performed by the IDNR in 2008, impervious surfaces average 25% in the watershed, with a range from 3% in the forest preserves to 45% in densely developed sub-basins.

Table 1 presents the population growth and mean annual stream flow values from the USGS stream gage at Buffalo Creek since 1950.

Table 1: Population Growth and Stream Flows in the Buffalo Creek Watershed				
Period	**Mean stream flow (cubic ft./sec)**	**Change (from 1953-62)**	**Population (000)**	**Change (from 1960)**
1953-62	12.3	-	11	-
1963-72	16.7	36%	27	145%
1973-82	20.4	166%	46	318%
1983-92	21.1	172%	65	491%
1993-2002	22.0	179%	76	591%
2003-2012	22.0	179%	79	618%

Since we do not have historical data for the increase in impervious surfaces, we use population growth as the indicator for increase in stream flows. Annual mean stream flow is a useful indicator, which encompasses both the peak flows from storm events and routine flows from more frequent rain events, snow melt and groundwater sources. Figure 2 shows the annual mean stream flows from 1953 to 2012, with a five-year moving average trend line, which shows the increasing trend.

Figure 1



1953-2013 population growth and stream flow trends in the Buffalo Creek watershed, with a five-year moving average trend line for stream flow

It should be noted that overall precipitation and frequency of large storm events have increased in Northeastern Illinois during this period. Markus et al. (2004) compared the contributions of urbanization and precipitation separately to increased stream flows from storm events and found that the contribution of urbanization is 29% larger than that of the increase in precipitation. Changnon (1999) and other researchers have reported similar results and concluded that urbanization in northeastern Illinois also has a more dominant effect on flood peaks than the increase in number and frequency of storms. This topic is developed further in the discussion of Module 3 flooding video, which follows. Projects and recommendations to mitigate the effects of impervious surfaces will be included in the Buffalo Creek watershed-based plan.

Module 3 – flooding video

As described in the prior section, the frequency and severity of large flood events is increasing as a result of increased frequency of severe storm events, reduced local stormwater storage capacity in wetlands and floodplains, along with increased flashiness due to impervious surfaces and traditional stormwater infrastructure.

The news footage in the video from the April 2013 flood event, which produced all-time record flood stages on the Des Plaines River and significant flood damage in communities across the Chicago region, dominated the news for several days. Heavy rainfall totaling more than seven inches fell on ground that was already saturated, resulting in a Major Disaster Declaration by the US Federal Emergency Management Agency (FEMA) and more than 60,000 applications totaling nearly $150 million in individual disaster relief across the region (U.S. Army Corps 2013).

The scenes of local flooding of Buffalo Creek from the April event were captured by a commercial videographer, who gave his permission to use the video.

On the morning of June 26, 2013, another rain event dropped more than 5.36 inches of precipitation in Buffalo Grove and 4.92 inches in Lake Zurich (LCHD, personal communication). This storm set an all-time record for flow at the USGS stream gage at Buffalo Creek and caused

further flood damage to a region that was still cleaning up after the April storms. The June 26 event also inundated and damaged an autosampler that the Partnership had installed to capture water samples from just such a "flush" event. Fortunately, we had removed samples just prior to the inundation. The results are included in the discussion of Module 4 Pollution.

The recently released study by USACE (2013) on flooding in the Des Plaines River watershed recounts damage from the April 2013 storm and earlier floods in 1986 and 1987. In addition, the Village of Buffalo Grove experienced severe flood damage in 2007 (Village of Buffalo Grove 2010), which led to the investments in local stormwater infrastructure shown in the video and described by Buffalo Grove Village Engineer, Darren Monico.

Buffalo Creek has been a focus of efforts to reduce regional flooding in the Des Plaines River watershed. During the 1980's, MWRD built the stormwater storage reservoir on Buffalo Creek on land that was transferred to LCFPD. The reservoir provides 720 acre-feet of storage at the 100-year design elevation of 702 feet. A 48"-diameter culvert is the outlet for low flows, while a 140-foot wide concrete auxiliary spillway and a 200-foot wide grass-lined emergency spillway are available for flows above the 100-year design event (IDNR 2008). However, the dam has been overtopped numerous times since it was constructed and twice in 2013 alone, during the April and June storm events. The MWRD and LCFPD recently announced plans to expand reservoir capacity by 170 acre-feet to a total of nearly 900 acre-feet and hosted an open house on January 22, 2014 to present the plan to residents.

Although the Buffalo Creek Reservoir was designed to be a multiple purpose facility, serving as a recreation area as well as stormwater storage for flood control, adverse impacts have been caused by the construction and restoration techniques that were used at the time. These are discussed in Module 6 habitat video.

Flooding is a regional and local issue. On a regional basis, the U.S. Army Corps plan lists projects for the Upper Des Plaines River with annualized flood risk management costs of $5.5 million and ecosystem restoration costs of $14.6 million to achieve estimated annual benefits of $15.2 million in reduced flood damage (U.S. Army Corps 2013).

In the Buffalo Creek watershed, MWRD has projected a cost of $15 million for expansion of the reservoir at Buffalo Creek Forest Preserve (MWRD staff, personal correspondence), after spending more than $30 million on a project at Heritage Park in Wheeling, to be completed in spring 2014 (Kratzer 2012).

The Heritage Park project provides 11 acre-feet of new detention capacity and 140 acre-feet of floodplain storage. This project provides sufficient compensatory stormwater capacity to allow USACE to close a gap in Levy 37 on the Des Plaines River and protect hundreds of homes and businesses in Wheeling and Prospect Heights from frequent episodes of flooding with an annualized cost in excess of $1.7 million (Kratzer 2012). The Heritage Park project will also provide improved in-stream and buffer habitats and infiltration, reduced erosion and sedimentation, and recreational opportunities (Kratzer, personal communication). This is a good example of a stormwater project with multiple benefits.

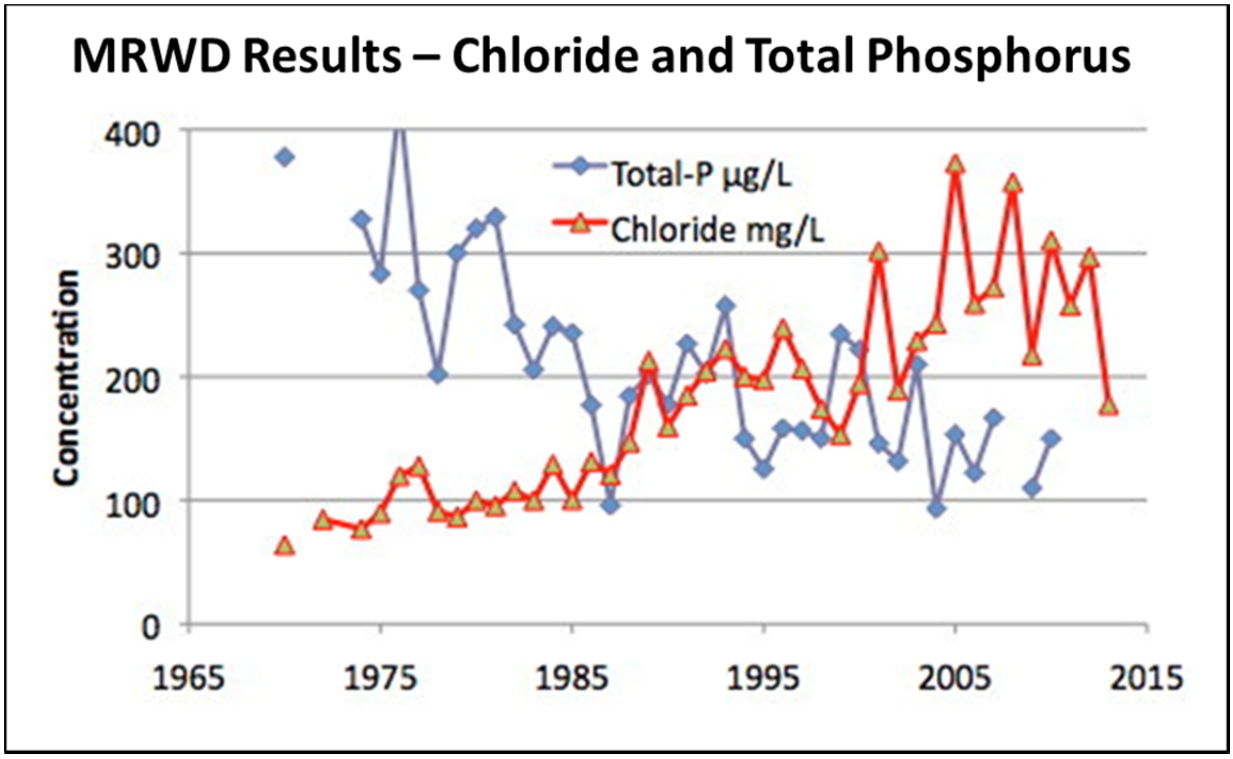
Locally, the Village of Buffalo Grove invested $3 million in projects following the 2007 floods in order to increase storage at Lions Park, improve conveyance, naturalize the White Pine Ditch and expand culverts and other stormwater systems throughout the Village (Village of Buffalo Grove 2010). The results are seen in the video. Other communities in the watershed have taken their own local actions.

Some climate scientists conclude that climate change has already produced more frequent and more severe storm events, and this will likely continue in the future (Easterling et al. 2000). If this occurs, the high cost of regional and local flood planning will provide even higher returns on investment. Alternatively, we may discover that no amount of engineering can protect humans from the consequences of actions that have permanently altered the climate, hydrology and geophysical landscape in our urban watersheds.

Module 4 - pollution video

Buffalo Creek and two of the lakes in the watershed are on the Illinois 303(d) list of impaired waters and were included in a Total Maximum Daily Load study of the Upper Des Plaines River (IEPA 2013). Impairments from excess phosphorus, chloride, fecal coliform, suspended solids, and low dissolved oxygen have been documented since the 1970s by MWRD at their station on Buffalo Creek and by the LCHD in the large lakes in the watershed. Long-term trends were identified by downloading test result data from the MWRD site.

Figure 2



Trends in chloride and phosphorus concentration in Buffalo Creek 1970-2013

Over the past 40 years, phosphorus has been trending downward, a time frame corresponding with the removal of phosphates from most detergents and some lawn fertilizers. In recent years, the Village of Long Grove passed a Village ordinance banning the sale of fertilizers containing phosphorus and most lawn care companies have stopped using phosphorus in lawn care applications.

During the same time period, chloride has trended upward. This is likely the result of increased application of sodium chloride to melt snow and ice on roads, driveways and parking lots as development in the watershed has increased. Based on calculations and extrapolation of data from salt applications by one of the communities in the watershed, the Partnership estimates that between 4,800 and 12,500 tons of chloride is released into the watershed annually, most of which makes its way into Buffalo Creek and downstream waters.

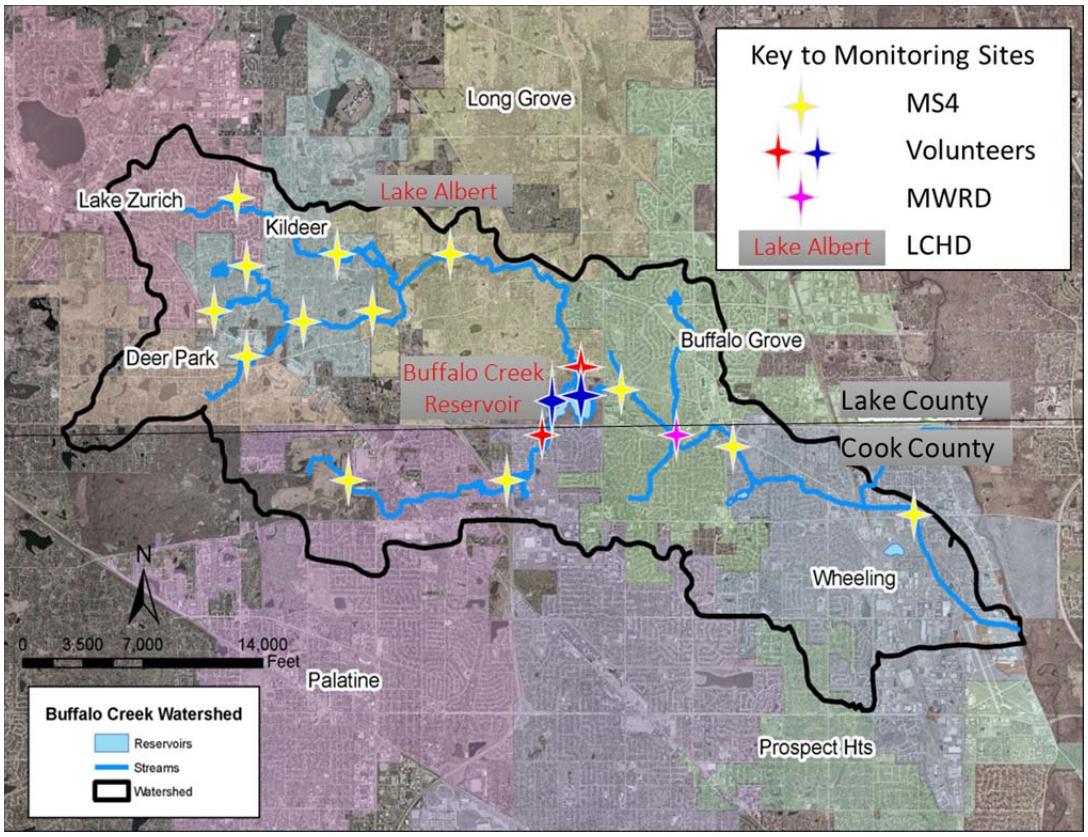
In 2013, the Partnership conducted the first year of a Coordinated Pollutant Monitoring Program (PMP), which was designed by Marcy Knysz and me. We applied for a Watershed Assistance Grant from SMC to fund two volunteer-run stations, secured financial participation by the eight MS4 communities with a large land area in the watershed for thirteen locations, and convinced MWRD to reopen their Buffalo Creek station, which they had closed in 2012. We selected a USEPA-approved testing laboratory, Environmental Monitoring and Technology, Inc. (EMT) to test samples, and selected a fairly broad, consistent panel of test parameters for all locations. We also set up a schedule so that all samples would be collected on the same day of the month across the watershed.

The PMP was designed to enable agencies, stakeholders and communities to identify sources of pollutants and support cleanup initiatives and Best Management Practices (BMPs). Prior to the PMP, infrequent and uncoordinated water quality monitoring efforts had resulted in limited usefulness of water quality data to identify sources or assess trends in water quality.

All 16 sites across the watershed were monitored on May 6 and October 7. In addition, Partnership volunteers collected monthly samples at two of the sites from April through October. All collection of grab samples followed USEPA protocols. During each visit, we measured water temperature, conductivity, dissolved oxygen and *p*H. We also measured stream stage and velocity at multiple points across the stream channel in order to calculate pollutant loadings. Finally, we installed two ISCO Autosamplers and collected a “flush” sample from rising water during the June 26 flood event.

The following map shows the location of monitoring stations:

Figure 3



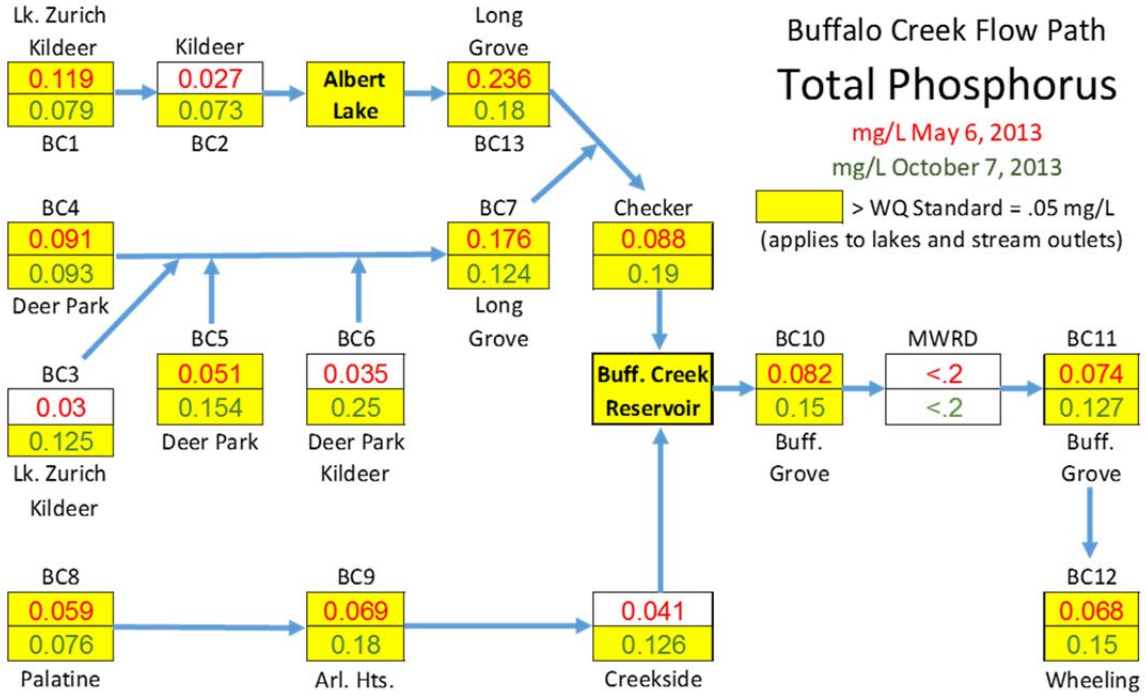
Water quality monitoring sites for the Pollutant Monitoring Program 2013

For the lakes program, Partnership volunteers in the Illinois Voluntary Lake Monitoring Program paddled on the reservoir from April to October to take Secchi disk measurements of water clarity, measure temperature and dissolved oxygen levels as various depths, and collect lake water samples. We filtered a part of each sample for a chlorophyll test, packed the samples in coolers with ice and shipped them to the IEPA lab in Springfield, Illinois. LCHD tested sediment samples from the Buffalo Creek Forest Preserve reservoirs and Lake Albert.

In February 2014, the Partnership published a Water Quality Report to the MS4 communities, stakeholders and partners who had participated in the Pollutant Monitoring Program. For each pollutant, we constructed a flow path diagram, showing the level of a given pollutant in the stream from our grab sampling dates in May and October. We highlighted stations where the applicable Water Quality Standard (WQS) was exceeded. For example, the following figure is

the flow path diagram for phosphorus. Nearly every station showed phosphorus levels in excess of the Illinois 0.05 mg/liter WQS, which applies to lakes and stream discharge points.

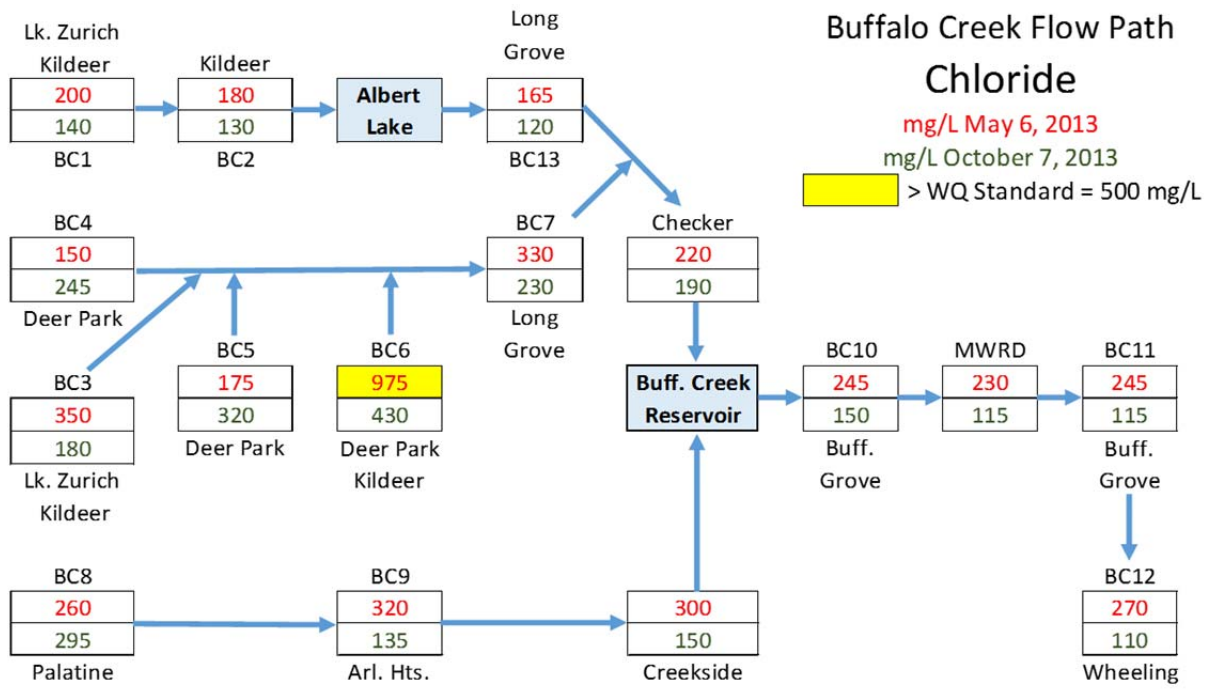
Figure 4



Flow path and concentrations of total phosphorus in samples from Buffalo Creek, 2013

Our chloride flow chart showed only one location in excess of the Illinois WQS for chloride, which is 500 mg/liter. The chloride level at this site was quite high, and we are investigating the area around this "hotspot" to determine whether a salt pile is being left uncovered near a stream.

Figure 5



Flow path and concentrations of chloride in samples from Buffalo Creek, 2013

LCHD did further testing for chloride during a thaw on February 19, 2014, using electrical conductivity as a proxy for chloride. Conductivity levels in excess of 1.8 mS/cm were found in four of five locations tested, which is indicative of chloride levels in excess of the Illinois water quality standard of 500 ml/liter.

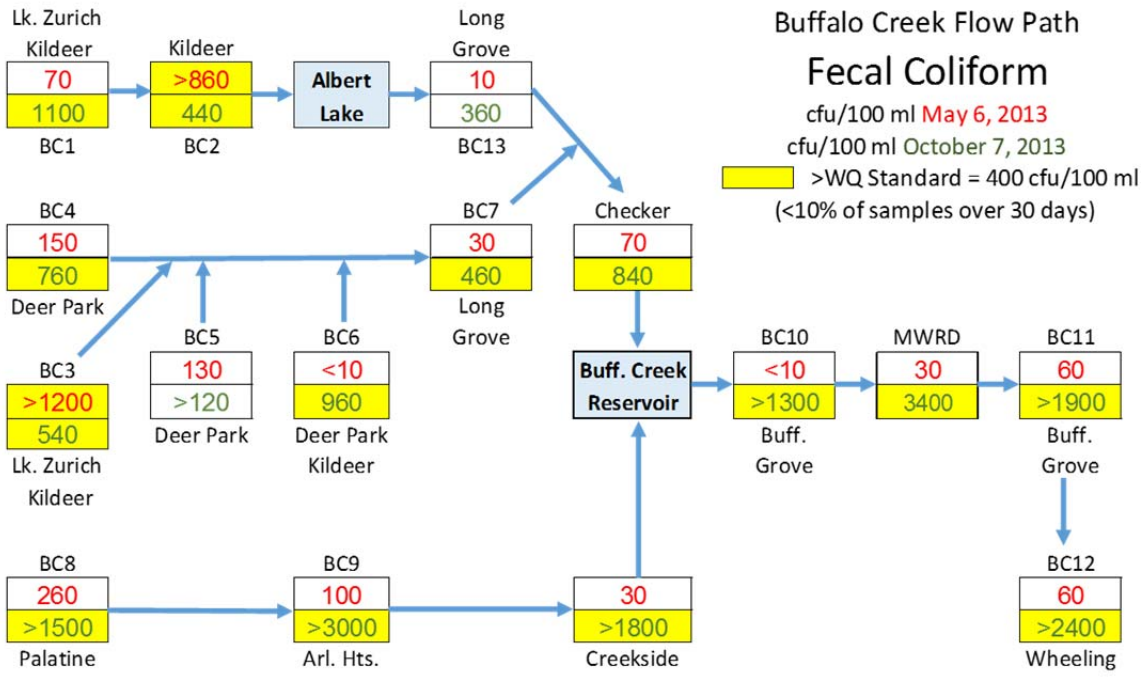
Figure 6

Site	Temp C	Cond (mS/cm)
Checker Road	0.51	2.0
Shaeffer Rd	2.2	1.5
Shaeffer Rd Cook Cnty	0.24	4.8
Shaeffer Rd Cook Cnty	2.7	11.8
Creekside	0.6	4.4

Electrical conductivity levels recorded in Buffalo Creek on February 19, 2014

We also found “hotspots” at BC2 and BC3, with high levels of fecal coliform in both May and October. We referred the results to the LCHD and they are working with the community to address the issue. Note in the flow path chart that we did not follow the full procedure to confirm fecal coliform pollution, which requires 30 days of testing.

Figure 7



Flow path and *E. coli* colony-forming unit counts in samples from Buffalo Creek, 2013

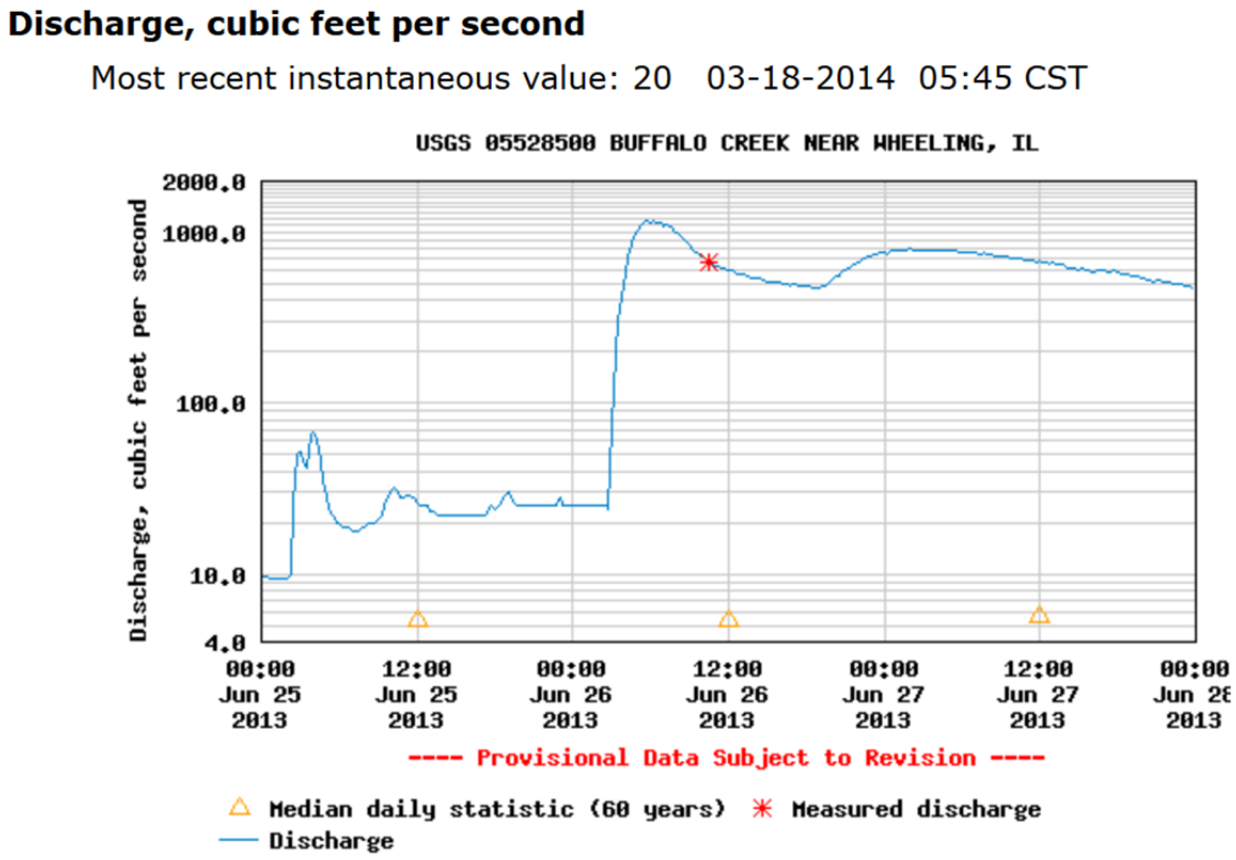
In summary, we found elevated levels of all of the impairments identified in the TMDL and are planning actions with communities to address them. Virtual Buffalo Creek has a link to the full 2013 Water Quality Report.

The Partnership’s ISCO autosamplers were equipped with pressure sensors in order to measure stream flows and trigger collection of water samples in the hours immediately following large storms. The objective was to capture the “flush” of nutrients and other pollutants washing off of roads and other surfaces in the early stages of a severe storm event.

On the morning of June 26, 2013, 5.36 inches of precipitation fell in Buffalo Grove and 4.92 inches in Lake Zurich (LCHD, personal correspondence), which approached the 100-year design

event precipitation of 6.55 inches. This storm set an all-time record for flow at the USGS gage at Buffalo Creek and caused further damage to a region that was hard hit in the April storms. Based on provisional data, instantaneous flow values exceeded 1000 cfs, and a USGS technician recorded a discharge rate on that day of 665 cfs.

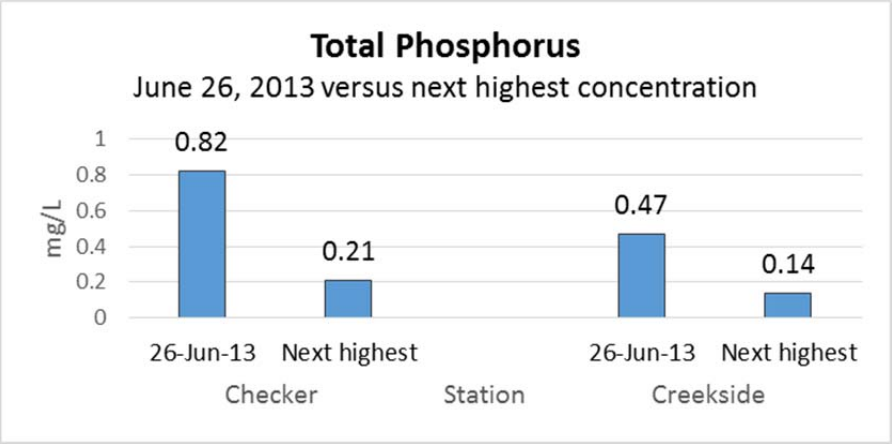
Figure 8



Discharge from Buffalo Creek during storm event of June 26, 2013

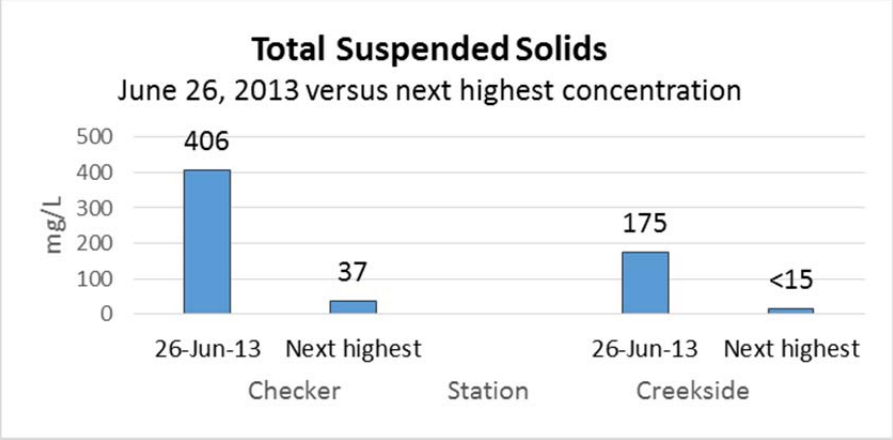
The June 26 event inundated and damaged one of the autosamplers. Fortunately, we had removed samples just prior to the inundation. The samples, collected over a six-hour period during the early hours of the event, yielded the highest concentrations of phosphorus, suspended solids and fecal coliform recorded at Checker Road and Creekside Park all year. By comparing the June 26 sample with the next highest value recorded at each site during the 2013 sampling season, it is clear that storm waters can release and carry large pollutant loads.

Figure 9



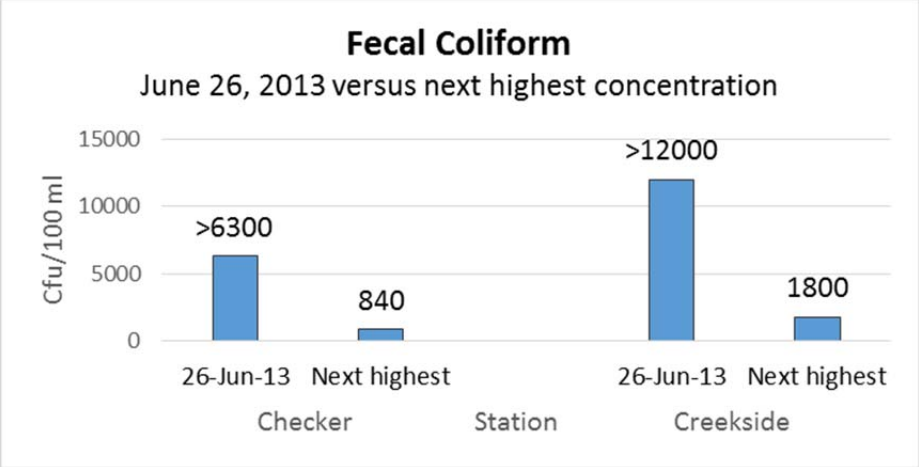
Concentration of total phosphorus from June 26, 2013 versus next highest sample

Figure 10



Concentration of Total Suspended Solids from June 26, 2013 versus next highest sample

Figure 11

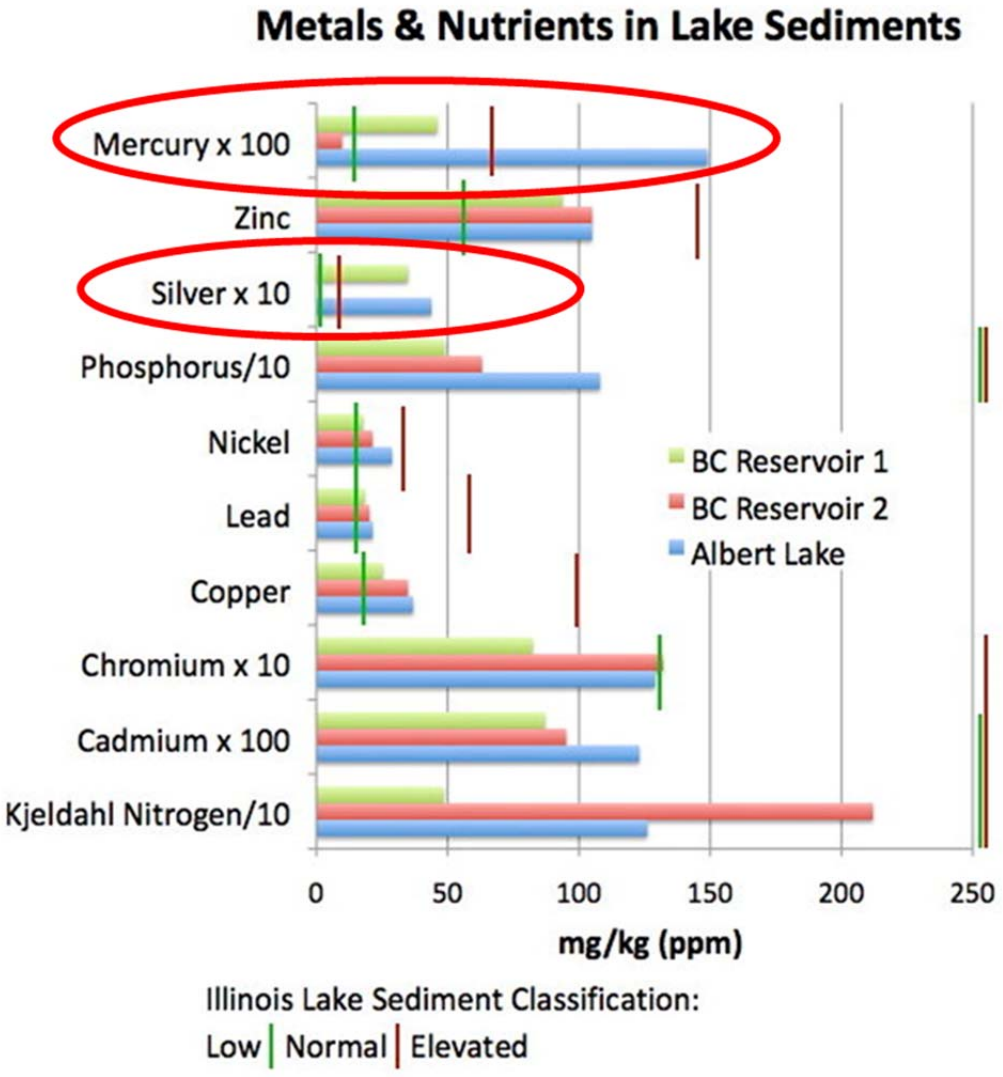


Colony-forming units of *E. coli* from June 26, 2013 versus next highest sample

In addition to causing property damage, severe erosion, and disturbance to aquatic and riparian plant and animal communities, floodwaters add to pollutant loadings in Buffalo Creek.

Pollutants are also contained in sediments deposited in lakes. Levels of metals and organic compounds were tested in the sediments of Lake Albert and the stormwater storage reservoirs at Buffalo Creek Forest Preserve. We plotted the Illinois Lake Sediment Classification levels on the following bar graph.

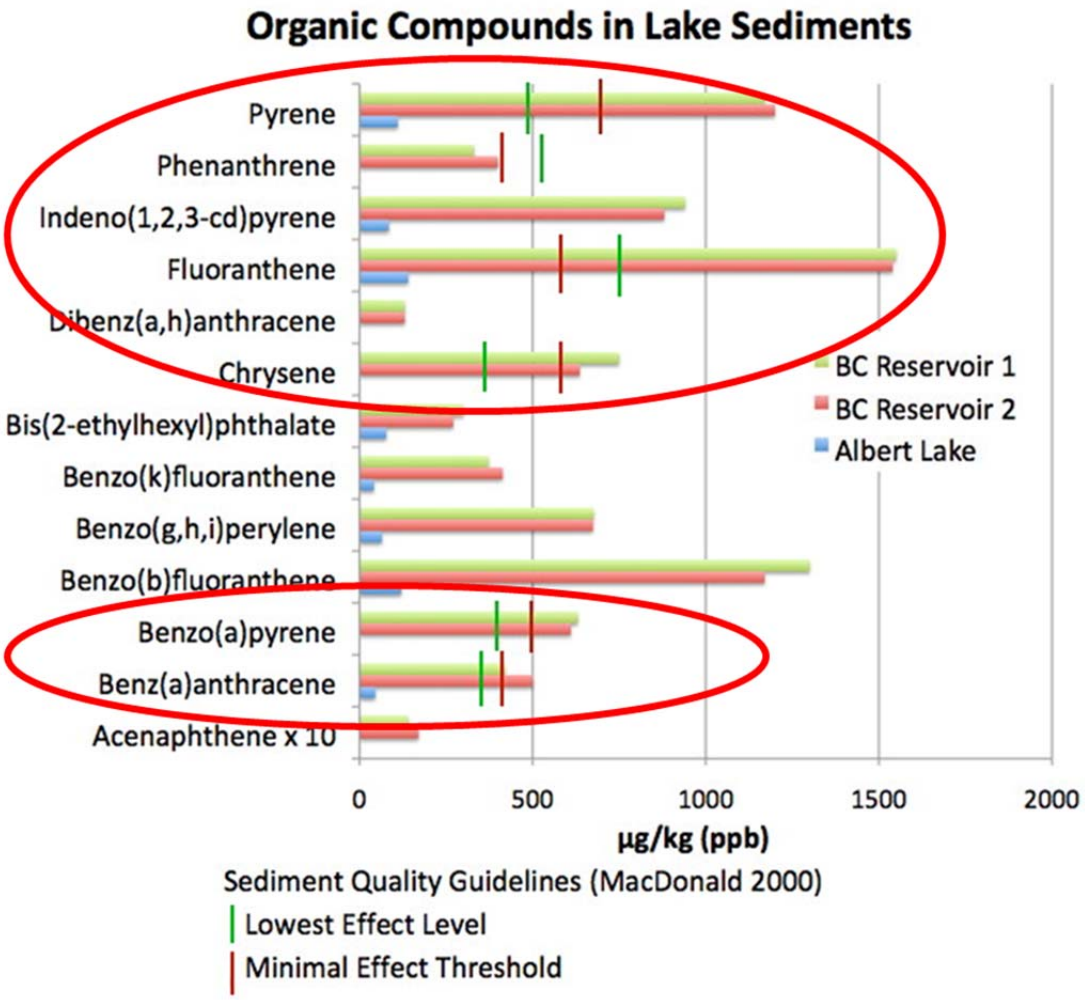
Figure 12



Tests of lake sediments revealed elevated levels of mercury and silver.

LCHD also tested for numerous organic compounds that can be toxic at certain concentrations. Since there is no US or Illinois EPA water quality standard for these compounds, we plotted the lowest and minimal effect levels from a frequently cited article by MacDonald et al. 2000.

Figure 13



Elevated levels of several toxic organic compounds were recorded in the lakes of the Buffalo Creek watershed.

Virtual Buffalo Creek has a link to LCHD report on the Buffalo Creek Reservoir, which includes these results.

Water quality was voted the top priority issue by the Partnership's stakeholders. The Partnership will utilize PMP and LCHD data to target areas for mitigation and to prioritize BMP's in the watershed-based plan for Buffalo Creek.

Module 5 – erosion video

In 2013, interns hired by SMC conducted a study across the Buffalo Creek watershed in order to document stream conditions and hundreds of artificial storage structures, i.e. detention and retention ponds, designed to channel, hold or slow floodwaters. The study inventoried 77 stream reaches totaling 28 miles and 357 water bodies identified as potential detention basins. Data from hundreds of condition reports are being entered into an Excel database and 3700 geo-referenced photographs are tied to a GIS and geo-databases which, when complete, will be accessible to the public.

Summary findings from the study include:

- 33% of stream reaches were ranked moderate or high for channelization,
- 251 debris jams were located and mapped,
- 20% of streambanks were ranked severe or very severe for erosion,
- 63 locations were identified where streambanks were armored,
- 51 "problem" discharge points were identified and mapped,
- 13 "problem" hydraulic structures were identified and mapped,
- Photos, descriptions and recommendations for more than 300 basins, and
- Identification of opportunities for Best Management Practices.

Once this data is incorporated into a geo-database, it will be used to identify and prioritize proposed Best Management Practices for the watershed planning process and beyond. Virtual Buffalo Creek links to the currently available data and photographs.

Around the world, many techniques have been employed to address the problems of erosion and sedimentation in urban streams. Unfortunately, many of them involve engineering approaches that, while solving a local erosion problem, exacerbate other problems of downstream flooding, habitat degradation or pollution. As noted, the SMC study identified 63 locations with armored streambanks on Buffalo Creek. These "hard armoring" techniques use concrete structures or gabion baskets in channelized stream reaches. This approach does not slow the force of water in the stream or support vegetation. In the future, we will consider more natural techniques, especially those using native plantings, to infiltrate rainwater and reduce erosion. However, these techniques are severely constrained when there is not enough area available for streambanks with gradual slopes that will allow the plants to establish and resist the erosive force of streams during high flows.

For erosion along the reservoir shorelines, LCHD recommends consideration of design factors that reduce sediments in the water such as reduced shoreline slopes and aquatic shelves vegetated with native emergent species. The shelves would assist in trapping sediments as storm water moves through the reservoir (LCHD 2014).

Module 6 – habitats video

This module examines initiatives to monitor and improve habitat conditions at forest preserves and natural areas in the watershed that have become degraded. One of the leading causes is changes to natural hydrology.

A key element of the wetland mitigation project at Deer Grove Forest Preserve was to disable agricultural drain tiles at the site, which resulted in restored hydrology, improved wetland function and increased biodiversity of plant and animal species. In 2012, I led a group of NRES students (Goretskie et al. 2012) who conducted a site visit and review of management plans and monitoring documents from Deer Grove East. We concluded that the project was on track to receive the full component of wetland credits. Since then, progress continues to be reported in annual reports prepared for Openlands, Inc., the project manager (Stantec 2014). Annual monitoring includes hydrology, vegetation and wildlife. In 2013, highlights included the following:

- Hydrology. Most of the 43 monitoring wells met the 23-day hydrology standard in 2013,
- Vegetation. The average number of species across all monitored wetlands has more than tripled from 2009 to 2013. In addition, there have been substantial increases in native mean Index of Conservatism (C) and native Floristic Quality Index (FQI) values. When averaged for all wetlands, the native mean C value is 4.0 and the native FQI is 33.3, which indicate high levels of diversity and quality (Swink and Wilhelm 1994).
- Wildlife (bird studies). During the four survey events of the Spring bird survey (totaling 11.98 survey hours), a total of 1,128 birds comprised of 73 species were detected along the line transect, including twelve species identified as Greatest Need of Conservation (SGNC) as determined by the IDNR (Stantec 2014).

The Partnership co-sponsors and leads ecological restoration stewardship and wildlife monitoring at the site with the Friends of Deer Grove East (Friends). We led more than 900 hours of volunteer stewardship in 2013, including an Earth Day event that attracted more than 200 volunteers. From 2011-13, we harvested and cleaned more than 80 species of native plants. We mixed the seeds into nine habitat types and sowed them into the restored wetlands, woodlands, savannas and prairie areas at the Preserve. We documented the species harvested, the amount of pure seed cleaned and the composition of mixes on a spreadsheet, and planned and documented the planting locations on a map application called Restoration Maps. The Partnership will continue to lead volunteer workdays and to assess the progress of ecosystem recovery at Deer Grove Forest Preserve. Virtual Buffalo Creek links to the Friends site and publicizes events at Deer Grove East.

The other large natural area in the watershed is Buffalo Creek Forest Preserve, where major impacts on hydrology were created when the original reservoir basins were constructed. The Partnership completed two years of RiverWatch macro-invertebrate monitoring; two Urban Stream Assessments, based on the protocols and forms developed by the Center for Watershed Protection; and monitored water quality in the reservoir basins and the streams discharging into the reservoir. Lake County Health Department also documented issues at the site and has

communicated them to the landowner, LCFPD, and the project manager for the reservoir expansion project (MWRD). Our findings include the following:

- Stream channels are badly degraded, with a "blowout" where the stream has cut a new channel into the reservoir, causing incised and undercut stream banks, debris jams and litter (Weiss et al. 2012),
- Floodplains and buffers are overgrown with exotic invasive plants (Weiss et al. 2012),
- Basin shorelines are badly eroded (LCHD 2014),
- Buffer areas are dominated by exotic, invasive plants (Weiss et al. 2012),
- Pollutant levels exceed WQS (LCHD 2014, Weiss et al. 2014),
- Sediment levels contain elevated levels of mercury, silver and several toxic organic compounds (LCDH 2014), and
- Aquatic habitats in one of the streams flowing into the reservoir support macro-invertebrate fauna taxa richness and macro-invertebrate biotic values (MBI) that indicate fair to poor water quality (RiverWatch 2013).

Taxa composition and diversity of macro-invertebrate populations can help to assess stream health. Illinois RiverWatch has proved to be an effective means of encouraging citizen involvement in watershed issues. A film crew from UIUC documented the capture phase of a local RiverWatch macro-invertebrate monitoring study. The taxa richness and Macro-invertebrate Biotic Index results for 2012-13 indicate poor water quality at the stream reach we monitored at Buffalo Creek Forest Preserve. In addition, we discovered the exotic invasive species *Dreissena polymorpha* (zebra mussel) for the first time in 2013. Virtual Buffalo Creek links to RiverWatch and shows video of the 2013 monitoring event. In the future, the Partnership will publish RiverWatch results, comparisons between reaches and trends in the data over time.

The proposed expansion of the reservoir at Buffalo Creek Forest Preserve project provides an opportunity to address issues that arose with the original basin construction. The project managers have retained a respected environmental consultant, who will attempt to mitigate these issues and incorporate BMPs as the engineering and construction phases proceed for

basin expansion. The Partnership will actively monitor developments and form a volunteer stewardship group to help maintain the site.

SMC is loading survey data and photographs from the 2013 basin inventory into a geo-database. Once that is completed, it will be used to identify areas where habitats can be improved or new aquatic habitat areas created by converting basins with dry bottoms to wet.

CONCLUSION

Virtual Buffalo Creek will support the Partnership's vision and mission, by helping to engage visitors with scientifically valid but accessible information and influence them to begin to change their social behaviors in order to make Buffalo Creek a better place for all of its residents.

Intended outcomes from this project include:

- Providing targeted audiences with an understanding of stream conditions in urban watersheds, the inter-relationships between various problems, and opportunities to contribute to solutions in their local watershed,
- Increased impact of the watershed-based plan, especially its ability to raise awareness and change social behaviors that will improve conditions in the Buffalo Creek watershed over the long-term, and
- Promotion of events and opportunities for students and members to get involved and improve watershed conditions.

The site will be enhanced over time to increase its value to watershed stakeholders and students. The following planned enhancements will make Virtual Buffalo Creek more effective and interactive:

- Increase connectivity with social media,
- Implement QR codes and signage at sites in the watershed to pull in more visitors at natural areas in the watershed,
- Incorporate the social indicator process and tools, such as attitude and opinion surveys to measure awareness and changes in social behaviors, and
- Migrate the Buffalo Creek website to Google Sites environment.

With the completion of the watershed-based plan, Virtual Buffalo Creek and the sites it is linked to will become a gateway to spatially organized materials and a repository for scientifically valid information used to engage and stakeholders, track social indicators, and identify, plan and prioritize watershed projects.

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APPENDIX – ACRONYMS USED

BCCWP	Buffalo Creek Clean Water Partnership
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
C	Coefficient of Conservatism
DNR	Illinois Department of Natural Resources
DO	Dissolved Oxygen
EMT	Environmental Monitoring and Technology, Inc.
FEMA	United States Federal Emergency Management Agency
FPDCC	Forest Preserve District of Cook County
FQI	Floristic Quality Index
IEPA	Illinois Environmental Protection Agency
LCFPD	Lake County Forest Preserve District
LCHD	Lake County Health Department
MBI	Macro-invertebrate Biotic Index
MS4	Municipal Separate Storm Sewer System
MWRD	Metropolitan Water Reclamation District of Greater Chicago
NPDES	National Pollutant Discharge Elimination System
PMP	Pollutant Monitoring Program
QR	Quick Response code
SMC	Lake County Stormwater Management Commission
SGNC	Species in Greatest Need of Conservation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USEPA	United Stated Environmental Protection Agency
VLMP	Volunteer Lake Monitoring Program
WQS	Water Quality Standard