Burgess & Niple
White Paper #UI2013001

WHITE PAPER

Reducing Wet Weather Flows: A Practical Guide for an Integrated Approach

July 2013

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Introduction

The EPA recently began promoting its "Integrated Program Approach" as an effective way to reduce urban wet weather pollution. The program integrates all wet weather pollution control programs – stormwater MS4, CSO and SSO. Finding the most cost-effective solutions for wet weather pollution, regardless of the source, allows communities to make the most of their limited funds.

Traditional solutions usually involve additions or modifications to large centralized infrastructure. This often is costly. One promising aspect of an integrated program is Source Control – methods of keeping unwanted storm runoff from entering the combined or sanitary sewer system. Integrated solutions can take advantage of the many elements of Source Control that can substantially reduce infrastructure program costs. Source Control solutions have the potential to redirect flows in a way that can minimize harm – flooding or pollution – and at the same time create community enhancements or amenities.

Source Control solutions are not new. For example, SSES and I/I programs have reduced CSO and SSO pollution by tightening collection systems and directing wet weather flows to storm drains or receiving streams. As part of Source Control, Green Infrastructure (GI) solutions are becoming an increasingly common remedy. GI solutions mimic nature by slowing or reducing runoff using infiltration and impoundment techniques.

If done correctly, an integrated program using Source Control methods can potentially save municipalities a substantial amount of money that might otherwise be spent on conveyance and treatment. If done incorrectly, Source Control methods could exacerbate problems.

This article shares the experience that Burgess & Niple (B&N) has gained over the years on a wide variety of related projects

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Introduction *(Continued)*

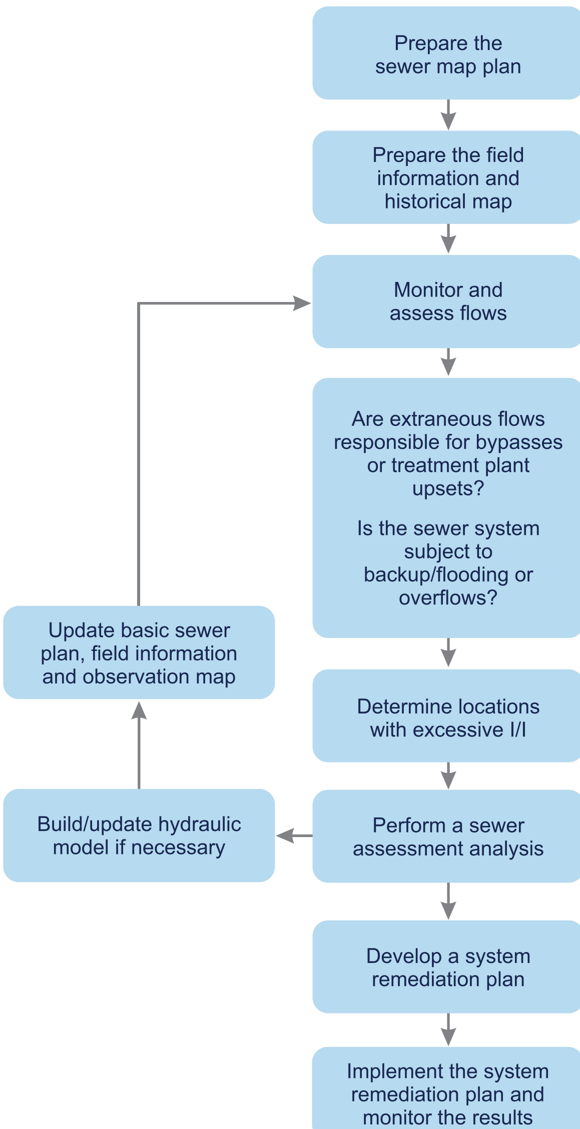

Figure 1 – I/I Control/Reduction Activities Flow Chart

as we've solved our clients' CSO, SSO and MS4 pollution problems. It discusses the importance of:

- **Understanding the sewer system's response to wet weather from field observations.**
- **Appropriate applications of certain Source Control solutions.**
- **Recognizing that issues may occur when these solutions are not properly implemented.**

Investigating Your **System**

Observing and evaluating the collection system provide data that is essential for successfully implementing Source Control solutions. Proper identification of Rainfall Derived Inflow and Infiltration (RDII) pathways can result in considerable cost savings. There are many tools available to detect RDII, and for best results, communities should match the right tools to each individual situation. **See Figure 1.**

Every community's RDII scenario is different. Much depends on the age of sewer infrastructure, age of the homes, construction materials and the building practices that were used when the sewers and homes were built. For instance, deterioration of house laterals varies with the methods and materials of construction.

A data collection program should make the most use of existing information. This includes:

- Data that is stored in databases from previous studies
- Observations of staff
- The perspectives of citizens

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Investigating Your **System** *(Continued)*

Figure 2 – Investigation Process

Only after this first step has been completed should a data collection program be initiated **(see Figure 2)**. This will provide an understanding of the current situation from all perspectives, and it also can reduce the cost of a field data collection program. This is important because data collection can be expensive.

For most communities, the first items to review are sewer system complaint records; operation and maintenance schedules and work orders; and reports of CSOs, SSOs and water in basements (WIB) from residents. Mapping incidents on a common database will facilitate an assessment of the system and an understanding of the interrelationships of the observations.

"Nobody knows a community's sewer system better than the people who live and work there, so we look to them first and leverage that knowledge to refine our evaluations," said John Swartzbaugh, PE, a project manager at B&N. For example, in many communities, residents can fill out questionnaires that will be used to pinpoint WIB **(see West Fifth Avenue project overview)** and surface flooding locations.

Flow metering data is important not only for understanding the system's response to wet weather stimuli, but also for observing improved performance as solutions are implemented. Rainfall data is as important as flow data since the two are integral. Flow data, analyzed along with rainfall data, will determine whether there is excessive RDII within the study area or if other issues are causing overflows. Flow metering is most effective when the entire system is metered. This allows communities to find the worst areas and prioritize locations to investigate in further detail.

Flow metering can identify the worst RDII areas, but requires a concentrated network to pinpoint all problems. Smoke testing can provide a more detailed analysis quickly and for much less

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Investigating Your **System** *(Continued)*

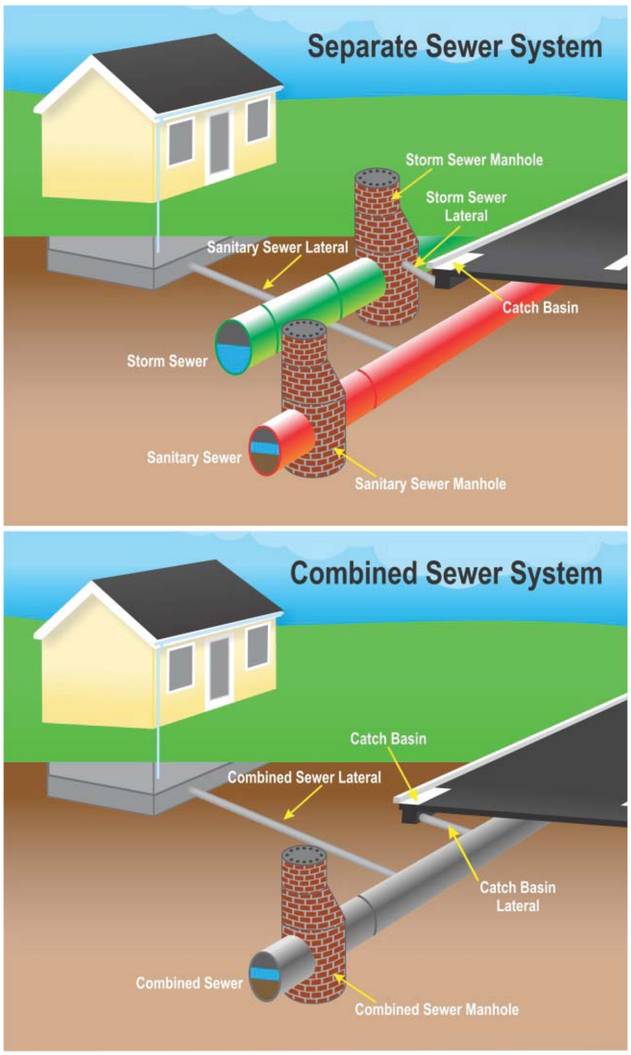

Diagram of Separate vs. Combined Sewer Systems

money. Collecting and analyzing data from flow metering and smoke testing will help prioritize the locations where dye testing and televising should be performed to confirm the existence of RDII pathways. Televising during wet weather can reveal where stormwater is entering the sanitary system and also can detect illegal connections to the sanitary system. Such programs are often done in a phased approach **(see Multi-Phase Sanitary Sewer Evaluation Study Program project overview)**.

Each step of the investigation process provides more detailed information on the exact locations of RDII. Other techniques and equipment, such as resistivity imaging and infrared photography, can be used to gather more specialized data, especially when locating buried infrastructure and other subsurface issues.

B&N engineers have performed these tests in many communities in the Midwest and across the country **(see San Antonio Sewer & Water System Testing project overview)**. We work closely with community leaders during the course of the project. "We review our data with city engineers to ensure it meshes with what they and the residents are seeing, and this also typically provides them with a more comprehensive understanding of their sewers' RDII problems," Swartzbaugh said.

Source Control **Solutions**

It's important to find the principal source of wet weather RDII. For example, if downspouts and sump pumps are tied into foundation drains and house service laterals, simply lining the mains and laterals will not remove that source of RDII. Because private sources of RDII contribute significantly to WIB

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Source Control **Solutions** *(Continued)*

The key is to intercept and control runoff removed before it's able to infiltrate back to the combined or separate sanitary sewer systems.

Above photos demonstrate rainwater capture strategies.

occurrences and sewer overflows, improvements on residential property often should take place concurrently with public improvements. B&N has developed programs that educate and assist communities in completing residential improvements in the most cost-effective way.

With separate systems, Source Control methods such as disconnecting and redirecting downspouts and sump pumps, in addition to rehabbing the mains and laterals, often can yield a significant reduction in RDII **(see Greencastle I/I Program project overview)**. However, the removal of these RDII sources from the combined and separate sanitary sewers results in additional flows to storm sewers. Since the storm sewers were not designed to receive the runoff from these RDII sources, this typically results in overburdening the storm sewer systems, especially in older areas where storm sewers were designed to a lower standard compared to present standards.

Another common sense solution to alleviating damage from an overloaded system is to simply isolate basements from surcharging sewers **(see Sewer Backup Prevention Program – Cincinnati project overview)**.

Rather than spend money on additional pipes or other "gray" infrastructure, it may be more cost-effective for communities to address the redirection of the RDII sources by implementing green infrastructure solutions, or a combination of gray and green solutions.

"The key is to intercept and control the additional runoff removed through downspout, sump pump, foundation drains and curb inlet redirections before it's able to infiltrate back to the combined or separate sanitary sewer systems," said Rusty Neff, PE, BCEE, B&N's Columbus Utilities Division Director.

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Source Control **Solutions** *(Continued)*

By incorporating green infrastructure practices to control stormwater runoff, communities and property developers can:

- Reduce pumping and treatment energy costs.
- Diminish the impacts of increased flooding from the redirected RDII sources.
- Enhance the environment by providing treatment of the runoff.
- Reduce overall infrastructure costs.

Over the past few decades many communities have realized considerable financial and water quality gains by adding green infrastructure to their stormwater reduction and management plans. Cities such as San Francisco, New York, Philadelphia, Chicago and Milwaukee have invested in green infrastructure solutions.

In an April 2012 report titled, "Banking on Green," the EPA asked the American Society of Landscape Architects (ASLA) to collect case studies on projects that successfully and sustainably manage stormwater. Among the 479 case studies the ASLA provided that used green infrastructure and low impact development (LID), 44 percent demonstrated reduced costs compared to estimated costs of using traditional gray infrastructure methods.[1]

A more specific example comes from Sanitation District No. 1 (SD1), which covers 220 square miles in northern Kentucky. SD1 signed a consent decree with the EPA in 2007 to address combined sewer and sanitary sewer overflows. Its first plan to comply with the requirements relied solely on gray infrastructure, but it was viewed as too costly. SD1 then developed an integrated watershed-based plan that provides cost-savings over the life of the program of up to $800 million compared to the traditional gray-only plan. The new plan also reduces a greater percentage of bacteria and nutrient pollution.

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Source Control **Solutions** *(Continued)*

Rain gardens

Permeable pavements

Biodetention basins

Bioswales

Tree plantings

SD1's Integrated Plan includes green infrastructure projects that are expected to annually reduce CSO burden by 506 million gallons, and also treat 562 million gallons of stormwater per year within the combined sewer system.[2]

While green infrastructure solutions can become more effective over time, performance may eventually diminish without proper maintenance. Like all infrastructure, green infrastructure will require periodic maintenance, although it holds the potential to be significantly less expensive over time than the equivalent gray infrastructure.

Other examples of green infrastructure-related cost savings include:

- In New Hampshire, porous pavements are reducing the winter salting and plowing costs because during freeze-thaw cycles, melt water infiltrates rather than freezing as an ice layer as it would on conventional pavements.[3]
- In Providence, Rhode Island, 67 privately financed LID projects remove nearly 9 million gallons of stormwater per year from an overflow-prone combined sewer system. This reduction in volume reduces operating costs for the utility.[4]
- The City of Portland, Oregon avoids conveyance costs of $100,000 per year for its Swan Island CSO Pump Station by managing the water with green infrastructure.[5]

Green infrastructure solutions for urban public areas may include:

- Rain gardens
- Permeable pavements
- Biodetention basins
- Bioswales
- Tree plantings

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Source Control **Solutions** *(Continued)*

In larger or commercial applications, techniques often include converting hardscape to landscape. This may include:

- Using rooftop vegetation to control stormwater and reduce energy use.
- Creating or restoring wetlands to retain floodwater.
- Installing permeable pavement in large areas to mimic natural hydrologic infiltration.
- Capturing and re-using stormwater for on-site uses such as watering lawns and other landscape features. This practice conserves treated drinking water.

A wealth of research exists on the performance of green infrastructure in reducing discharge of pollutants to rivers and streams, and reducing energy use. Many of these resources may be found in the Best Management Practices database: http://www.bmpdatabase.org/BMPPerformance.htm.

Proceed with **Caution**

"This is not a one-size-fits-all approach."

– Greg Breetz, PE

Because every community is different – with different constraints and goals for improvements – care must be taken when implementing Source Control methods, particularly green infrastructure solutions. "This is not a one-size-fits-all approach," said Greg Breetz, PE, B&N Director of Cincinnati's Civil & Site Engineering Section. "There are so many variables that communities need to consider before implementing a program that includes green infrastructure elements."

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Proceed with **Caution** *(Continued)*

" ...the infiltration capabilities of the soils may call for the addition of underdrains..."

– Rusty Neff, PE, BCEE

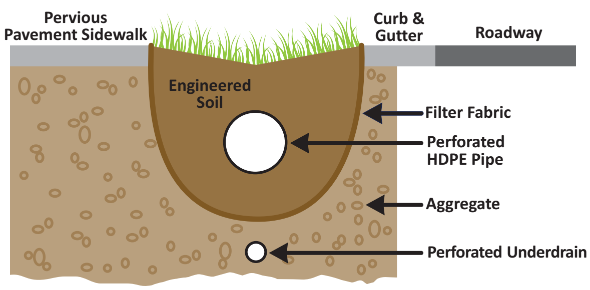

Figure 4 – Underdrains used with green infrastructure

Questions communities should ask before adding a green infrastructure program include:

- How much water do I need to redirect?
- What are my soil types?
- How much impervious pavement exists in the project area?
- Are the plants native to my area suitable for use in rain gardens? Plants that are not drought resistant or able to thrive in wet conditions will quickly die off.
- Are public open spaces available for green infrastructure?
- Is there private vacant land available for use? Some larger urban areas are using grant funding and land bank programs to purchase abandoned homes and vacant lots to use for extensive rain gardens and bio-retention areas.
- How will maintenance of green infrastructure take place?

These considerations are important to address up front because if the wrong Source Control measures are carried out, communities could be spending more money and end up not solving the problem. For example, the infiltration capabilities of soils are a critical component in designing green infrastructure, as one community in Seattle, Washington, recently discovered. After constructing several rain gardens, the city discovered the collected runoff was not infiltrating and residents wanted the city to remove the rain gardens, as the residents complained of stagnant water and odors, mosquito breeding and safety and aesthetic issues.[6]

"The clay, glacial till soil in Seattle is similar to soils throughout Ohio," Neff said. "So the infiltration capabilities of the soils may call for the addition of underdrains for the green infrastructure, as well as additional storage underground, such as an exfiltration trench with underdrains in lieu of additional stormwater piping." **See Figure 4.**

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Proceed with **Caution** *(Continued)*

B&N engineers practice open and candid communication with stakeholders and partners

A similar situation can occur with the use of pervious pavement. The proper combination of engineered soils and drainage components need to be installed to prevent flooding and ponding. Lack of adequate drainage can create mosquito breeding habitats, bacteria growth and bad odors.

Other issues to consider with green infrastructure are:

- Possible loss of parking spaces and sidewalk areas to create needed space for rain garden cells on urban streets.
- Proximity of rain gardens to sidewalks and sloped areas.
- Depth of rain garden cells to allow for runoff storage and infiltration.

Among the many lessons learned and shared by cities that have implemented source control measures is the importance of communication – not just among engineers, but also with the public. Because projects involving home drainage redirects, and green infrastructure changes to street rights-of-ways and public areas, are relatively new for communities, public misunderstandings of a project's goals may occur. Public involvement and education are critical to achieving project success. More than ever, the public will be directly impacted, and this becomes an issue of paramount importance.

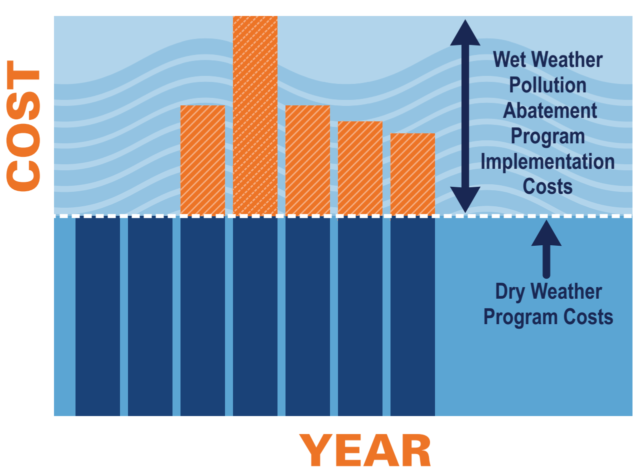
B&N engineers practice open and candid communication with stakeholders and partners to manage any unforeseen problems in implementing projects. "We regularly interact with many different people," Breetz said. "Never before has the engineering community had to deal with issues that affect the public as directly as these."

Cost **Considerations**

...total wastewater and stormwater management needs for the nation are $298.1 billion...

According to the EPA's latest national survey of capital costs to address water quality or water quality related public health problems, total wastewater and stormwater management needs for the nation are $298.1 billion as of January 1, 2008. This amount includes $192.2 billion for wastewater treatment plants, pipe repairs, and buying and installing new pipes; $63.6 billion for combined sewer overflow correction; and $42.3 billion for stormwater management. Small communities have documented needs of $22.7 billion.[7]

In addition to the $298.1 billion in wastewater and stormwater needs, other documented needs include $22.8 billion for nonpoint source pollution prevention and $23.9 billion for decentralized wastewater (septic) systems. An estimated $334.5 billion and $81.5 billion in needs are potentially eligible for assistance from EPA's Clean Water State Revolving Fund and Nonpoint Source Control Grant programs respectively. For more information see http://water.epa.gov/scitech/datait/databases/cwns/2008reportdata.cfm.



Wet weather pollution abatement program costs can be greater than dry weather costs.

Because each municipality is different, a cost analysis should be performed after investigating the extent of the problem and identifying necessary improvements. Among the many cost factors that should be considered are:

- Keeping stormwater out of the system.
- Modifications to the wastewater treatment plant.
- Various combinations of gray vs. green improvements.
- Maintenance throughout the lifespan of green infrastructure installations.

A range of models are available from the USEPA to assess the costs and environmental outcomes associated with green infrastructure development. The modeling approaches range from simpler, less resource-intensive, to more complex approaches that require greater time and expertise. These can be found at http://water.epa.gov/infrastructure/greeninfrastructure/gi_modelingtools.cfm.

Conclusion

Communities now have the opportunity to approach wet weather solutions from an integrated planning perspective.

An integrated planning approach offers opportunities to identify cost-effective, feasible solutions. It also may reduce capital expenses and operating costs while it reduces pollutants in sanitary, combined and stormwater systems. Using an integrated approach also provides the added benefits of fostering greater public involvement and protecting our water resources and public health.

B&N on the **Job**

The following examples of recent B&N project work show how many of the approaches noted in this paper have worked to reduce the impact of wet weather.

West Fifth Avenue Sanitary Sewer System I/I Remediation
City of Columbus, OH

Multi-Phase Sanitary Sewer Evaluation Study Program
Upper Arlington, OH

San Antonio Water System
City of San Antonio, TX

Greencastle I/I Program
City of Greencastle, IN

Sewer Backup Prevention Program
Cincinnati, OH

Project Overview

West Fifth Avenue Sanitary Sewer System I/I Remediation

Division of Sewerage and Drainage
Columbus, Ohio

B&N led a multi-consultant team that included Brown & Caldwell (BC), Dynotec, and CAD Concepts, Inc. (CCI) on the West Fifth Avenue infiltration/inflow (I/I) project. The primary purpose of the project was to identify the locations and cause of excess I/I within the 126,000 lineal feet of sewer within the study area and recommend cost-effective improvements that will remove I/I from the system. Primary tasks included:

- Cleaning and televising of sanitary and storm sewers within the study area,
- Performing detailed field investigations and flow monitoring,
- Modeling the system to identify areas and causes of capacity limitations and maintenance problems, and
- Identifying and recommending cost-effective improvements using a Life Cycle Analysis process.

The first phase of work involved review of existing system information and detailed field investigations. The sewer cleaning and TV inspection task involved review of mapping data, development of a traffic maintenance plan, notification of property owners, cleaning and televising of sewers, and review and evaluation of the inspection data. Manhole inspection work included development of a maintenance of traffic plan, field survey, and manhole inspections. Evaluation of the City's past sewer maintenance program included a review and tabulation of the previous 5 years of maintenance and GIS mapping preparation.

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Project Overview

West Fifth Avenue Sanitary Sewer System I/I Remediation *(Continued)*

A detailed analysis was performed using the structural scoring of CCTV pipe inspection. Using input from DOSD staff, a model was developed to predict the remaining useful life of a pipe segment and its probability of failure. The model output provided a strategy of pipe replacement and rehabilitation to correct structural deficiencies.

Concurrently with the first phase of work, the project team updated the City's existing sewer model. The work included reviewing the existing model, performing a detailed flow monitoring program, calibrating dry and wet weather flows, and determining rain dependent I/I. Following these tasks, the new model was used to evaluate the sanitary sewer system.

Following these initial phases of work, the project team performed both private and public I/I source investigations. The private source I/I investigations included the development of a procedures manual, performance of interviews, televising of laterals, dye testing, foundation flooding, summarization of findings, specification of methods for I/I removal, development of estimates for cost improvements, estimation of I/I reduction, and performance of a cost benefit analysis. The public source I/I investigation included the development of a procedures manual, dye testing/rainfall simulation, review and incorporation of existing materials, sanitary and storm sewer evaluations, storm sewer testing, development of methods/procedures to mitigate I/I, determination of solutions to mitigate I/I, and development of a report summarizing the public source I/I.

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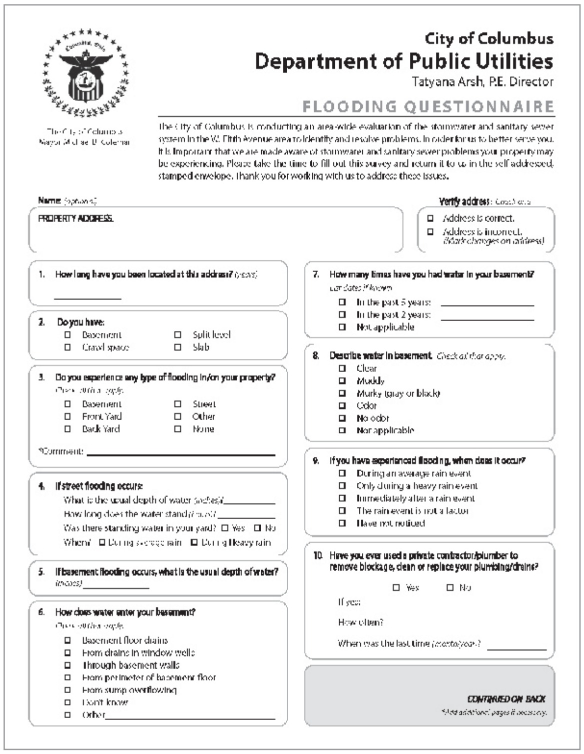
Project Overview

West Fifth Avenue Sanitary Sewer System I/I Remediation *(Continued)*



City of Columbus
Department of Public Utilities
Tatyana Arsh, P.E. Director

FLOODING QUESTIONNAIRE

The City of Columbus
Mayor Michael B. Coleman

The City of Columbus is conducting an area-wide evaluation of the stormwater and sanitary sewer system in the W. Fifth Avenue area to identify and resolve problems. In order for us to better serve you, it is important that we are made aware of stormwater and sanitary sewer problems your property may be experiencing. Please take the time to fill out this survey and return it to us in the self addressed, stamped envelope. Thank you for working with us to address these issues.

Name *(optional)*

PROPERTY ADDRESS:

Verify address: *Check one*
- ☐ Address is correct.
- ☐ Address is incorrect. *(Mark changes on address)*

1. How long have you been located at this address? *(years)* ________
2. Do you have:
   - ☐ Basement ☐ Split level
   - ☐ Crawl space ☐ Slab
3. Do you experience any type of flooding in/on your property? *Check all that apply.*
   - ☐ Basement ☐ Street
   - ☐ Front Yard ☐ Other
   - ☐ Back Yard ☐ None

   *Comment: ________
4. If street flooding occurs:
   - What is the usual depth of water *(inches)*? ________
   - How long does the water stand *(hours)*? ________
   - Was there standing water in your yard? ☐ Yes ☐ No
   - When? ☐ During average rain ☐ During heavy rain
5. If basement flooding occurs, what is the usual depth of water? *(inches)* ________
6. How does water enter your basement? *Check all that apply.*
   - ☐ Basement floor drains
   - ☐ From drains in window wells
   - ☐ Through basement walls
   - ☐ From perimeter of basement floor
   - ☐ From sump overflowing
   - ☐ Don't know
   - ☐ Other ________
7. How many times have you had water in your basement? *List dates if known.*
   - ☐ In the past 5 years: ________
   - ☐ In the past 2 years: ________
   - ☐ Not applicable
8. Describe water in basement. *Check all that apply.*
   - ☐ Clear
   - ☐ Muddy
   - ☐ Murky (gray or black)
   - ☐ Odor
   - ☐ No odor
   - ☐ Not applicable
9. If you have experienced flooding, when does it occur?
   - ☐ During an average rain event
   - ☐ Only during a heavy rain event
   - ☐ Immediately after a rain event
   - ☐ The rain event is not a factor
   - ☐ Have not noticed
10. Have you ever used a private contractor/plumber to remove blockage, clean or replace your plumbing/drains?
    - ☐ Yes ☐ No
    - If yes:
    - How often?
    - When was the last time *(month/year)*? ________

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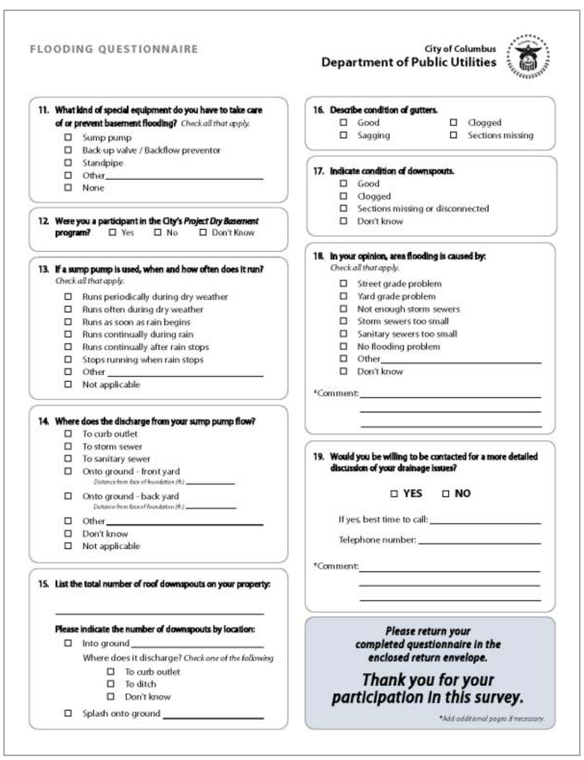

FLOODING QUESTIONNAIRE

City of Columbus
Department of Public Utilities

11. What kind of special equipment do you have to take care of or prevent basement flooding? *Check all that apply.*
    - ☐ Sump pump
    - ☐ Back-up valve / Backflow preventor
    - ☐ Standpipe
    - ☐ Other ________
    - ☐ None
12. Were you a participant in the City's *Project Dry Basement* program? ☐ Yes ☐ No ☐ Don't Know
13. If a sump pump is used, when and how often does it run? *Check all that apply.*
    - ☐ Runs periodically during dry weather
    - ☐ Runs often during dry weather
    - ☐ Runs as soon as rain begins
    - ☐ Runs continually during rain
    - ☐ Runs continually after rain stops
    - ☐ Stops running when rain stops
    - ☐ Other ________
    - ☐ Not applicable
14. Where does the discharge from your sump pump flow?
    - ☐ To curb outlet
    - ☐ To storm sewer
    - ☐ To sanitary sewer
    - ☐ Onto ground - front yard *Distance from face of foundation (ft.)* ________
    - ☐ Onto ground - back yard *Distance from face of foundation (ft.)* ________
    - ☐ Other ________
    - ☐ Don't know
    - ☐ Not applicable
15. List the total number of roof downspouts on your property: ________

    Please indicate the number of downspouts by location:
    - ☐ Into ground ________
      - Where does it discharge? *Check one of the following*
      - ☐ To curb outlet
      - ☐ To ditch
      - ☐ Don't know
    - ☐ Splash onto ground ________
16. Describe condition of gutters.
    - ☐ Good ☐ Clogged
    - ☐ Sagging ☐ Sections missing
17. Indicate condition of downspouts.
    - ☐ Good
    - ☐ Clogged
    - ☐ Sections missing or disconnected
    - ☐ Don't know
18. In your opinion, area flooding is caused by: *Check all that apply.*
    - ☐ Street grade problem
    - ☐ Yard grade problem
    - ☐ Not enough storm sewers
    - ☐ Storm sewers too small
    - ☐ Sanitary sewers too small
    - ☐ No flooding problem
    - ☐ Other ________
    - ☐ Don't know

    *Comment: ________
19. Would you be willing to be contacted for a more detailed discussion of your drainage issues?
    - ☐ YES ☐ NO
    - If yes, best time to call: ________
    - Telephone number: ________

    *Comment: ________

Please return your completed questionnaire in the enclosed return envelope.

Thank you for your participation in this survey.

*Add additional pages if necessary.

Alternatives were developed using a Life Cycle Analysis accounting for Environmental, Social, and Direct Capital costs. Every basin in the study area was evaluated using a variety of RDII mitigating technologies including: pipe and manhole rehabilitation, private lateral rehabilitation, inline storage, off line storage, drainage improvements, and green infrastructure. The green infrastructure included evaluation of rain gardens, rain barrels, curb bump-outs, tree boxes, pervious curb, and pervious pavement. The storm sewer component included evaluation of existing storm sewer capacities and potential for flooding that would negatively impact the sanitary sewer.

A community interaction program was performed throughout the duration of the project. This program included mass mailings, a funding questionnaire, press releases, and other public participation functions that kept local residents and businesses up to date on the project's progress and involved them as active participants.

Project Overview

Multi-Phase Sanitary Sewer Evaluation Study Program

Upper Arlington, Ohio

B&N recently completed several of the City's SSES studies:

Phase 2, Part 1: This project included **development of GIS mapping** of sanitary sewer districts 2, 3, 6, and 26; review of historical data related to maintenance and complaints; and flow monitoring and system analysis to ascertain general locations of excessive I/I for further study. Critical to this study was obtaining concurrence from Ohio EPA on the determination of "excessive" I/I, since this determination sets the framework for all future SSES studies. **B&N worked diligently with the City to collaboratively develop a tiered I/I ranking system that was in the City's best interest and meet the spirit of the Ohio EPA Director's Final Findings and Orders.**

Phase 2, Part 2: This project is the continuation of the Phase 2, Part 1 project that we completed in February 2011. The Part 2 tasks for this project include intense field investigations to identify private and public sources of I/I in areas that exhibited excessive I/I from the flow monitoring (Part 1) activities in districts 2, 3, 6, and 26. Investigations include smoke testing and rainfall simulation (dyed water testing) on public and private property in districts 2 and 6 (subdistricts 3 and 26 were within acceptable I/I limits) to further identify sources of infiltration and inflow. Estimates of I/I were derived from these test results, along with recommendations to remediate these sources of I/I and preparation of estimated construction costs.

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Project Overview

Multi-Phase Sanitary Sewer Evaluation Study Program *(Continued)*

Phases 3 & 4, Part 1: This project included development of GIS mapping of sanitary sewer districts 4, 5, 9, and 10; review of historical data related to maintenance and complaints; and flow monitoring and system analysis to ascertain general locations of excessive I/I for further study. Our project work plan for this study mirrored the work plan that we developed for the SSES Phase 2, Part 1 project with a few exceptions related to the timing of the mapping preparation and the questionnaires.

Phase 5, Part 1: As a subconsultant to Camp, Dresser, and McKee, Inc. (CDM), B&N installed and calibrated the City's 17 flow meters and one tipping bucket rain gauge in districts 1, 11, 12, 13, 14, 18, 21, 25, 29, and 31; inspected the meters 24 hours following the installation for direct verification of flow parameters; performed weekly site visits and downloads for the meters for a duration of 4 months; performed any necessary troubleshooting of the meters; processed the flow meter data; and transmitted raw and processed flow meter data to CDM on a weekly basis.

Phase 6, Part 1: This project included development of GIS mapping of sanitary sewer districts 15, 16, 17, 24, 27, 29, and 32; review of historical data related to maintenance and complaints; and flow monitoring and system analysis to ascertain general locations of excessive I/I for further study. Our project work plan for this study mirrored the work plan that we developed for the SSES Phases 3 & 4, Part 1 project.

Project Overview

San Antonio Sewer & Water System Testing

City of San Antonio, Texas

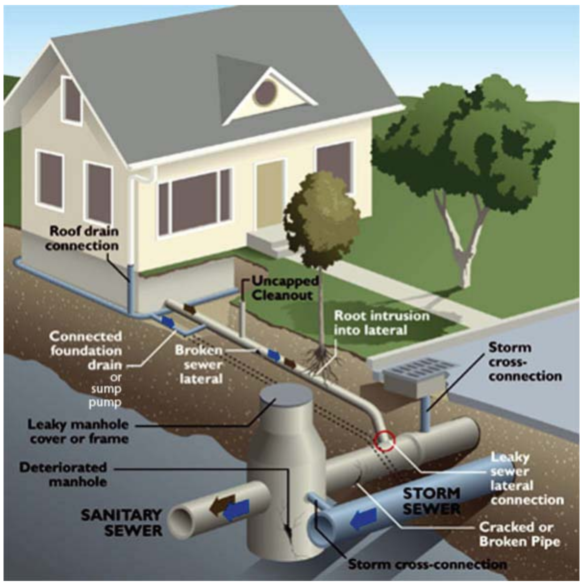
Burgess & Niple performed evaluations of portions of the wastewater collection system serving the City of San Antonio, Texas. Activity included smoke testing, sewer main cleaning and closed circuit inspection of selected service laterals. The project was conducted by the San Antonio Water System (SAWS). SAWS provides water, wastewater, and reuse water services to the greater San Antonio area. The project was conducted in order to maintain compliance with State of Texas requirements regarding wastewater collection systems located over the Edwards Aquifer. The Edwards Aquifer is a unique geologic formation spanning much of South Central Texas along the IH-35 corridor and is the major source for drinking water in the area.

The smoke testing project consisted of the following major tasks:

- Smoke testing of designated wastewater mains, ranging in size from 4" to 18"
- Notification of the public and public meetings
- Traffic control
- Wastewater main cleaning to facilitate inspection
- Closed circuit television inspection of selected service laterals
- Data and map management
- Reporting and schedule compliance

The project was conducted in four major drainage areas and included smoke testing of 3,019,000 linear feet of pipeline, cleaning of 12,000 linear feet of sewer main, and inspection of 4,120 service laterals. The service lateral inspections were conducted and recorded in compliance with NASSCO LACP requirements. The project schedule for the work was set at a very aggressive six months. Burgess & Niple completed the work in five months.

Project Overview



Greencastle I/I Program

City of Greencastle, Indiana

The City of Greencastle, Indiana was experiencing sanitary overflows as a result of the Inflow and Infiltration (I/I) of stormwater into its sanitary sewer system.

Traditional I/I elimination projects address public sources such as sewer mains and manholes that need to be replaced or rehabilitated. However, studies report that 60 to70 percent of I/I can be attributed to private sources. Burgess & Niple Professional Engineer Glen Morrow, while working as an employee of The City of Greencastle, developed a unique I/I program for Greencastle that targeted infiltration from private properties.

The program requires all Greencastle private properties to have downspouts disconnected, sump pumps redirected and cleanouts tightly covered. Each time a new water account is opened, a form completed by a certified inspector showing that the property is I/I compliant must be provided. All non-residential properties were required to have the inspection completed within the first two years of the program.

In addition, a training session for plumbers, home inspectors and contractors was conducted to explain the importance of eliminating I/I and how to inspect properties as part of this new program.

The program resulted in a new City of Greencastle Private Property I/I Policy. The U.S. Environmental Protection Agency and Water Environment Research Foundation provided grant funding to study and document the program's effectiveness.

(Continued ▶)

Project Overview

Greencastle I/I Program *(Continued)*

Before the policy took effect, Greencastle's 2 million gallon per day (MGD) wastewater treatment plant (WWTP) with a separate sanitary sewer collection system experienced rain events with flows often exceeding 15 MGD. These events caused overflows throughout the system that remained for several days. Additional, similar rain events caused overflows that remained for weeks.

The study found that after the policy was implemented it takes a very serious rain event for flows to exceed 5 MGD. If flows reach 15 MGD, they return to normal within 24 hours.

This private property I/I policy helped increase the growth capacity of the WWTP, prevent overflows and satisfy regulatory agencies for a minimal cost. The model for this project has been successfully adopted by other communities.

Project Overview

Sewer Backup Prevention Program

Metropolitan Sewer District of Greater Cincinnati (MSD)
Cincinnati, Ohio

As part of the CSO global consent order, MSD is undertaking a program to eliminate basement flooding resulting from sewer surcharges. Flooding eliminations are being accomplished through designing modifications to the plumbing systems of individual houses and businesses. This includes separating basement and upper floor plumbing, pumping of basement and/or full house waste flows, and providing isolation valves that isolate the basement plumbing during surcharge events.
In many cases it is necessary to deal with both sanitary and stormwater flows.

B&N initially received a 5-year task order contract with MSD to conduct an initial property owner interview and site inventory, complete a detailed evaluation, design a correction, and observe construction activities. The program began on January 1, 2004 and MSD extended the contract in 2009 to address additional properties. B&N was assigned more than 650 properties, 467 of which went into design phase and 420 were constructed. Most improvements included pump installations on the resident's property.

Other **Resources**

B&N is pleased to provide links to additional resources on these topics.

- Funding Resources for Municipalities
  - "Utilizing Green Infrastructure to Manage and Mitigate Stormwater to Improve Water Quality Grants" by the National Urban and Community Forestry Advisory Council. http://www.fs.fed.us/ucf/nucfac.html
  - http://water.epa.gov/infrastructure/greeninfrastructure/gi_funding.cfm
- Incentives
  - http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_incentives.pdf
  - http://nepis.epa.gov/Exe/ZyNET.exe/P1007BYL.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C06thru10%5CTxt%5C00000017%5CP1007BYL.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL
- Green Infrastructure
  - http://water.epa.gov/infrastructure/greeninfrastructure/gi_costbenefits.cfm
  - http://water.epa.gov/infrastructure/greeninfrastructure/gi_policy.cfm
  - http://water.epa.gov/infrastructure/greeninfrastructure/gi_regulatory.cfm
  - http://water.epa.gov/infrastructure/greeninfrastructure/gi_design.cfm
- General
  - http://www.epa.ohio.gov/dsw/SurfaceWater.aspx
  - http://www.ohioswa.com/
  - http://www.cwp.org/

Endnotes

1 American Rivers, the Water Environment Federation, the American Society of Landscape Architects (ASLA) and ECONorthwest, Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide, 2012, Accessed May 2013, available online at http://www.asla.org/ContentDetail.aspx?id=31301

2 Watershed Plans for Northern Kentucky, Executive Summary. Sanitation District No. 1, 31 March 2011. Available online at http://www.sd1.org/Resources.aspx?cid=5

3 J. Gunderson, R. Roseen, T. Janeski, J. Houle, and M. Simpson, "Cost-Effective LID in Commercial and Residential Development." Stormwater. March 2011.

4 American Rivers, the Water Environment Federation, the American Society of Landscape Architects (ASLA) and ECONorthwest, Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide, 2012, available online at http://www.asla.org/ContentDetail.aspx?id=31301

5 Ibid

6 "Ballard Roadside Raingardens, Phase 1 – Lessons Learned"; Shanti Colwell and Tracy Tracker, Green Infrastructure Program, Seattle Public Utilities, available online at http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_ballardproject.pdf

7 J. Gunderson, R. Roseen, T. Janeski, J. Houle, and M. Simpson, "Cost-Effective LID in Commercial and Residential Development." Stormwater. March 2011.