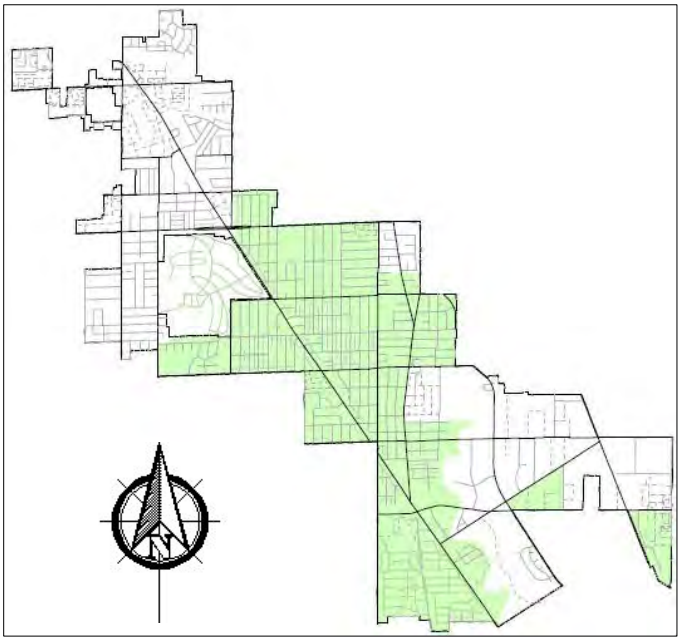
VILLAGE OF NILES

Village of Niles, Illinois
Stormwater Commission Report



September 22, 2009

Acknowledgements

Numerous organizations and individuals have contributed both time and valuable information to this Stormwater Commission Report.

Stormwater Commission Members:

- Joe LoVerde, Trustee - Commission Chair
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The Stormwater Commission wishes to thank all stakeholders and members of the public who completed the Resident Stormwater Survey, attended the Stormwater Workshop, contributed flooding information, and discussed their experiences with the Commission.

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EXECUTIVE SUMMARY

The Stormwater Commission presents this report and the recommendations that flow from it to the Mayor, the Village Board of Trustees, and Village residents. Seven Commission members appointed by the Mayor have worked together to prepare and present this report without dissent.

A Record Storm.

During the 12th through 14th of September 2008, the Village of Niles and surrounding communities experienced a record rainfall event of approximately 9.5 inches over a 15-hour period resulting in flash and prolonged flooding that damaged approximately 781 homes, three businesses, and one school in the Village of Niles alone. The flood event, declared a disaster by the President of the United States, overwhelmed the local and regional combined sewer systems causing an estimated $1.5 million of residential and municipal damage.

The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) estimated that 112 billion gallons of precipitation fell during the event to completely fill 109 miles of Deep Tunnel and 37 regional detention ponds and reservoirs, leaving municipal combined stormwater systems to impossibly handle the 40 billion gallons of stormwater that could not be released downstream or into Lake Michigan. Although MWRDGC plans to add another 3.5 billion gallons of capacity with the McCook Reservoir project in 2015 and 7.0 billion gallons more in 2023, the region will most likely never be able to handle the stormwater runoff of similar rain events as was experienced in September of 2008.

Stormwater Commission.

Shortly after flood disaster recovery operations began, Mayor Robert Callero appointed a Stormwater Commission to identify, evaluate, and provide a comprehensive report on stormwater related issues within the Village of Niles stemming from the September 2008 storm. However, due to the identified unlikelihood of the Village, region (MWRDGC) or State to protect homeowners from comparable floods in the foreseeable future, the intent of this study was revised to look beyond the devastation of the 100-year rain and to focus in on the stormwater runoff issues impacting homeowners during more frequent two-, five- and ten-year storms.

The Commission's methodology of identifying existing conditions, obstacles and opportunities was to work as closely with stakeholders as possible. This was done through a stormwater survey, a community workshop, site visits and one-on-one homeowner discussion. The site information collected was then entered into the Village's Geographic Information Systems (GIS), a mapping system that allows data linked to a location to be stored, analyzed, and managed by the Commission.

Analysis and Findings.

When the Commission began analyzing results from the Resident Stormwater Survey, discoveries were immediate. First, survey results demonstrated that a significant number of homeowners lack a clear understanding of stormwater basics in and around their home and property, let alone the Village or the region. This speculation was reinforced through site visits and the community workshop where homeowners took full advantage of the opportunity to ask and learn about stormwater issues.

In addition, survey results allowed the Commission to begin mapping areas where the heaviest flooding occurred during 2008, identifying areas of "concern" that were then investigated further with follow up site inspections. True to the data, larger contributing factors outlined in this report, such as stormwater runoff from select open spaces, were identified. When practicable, the Commission went to work immediately to address stormwater runoff issues with the parties concerned.

There were also a number of stormwater issues that could be addressed with little or no effort. In some cases, a homeowner simply required knowledge of which flood control system would work best for their particular home. Other times, a street/alley was flooding that did not normally hold water and the Village immediately inspected and cleaned the sewer system only to find a clogged inlet restrictor valve or other repairable issue.

The following are the most common flooding concerns identified in homes:

1. Sewer Surcharge. Sanitary backup occurs when sewer water enters the home in a basement through a floor drain, shower drain, sink, toilet or even sump.

2. Stormwater Runoff through Windows and Doors. This occurs when stormwater collects around the home entering doors, garages, basement windows, and in some cases, crawl spaces.

3. Basement Seepage. This water will enter through cracks, holes, and joints in basement floors and walls. Seepage such as this also occurs over the top of a foundation between the foundation and wall.

4. Sump Pump Failure. Sump pumps fail for several reasons, but in most cases it is due to a failed switch, a lack of annual maintenance, absence of battery backup or insufficient capacity.

The following are a number of general stormwater concerns outside of the home:

1. Street and Alley Flooding. Some streets are meant to serve as a secondary conveyor of stormwater during extreme events so that the road floods

instead of the homes. However, some of these streets may flood in extreme rains to a point of breaching flood control systems and actually wake against homes due to passing vehicles.

2. Yard Flooding. Rear yard flooding is, in most cases, caused by the unintentional obstruction of the natural flow of stormwater. This is done with the installation of a fence, landscaping, or a berm by the homeowner or a neighbor. Rear yard flooding can also be attributed to urban development or a poorly placed sump pump outlet or downspout.

3. Stormwater Runoff. Although stormwater runoff from a residential lot can cause much grief for a neighbor, stormwater from large lots of land such as cemeteries, parks, or even adjacent municipalities can generate as much as 50,000 gallons of water per acre during a 2-year storm. If this stormwater is not captured and slowed, it flushes into combined sewer systems as inflow contributing to flooded streets, yards, and homes.

4. Inflow and Infiltration. 75% of the Village's sewer system is combined and it is imperative that inflow and infiltration be eliminated where possible because it severely impacts sewer capacity during extreme rain events. An example of inflow is stormwater from a downspout that drains directly into a sewer and an example of infiltration is water that enters the combined sewer through cracks in a service lateral from the home to the public sewer.

5. Regional vs. Local System. The function of the Village's combined system is closely tied to the current and future function of the regional system. Any future stormwater work within the Village of Niles must be based on a clear understanding of the current and future hydraulic capabilities of the regional system.

6. GIS Mapping. The geographic information system was crucial to determining current stormwater issues. It will be equally crucial as the Commission moves forward with computer modeling and system analysis to identify hidden issues, as well as tracking the success of implemented stormwater improvements.

7. Green Infrastructure. The goal of managing stormwater in the Village of Niles is to prevent combined sewer overflow. One method of accomplishing this goal is by capturing stormwater runoff before it enters the sewer system with green infrastructure such as pervious pavement and bioretention strips in areas where increased sewer capacity is not an option or cost prohibitive.

8. Homeowner Education. As mentioned earlier, there are strong indications that there is a genuine need for the Village to provide homeowners with stormwater education.

9. Sewer Capacity/Enhancements. There is a recognized need for an engineering systems analysis of either the entire Village-owned collection system or a few select systems to determine necessary sewer capacity solutions.

Mapped Stormwater Issues by Area.

This document further reports on stormwater issues by area utilizing the maps in Appendix E. This section is not meant to be an all inclusive report on each and every home experiencing flooding. It does, however, make an attempt, based on the information provided by homeowners, the survey, site visits and the workshop, to locate areas of concern or persistent problem areas that can be addressed through improved stormwater policy, operations, and education, as well as potential capital programs substantiated by stormwater systems modeling.

The following is a brief description of areas with shared stormwater issues:

North Region Map –

1. Area One.
    a. Stormwater runoff from Glenview may be contributing to flooding of nearby streets and yards in Niles.
        i. The Commission is working with the Village of Glenview to investigate the issue further and develop recommendations.
    b. Greenwood Avenue is contributing to stormwater issues.
        i. The Commission is opening dialog with the County.

2. Area Two.
    a. Significant street flooding on Courtland and nearby streets causing below grade garages/homes to be flooded.
        i. The Commission recommends engineering analysis.
    b. Milwaukee Avenue and Maryland Street flood in heavy rains severely impacting driving patterns.
        i. The Commission recommends engineering analysis and a capital improvement plan for consideration by the Village Board of Trustees.

3. Area Three.
    a. Greenwood Avenue flooding side streets from Oakton Street to Dempster Street.
        i. The Cook County Highway Department hired an engineer who has identified deficiencies.
        ii. The Commission is pressing the County to move forward with improvements.
    b. Open field at Our Lady of Ransom (OLR) generates stormwater runoff contributing to flooding to the north.

i. The Commission is working closely with OLR to develop and implement a stormwater management plan.

c. Swales along North Park in Park Ridge were filled in resulting in significant stormwater runoff that negatively impacts nearby streets and homes in Niles.
   i. The Commission is working with Park Ridge to have swales replaced.

4. Area Four.
   a. Maryhill Cemetery generates a significant amount of stormwater runoff negatively impacting homes to the south and possibly the west. This stormwater runoff contributes to street flooding, flooded yards, and charged sewers and in some cases flooded homes.
      i. The Commission is working closely with cemetery management to develop a plan of action. Since discussions have started, sewer pipes within the cemetery have been inspected and clogs cleaned. A blocked drain near Monroe was identified and since opened.

Central Region Map –

1. Area One. (Open Lands)
   a. Grennan Heights Park has been identified as contributing to area stormwater runoff.
      i. The Commission is working with the Park District on plans to install a sidewalk system on the east side of the park to help retain stormwater.
   b. NICO Park had been identified as contributing to area stormwater runoff.
      i. The Niles Park District worked with the Commission by installing sewer and drainage structures to remove peak flow off the park during heavy rains.

2. Area Two. (Rear Yard Flooding)
   a. A large number of homes in this area are experiencing rear yard flooding issues that, in some cases, have resulted in basement flooding and seepage, as well as other damage.
      i. The Commission recommends several items within Part 5 of this report to help with the causes of this issue; however, current persistent rear yard flooding that occurs may require drainage systems to be installed. If the Village at some time approves a rear yard flooding program, a prioritization process will need to be developed.

3. Area Three. (Street Flooding)
   a. Some streets in Niles are designed to hold water through the use of inlet restrictor valves. However, a number of streets within the

central part of Niles will flood to a point of reaching homes and breaching flood control systems. This issue is exacerbated by wakes caused by vehicles driving through flooded streets.

i. The Commission has worked to ensure sewers in each of these areas were inspected, flushed and cleaned.
ii. The Commission recommends engineering analysis and a capital improvement plan for consideration by the Village Board of Trustees.

South Region Map –

1. Area One. (Open Lands)
    b. Jonquil Terrace Park contributes considerable stormwater runoff to the area that results in flooded yards, streets, and homes.
        i. The Commission is working with the Park District on plans to install sewer and drainage structures on the site.
    c. Kirk Lane Park contributed to rear yard flooding along Jonquil Terrace.
        i. The Park District installed sewer and drainage structures that eliminated flooding.
    d. Saint Adalbert Cemetery stormwater runoff has impacted the Renaissance Condominiums by flooding parking lots and in some cases homes.
        i. The Commission worked with cemetery and condominium management to identify and address most of the issues. The condominium associations must now complete some work.

2. Area Two. (Street Flooding)
    a. Street flooding to the south of Oakton is similar to what occurs within the Central part of Niles, but is not nearly as prevalent.
        i. As with streets throughout the Village of Niles that experience extreme flooding, the Commission recommends engineering analysis and a capital improvement plan for consideration by the Village Board of Trustees.

Through this report, the Stormwater Commission has identified the parameters of stormwater management limits within the Village of Niles, the persistent stormwater runoff issues that negatively impact homeowners, and where the negative impact of stormwater is most prevalent. In addition, a number of examples were included where the Commission has been actively working to help individual homeowners and entire neighborhoods through interaction, discovery, and, when practicable, action.

Now the Village Board must consider the recommendations at the end of this report that are regarded by the Commission as crucial to properly managing stormwater within the community. Through these recommendations, the Village of Niles will set the stage for short- and long-term improvements.

1 INTRODUCTION

The "100-year" storm and flood of September 2008 was devastating for a good number of homeowners in the Village of Niles and surrounding municipalities. Not since August of 1987 was there a comparable rainfall on record. It is estimated that the 2008 flood impacted ten to fifteen percent of "ground level" homes in the Village and cost nearly $2.0 million in damages and cleanup, not to mention the untold loss of irreplaceable family heirlooms, memories, and general peace of mind.

The purpose of this report, however, is not simply to recount the flood event of 2008, but more importantly to provide a comprehensive look at more "persistent" stormwater conditions within the Village of Niles that occur during intense two- and five-year storm events, such as those experienced in March 2009 when we had nearly two inches of rain on frozen ground and June of 2009 when a record breaking three inches caused flash flooding in streets. To accomplish this, the Stormwater Commission worked and continues to work with homeowners to identify where and how stormwater is persistently impacting their homes and property.

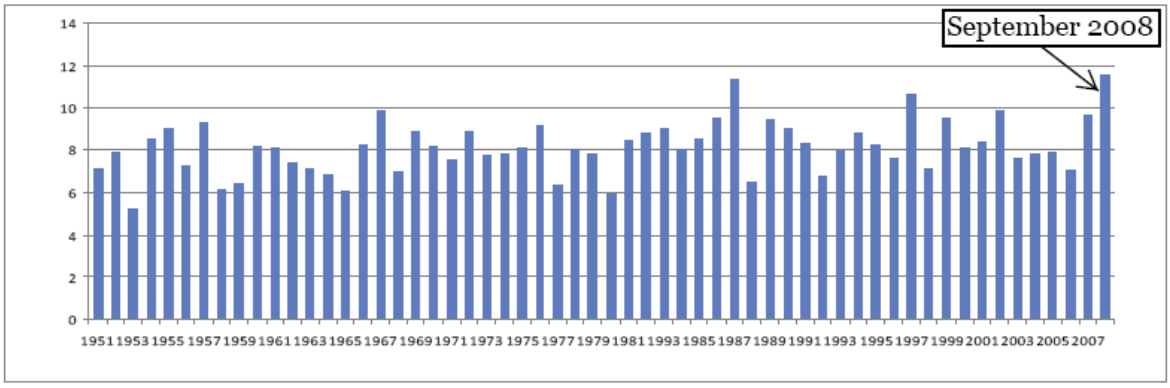
Within the Analysis and Findings section (3.5) of this report, persistent stormwater issues and contributing factors are identified. This section continues by illustrating, with maps (Appendix E) developed by the Commission through resident surveys, a public workshop, and site investigations, where stormwater events most often impact homes and properties. Though the Stormwater Commission has been actively tackling stormwater runoff issues when practicable, a number of recommendations are included at the end of the report for consideration by the Village of Niles Board of Trustees. These recommendations are meant to help the Village and homeowners to reduce the impact of future stormwater events.

This Report provides the first comprehensive look at regional, local, and home stormwater systems within the Village of Niles. It was completed through a cooperative effort of agencies, community stakeholders, and homeowners. The result is a thorough review of stormwater issues within the Village of Niles along with ways homeowners and the Village can reduce the future impact of stormwater runoff caused from intense rainfall events. The Board of Trustees will be able to utilize this report to amend dated stormwater legislation, reevaluate current municipal operations and consider long- and short-term capital programs.

2 SUMMARY OF EVENTS – SEPTEMBER 2008 Flood

2.1 A Record Storm Event

On September 12 through 14, 2008 a record rainfall of approximately 9.5 inches of rain fell on the Village of Niles and surrounding communities over a 15-hour period. Preceding this rain event was a 3 inch rain on September 4th and a 1-inch rain on September 8th, leaving the ground nearly saturated and rivers swollen. A local look at the peak stream gage height in the North Branch of the Chicago River at Howard Street displays how the September 2008 storm caused the highest river level since records were kept in 1951.

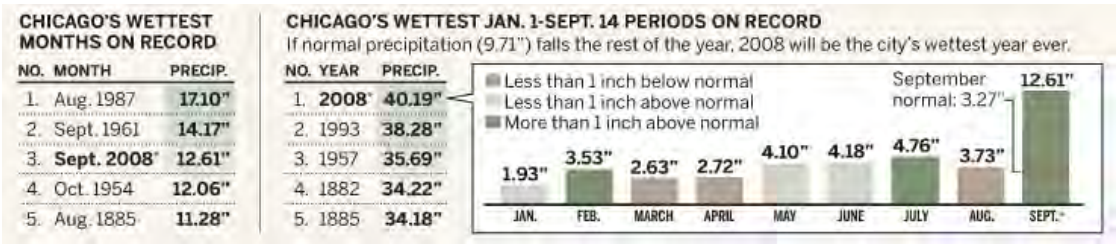


Source: U.S. Geological Survey

Since 1951, the peak stream gage height in the North Branch of the Chicago River at Howard Street exceeded 10.00' above the gage datum of 601.99 (normal river level) on three occasions – August 1987, February 1997, and September 2008.

Figure 2-1: Peak Stream Gage Height in the North Branch of the Chicago River

Based on information from the National Weather Service, September 2008 was Chicago's third wettest month on record and 2008 was the wettest year on record since 1993.



Source: National Weather Service Archives

Figure 2-2: Chicago's Wettest Months on Record

This particular flood has been referred to as a 100-year flood, which is defined as a flood that statistically has a one percent chance of occurring in any given year.

According to the Illinois State Climatologist Office's table below from "Bulletin 70 – Frequency of Distributions of Heavy Rainstorms in Illinois," the September rainfall would be considered a 100-year event.

RAINFALL TOTALS

Rainfall in inches for Given Recurrence Interval

Storm Duration	Recurrence Interval					
	2 year	**5 year**	**10 year**	**25 year**	**50 year**	**100 year**
1 hour	1.18	1.79	2.10	2.59	3.04	3.56
3 hour	1.60	2.43	2.86	3.53	4.14	4.85
6 hour	1.88	2.85	3.35	4.13	4.85	5.68
12 hour	2.18	3.31	3.89	4.79	5.62	6.59
24 hour	2.51	3.80	4.47	5.51	6.46	7.58
48 hour	2.70	4.09	4.81	5.88	6.84	8.16

Source: Bulletin 70 Illinois State Water Survey 1989

Table 2-1: Frequency of Distributions of Heavy Rainstorms in Illinois

However, it is important to note that to accurately predict a 100-year storm would require 1,000 years of records, which do not exist. The engineering profession does have enough records (100 years) to more accurately predict a 10-year recurrence frequency event.

What is certain is that there are several factors that independently influence flood conditions, such as intensity, duration, and soil saturation. The 2008 storm event encompassed all three factors with a total of 9.5 inches of rainfall over a short period of time under saturated soil conditions.

Recurrence intervals and probabilities of occurrences

Recurrence Interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year
100	1 in 100	1%
50	1in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1in 5	20%
2	1in 2	50%

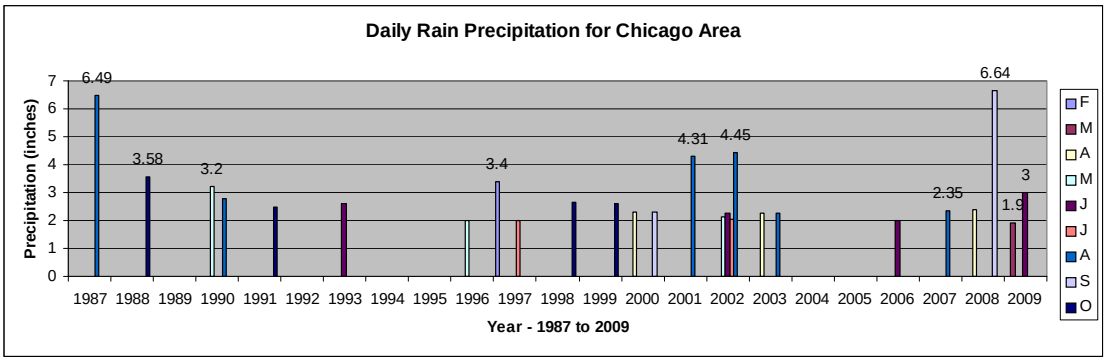
Source: U.S. Geological Survey

Table 2-2: Recurrence Intervals/Probabilities of Occurrences

Many homeowners have asked the question, "Why does it seem 100-year floods are happening more often?" and this is very difficult to answer. Is it chance or is it a case of climate change? According to the Environment Illinois Research and Education Center,

> "Global warming increases the intensity of precipitation in two key ways. First by increasing the temperature of the land and the oceans, global warming causes water to evaporate faster. Second, by increasing air temperature, global warming enables the atmosphere to hold more water vapor. These factors combine to make clouds richer with moisture, making heavy downpours or snowstorms more likely." (Figdor, 2007)

For all intents and purposes, those in the minority believe it is inconclusive that Illinois is experiencing an increasing number of heavy storms for any reason other than chance. According to Chief Engineer Joseph Sobanski at the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), we must "Beware and Be Aware" because it is unpredictable whether or not we will experience a growing number of 100-year storms. However, in the case that the climate change prediction of more frequent heavier rains may be correct, MWRDGC believes that more intense storms can be managed and adapted to when they occur.



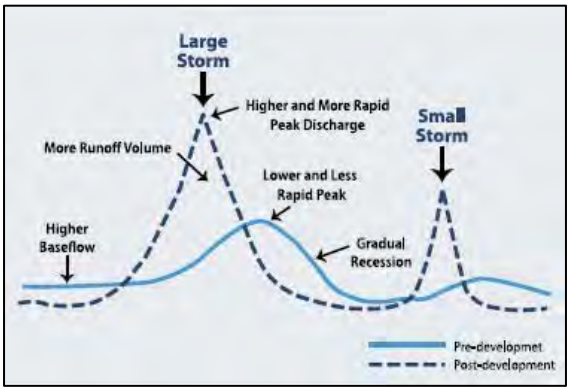
Source: Chicago National Weather Service Office

Figure 2-3: Daily Rain Precipitation for Chicago Area

Note 1: Based on the limited number of survey respondents who knew the dates of previous flooding events, the "daily" rainfall in August 1987 and September 2008 were most damaging, as were the heavy rains of 2001 and 2002. The 3.4 inch rain in February of 1997 most likely caused issues due to frozen ground, but very few respondents noted the date. A significant number of respondents, however, did state the 2.35 inch rain storm in August of 2007 caused flooding, which is partially due to wide-spread power outages and failed sump pumps. During 2009, flash flooding was caused by a 1.9 inch rainfall in March due to frozen ground. A second 2009 flash flood was caused in June when 3.0 to 3.5 inches fell breaking a June 19th record set in 1961.

There is also the issue of urban development and the negative impact that it has on stormwater runoff by reducing pervious surface. It is no secret that when a homeowner installs a new concrete porch or expands their home or garage, there is less pervious surface available to absorb the rain and stormwater from sump pumps and downspouts.

Figure 2-4 shows how stormwater runoff volume, peak discharge, and time to peak increases with urban development. Ground saturation occurs earlier if there is less of it.



Source: Center for Watershed Protection

Figure 2-4: Development increases runoff volume and peak discharge

2.2 The Village of Niles

The impact of the record rainfall in September 2008 was both immediate and widespread. Record of the earliest reports of flooded basements, yards and streets were made by the Fire Department as early as 4:30 a.m. on Saturday, September 13th. Over the weekend, emergency recall procedures brought in Fire, Police and Public Services personnel to respond to flooded basements, flooded streets, debris in roadways, utility hazards, blocked sewers, and emergency evacuations. Two major roads, Howard Street and Harts Road, were closed due to flooding. Milwaukee Avenue also experienced closure near Maryland Street.

Recovery operations began immediately following the flood event with General Government coordinating department operations, establishing a flood hotline, preparing news releases and updating the Village website with flood related information, alerting the municipal waste hauler to collect home flood debris and reaching out to public assistance agencies such as the American Red Cross, the Cook County Emergency Management Agency (CCEMA), the Illinois Emergency Management Agency (IEMA), the Small Business Administration (SBA), and the Federal Emergency Management Agency (FEMA).

During the week of September 22nd, Village staff toured the municipality with representatives from IEMA, SBA, and FEMA to meet with residents in some of the worst hit areas identified at the time. These agencies broke up in groups and went door-to-door to get a first hand account of flood damages and to share information with residents about the Disaster Recovery Loan Program for flood victims without flood insurance. The main goal of the group was to make an assessment of the area for a potential federal disaster declaration.

Early estimates were that 781 homes may have been damaged from flood waters in basements and, in several cases, first level living space (The blue dots on the maps in Appendix A represent the 781 homes with initial damage). There were three reported businesses with heavy damage as well as flooding at Gemini Junior High School which had to be closed for a week due to cleanup operations. Other than some homes that lost AT&T phone service, about 58 area homes on the west side of town (not all Niles homes) lost ComEd power due to a submerged transformer near Lincoln Avenue, which may have resulted in some basement flooding for those who did not have battery backup on their sump pumps.

On October 3, 2008, President Bush declared that a major flood disaster occurred in the State of Illinois. At that time, General Government made a Public Service Announcement (reverse 911) informing residents of the declaration and the phone number to call for disaster assistance.

Figure 2-5: Flood Recovery Meeting

Following the anticipated federal declaration, the Village of Niles established a Public Information Meeting (See Appendix B for Flyer) at the Niles Senior Center on Tuesday, October 14th titled "Flood Recovery – Where Do We Go from Here?" Over 250 citizens attended the meeting. The first half of the meeting was dedicated to the following guest agencies: the Federal Emergency Management Agency (FEMA) to discuss disaster assistance; the Small Business Administration (SBA) to discuss Low-Interest Disaster Loans; The Illinois Department of Natural Resources (DNR) to discuss Flood Insurance; the Cook County Department of Public Health to discuss the Dangers of Mold; and the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) to discuss Future Stormwater Management.

The second half of the meeting was planned to provide a flood event and recovery update and then allow residents an opportunity to speak about flooding and ask questions of Mayor Callero and Village staff. This public event was taped and streamed on the Village of Niles website.

Although an estimated 781 homes had flood damage, only 561 residents applied for and received flood assistance totaling $1,147,424.17 or an average of $2,045 per household. For those who qualified for support, we have been told that the process was relatively simple and payment was quick. However, there was a general concern that many qualified residents were not pursuing flood assistance because they thought it was a loan or maybe they simply dropped out of the process prematurely. In an effort to increase the number of residents getting assistance, the Village successfully encouraged FEMA to establish a base of operations at Village Hall with a representative who worked directly with referred residents having difficulties.

FEMA		
Final State Recovery Program Summary		
County	**Registrations**	**Assistance**
Cook	42,479	$5,284,891.85
DeKalb	236	$45,964.75
Du Page	1,255	$270,915.28
Grundy	100	$32,098.49
Kane	528	$81,821.85
LaSalle	243	$107,396.96
Peoria	1,170	$176,285.13
Will	1,217	$107,228.26
Woodford	140	$7,403.69
Village of Niles	**561**	**$1,147,424.17**

Table 2-3: Final FEMA Flood Assistance

Note 2: The Commission estimates about 781 homes experienced initial flood damage during the September 2008 flood. This number of homes is based on resident calls for emergency service during the storm combined with a visual count of homes with curbside flood debris.

The municipality of Niles experienced $132,321.60 in property loss and extra costs due to the September 2008 flood, of which $84,643.72 qualified for FEMA flood relief. The following shows municipal losses due to the flood:

1) Two police cars were overcome by flood water at a cost of $9,255.01, which was insured and did not qualify for FEMA flood relief;

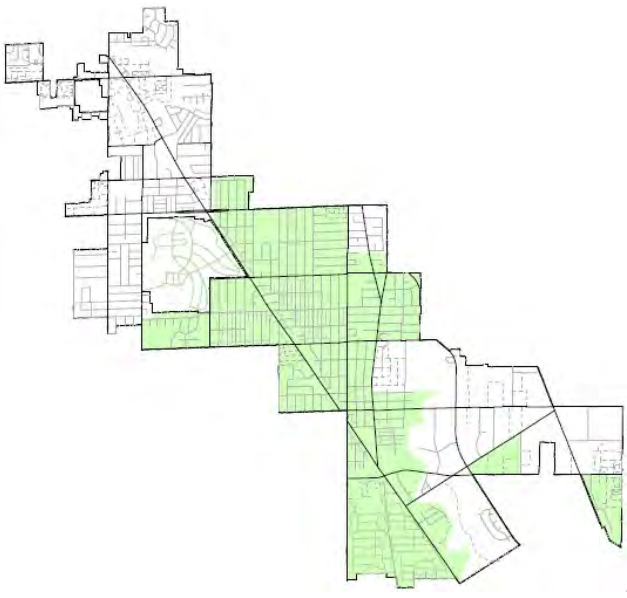
2) The truck weight scale located on Touhy Avenue experienced a damaged "j-box" and "load cells" at a cost of $10,208.30 which was insured and did not qualify for FEMA flood relief;

3) Police, Fire, and Public Services labor (592.4 hrs) and equipment (343.7 hrs) to work during incident period at a cost of $41,841.85, qualified for $31,381.39 in FEMA flood relief; and

4) During the period of September 18th through October 7th the Village waste hauler collected and removed approximately 1,897 cubic yards of destroyed household goods, furniture, and other flood damaged debris brought to the curb for removal. This special haul cost the Village $71,016.44 for collection and SWANCC tipping fees. FEMA reimbursed the Village $53,262.33 in flood relief.

2.3 Local and Regional Stormwater Systems

2.3.1 Local Stormwater System. The Village of Niles has 150 miles of combined sewer mains, 75 miles of sanitary sewer mains, and 35 miles of storm sewer mains. The combined sewer system, which consists of 75% of the system, is primarily within the older section of the Village (See green area in Figure 2-6).

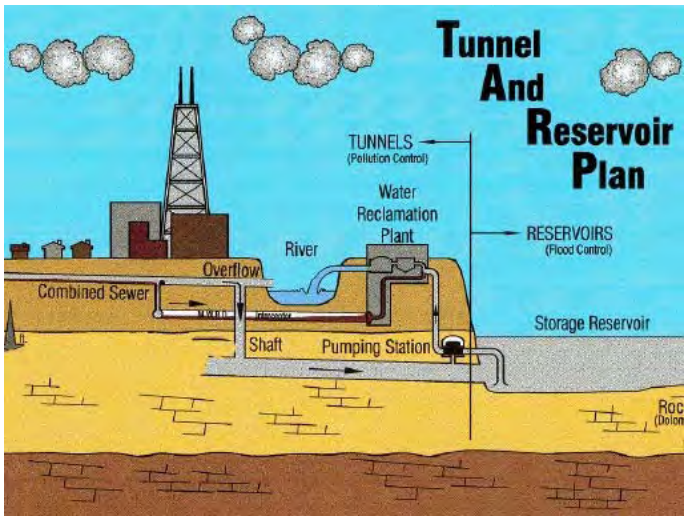


Source: Village of Niles GIS Department

Figure 2-6: Village Combined Sewer

The combined sewer system conveys both sanitary and storm water to the MWRDGC treatment plant in Skokie located on Howard Street. The sewage and waste water is generated from inside homes and businesses through sinks, toilets, dishwashers, washing machines, etc. The stormwater enters the combined sewer system from yards, fields, streets, parking lots, and exterior drains.

In addition, stormwater enters the sanitary system through elicit inflow points from downspouts, footing tiles, and sump pumps, as well as through infiltration points caused by cracks or defects in the main line or defective sanitary sewer laterals between the home and main sewer. Inflow and infiltration (I/I) seriously reduces a combined sewer's ability to transport wastewater to the treatment facility potentially causing sanitary backups in homes during intense rain events.



Source: US Army Corps of Engineers

Source: MWRDGC

Figure 2-7: Tunnel and Reservoir Plan

2.3.2 Regional Stormwater System. The combined sewer and sanitary systems discharge into MWRDGC sewer lines which are much larger and are commonly referred to as interceptors. In Niles there are seven interceptors and eight Deep Tunnel overflow points as part of the Tunnel and Reservoir Plan (TARP) (see Appendix C for Village of Niles MWRDGC Outfalls Map). Under normal conditions, the interceptors convey the Village's wastewater to the MWRDGC North Side Waste Reclamation Plant (WRP) in Skokie.

> Note 3: "The main goals of TARP are to protect Lake Michigan – the region's drinking water supply for more than 5 million people – from raw sewage pollution, improve the quality of area waterways and provide an outlet for floodwater to reduce street and basement sewage backup flooding." (MWRDGC, 2008)

This treatment plant serves an area generally bordered by Lake-Cook Road on the north, the Tri-State on the west, Lake Michigan on the east and Fullerton Avenue on the south. This area is roughly 141 square miles and incorporates more than 15 communities and is home to approximately 1.3 million people. Under normal dry weather conditions, the North Side WRP can adequately treat the sewage and then release it into the North Branch of the Chicago River and the North Shore Channel.

During periods of high intensity and/or prolonged rainstorms, these interceptors get inundated by rain water through excess inflow and infiltration from the combined sewer systems. Although the North Side WRP can pump a maximum of 500 million gallons per day, measures are taken at times to bypass the

treatment plant and discharge directly into the Deep Tunnel overflow points. Under extreme conditions, untreated sewage is released into Lake Michigan.

2.4 The Regional Flood Reaction

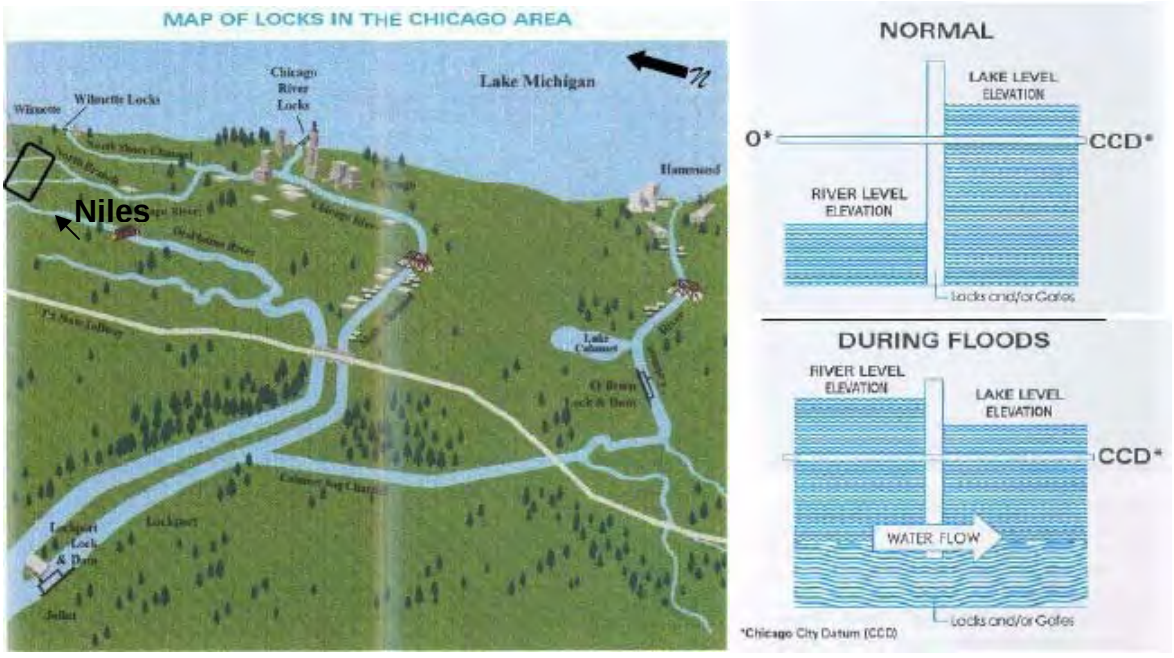
The following account of the September 2008 storm event was provided by MWRDGC Assistant Engineer of Treatment Plant Operations, Paul Woszczak.

- Prior to the start of the main rain event, MWRDGC obtained permission from the Army Corps of Engineers to lower the area waterways by running extra water through the turbines at the Lockport Powerhouse. This action allowed MWRDGC to get more holding capacity for the water that drains into the Des Plaines River, the Chicago River, Sanitary and Ship Canal, and the North Shore Channel. The lowering of the river is controlled by the Army Corps of Engineers, so as to not impede river navigation.

- At 6:18 a.m. on Saturday, September 13th, the Wilmette sluice gates were opened for the first time in six years to lower water levels in the Chicago River and area waterways.

- At 7:30 a.m. on Saturday, September 13th, the Deep Tunnel's 2.6 billion gallon capacity was full.

- At 10:15 a.m. on Saturday, September 13th, the Chicago River Controlling Works gate near Navy Pier was opened.

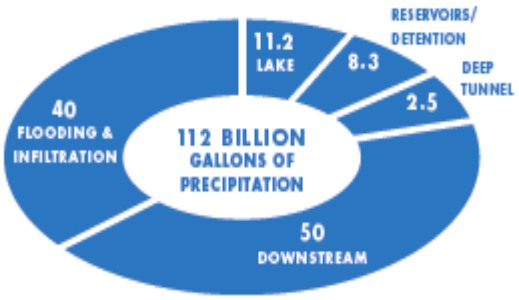


Source: MWRDGC

"Why didn't we (MWRDGC) open the Wilmette gate sooner? Because there has to be a five foot increase in the North Shore Channel (NSC) water elevation otherwise Lake Michigan would flow back into the NSC compounding the problem and causing more flooding issues downstream."
- Paul Woszczak, Assistant Engineer of Treatment Plant Operations

Figure 2-8: Map of Locks and Operation during Floods

MWRDGC estimates that close to 112 billion gallons of precipitation fell across Cook County during the September 2008 storm (Figure 2-9). During the storm, about 11.2 billion gallons were released into Lake Michigan, 10.8 billion gallons were retained by the reservoirs and deep tunnel and another 50 billion gallons were released in the river. That leaves about 40 billion gallons that caused flooding and infiltration. MWRDGC Commissioner Debra Shore (2008) states in her 2008 Annual Report,



Source: Debra Shore - 2008 Annual Report

Figure 2-9: Total Precipitation Sept. 2008

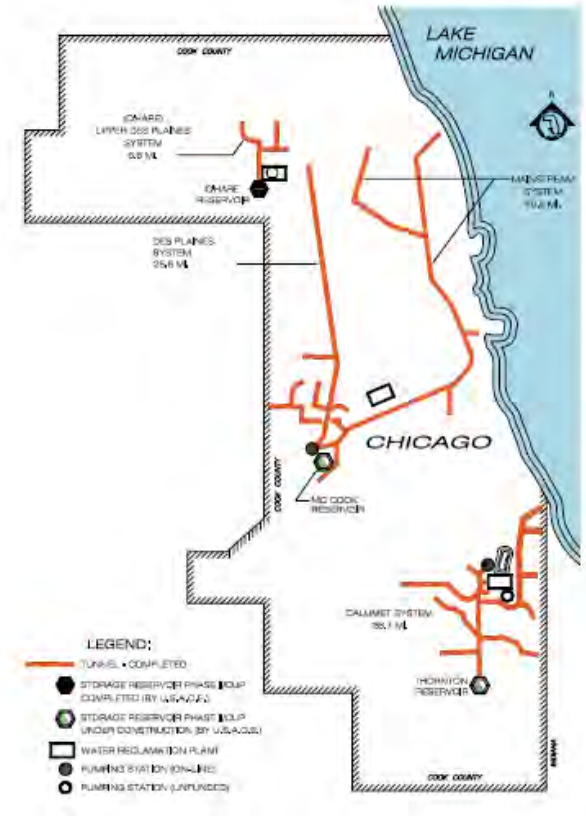
> "What can we do about this? In truth, we cannot build pipes and reservoirs big enough to hold such huge amounts of stormwater runoff. Municipal leaders agree that the costs would be astronomical and the federal support for such large-scale infrastructure projects is dwindling. Yet we can try to peel back some of the concrete skin (impervious surfaces) we have laid over the landscape to capture rainwater where it falls and allow it to recharge our underground aquifers."

MWRDGC TARP SYSTEM CAPACITY

- 109 miles of Deep Tunnel holds 2.5 billion gallons.
- 37 regional detention ponds and reservoirs hold 8.3 billion gallons.

Future Improvements:

- McCook Reservoir is under construction and due to be completed in 2015 which will initially hold 3.5 billion gallons.
- Enlarging McCook Reservoir will add 7 billion gallons of capacity by 2023.



Source: MWRDGC

Figure 2-10: TARP System Map

Note 4: The Village of Niles does not control any of these combined sewer points (Appendix C) connecting to the MWRDGC system.

Note 5: Many residents stated that they noticed a quick drop in the level of water in the street during various times on September 13th. It was explained by stormwater engineers that once the intensity of rain subsides, even slightly, surcharged sewers are given a chance to catch up and again begin taking water. When a full sewer is again able to accept water, a quick drop and even swirling water into drains may be observed. This can be compared to having a sink or tub full of water, then suddenly opening the drain.

3 STORMWATER COMMISSION

Following severe village-wide and regional flooding that was declared a disaster by FEMA, Mayor Robert M. Callero reached out to residents by arranging an emergency public meeting to promote flood recovery operations and to gain insight about ongoing or "persistent" flooding issues in the Village. After hearing from over 250 residents in attendance at the public forum, the Mayor directed staff to develop a Resident Stormwater Survey that would be used to reach out to the entire Village about stormwater issues.

Shortly thereafter, Mayor Callero appointed a Stormwater Commission consisting of the following personnel: Commission Chair Trustee Joe LoVerde, the Assistant Village Manager, the Public Services Director, the Village Engineer, the Community Development Director, the Assistant Community Development Director, and the Senior GIS Coordinator. The Stormwater Commission met nearly twice a month since the kickoff meeting held on January 30, 2009. The Mayor and Village Manager also attended many of the scheduled meetings.

3.1 Stormwater Commission Goals

To identify, evaluate, and report back on "persistent" stormwater related issues within the Village of Niles.

3.2 Study Methodology. The following study methodology was developed:

Study Methodology

I. Collect data
- Resident Stormwater Surveys
  - Site visits and field inspections
  - Field and phone interviews
- Mapping data
  - FEMA Flood Zone
  - MWRDGC Outfall Points
  - 2 foot contour
  - Street and property lot lines
  - Combined sewer area
  - Roofline (on order)

- Sewer system (hard copy only)
  - Visible sewer assets (in process)
  - Invert elevations (not available)
- Local and regional stormwater policies/practices
- MWRDGC regional efforts (TARP)

II. Plot data with GIS mapping system

III. Stormwater Workshop – this step was added by the Commission to facilitate the collection of "persistent" flooding data

IV. Determine existing conditions, opportunities, and make Recommendations

V. Report to Mayor and Village

3.3 Resident Stormwater Survey Results

Over 12,000 Resident Stormwater Surveys were mailed to residents through the *Focus on Niles* Newsletter (See Appendix D). Many more were downloaded from the Village of Niles website and hand delivered by request. 436 surveys were completed and returned by residents. The Commission considers a return of 436 surveys to be very good.

1.	Has stormwater ever flooded your property?	**89%** Yes	**11%** No If Yes….
2.	What were the limits of the flooding? (Check all that apply)	In Yard In Street In House	**63%** Yes **63%** Yes **80%** Yes
3.	In the last ten years, how many times has your home flooded? **18%**-Never **19%**-1 time **25%**-2 times **15%**-3 times **8%**-4 times **16%**-5 or more times		
4.	Are storm drains or ditches located on your property?	**20%** Yes	**77%** No
5.	Have you ever observed storm drains overflowing by your home?	**45%** Yes	**52%** No
6.	Do you have a sump pump?	**47%** Yes	**53%** No
7.	Where does the sump pump discharge?	**23%** Yard	**20%** Sewer **1%** Other
8.	Do you have a combination sanitary and stormwater sewer?	**17%** Yes	**18%** No **65%** don't know
9.	Have you experienced sanitary sewer backups (through drain, toilet, etc.)?	**50%** Yes	**49%** No
10.	Do you employ any of the following combination sewer backup methods? **14%** Floor Drain Plug **8%** Standpipe **15%** Overhead Sewer **13%** Flood Control System		
11.	During this last flood on September 12 – 14, what area of your home flooded? **17%** No Flooding **9%** Crawl Space **75%** Basement **3%** First Floor **12%** Garage		
12.	How did the flood water enter your home? **62%** Sewer Drain **7%** Door **7%** Window **13%** Cracks in Walls **2%** Other		

Source: Village of Niles GIS Department

Table 3-1: Resident Stormwater Survey Results

Note 6: 21% of respondents to the Resident Stormwater Survey have installed a Flood Control System since September 2008.

Although over 12,000 surveys were mailed, we must take into account that the survey is designed to be answered by those who experienced flooding in the last ten years. So, if the Commission considers the 781 homes identified with flood damage last September, there is a 56% response rate. If the Commission considers the 561 homeowners who applied for FEMA flood assistance, there is a 78% response rate. A typical non-employee response rate for a survey is between 10% - 30%.

The Stormwater Survey provided valuable information regarding the devastation of the September 2008 storm and other stormwater education issues (Table 3-1). However, the Commission required a better understanding of "persistent" flooding events over the past ten years. To gain a better understanding of persistent flooding, the Commission held a public workshop, conducted additional site investigations, and extracted survey data from homes that flooded 3, 4, and 5+ times. The three tables below and the maps in Appendix E identify what some of the most persistent issues are and where they occur.

Flooded 3 Times in 10 Years (62 Homes)- Yellow Circles on Map

Point of Entry	Number of Homes Impacted	Percentage
Sewer Drain Backup (drain, toilet, and/or sink)	53	85%
Seepage (cracks or over foundation)	9	15%
Window or Door	6	10%
Sump Pump System Failure	2	3%
Recently Installed Flood Control System	*8*	*13%*

Note: Some homes experience multiple issues

Source: VON, GIS Department

Table 3-2: Resident Data for Flooding In-home Three Times in Ten Years

Flooded 4 Times in 10 Years (33 Homes) Orange Circles on Map

Point of Entry	Number of Homes Impacted	Percentage
Sewer Drain Backup (drain, toilet, and/or sink)	21	64%
Seepage (cracks or over foundation)	11	33%
Window or Door	4	12%
Sump Pump System Failure	4	12%
Recently Installed Flood Control System	*4*	*12%*

Note: Some homes experience multiple issues

Source: VON, GIS Department

Table 3-3: Resident Data for Flooding In-home Four Times in Ten Years

Flooded 5 or More Times in 10 Years (59 Homes) Red Circles on Map

Point of Entry	Number of Homes Impacted	Percentage
Sewer Drain Backup (drain, toilet, and/or sink)	36	61%
Seepage (cracks or over foundation)	19	32%
Window or Door	11	19%
Sump Pump System Failure	3	5%
Recently Installed Flood Control System	*6*	*10%*

Note: Some homes experience multiple issues

Source: VON, GIS Department

Table 3-4: Resident Data for Flooding In-home Five Times in Ten Years

Note 7: The Commission does not downplay the negative impact and devastation of the September 2008 storm. As noted above in 2.1 of this report, this storm was a regional disaster containing all three factors that independently influence flood conditions: intensity, duration, and soil saturation. Based on the recurrence interval data used today (*Bulletin 70 Illinois State Water Survey 1989*) this was rated to be a 100-year storm or a storm with a one percent chance of occurring. Although rain storm intensity may be increasing in the State of Illinois, it is widely accepted that it is not possible for any combined sewer community to construct a stormwater system that would protect all homeowners from flooding during a 100-year storm.

Note 8: See Appendix F to see written comments made by survey respondents.

3.4 Stormwater Workshop

In an effort to gather more information from homeowners and to focus on "persistent" stormwater issues within the Village of Niles, the Commission held a Stormwater Workshop on Wednesday, May 20, 2009 (See Appendix G for Layout and summary of Workshop). The goal of the workshop was threefold: 1) To gather information from homeowners who did not submit a survey; 2) To validate collected data and focus on "persistent" flooding issues; and 3) To help educate homeowners about home, local, and regional stormwater issues.

After Action Review - Workshop

- Over 250 homeowners participated.
- 38 new Resident Stormwater Surveys were completed.
- 70 or more homeowners requested site visits to discuss stormwater and sanitary system issues at home.
- Homeowners requested information on how to install rain barrels and where to purchase them.
- Homeowners requested plumbing advice and asked about types of flood control available to them.
- Based on homeowner questions, Commission members agree there is a general need for homeowner education regarding home stormwater systems.

- Homeowners asked questions about street flooding and combined sewer areas.
- It was common to hear about sump pump failures.
- Homeowners requested Engineer to shoot grades and recommend storm relief solution for rear yard flooding. Some homeowners are happy to get advice and some want Village to pay for solution.
- Homeowners found the representatives from MWRDGC, the Friends of the Chicago River, the Center for Neighborhood Technology, and the Environmental Protection Agency to be informative.
- Atlas, the GIS and Property Information program recently developed, was used extensively by residents during the workshop.
- Appendixes H, I, J, and K were created for this workshop.

The overall workshop was a success. Although it delayed the final report due to generating many more site visits for members on the Commission, it left homeowners and Commission members more informed about stormwater issues. Homeowners were also pleased to see the level of study being conducted on the issue. There were, however, a few who voiced disappointment because they expected some sort of Village subsidy or they were simply frustrated that Commission members could not answer complex questions requiring more study and/or funds.

Note 9: The workshop was advertised in local papers and on the Village website. Letters were also sent to any household that submitted a survey or was previously identified as having storm damage.

4 ANALYSIS AND FINDINGS

Over nearly eight months, the Stormwater Commission has conducted a comprehensive Stormwater Survey of homeowners, hosted a public hearing and workshop, and conducted scores of site investigations (See Appendix L). This information was then utilized to map areas of concern, to identify the location and types of persistent stormwater issues, to determine contributing factors, and to reevaluate Village policy and/or operations in an effort to suggest recommendations designed to improve stormwater conditions. When it was practicable, the Stormwater Commission facilitated the pursuit of stormwater solutions.

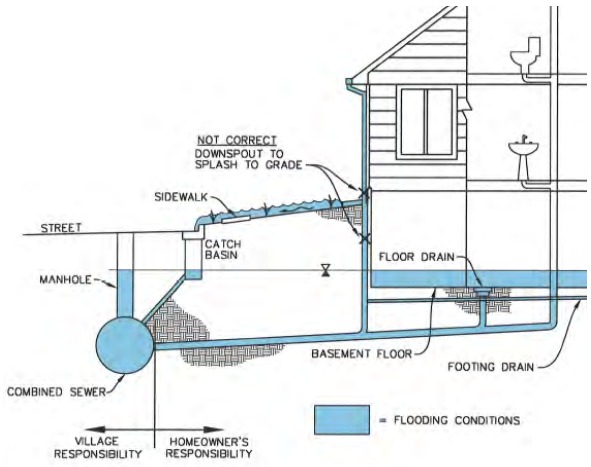
4.1 In-home flooding issues

4.1.1. Sewer surcharge – During the September 2008 storm, 62% of those who responded to the survey (about 270 respondents) had some form of sanitary backup in their home. This sewer water entered their home through a floor drain, shower drain, sink, toilet or sump located in their basement. Contributing factors could be: 1) no flood control; 2) failed flood control; 3) a sump pump directly connected to the sanitary

sewer; or 4) a blocked or defective connection between the home and sanitary sewer main. Figure 4-1 shows a typical Niles home without a flood control system.

To get an idea of more persistent sanitary sewer backups, the following data is pulled from Tables 3-2, 3-3, and 3-4:

- Sanitary backup 3 times in ten years: 53 homes
- Sanitary backup 4 times in ten years: 21 homes
- Sanitary backup 5 or more times in ten years: 36 homes



This figure shows a typical Niles home without flood control. Homes without operational flood control will always face the threat of sewer surcharge.

Source: Village of Niles

Figure 4-1: Typical Niles Home without Flood Control Protection

See Appendix N to better understand typical residential storm and sanitary systems. See how stormwater impacts homes without flood control and how it impacts homes that have flood control such as overhead plumbing, check valves, check valves with pumps, lift stations and a typical home with separated sanitary and storm sewers.

Note 10: 26 survey respondents installed flood control since the September 2008 storm.

Note 11: Overall, 110 households installed flood control after the September 2008 storm.

4.1.2. Stormwater through windows or doors – During the September 2008 storm, 14% of those who responded to the survey (about 61 respondents) had stormwater enter their home or a garage through a door, window, and/or window well. In some cases, the stormwater filled a crawl space and then entered the living spaces of the home through the floor or vent. Contributing factors could be: 1) a flooded street; 2) vehicles causing wakes; 3) a below grade garage; or 4) poor lot grading.

To get an idea of more persistent cases, the following data is pulled from Tables 3-2, 3-3, and 3-4:

- Window or Door 3 times in ten years: 6 homes
- Window or Door 4 times in ten years: 4 homes
- Window or Door 5 or more times in ten years: 11 homes

4.1.3. Seepage – During the September 2008 storm, 13% of those who responded to the survey (about 57 respondents) had some form of seepage in their home. This water would enter through cracks, holes, and joints in their basement floors and/or walls (See Figure 4-2). Many also reported seepage over the top of foundation where the foundation meets the walls. Contributing factors could be: 1) poor lot grading; 2) downspouts discharging too close to foundation; 3) cracked or failed drain tile; 4) deficient flood proofing; or 5) absence of sump pump system.

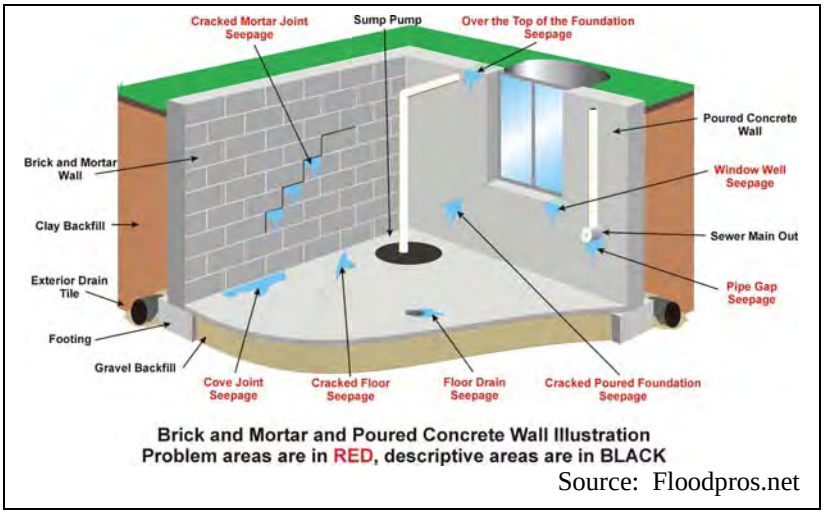


Figure 4-2: Typical Basement Seepage

To get an idea of more persistent seepage issues, the following data is pulled from Tables 3-2, 3-3, and 3-4:

- Seepage 3 times in ten years: 9 homes
- Seepage 4 times in ten years: 11 homes
- Seepage 5 or more times in ten years: 19 homes

4.1.4. Sump pump failure – Based on the general survey totals, it is difficult to determine exactly how many homes experienced flooding due to sump pump failure, which is usually caused by inadequate maintenance, insufficient capacity, or absence of battery backup systems. It is also very likely that some households reported seepage that was actually caused by a sump pump pit overflow. Contributing factors could be: 1) inadequate maintenance; 2) insufficient pump capacity; 3) absence of battery backup; or 4) switch failure.

A closer look at the surveys of those who reported more persistent flooding provides some answers. The following data is pulled from Tables 3-2, 3-3, and 3-4:

- Sump Pump Failure 3 times in ten years: 2 homes
- Sump Pump Failure 4 times in ten years: 4 homes
- Sump Pump Failure 5 or more times in ten years: 3 homes

4.2 General Stormwater Issues

Photo 4-1: Street Flooding

4.2.1. Street/alley flooding – There are a number of streets that flood during significant rain falls (See Appendix M). One contributor to flooding may be clogged or obstructed sewer inlets, restrictors, and/or sewers. Some sewers are simply too small or may require a separated sewer system. Another reason for street flooding is that some roads are meant to serve as a secondary conveyor of stormwater during extreme events so that the road floods instead of the buildings along the street. This is done by installing an inlet restrictor valve.

Photo 4-2: Alley Flooding

The issues caused by flooded streets or alleys:

- Stormwater reaches the home, breaching storm control system.
- Homes splashed by wakes caused by vehicles (in some cases these vehicles breach barricades erected by Village or residents).
- Vehicle water damage.
- Limited emergency vehicle access.
- Limited homeowner access.
- The lack of barricades on flooded streets when needed.
- Flooded alleys that flood rear yards and garages.
- Alleys graded higher than rear yards restricting stormwater flow from rear yards.

4.2.2. Yard flooding – Beyond in-home, yard flooding (primarily rear yard) is by far the most aggravating stormwater issue for many homeowners in the Village of Niles (See Appendix M).

Photo 4-3: Rear Yard Flooding

The causes of yard flooding:

- Yard flooding can develop over time or overnight from the obstruction of the natural flow of stormwater by a fence, a wood pile, a garden, shrubbery, a berm and any landscaping that changes the grade of the property without a permit as per Sec. 18-376.
- An improperly graded yard that is flat causing minor ponding.

- A neighbor's sump pump or downspout that is ejecting onto an adjacent property.
- An adjacent property grade improperly raised during new construction or reconstruction.
- An adjacent business property stormwater system is insufficient and spills over.
- New construction that eliminates pervious surfaces.

The issues caused by yard flooding:

- Ruined lawns and landscaping.
- Rotted fences and other structures.
- Reduced access to property and enjoyment of yard.
- Increased chance for standing water and mosquitoes.
- Seepage into window wells and basements that are not properly waterproofed.
- Flooding into basement stairwells.
- Adding rear yard "mini" sewers that drain into combined sewer system reduces sewer capacity.

4.2.3. Stormwater runoff – Stormwater runoff from 3rd party properties is a significant issue in the Village of Niles. This runoff is coming from public and private parks, parking lots, cemeteries, and adjacent municipalities. Over the past year, the Commission has been working with several 3rd parties to work on solutions.

Photo 4-4: Stormwater Runoff & Vehicle Wake

The issues caused by this stormwater runoff that is not detained or retained:

- It can quickly surge the combined sewer and stormwater sewer systems, raising street flooding levels and increasing probability of sewer backups.
- Overland flow of stormwater causing direct flooding through doors, windows wells, garages and in crawl spaces.
- Overland flow of stormwater flooding in rear yards that may increase the chance for basement seepage or sump pump failure.

Note 12: 2.1 inches of rain or a 2-year storm on an empty field generates about 50,000 gallons of stormwater per acre.

4.2.4. Inflow and Infiltration – Most of the Village of Niles, like most older municipalities in the United States, was built with a combined sewer system - 75% combined sewer. Designed many years ago to collect stormwater runoff and sewage in a single pipe, this system was more

effective when there were fewer homes and more pervious surface for stormwater to permeate before entering the sewer system. But even the heavy rainfall of 1967 was too much for the combined sewer system, as was the rainfall conditions of 2008. Heavy rainfall or snowmelt will cause the capacity of a combined sewer system to be exceeded.

Figure 4-3: Downspout Inflow

Example of Inflow: A downspout connected directly to the combined sewer system.

In an effort to reduce the peak flow of stormwater entering the combined sewer system; the Village must work to reduce Inflow and Infiltration, which can add as much as 25 times more flow per day during a rain storm. Inflow is stormwater that enters the combined sewer system at points of direct connection to the system. Various sources contribute to the inflow, including footing or foundation drains, downspouts, drains from window wells, and sump pumps. Many of these types of illicit connections have been identified during the study and must be addressed.

Instead of a sump pump being splashed across a rear or front yard where the water is allowed to permeate, sump pump lines have been discovered connected directly to combined sewers. Not only does this connection add to the peak sewer flow during storms, but if the sewer was to back up, there is now a direct connection into the home. There are some cases, however, where a homeowner may have a high water table and a sump pump that runs constantly. There must be somewhere for this water to go and the rear yard may not be practical, so a direct connection to a sewer may be necessary in some cases to prevent rear yard flooding.

Infiltration is from ground water or excess stormwater that enters the combined sewer through open joints, cracks, breaks in the pipes and/or damaged household laterals. The average household lateral is designed to last about 20-50 years, depending on material, settlement, or root intrusion. In many cases, however, they go too long without inspection or repair.

Example of Infiltration: A deteriorated house lateral that allowed water to seep into the combined sewer

Figure 4-4: Home Lateral Infiltration

4.2.5. The regional system – The function of the Village's combined sewer system is closely tied to the proper and future function of the planned expansion of the regional MWRDGC system. Although the Village of Niles is developing a close

working relationship with MWRDGC, it would be wise for the Village to better understand and evaluate the hydraulic performance of the river stages and collection systems owned by the District, State, or other municipalities to assess their possible contribution to local flooding. There should also be a strong understanding of what the local impact of the improvements at the McCook Reservoir in 2015 will be.

A strong understanding will guide future studies as to whether improvement strategies may focus on the local system or providing protection from systems draining into it.

4.2.6. GIS stormwater mapping – The greatest tool for the Stormwater Commission is the GIS mapping system, which has played a crucial role in identifying areas of persistent flooding. But, more must be done to improve the data that will be invaluable for future understanding of the deficiencies in the systems performance and identify potential locations for implementing stormwater best management practices (BMPs). And more must also be done to create a GIS system that will allow the Village to monitor flood events, identify new problems, track success of improvements, and anticipate potential problems. However, GIS is data driven and labor intensive. To date, the Village of Niles is collecting "visible sewer assets" data, but still requires the collection of invert elevations that will allow future computer modeling and hydrology/hydraulics testing. In addition, the Village has one GIS trained employee to complete this labor intensive work.

4.2.7. Green Infrastructure – As an environmental strategy, green infrastructure addresses the root cause of stormwater and combined sewer overflow by collecting stormwater before it becomes runoff. "Green infrastructure is being used to intercept precipitation and allow it to infiltrate rather than being collected on and conveyed from impervious surfaces" (Kloss, 2006). Will green infrastructure replace sewer pipe solutions? No. Although there may be some cases where this is true, most significant projects could benefit from a combined approach.

Figure 4-5: Residential Rain Garden

Rain Gardens:

Rain gardens utilizing native plantings – Glenview and Palatine have implemented a rain garden program to reduce the amount of stormwater entering sewer systems during peak flow periods.

Rain barrels also serve this function and may be purchased through MWRDGC.

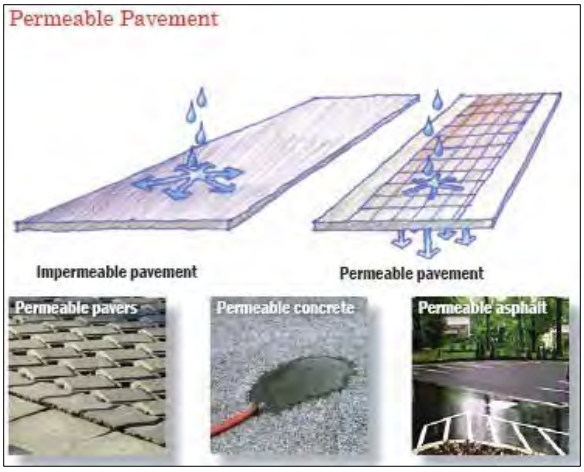


Figure 4-6: Permeable Pavement

Permeable Pavement:

Permeable concrete and asphalt – The City of Chicago and Des Plaines have successfully used permeable concrete to reduce flooding in alleys. This solution can also be used on parking strips of residential side streets that flood.

Permeable pavement is an alternative solution to more costly sewer system expansions.

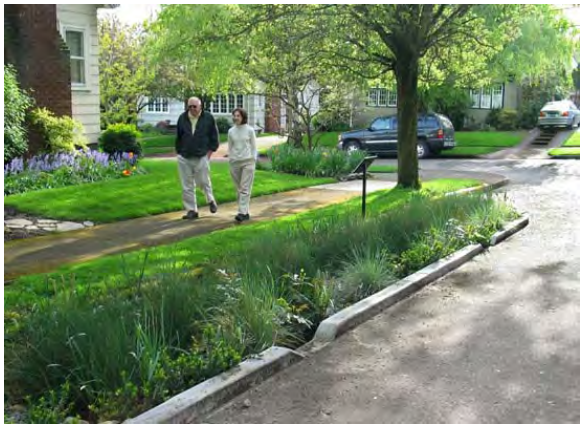


Figure 4-7: Residential Street Bioretention/Green Street

Bioretention used in residential and commercial areas (Green Street)

Green infrastructure solutions provide additional stormwater storage capacity without requiring costly sewer improvements.

Figure 4-7 demonstrates how bioretention may be utilized on a side street to increase stormwater capacity where new or larger sewers are not an option.

Figure 4-8 demonstrates how parking lot bioretention islands can replace "raised islands" to increase stormwater capacity and reduce the amount of stormwater that enters a local combined or storm sewer system.

The federal stimulus act explicitly places clear priority on projects utilizing green infrastructure solutions.

In addition, Illinois Environmental Protection Agency permits now require consideration by permittees of incorporation of green infrastructure concepts into their stormwater program.

Figure 4-8: Parking Lot Bioretention Islands

Collecting stormwater with green infrastructure before it enters the sewer system serves four purposes: 1. Peak flows that cause backups is reduced because the rain water is detained and slowed from entering the sewer system; 2. Reducing peak flow can reduce the size and cost of a sewer system; 3. Reducing runoff with green infrastructure decreases the amount of pollution introduced into waterways; and 4. Additional environmental benefits include improved air quality, mitigation of the urban heat island effect, and better aesthetics.

There is limited green infrastructure methods knowledge in the Village of Niles and some practices may even face obstacles due to current municipal law. Village Code and policy must be reviewed not only to remove obstacles that may prevent green infrastructure projects, but to encourage them as well.

> "A growing number of cities and utilities have recognized that sewer overflows can be reduced effectively by diverting stormwater from the sewer system and directing it to areas where it can be infiltrated, evapotranspirated or re-used. These approaches are often referred to as "green infrastructure" because soil and vegetation are used instead of, or in addition to, pipes, pumps, storage tunnels, and other "hard infrastructure" that is traditionally used to store and treat the combined sewage and stormwater" (EPA, 2007)

4.2.8. Homeowner education – There were strong indications from both the Resident Stormwater Survey and the Stormwater Workshop that there is a genuine need for the Village to provide better homeowner education regarding stormwater and sewers at home, at the municipal level and regionally. Case in point: 1. A large number of survey respondents (65%) were not sure if their home is served by a combined sanitary and storm sewer system; 2. During the workshop and at one-on-one site visits, many homeowners simply did not understand their own residential storm and sanitary systems; and 3. Many homeowners believe that the Village of Niles controls when and how water is sent to the regional TARP system.

4.2.9. Sewer Capacity/Enhancements – Although the Stormwater Commission has come a long way to identify stormwater issues that do not require increased sewer capacity, there is a recognized need for systems analysis of either the entire Village owned collection system or a few select systems to identify engineering solutions. This would be followed by a capital improvement program and a financing analysis. To complete this scale of work requires contracted engineering services.

4.3 Mapped Stormwater Issues by Area.

The Stormwater Commission has utilized the GIS mapping system to identify areas of "concern" within the Village. This map is based on the Resident Stormwater Survey, the Stormwater Workshop, one-on-one site

visits with homeowners, and visual confirmations during a 1.55 inch rain in March 2009 and a 3(+) inch rain in June 2009. Not all homes that experience flooding will necessarily fall within an area identified below.

The purpose of these maps is simply to provide comment on areas with shared flooding issues.

4.3.1. Stormwater Map North (Appendix E)

Area One - North

Issue One - Stormwater runoff from Glenview near Glendale Road may be contributing to flooding of nearby streets and yards in Niles.

Commission Efforts – The Village Engineer is in discussions with the Village of Glenview to work on a solution. Glenview has hired an engineer to review the issue. Area sewers were inspected and cleaned as a precaution.

Issue Two – The Village Engineer suspects that the sewer system on Greenwood is contributing to stormwater issues near Maynard Road.

Commission Efforts – The Village Engineer will be contacting County highway department to investigate further.

Area Two - North

Issue One – Courtland Drive, surrounding streets and the corner of Milwaukee Avenue and Maryland Street have significant flooding issues. There are also several homes with attached below grade garages that flood when water in street crests sidewalks. Wakes from cars become an issue when flooded.

Commission Efforts – Area to be recommended for engineering analysis. Area sewers were inspected and cleaned as a precaution.

Area Three - North

Issue One – Greenwood Avenue flooding from Oakton Street to Dempster Street.

Commission Efforts – The County hired an engineering firm to conduct an in-depth analysis of the issue and discovered that restrictors were not installed properly and sewer lines were either back pitched or built higher than the existing sewer. The Director of Public Services is working with the County Highway Department to reach resolution.

Issue Two - Stormwater runoff from Our Lady of Ransom property is seen to be negatively impacting adjacent properties and stormwater levels in the area.

Commission Efforts - Our Lady of Ransom leadership is working with the Mayor's Office toward a solution that will cause runoff from OLR property to be detained in a series of planted swales and rain gardens. During very heavy rains, such as we had on June 19, 2009, water flows from OLR property north toward Sunset Road, potentially exacerbating flooding from the street. Area sewers were inspected and cleaned as a precaution.

Issue Three - North Park in Park Ridge is negatively impacting adjacent properties and stormwater levels in the area.

Commission Efforts - The Village Engineer has discussed the issue of replacing some drainage swales on North Park that have over the past been removed or deteriorated. The Park Ridge Park District is working on rectifying the problem by replacing the swales.

Area Four - North

Issue One – Stormwater runoff from Maryhill Cemetery is negatively impacting adjacent properties and stormwater levels to the west and south. It is believed that the stormwater runoff from the cemetery is flooding streets, yards, and charging the sewers causing flooding in homes.

Commission Efforts - Commission members have been working closely with cemetery management to develop a plan of action. Since discussions have started, the cemetery has cleaned out ditches and sewer pipes that lead to the ponds along Cumberland Avenue. One outflow pipe was plugged with a very large tortoise and other debris. Area sewers were inspected and cleaned as a precaution. A blocked sewer drain was located on the southeast section of the cemetery and it has since been opened. Area sewers were inspected and cleaned as a precaution.

4.3.2. Stormwater Map Central (Appendix E)

Area One – Central (Open Land)

Issue One – During heavy rainfalls, Grennan Heights Park contributes a considerable amount of stormwater to the already taxed combined sewer system along Odell, Octavia, and Oconto.

Commission Efforts – The Park District has proposed constructing a raised sidewalk along the east side by Odell Avenue and grade the park property to retain stormwater. Area sewers were inspected and cleaned as a precaution.

Issue Two – During heavy rainfalls, NICO Park contributes a considerable amount of stormwater to the already taxed combined sewer system near Seward Street.

Commission Efforts – The Park District has worked to install a 350 foot sewer and four drainage structures to help remove the peak flow off the park during heavy rain storms.

Area Two – Central (Rear Yard Flooding)

Issue One – A significant number of homes in this area are experiencing rear yard flooding issues. As stated in 3.5.1 above, there are a number of reasons why rear yards flood. The number one reason is that a neighbor in the area somehow changed their property and interrupted the natural flow of stormwater. This can be done through simple landscaping, adding a fence, or changing the property grade. There are also a number of homes that have rear yard flooding due to stormwater runoff from a private parking lot or some other large surface.

Commission Efforts – The Commission has visited these sites and provided, in the short-term, engineering recommendations to drain yards to the sewer system. This could be problematic, however, in areas where the sewers are frequently charged in heavy rains. The Commission on at least one occasion was able to identify a blockage caused by a neighbor and, through cooperative efforts, had the neighbor remove the blockage. The blockage was the beginning of a landscaping project that was caught early before a substantial amount of money was spent.

In the long-term, several recommendations in Part 5 below, to some extent, address rear yard flooding. In the short-term, if the Village decides to assist homeowners with rear yard flooding, a prioritization process will need to be developed to assist those with the worst flooding first.

Area Three – Central (Street Flooding)

Issue One – Most homeowners understand that a number of streets have been designed to flood with the installation of inlet restrictor valves. This device, in essence, shrinks the sewer pipe to funnel and regulate the water from the street to the main sewer line. During a heavy rain event, the smaller opening allows less water into the sewer system. The streets act as a temporary holding area for the rainfall. Surplus water in the system will not be forcing contaminated water back through homeowners' private lines and into the home's lowest spot - the basement. The street ponding buys time for the system to catch up.

However, there are a number of streets in the central part of Niles where flood waters will reach homes and enter crawl spaces, window wells, and

even front doors. What good are basement flood control devices when water from the street literally overruns them? This issue is exacerbated by wakes caused from vehicles driving through flooded streets – with or without erected road blocks.

Commission Efforts – The Commission spent a significant amount of time meeting with homeowners of this area. Whenever a street was identified as a street that floods persistently, Public Services was sent to inspect and clean the sewer system inlets and catch basins. In some cases, blockages were identified and removed. The Commission agrees that this area and any area impacting it require engineering analysis.

4.3.3. Stormwater Map South (Appendix E)

Area One – South (Open Lands)

Issue One – During heavy rainfalls, Jonquil Terrace Park contributes a considerable amount of stormwater to the already taxed combined sewer system along Mulford Street and Oleander Avenue. This stormwater also contributes to the rear yard flooding of the homes on Oleander Avenue.

Commission Efforts – The Park District has proposed a 400 foot sewer and six drainage structures. Area sewers were inspected and cleaned as a precaution.

Issue Two – During heavy rainfalls, Kirk Lane Park contributed to rear yard flooding at the homes along Jonquil Terrace.

Commission Efforts – The Commission did not act on this issue, for it was already under consideration by the Niles Park District. The Park District graded the park and installed 200 feet of sewer with four drainage structures.

Issue Three – Stormwater runoff from Saint Adalbert Cemetery has impacted the Renaissance Condominiums by flooding parking lots and homes. Property grade issues were identified on condominium property and a failed berm was identified on cemetery property.

Commission Efforts – The Commission worked with both the cemetery and condominiums to rebuild a failed cemetery berm, install a flap gate to prevent sewer surcharge, and is now waiting for condominium management to complete additional site work.

Area Two – South (Street Flooding)

Issue One – Street flooding to the south of Oakton Street is similar to what occurs within the Central Map, but not nearly as prevalent.

5 CONCLUSION

The record storm event of 2008 and the Public Forum that followed was the catalyst to the creation of the Stormwater Commission. Over the past nine months, the Stormwater Commission has utilized extensive data collection, analysis and public interaction to bring to light in this report the type and location of persistent stormwater runoff issues that should be addressed by the entire community in an effort to reduce the negative impact of high intensity and prolonged rainstorms.

The Village and the Commission must reach out to educate and work with large property owners (schools, churches, parks, neighboring municipalities, businesses, etc.) with stormwater runoff issues in an effort to encourage them to be good neighbors and do what they can to capture and slow stormwater runoff at the source, preventing it from contributing to the flooding of streets, yards and homes. The Village and the Commission must reach out to educate and work with homeowners to promote flood proofing within and around their home and to encourage stormwater best management practices that benefit the entire community.

In addition, the Village and the Commission must aggressively move forward updating municipal ordinances, policies, and procedures that will help to meet the changing needs and challenges of stormwater management within the Village and region. Most importantly, the Village must take the steps necessary to better understand the weaknesses of the stormwater system and to develop short- and long-term approaches to a capital plan meant to reduce or eliminate persistent stormwater incidents caused by an aging infrastructure.

6 RECOMMENDATIONS

6.1 Homeowner Education

A homeowner education campaign consisting of: site visits; public forums; streaming video for the Village website and a future government channel; newsletter and newspaper articles; and community-wide mailings and information packets should be implemented on the following items.

6.1.1. Establish a "flood protection starts at home" campaign. The campaign would encourage homeowners to install "flood control devices" if they have not already done so. It is important to understand that all stormwater facilities have their own limits of capacity, and each swale, ditch, sewer, etc., at times, may be exceeded during an event and no person or property is ever truly free of the risk of flooding. In addition, capacity issues within the Village's separate storm and combined sewer systems that have been observed will take time to and it is ultimately up to the individual to protect their own investments.

The Village's role in the program is recommended to be one of being a technical resource by providing information on techniques homeowners might use and possibly a list of Village licensed plumbers that would perform the work.

Flood protection methods include: Installing flood control devices such as overhead sewers, check valves and lift stations; repairing leaks in walls, floors, windows, or foundations; installing sump pumps due to a rising water table; improving lot grading with proper permits; ensuring stormwater does not collect next to the house; directing sump pump and downspout discharge 6 to 10 feet from house over grassy/permeable areas; ensure gutters and downspouts are free of debris; disconnecting sump pumps from sanitary lines; regularly clean sanitary sewer lateral between home and sewer to protect against blockages caused by tree roots, grease, and objects not meant to go down toilet or drain; maintain and consider check valves in private yard drains; install and consider raising washers, dryers, water heaters, furnaces and other valuable items off basement floors. Annual inspections and maintenance of home drainage systems is a must to guard against system failure. In addition, homeowners will be encouraged to be a good neighbor and keep sewer manhole covers near their homes clear of debris, especially prior to and during rain events.

6.1.2. Encourage homeowners to add battery backup and switch alarms to sump pump systems. It is well known that if more homes lost power during the September storm than did, there would have been more flood damage caused by inoperable sump pumps due to no battery backup. Also, failed switches are the number one reason for sump pump failures, so frequent maintenance is recommended.

6.1.3. Educate homeowners about areas designed to flood in heavy rain. Many homeowners do not understand that in areas of combined sewers, it is to their benefit that the stormwater stored in their street is not in the combined storm sewer system because this would most likely cause basement flooding. This information may also encourage some residents not to park vehicles in low areas during substantial rains.

6.1.4. Educate homeowners to stop stormwater inflow into combined sewers from sumps, downspouts, and other sources. On average during a heavy rain, homes that have downspouts and sump pumps connected to a sanitary sewer can add 1,000 gallons per hour to the wastewater flow, which is the normal flow from over 60 homes.

See educational material (Appendix I) developed by Commission: "Managing Stormwater at Home – A How-to Guide". This guide discusses downspout disconnection, rain barrels, rain gardens, permeable paving, and illustrates typical combined sewer systems found within the Village of Niles.

6.1.5. Educate homeowners about reducing stormwater runoff. Residents' management of their own properties can make a significant difference in the amount of stormwater runoff that contributes to flooding. This includes both properties located in flood-prone areas and properties located in steep areas that experience little or no flooding but that contribute substantial runoff to lower-lying homes. Homeowners should take actions to reduce runoff on their property by: increasing on-site stormwater storage with rain barrels, rain gardens, vegetated swales and/or drywells; reducing impervious surfaces; and utilizing pervious concrete, asphalt, or pavers for paths, driveways, and/or patios.

See educational material (Appendix J) developed by Commission: "Rain Gardens and Native Plantings – A Step-by-Step Guide".

6.1.6. Educate homeowners not to disturb natural water flow through their properties. Front, side, and back yards typically utilize overland drainage. The water flows from the home, toward the front or back yards and eventually across four or five lots until it reaches an outfall location. This outfall location could be a sewer, detention/retention, or a natural low area. Over the years, property owners have installed landscaping, fences, etc. that impede the overland flow of stormwater causing soggy areas and standing water on their property or the property of neighbors during heavy rain events.

Although the commission is recommending policies guarding against the disturbance of natural water flows and negatively impacting neighboring properties with stormwater runoff, homeowners must be cognizant that the placement of wood piles, gardens, etc. in their yard should be done carefully as to not negatively impact the natural water flow in the area.

6.1.7. Encourage homeowners to avoid contaminating stormwater. Homeowners can help to protect the stormwater that eventually returns to rivers and lakes. They can do this by: never pouring toxic materials, oils, or paints down household drains or into sewers; picking up after pets; using pesticides and fertilizers carefully or not at all; selecting native plants and grasses for gardens; bagging yard debris and ensuring it does not get blown or raked into the street where it may enter sewers; cleaning cars at a car wash; and cleaning paint brushes in a sink. The commission has created the handout "After the Rain – Guide to Understanding Stormwater Management" that speaks to these issues (Appendix K).

6.2. Village Policy

There is a need for the Village of Niles to update a number of ordinances and create new ordinances in an effort to meet the changing needs and challenges of stormwater management. Any new regulation may not generally relieve existing problems, but it can prevent the creation of new ones.

6.2.1. Require overhead sewers. Plumbing state law with local ordinance Sec. 18-22 does already require overhead sewer. The local ordinance is stricter for major renovation that occurs. **Approved [1965, 2002 Amended]**

6.2.2. Lot grading verification. 18-375 is regarding grading requirements for land improvements to ensure proper lot grading before Certificate of Occupancy is approved. This allows Engineering to confirm final grading is what was approved by Engineering Department. **Approved [June 17, 2009]**.

Also, the Village must **raise awareness with homeowners** about grading changes on their or their neighbor's property in an effort to prevent negatively impacting the natural flow of stormwater and prevent rear yard flooding. Grading changes, the number one cause of rear yard flooding, usually occur when homeowners install landscaping projects such as raised gardens, decorative garden walls, etc. without Village permit as per Sec. 18-376 of the Village Code.

6.2.3. Downspouts and "ground water" drains connected to sewers. Enforcement of existing Sec. 102-41 (f) and Sec. 102-59 should be conducted to eliminate the connection of downspouts to the sewers. Although it is estimated that 85% to 90% of the homes are disconnected, a number of homes were identified to still have downspouts connected to the sanitary system. This enforcement could be accomplished when homes are sold or by committing an inspector to accomplish this with all homes within 1 to 2 years.

6.2.4. Increase permeable requirements in residential districts. Section VII, (B), (14) allows as much as 65% of a lot to be covered with impermeable surfaces. The Planning Commission should review a recommendation to have this amended to 60%. **To be reviewed by Planning Commission.**

6.2.5. Add a fee schedule for all zoning districts creating a minimum inspection fee and sewer connection fee. The Village of Niles is one of the only municipalities without these fees, which are adopted to help support local sewer system maintenance and repair. **Additional Research Required. Commission will Request Approval [October 27, 2009]**

6.2.6. Stormwater management for developments. The purpose of this Ordinance is to mitigate the negative impacts of stormwater for the development of residential and commercial lots. **Additional Research Required. Commission will Request Approval [October 27, 2009]**

6.2.7. Prohibit depressed (below grade) attached garages. A limited number of homes in Niles that have depressed garages are negatively impacted from flooded streets. The stormwater breaches a sidewalk and runs down the drive entering the garage and then the home. Unless conditions are right, depressed garages should be prohibited. **Requesting Approval [September 22, 2009]**

6.2.8. Sump Pump discharge. Amend Sec. 102-65 to end discharge into sanitary sewer and include language to ensure stormwater discharge is passed over permeable yard surface prior to being directed into sewer system. This helps to reduce inflow and the speed in which it enters the sewer system. **Requesting Approval [September 22, 2009]**

Also, **Enforcement required** of existing Sec. 102-65 to eliminate direct connections to the sanitary sewer. This could be done when homes are sold or by committing an inspector to accomplish this with all homes within 1 to 2 years.

6.2.9. Amend fence regulations to prevent obstruction of natural flow. Sec. 18-323 (h) should be amended to ensure no new fences impede or divert the natural flow of water through a property. This ordinance is under property maintenance code to make it a violation on existing fences also when it is determined to cause a negative effect on natural flow of water. **Requesting Approval [September 22, 2009]**

6.2.10. Eliminate outdated sanitary sewer service laterals. Sec. 102-68 and Sec. 102-57 need to be amended. The goal of the amendments would be to require new structures and major remodeling projects to replace an old service line with approved pipe. **Requesting Approval [September 22, 2009]**

6.3. Village Operations

As challenges, standards, and technologies change, the Village of Niles must consider operational enhancements in an effort to reduce stormwater incidents. The following recommendations should be considered:

6.3.1. Continue utilizing and updating GIS mapping data of the Village combined/storm sewer system and identified stormwater issues. GIS plays a crucial role in managing stormwater. The GIS Coordinator, a member of the Stormwater Commission, built several layers of stormwater data that is currently being utilized to identify areas of "persistent" flooding within the Village. Although this is being done with limited GIS combined/storm sewer data, the mapping is invaluable and allows a better understanding of flooding problems and potential solutions.

Through the efforts of the GIS Steering Committee, GIS mapping data collection is moving forward with the collection of "visible sewer assets" such as catch basins, manholes, and inlets. This will be followed with the mapping of sewer lines and then eventually invert elevations. The final invert elevations will allow engineering modeling to estimate the hydrology of contributing drainage areas and the hydraulics of the sewer collection systems.

This GIS system will not only help the Village to monitor existing stormwater management practices, but also guide the Village in analyzing vulnerable areas, retrofitting existing facilities, and identifying potential locations for implementing stormwater best management practices (BMPs). This system must continue to be used by Public Services to monitor flood events, identify problems, track success of improvements, and anticipate potential flooding events.

The creation of a general use form is recommended that can be used by any Village department responding to a flood incident call. Potential data to be collected after each significant rainfall: data showing all homes with basements, overhead sewers, or flood control; total rainfall; rainfall event period; Howard Street river level; data showing specific areas of street that flood; data showing addresses with basement flooding; and data identifying homes that flood over foundation, experience sump pump failure and why, and seepage. Digital pictures should also be obtained to capture observations.

6.3.2. Establish a strong working relationship with the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). The Village of Niles serves on the North Branch Chicago River Watershed Planning Council and attends meetings for the Lower Des Plaines Watershed Planning Council. The MWRDGC has participated in two Village of Niles public events and provides public information materials. Communication lines are open for the maintenance of any nearby waterways. There is discussion between MWRDGC Public Affairs and the Village of Niles about a potential collaboration promoting stormwater best management practices (BMPs) within the Village of Niles.

6.3.3. Continue an aggressive sewer inspection and maintenance program. The Public Services Department maintains, on a daily basis, 150 miles of combined sewer mains, 75 miles of sanitary sewer mains, and 35 miles of storm sewer mains. Each of these sewer mains has hundreds of drainage basins, sewer connections, catch basins and manholes.

6.4. Capital Programs

This portion does not address a "capital improvements" plan specifically for the construction of sanitary or storm sewer capacity, which would need to be developed by a consulting civil engineering firm.

6.4.1. Continue the slip-lining program for main sanitary sewers to reduce inflow and infiltration (I/I). Back-ups in the sanitary sewer system have been experienced primarily due to the entrance of stormwater into the sanitary sewers, known as infiltration and inflow. Infiltration consists of leaks into the sewer through cracks in the pipes, open joints and root intrusions. Inflow includes direct connections such as downspouts, sump pumps, and area drains. In addition, some stormwater enters the sanitary sewer through illicit connections. It is important to note that damaged or breached laterals from homes are a major source of I/I in sanitary sewers.

6.4.2. Plan the incorporation of green infrastructure concepts. Illinois Environmental Protection Agency regulations for the MS4 Storm Water General NPDES Permit ILR40 and funding eligibility under the American Recovery and Reinvestment Act (Stimulus Bill) that requires funds be set aside for "green infrastructure". This funding could be set aside for a community-wide rain garden, rain barrel, or similar green infrastructure cost share program.

6.4.3. Identify State qualified property acquisition projects through FEMA to provide stormwater storage or improve overland flow. For State qualified projects, FEMA would provide 75 percent for the buyout. The municipality would buy the property, acquire title to it, and then clear it. The property must forever remain open space land. Property owners who want to sell their State qualified properties would be given fair market value of the home.

6.4.4. Consider employing a part-time stormwater specialist. During the months of March through October, employ a part-time individual who is knowledgeable in field of stormwater management. This individual would be available to meet one-on-one with homeowners to educate them about stormwater issues, assist them with specific stormwater problems, and provide ongoing stormwater data for GIS monitoring. This employee may only need to be employed for one season.

6.4.5. Employ an engineering services consulting firm to provide stormwater systems modeling, analysis, operation enhancements and a recommended capital improvement program. Although the commission has successfully identified stormwater issues that may be addressed through in-house efforts, some areas of concern require professional system analysis that is beyond the commission's means and capabilities. **Requesting Approval to Begin Interviewing Engineering Firms [September 22, 2009]**

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APPENDIX

Appendix A – Flood Maps (3 of 3) of September 12-14, 2008.

Appendix B – Public Meeting Flyer "Flood Recovery – Where do we go from here?"

Appendix C – Village of Niles MWRDGC Outfalls Map.

Appendix D – Winter *Focus on Niles* Newsletter with Stormwater Survey.

Appendix E – Stormwater Study Maps (North Region/Central Region/South Region) of "Persistent" Street, Yard, and Home Flooding.

Appendix F – Stormwater Survey Comments (Addresses and Names Omitted).

Appendix G – Stormwater Workshop Summary and Layout.

Appendix H – "Working Toward Stormwater Management Solutions - A Note on Our Progress."

Appendix I – "Managing Stormwater at Home – A How-to Guide."

Appendix J – "Rain Gardens and Native Plantings – A Step-by-Step Guide For Your Home."

Appendix K – "After the Rain – A Guide to Understanding Stormwater Management."

Appendix L – Partial List of Stormwater Issue Site Visits (Addresses and Names Omitted).

Appendix M – Stormwater Study Maps (North Region/Central Region/South Region) of "Persistent" Street and Yard Flooding.

Appendix N – Typical Residential Storm and Sanitary Systems