

8- Shorewood Private Property Inflow and Infiltration Prevention Strategy

The Village of Shorewood is proposing to address private property inflow and infiltration (PPII) in its sewer systems through a combination of investigative and rehabilitation efforts. Among the five separate sewer service areas, the Village has identified two with excessive inflow and infiltration. Basins SH5001 and SH6006 have also been tagged by MMSD as “broken.”

The Village has taken inflow and infiltration reduction seriously and has completed detailed I-I studies in basin SH5006 in 2010 and SH5001 in 2011. ATTACHMENTS 6 and 7 present these studies.

The Village of Shorewood is proposing to use its PPII allocation toward engineering consulting and investigative efforts in determining the extent and location of private property inflow and infiltration sources. The Village has already conducted smoke and dyed water testing in areas previously identified as prone to high inflow, indicating possible cross connections and leakage to and from private laterals.

The detailed investigative work recommended for Basin 1 and 6 sewers targets the location and identification of specific leakage suspected throughout the system. The expectation is that unintended connections and leakages between storm sewers and private laterals can cause significant inflow into the sanitary system.

In Basin 1, the Village is undertaking an extensive program of leaky lateral identification through both storm sewer flooding and injection of dyed water into the ground in the vicinity of the lateral. This program is being rolled into the current PPII program Work Plan and paid through the MMSD funds reserved for this purpose.

In Basin 6, the investigation of leaky laterals has been on-going. Storm sewer flooding has revealed that dyed water leaks out of storm sewers and is immediately captured by laterals crossing the storm sewer. The dyed water is found flowing into the sanitary sewers soon after it is introduced into the storm sewers.

Additional testing in Basin 6 is also being rolled into the current program, so the entire Basin is evaluated in this manner.

8.1 – Investigation of Laterals

The investigation targets the identification of individual laterals that are leaking. To accomplish this, the Village has devised a comprehensive approach that focuses on minimizing investigative costs and maximizing speedy results. The Village is using several means of testing, all widely used in the infrastructure management.

1. Flooding of Storm Sewers: Shorewood has had success in identifying leaky laterals by flooding storm sewers and televising sanitary sewers for evidence of leakage. In general, the Village finds that the leakage occurs through the laterals that cross the storm sewers.

2. Underground Dyed Water Injection: Shorewood is also using dyed water injection into the ground, close to or right above the sanitary sewer lateral. The camera in the sanitary sewer is used to observe any potential leakage or inflow.

The methods are currently being used and funded through the MMSD PPII funds in both Basins 1 and 6. MMSD has let and awarded a contract for lateral investigations, with specific protocols to investigate laterals as well as in-home inspections for connections in basements. The Village is currently not proposing in-home inspections.

8.2 – Rehabilitation of Laterals

The investigative work so far performed has identified individual laterals known to receive direct unintended inflow from storm sewers. These laterals will be scheduled for repairs through sealing, grouting, and lining. Storm sewers that leak out will also be scheduled for potential rehabilitation, though this work is not expected to be eligible for MMSD PPII funding.

The lateral rehabilitation work in Basin 6 is expected to occur throughout 2012. Basin 1 investigations are scheduled to start late 2011 and early 2012; such that by spring of 2012, the Village will have a lateral rehabilitation list similar to what it has in Basin 6.

A combination of funding sources, including MMSD funding will be used for lateral rehabilitation. The Village intends to supplement the MMSD funding with general tax levy funds and special assessments to residents.

Lateral rehabilitation will include the following methods:

1. Lateral Replacement: in some cases, laterals may have to be replaced due to excessive structural damage. However, the Village anticipates that lateral replacements will be exceedingly rare.
2. Lateral Lining: leaky laterals may be either entirely or partially lined. From a technological stand point, the lateral lengths in Shorewood will be suitable for lining in almost all cases.
3. Lateral Grouting: laterals where joints are identified as the source of inflow may be rehabilitated by joint grouting. A tried and true rehabilitation method, these methods can effectively address individual leakage points.
4. Service Tap Grouting: broken or damaged taps are a known source of leakage into the sewers. In some cases, the laterals may be fine, but have broken connections. Grouting at the taps will be part of the Village's lateral rehabilitation arsenal.

The decision to use which method will be developed based on visual evidence gathered through the investigation program described in this document.

8.3 – Foundation Drain Disconnection

Like many other communities in the Milwaukee metropolitan area, Shorewood has a great number of homes built before 1954, when foundation drains were connected to sanitary sewer

laterals instead of being drained into a sump crock and discharged via a sump pump. Conventional wisdom has it that foundation drains contribute a considerable amount of clear water into the sanitary system.

In fact, the Village of Shorewood has had a pioneering role in the investigation and evaluation of foundation drain impacts on the sanitary sewers. In 2001, the Village designated Basin 6 as a special area of concern and established a pilot program to remove foundation drainage from laterals and construct sump crocks and sump pumps. This was a voluntary program open to the residents of selected blocks in Basin 6. As a result, 16 sump pumps were built, presumably resulting in the removal of these foundation drains from the sanitary sewer system.

The Village has studied the flow monitoring results for Basin 6 with the objective of identifying the effects of the foundation drain disconnections. The study framework is as follows:

1. MMSD has installed several flow meters in Basin 6.
2. Data from the tipping bucket rain gauge at the Department of Public Works provides rainfall amounts for the study.
3. In each block of the study area, flows are measured upstream and downstream of the homes targeted for foundation drain disconnection.
4. On Wildwood Avenue, flows are measured in manholes 290 (at Kensington Blvd.) and 262 (just south of Glendale Ave.). Of the 12 homes between these manholes, our records show that 6 have disconnected their foundation drains.
5. On Ardmore Avenue, flows are measured in manholes 246 (at Kensington Blvd.) and 249 (just south of Glendale Ave.). Of the 10 homes between these manholes, our records show that 4 have disconnected their foundation drains.
6. On Woodburn Street, flows are measured in manholes 290 (south of Kensington Blvd.) and 293 (at Kensington Blvd.). Of the 18 homes between these manholes, our records show that 7 have disconnected their foundation drains.
7. The operation of sump pumps is monitored by the residents, who were asked to send monthly sump pump meter readings to the Department of Public Works.

8.3.1 - Dry Weather Flows From Foundation Drains in Basin 6:

1. In all three streets, we are able to reasonably define dry weather flows and establish a correlation with known water usage information for the area. Based on water meter readings from the study area, we established an average daily water consumption of 200 gallons per day (gpd) per residential connection to the sewers.
2. In the study area, daily dry weather flows are approximately 15,000 gpd for Wildwood, and 25,000 gpd for both Ardmore and Woodburn.
3. Wildwood Avenue data indicates that the measured dry weather infiltration in the study area is about half as much as the rest of the Wildwood Avenue sewer upstream of the study area. Though it is possible that this is simply an error in flow measurements, it can also indicate the existence of an infiltration or inflow source along the Wildwood sewer upstream of Kensington Avenue.

4. Ardmore Avenue Data indicates that the measured dry weather infiltration in the study area is about twice as much as the rest of the Ardmore Avenue sewer upstream of the study area. Again it is possible that this is simply an error in flow measurements, however, in this case, we know the existence of an infiltration or inflow source along the Ardmore sewer within the study area. This source was discovered by the Department of Public Works during dye water flooding of storm sewers in the summer of 2001.
5. Woodburn Street data indicates that the measured dry weather infiltration in the study area is about the same as the rest of the Woodburn Street sewer upstream of the study area. Given the infiltration rates observed in flow metering, we would not expect any concentrated inflow or infiltration sources along the Woodburn sewer either within or upstream of the study area.

8.3.2 - Wet Weather Flows From Foundation Drains in Basin 6:

1. In all three streets, the Village found that sewer flows respond relatively quickly to rainfall events. In wet weather, measurement show that daily flows approaching 2 to 4 times the daily dry weather volumes are not uncommon. Even if we allow for the variability of flow measurements, calibration errors, and other unforeseen factors affecting the accuracy of flow meters, we can still conclude that the wet weather inflow and infiltration into the system should be measured in tens of thousands of gallons per day.
2. In contrast, resident reports indicate that the sump pumps currently in place operate rarely, if at all, and when they do, the estimated volume of water extracted from the sewer system is not significant. For example, on Wildwood Avenue, out of the six homes equipped with sump pumps, only three reported any pumping, on Ardmore, out of four homes, only two reported pumping, and on Woodburn Street, out of seven homes with sump pumps, none reported any pump activity.

The reported pumping varies greatly between the sixteen homes that took part in the foundation drain disconnection study. The following table shows the total volume pumped from each home during the twelve-month study period.

Foundation Drain Disconnection Study Findings

Street and Address	Total Sump Pump since installation (gal.) (12 month period)
N. Wildwood Ave.	
4521	49,466
4525	24,177
4532	722
4535	71
4536	2,498
4539	9,931

Street and Address	Total Sump Pump since installation (gal.) (12 month period)
Total Wildwood	86,866
N. Ardmore Ave.	
4521	4,158
4525	7,998
4535	4
4542	139
Total Ardmore	12,299
N. Woodburn Ave.	
4472	25
4473/75	5
4480	5,556
4491	0
4493	17
Total Woodburn	5,602
Kensington Blvd.	
1204	731

The sewer flow data shows that the highest flows of the summer were observed during the period between June 11 and 17, 2001, where rainfall amounts of 1.1 inches (June 11), 0.48 inches (June 14), and 0.53 inches (June 17) were recorded. The next important period of high flow was between July 20 to 24, 2001, where rainfall amounts of 0.25 inches (July 20) and 0.77 inches (July 23) were recorded. Both of these periods of high infiltration and inflow seem to correspond to some sump pump activity.

However, it is puzzling that not a single home reported sump pump activity during August where the total monthly rainfall amount exceeded the two previous months, and the daily rainfall amounts twice exceeded 1.2 inches. During these two events, measured daily sewer flows equaled or exceeded July peaks, and sometimes, approached June peaks.

It is also important to note that none of the homes on Woodburn Street have reported any sump pump activity between June and August.

- Two residences on Wildwood Avenue (4521 and 4525) have reported sump pump activity that is much higher than the other 14 sump pumps installed so far. Specifically, the sump pump activity at 4521 Wildwood recorded 49,500 gallons of pumping between June 2001 and May 2002; the pump at 4525 Wildwood recorded 24,200 gallons in the same period. Favorable soil conditions or highly effective foundation drains at these residences are some possible reasons for the large discharge quantities. However, it is also possible that these high volumes are due to pump meter malfunction or reading inaccuracies.

4. Six homes (4532 and 4535 Wildwood; 4535 and 4542 Ardmore; 4472, 4473, 4491, and 4493 Woodburn) reported very little or no pumping during the twelve-month recording period. Clearly, these sumps do not appear to be receiving enough groundwater either due to surrounding soil conditions, or the condition (i.e., failure) of the foundation drains.
5. The remaining five homes have recorded discharges varying between 2,500 and 10,000 gallons during the study period.
6. Even during the months where sump pump activity was reported, the flow measurements in the sewers continue to indicate quick and sometimes severe response to rainfall. Our study of the available data from the flow meters was not able to identify any measurable differences in wet weather flows before or after sump pump installation.

8.3.3 – Shorewood’s Conclusions on Foundation Drain Disconnection:

There is a strong correlation between the reported sump pump activity and the amount of monthly rainfall recorded at the Village rain gauge. The wetter months have resulted in increased pumping from the sumps.

Given the fact that the sewer flow response to rainfall is measured in tens of thousands of gallons per day, and that the monthly sump pump activity amounts to thousands of gallons per month, the Village concludes that other, as yet unidentified sources of wet weather inflow and infiltration sources present a much bigger problem than the inflow from foundation drains. The Village finds this to be the case in all three streets in the study area.

The relatively small amount of water extracted by the sump pumps may be due to ineffective foundation drain systems in most homes, or due to the fact that foundation drains of this vintage only respond to rainfalls above a certain amount and intensity. Since the sewer system itself responds to almost any rainfall of any intensity or duration, we must look at other sources of inflow.

The Village’s findings appear to challenge the commonly held notion that foundation drain disconnection will yield a high level of wet weather inflow reduction. However, it should be noted that, this premise is valid in cases where the other components of a sewer system are relatively intact.

If we assume that the sump pump activity is measured and reported properly, significant inflow reduction due to sump pump installation will only be achieved in a very small number of cases. The current data suggests that most sump pumps will either provide negligible or very modest inflow removal benefits.

This conclusion is further supported by the fact that flow measurements taken downstream of the sump pumps have not recorded any reduction in response to rainfall. In other words, despite the fact that sump pumps remove some of the inflow into the sewer system, the amount of removal has not been significant enough to register in the flow measurements in the sewer pipes.

Therefore, the Village will first concentrate all other inflow and infiltration sources in the public mains are identified and rehabilitated before seeking further inflow reductions through foundation drain disconnection.

In the meantime, as a matter of policy, the Village will also construct a secondary drainage system whenever and wherever street reconstruction occurs. This will allow future foundation drain disconnections.

The protocol currently proposed for foundation drain disconnection by Shorewood involves foundation drain disconnection at the time of sale or issuance of a building permit for building improvements.

8.4 – Private Infrastructure I-I Control Summary

Anticipated Costs

- Lateral rehabilitation - \$300,000 per year
- Downspout disconnect incentive – to be determined (implement after lateral program)

Implementation Schedule

- 2012-2021 – lateral rehab program, 50 homes at \$6,000 per year
- 2022 and forward – foundation drain disconnection incentive

Funding Source

- Lateral rehab – General Tax Levy, MMSD grant, Special Assessment