Comprehensive Facility Plan

June 8, 2011

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Sanitary Sewer, Combined Sewer and Storm Sewer Improvements

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I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Wisconsin.

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1- Background and Existing Conditions

The Village of Shorewood is bound by Lake Michigan to the east, the Milwaukee River to the west, the Village of Whitefish Bay to the north and the City of Milwaukee to the south. With a population of about 14,000 and an area of 1,004 acres, it is the "most densely populated municipality" in Wisconsin.

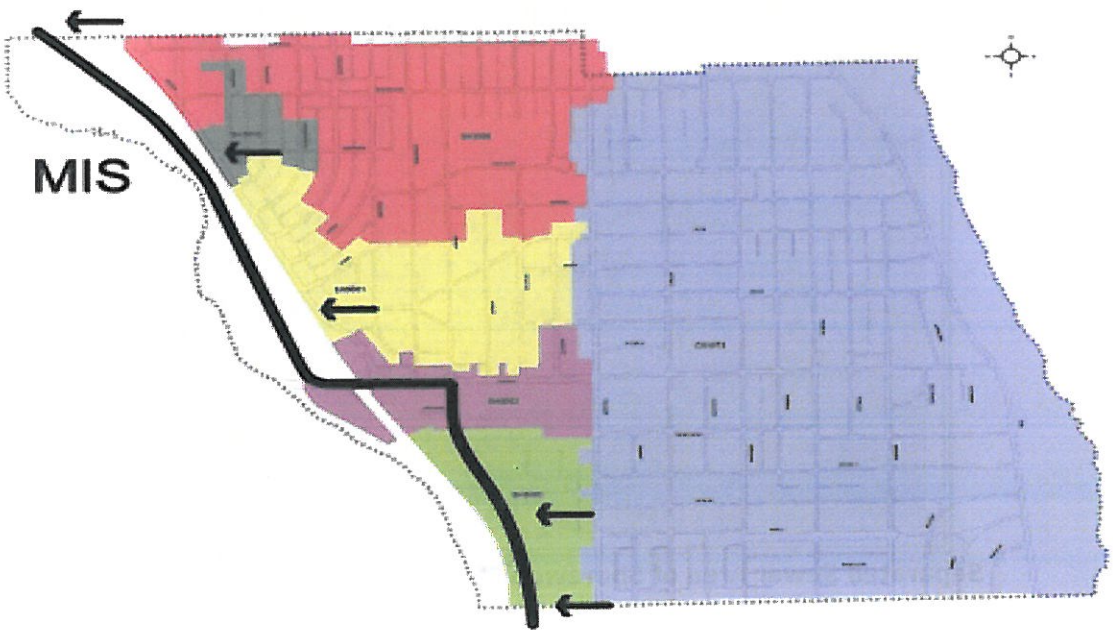
Shorewood is characterized by its fully developed land as vacant lots are virtually nonexistent within its boundaries. Over 50 percent of the Village was developed by 1940, and over 80 percent was built by 1950.

The predominant land use is residential, with two principal commercial/business corridors consisting of North Oakland Avenue and East Capitol Drive, both of which cross the Village from one end to the other. Several apartment building and condominium properties are located along these corridors, most notably along Oakland Avenue. No industrial properties are present in the Village.

Shorewood owns and operates a water distribution system with water purchased from the Milwaukee Water Works. In addition, the Village owns and operates a sewer system consisting of separated and combined sewers. The Village is a customer of the Milwaukee Metropolitan Sewerage District (MMSD) and delivers its discharge to MMSD at five locations along the North Shore Metropolitan Interceptor Sewer (MIS).

1.1 - Description of Sanitary Sewers

Sanitary sewer service in Shorewood consists of separate sanitary sewers and combined sewer systems. All sewers are connected to the MMSD North Shore MIS. In the nearby figure, the eastern half of the Village, shown in blue, is the combined sewer service area and connects to the MIS at a single location, near the intersection of North Oakland Avenue and East Edgewood Avenue. This is represented by the southernmost arrow to the MIS.



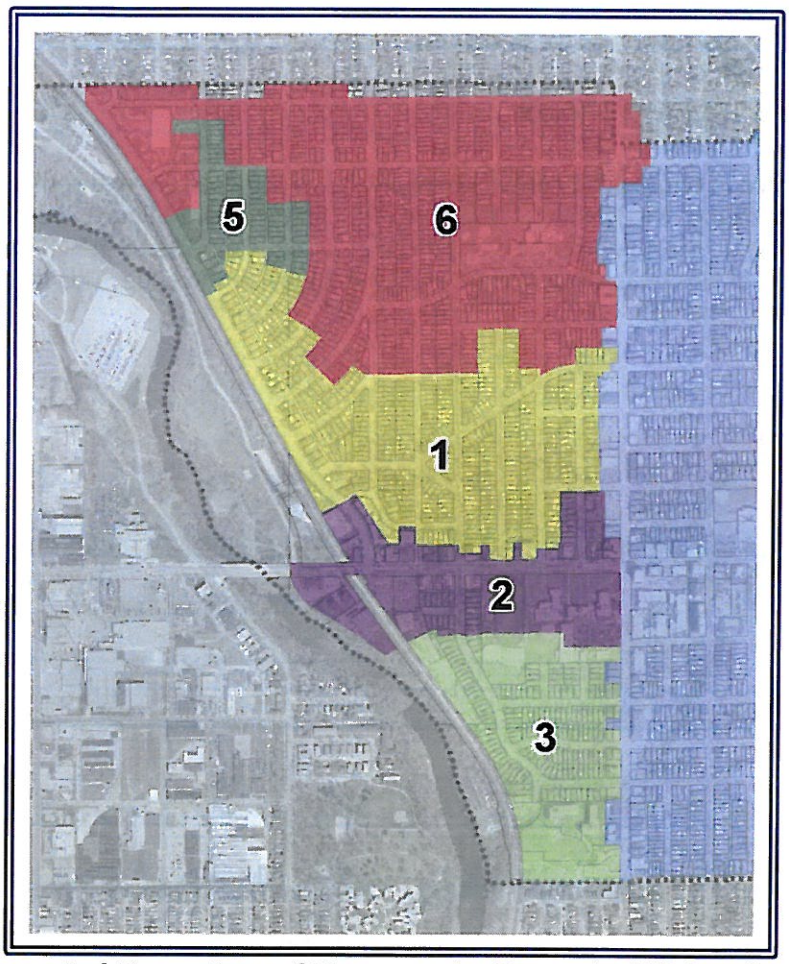
There are five separate sewer basins (sewersheds) on the west half of the Village, each with its own connection to the North Shore MIS. The figure on the previous page schematically describes this configuration.

Despite enjoying fully satisfactory dry weather service, the Village has historically suffered from higher than normal wet weather flows in sanitary sewers, especially in Basins 1 and 6. Wet weather basement backups have been occurring quite frequently in the last decade. In order to combat the risk of basement backups, it appears that a number of relief measures were implemented through the years. In general, these measures probably provided only temporary benefits as the continuously deteriorating structural integrity of the system must have resulted in progressively increasing inflow and infiltration opportunities.

The sanitary sewer system has four overflow locations consisting of gated connections to storm sewers, all located in Basin 6, along Glendale Avenue.

Despite these overflows, the sanitary sewer system in Basin 6 continues to pose an unacceptable risk of basement backups to the residents. Even when basement backups do not occur, the possibility of wet weather overflows exists, and consequently, the Village is seeking aggressive and decisive action to control and manage its sanitary sewer system operation and capacity.

1.2 - Problem Definition



Separated Sewer Area of Shorewood – Sewershed ID Numbers

Widespread basement backups in both the separated and combined sewer service areas have occurred in the last decade and a half. Notable rains that led to property damage in the Village are:

- June 21, 1997, 4.7" in 6 Hours
- August 6, 1998, 2.9" in 16 Hours
- July 21, 1999, 4.3" in 4 hours
- June 7, 2008, 8.68 in 24 hours
- July 15, 2010, 3.56" in 9 hours
- July 22, 2010, 8.5" in 8 hours

Each of these events caused excessive inflow-infiltration in separated sewers and extreme surcharging in the combined sewers to produce basement flooding and attendant property damage. Combined Sewer Overflows (CSO) and Separated Sewer Overflows (SSO) have occurred in each case. Accordingly, the present problem can be represented by three statements that will guide our solution alternatives:

1. The runoff handling capacity of the combined sewers is exceeded over 1.5 inches of rain in one hour. Surcharging and basement backups occur when rains exceed this amount. Previous capacity improvements have targeted the 10 year 1 hour design rainfall at 1.9 inches. It appears that at that level of design, the combined sewer area continues to suffer frequent surcharging and basement backups.

   While some additional hydraulic improvements are available to increase capacity, these will be limited to specific areas and the overall vulnerability of the area to intense rains will remain.

2. Two of the five separate sewer basins (sewersheds 1 and 6) suffer from excessive wet weather inflow and infiltration (I-I), resulting in frequent exceeding of sewer capacities, leading to surcharging to such a degree that basement backups occur. Basin 2 does not appear to have I-I issues, and even in extraordinary rainfalls has not been subject to basement backup ruisks. Basins 3 and 5 have low to moderate wet weather I-I problems, consisting mainly on infiltration (long term seepage of groundwater into sewers). A summary of I-I concerns is presented below.

   Foundation Drains
   Previous studies of the effect of foundation drains in Shorewood and elsewhere suggest that, if foundation drains can be disconnected from sanitary sewer laterals, we should expect significant reductions in wet weather inflows. In Shorewood, a strong correlation was noted between the reported sump pump activity and the amount of monthly rainfall recorded at the Village rain gauge, i.e., the wetter months have resulted in increased pumping from the sumps.

   Groundwater Infiltration
   Structural defects allow ground water to leak into the sewers by presenting unobstructed hydraulic paths for the ambient ground water. Since ground saturation closely follows rainfall, the broken or missing pipes, disconnected lateral connections, etc. represent wet weather inflow opportunities. In addition, structural defects play an important role in conveyance capacity of sewers. Missing pipes, broken or collapsed sections impede flow and reduce performance. Sags in pipes usually result in reduced hydraulic capacity and cause surcharging in the system.

Storm Sewer Connections

At each locations where a storm sewer or a catch basin lead crosses a sanitary sewer or a sewer lateral, there is a n opportunity of a cross connection and a path for clear water transference between systems. Past work in Shorewood has shown that this phenomenon is common.

3. In both Basin 1 and 6, the sewer network layout and geometry create surcharging even in less than excessive I-I conditions. Hydraulic shortcomings are exacerbated during wet weather flow, but the overall configuration of some sewers directly lead to increased surcharge and increased backup risk.

   Basin 1 has a sewer layout that follows the ground profile to minimize sewer depth, but produces many sharp angles that rob the system of precious hydraulic capacity. Basin 6 is connected to basin 3 of Whitefish Bay, and both systems suffer from hydraulic inefficiencies.

4. Basin 3 is located at the southwest corner of the Village and is characterized by relatively steep slopes in topography as well as sewer pipes. This feature helps with flows, and the connection to the 42 inch MIS interceptor occurs at the intersection of Morris Boulevard and Menlo.

   Only a handful of basement backup reports were filed for the July 15, 2010 storm, all of them on Morris between Beverly and Newton. On July 21, 2010 more reports came in, and as expected, basement backups were more widespread, on Morris, as well as on Beverly and Newton. This behavior indicates that Basin 3 has low to moderate infiltration which is most likely the cause of aging infrastructure, both public and private.

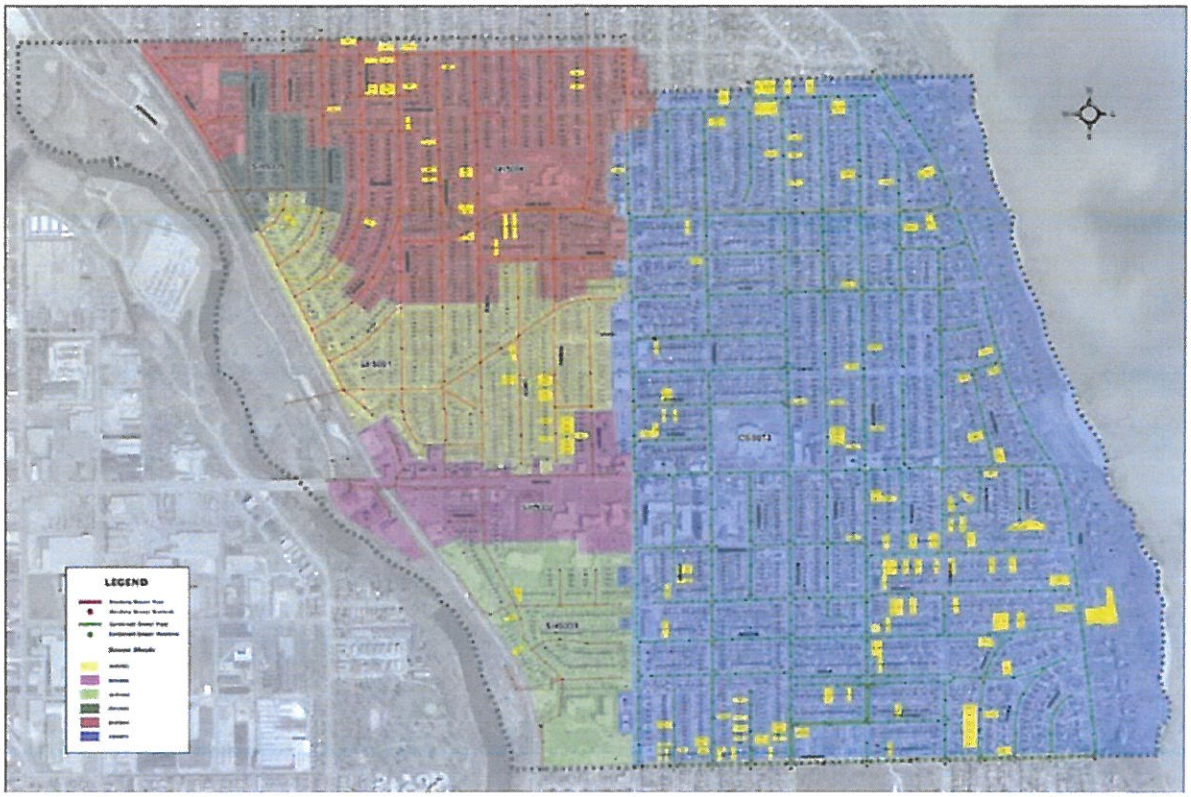
5. Basin 2 is located along Capitol Drive, from Oakland to the Milwaukee River to the west. No backups were reported on July 15, and only one report came in on July 21. Since this sole report was on Morris at the boundary of Basin 3, the reasons for it are related to Basin 3 performance rather than Basin 2.

6. Basin 5 is a small system, nestled within Basin 6 in the northwest side of the Village. While Basin 5 should have very similar performance characteristics to Basin 6, a few important features improve its protection against basement backups. For example, no reports of any backups came on July 15, a day many Basin 6 properties sustained flooding.

   On July 21, a relatively small number of complaints were reported. A closer look into the differences between basins 5 and 6 reveals that it enjoys a simple layout with efficient hydraulics, combined with a small size and therefore lower propensity of high flow potential.

The two maps on the following page show the impact of the July 15 and July 21 rainfalls on Shorewood. Yell properties reported flooding by either surface runoff or basement backups.

The solutions outlined in this document directly address these focus areas. This means that short term sanitary, storm, and combined sewer improvements, I-I reduction measures, and long term separation of combined sewers all play a role in a comprehensive solution package.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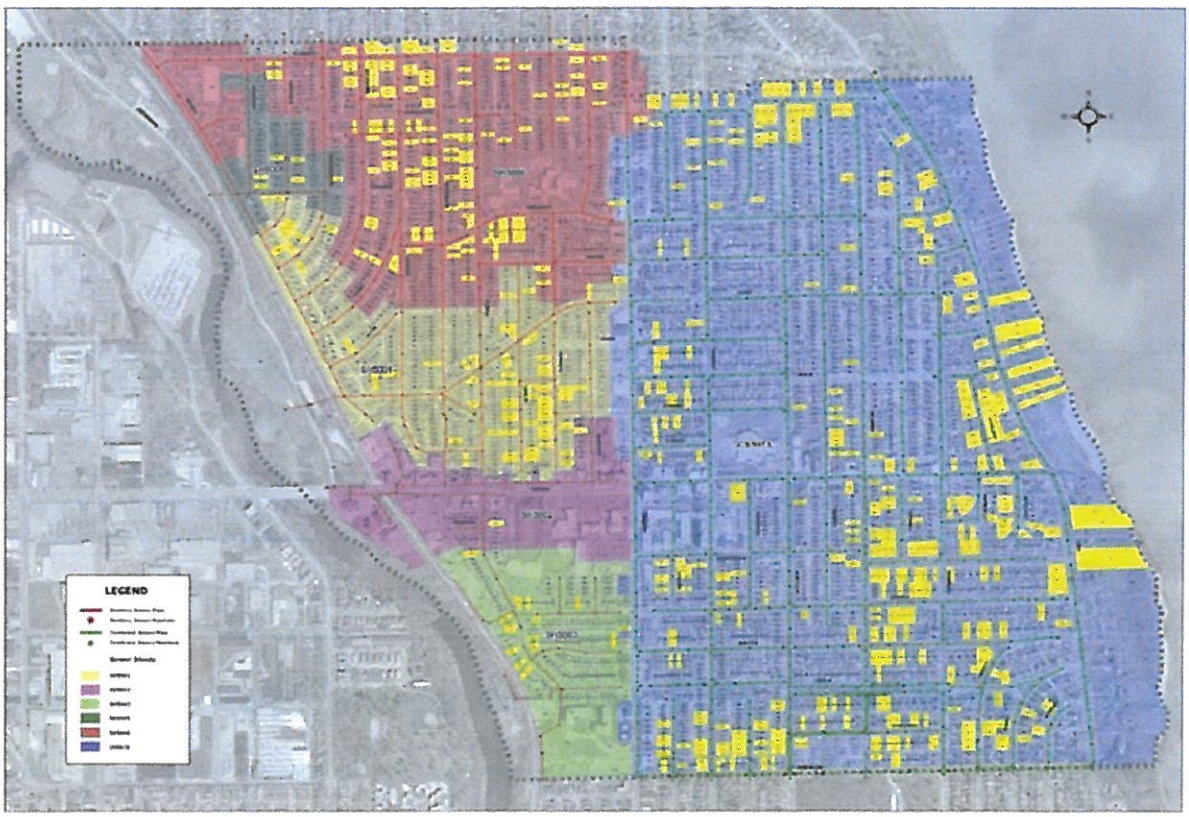
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