Northfield Township WWTP Capacity Evaluation Report

March 18, 2015

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviations	Definition
gpd	gallons per day
I/I	infiltration and inflow
MDEQ	Michigan Department of Environmental Quality
MG	million gallons
MGD	million gallons per day
NPDES	National Pollution Discharge Elimination System
REU	residential equivalent unit
SAD	special assessment district
SRF	State Revolving Fund
SSES	Sewer System Evaluation Survey
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

Northfield Township owns and operates a wastewater treatment plant and sanitary collection system, which has an average flow rate of 0.7 MGD and can be as high as 0.9 MGD during the spring season. This is less than the treatment capacity of 1.3 MGD, but with potential future development, improvements will be necessary. The Township engaged Tetra Tech to define the potential growth within the existing wastewater service area and identify improvements necessary at the wastewater treatment plant to meet the growth. Tetra Tech used flow data measured at the influent of the wastewater treatment plant as a basis point to estimate the magnitude and timeline for the improvements. The purpose of this report is to document the level of projected growth, summarize the analysis used to develop recommendations, and summarize the recommendations.

In addition to service areas within Northfield Township, flows from neighboring Green Oak Township are also treated at the Northfield Township wastewater treatment plant. Two service agreements between the two townships specifies that Green Oak Township can discharge an additional 227,000 gallons per day (equivalent to 873 REUs) to Northfield Township than it does currently.

The four sanitary sewer special assessment districts in Northfield Township have a potential to include an additional 1,865 REUs with a design average day flow of 485,000 gallons per day. Three of these SADs have been in place several years with only modest recent interest in development and in new connections being made.

However, should this development occur, improvements will be needed to meet both the additional daily flow and to meet the requirements of the state for wet weather flows up to the 25-year, 24-hour design storm. An increase in treatment capacity will address dry weather flow requirements, while a long-planned storage basin at the wastewater treatment plant will address wet weather flow requirements.

The initial recommendation is to construct a storage basin large enough to meet future needs up to the next expansion in treatment capacity because the cost of the storage will be less than the cost of the facilities required to increase the treatment rate. A 1.7 million gallon storage basin is recommended in the near term before much growth occurs. The basin size may be able to be made smaller through a more detailed analysis during the preliminary design of the facility. Previous analysis of the WWTP indicated the basin will equalize peak flows and allow an even higher rate of flow to be treated. When between 800 and 1,500 REUs of growth occurs (the lower end corresponding to no storage basin and the upper end corresponding to a condition where the storage basin is in place), a commitment to increase the WWTP capacity will need to be made.

If the Township decides to construct the recommended storage and wants to pursue construction funding through the State Revolving Fund Loan Program, additional intermediate studies are required to secure the funding. These intermediate studies will take multiple years to complete; therefore, pursuit of funds through the state's loan program will likely mean that funding will not be available until at least July 2017. Should the Township desire to initiate construction earlier, the Township will need to arrange its funding through another source.

1.0 INTRODUCTION

Northfield Township owns and operates a wastewater collection and treatment system that serves portions of Northfield and Green Oak Townships, but has not previously adopted a defined sanitary sewer service area. The Township has evaluated developments on a case-by-case basis. A formal sanitary sewer master plan has been discussed but is yet to be completed. Developing a wastewater master plan for Northfield Township is a large undertaking. As an initial step in better understanding the sewer system needs, the Board of Trustees elected to initiate this study of the sewer system to better understand the Township's wastewater treatment needs. This study has the following objectives:

- Update the Township's sanitary sewer map to include changes since the last map was created in 1996
- Identify potential development in the existing special assessment districts within Northfield Township and the likely flow impact on the Township's wastewater treatment plant (WWTP)
- Understand the commitment to provide sewer service to Green Oak Township and the likely flow impact at the WWTP
- Conceptually size a wet weather storage tank (also referred to as an equalization basin) at the Township's WWTP

A smaller scale revised sewer map is included in this document, and a full scale map will be delivered to the Township separately.

Two other components that are commonly included in a master plan have been deferred to a later time, including the detailed analysis of wastewater treatment plant expansion(s) and impacts to the collection system caused by potential growth. Impacts to the collection system generally require flow monitoring and detailed calculations to fully understand.

2.0 EXISTING WASTEWATER INFRASTRUCTURE

2.1 INFRASTRUCTURE HISTORY AND CONFIGURATION

The Township's WWTP was originally constructed in 1961 to serve a State of Michigan correctional facility. The WWTP was then purchased by Northfield Township and sewer systems were constructed through the 1970s to initially serve portions of Green Oak Township and Northfield Township around Whitmore Lake and portions of Northfield Township around Horseshoe Lake. Expansion of the system continued in the 1980s and 1990s to serve growing residential development.

The Township's existing wastewater treatment plant has a National Pollution Discharge Elimination System (NPDES) permit limit of 1.3 MGD. This is a nominal limit on the average daily flow that the WWTP may accept, treat and discharge. Peak flows into the WWTP may be higher than this and are allowed as long as the WWTP can acceptably process and treat the water. Calculations by Tetra Tech in 2005 suggest that the WWTP may be able to treat up to 1.5 MGD on average and meet limits if the peak flows into the WWTP are controlled through the use of a storage basin.

The WWTP has been expanded and upgraded numerous times since its 1961 construction. In its current configuration, the plant provides primary treatment (clarification), secondary treatment with a trickling filter and a second stage activated sludge process, and tertiary treatment with travelling bridge sand filters. The wastewater is disinfected with chlorine gas and receives post aeration by a cascade before being discharged to the Horseshoe Lake Drain.

WWTP operations staff indicate that they can routinely treat a peak flow rate of 2.5 to 3.0 MGD. However, they also indicate that the sand filters have reduced capacity due to suspected biological fouling of the underplates. These plates are due to be refurbished in the next few years. In its present configuration, the sand filters can only process a peak flow rate of approximately 2 MGD.

2.2 WWTP FLOW RATES

Average flows to the WWTP are lower than the permit limit of 1.3 MGD. Between 2011 and 2014, the WWTP averaged 0.7 MGD of influent flow. In the spring, when more precipitation and a higher groundwater table typically occur, the average flow was 0.9 MGD.

During wet weather, influent flows to the WWTP increase. On several occasions the Township has observed the peak flow into the WWTP reaching 3 MGD, which is the limit that can be measured at the WWTP. This increase in flows with wet weather is typical of older systems and is due to stormwater and groundwater being allowed to enter the sewer system. This water is referred to as infiltration/inflow (I/I) and can occur due to leaks in the public sewer, leaks in the privately-owned laterals, and improper connections made to either the publicly-owned system (such as storm drains) or to privately-owned parts of the system (such as basement sump pumps).

The Township has not previously conducted a comprehensive evaluation of I/I. However, in 1999, a brief flow monitoring program was conducted that showed that most parts of the Township's sewer system experienced flow increases with rainfall. Thus, the I/I was not isolated to a single part of the system. The Township also conducted a survey that showed that several homeowners had sump pumps connected to the sanitary sewer. While these connections are in violation of the Township's sewer use ordinance, there is no record that the Township followed up on removing these sources of I/I. It is also known that high water levels in Horseshoe Lake have submerged toilets and other sewer inlets creating lake inflow.

3.0 WASTEWATER SERVICE TO GREEN OAK TOWNSHIP

Wastewater service to Green Oak Township originated in the 1960s and 1970s concurrently with service to Northfield Township. The majority of this early service area occurred around the perimeter of Whitmore Lake.

A 2001 agreement between the Townships allows an additional 124 REUs to be connected within the existing service area around Whitmore Lake. Mr. St. Charles, Green Oak Township Supervisor, indicated in a telephone call that Green Oak Township's records show that 20 REUs around the lake have been connected since the 2001 agreement. Therefore, 104 REUs remain to be connected from Green Oak Township around Whitmore Lake. At 260 gallons/day, these 104 REUs produce an average daily flow of 27,040 gallons/day.

Sometime after 2001, Green Oak Township approached Northfield Township about serving an additional area in Green Oak Township. Northfield and Green Oak Township entered into a sewer service agreement dated November 11, 2004, to serve development in a designated area west of US-23 and north of 8 Mile Road. This agreement specifies that an additional 200,000 gallons of average daily flow will be allowed from Green Oak Township equivalent to 1,600 residential equivalent units (REUs). These agreements with Green Oak Township are presented in Appendix A.

Recent discussions with Green Oak Township resulted in a determination that a negligible amount of development has occurred in this new service area, so Northfield Township has a remaining obligation of approximately 200,000 gallons per day (gpd) to Green Oak Township. The discussions with Green Oak Township also addressed the 1,600 REUs mentioned in the agreement. Northfield Township's engineering standards define one REU equal to 260 gpd of average daily flow. Thus, 200,000 gallons equates to 769 REUs, not the 1,600 REUs listed in the agreement. Green Oak Township Supervisor Mark St. Charles indicated that Green Oak Township was likely to honor the 769 REU allocation.

In summary, the agreement with Green Oak Township suggests that Northfield Township is obligated to provide an additional 873 REUs, or an equivalent average daily flow rate of 227,040 gpd.

4.0 FUTURE WASTEWATER SERVICE IN NORTHFIELD TOWNSHIP

Northfield Township has existing obligations to provide wastewater service to four special assessment districts (SADs). The SADs were created specifically to provide wastewater service. The four SADs include the Lake Point SAD, North Territorial SAD, Seven Mile Road SAD, and Whitmore Lake Road SAD, and are shown on Figure 1.

Northfield Township's design standard for average daily wastewater flow is 260 gpd per REU. The density of REUs for a particular zoning type is an estimate based on minimum lot size in the Township's zoning ordinance and values used on past planning projects.

4.1 LAKE POINT SAD

The Lake Point SAD was established in 2003. The SAD is small, consisting of four parcels along Lake Point Drive on a peninsula extending into Whitmore Lake. All of the parcels are zoned single family residential or low density residential and appear to be developed and understood to be already connected to the WWTP. There are four total REUs in this SAD, all of which are currently connected to the WWTP.

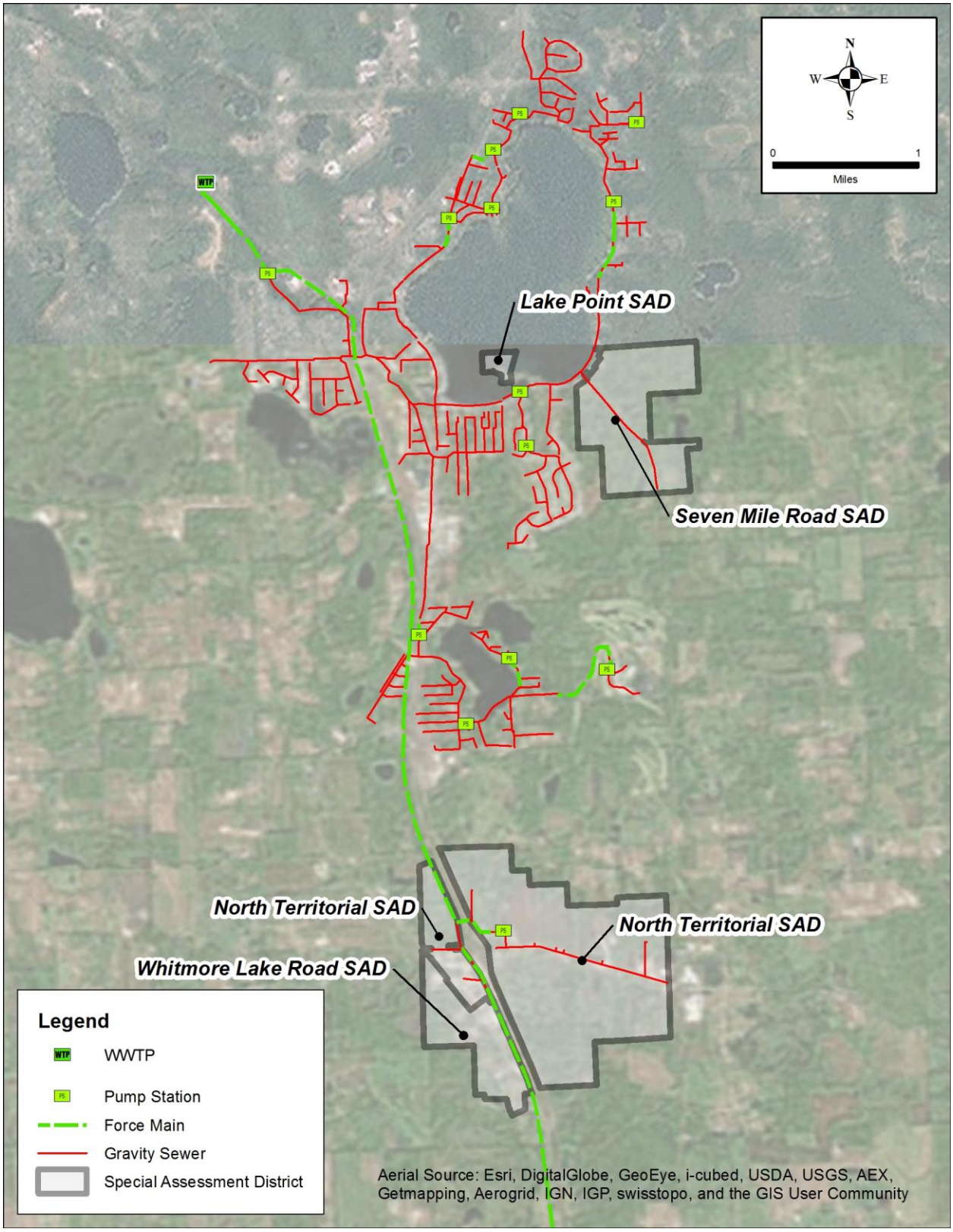
4.2 NORTH TERRITORIAL SAD

The North Territorial SAD was established around 2000 to provide wastewater service to a planned commercial area. A trunk sewer, pump, station, and force main were constructed. The force main discharges to the Township's Eight Mile Road Pump Station. To date, only a few parcels within the SAD have connected to the trunk sewer representing about 49 REUs. The concept for this SAD was that the area could be expanded both west and east as development demanded more wastewater service. Only the area within the current SAD is depicted on Figure 1. Table 1 shows the estimated wastewater demand for parcels within the current district limits.

Table 1: REUs and Average Daily Wastewater Flow in the North Territorial SAD

Zoning	Parcel Density, REUs / acre	Current Parcels	Total Area, acres	Ultimate REUs	Average Daily Wastewater Flow, gpd
Local commercial	3.0	3	16.59	50	13,000
General commercial	3.0	14	167.95	504	131,040
Planned shopping center	3.5	4	87.29	306	79.560
Research, technology, manufacturing	2.5	18	323.58	809	210,340
Total	**-**	**39**	**595.41**	**1,669**	**433,940**

Figure 1: Map of Special Assessment Districts



4.3 SEVEN MILE ROAD SAD

The Seven Mile Road SAD was established in approximately 2003 to serve the area along Seven Mile Road southeast of Whitmore Lake. The sewer has been constructed but only three connections have been made consisting of three REUs. Table 2 shows the estimated wastewater demand for the SAD.

Table 2: REUs and Average Daily Wastewater Flow in the Seven Mile Road SAD

Zoning	Parcel Density, REUs / acre	Current Parcels	Total Area, acres	Ultimate REUs	Average Daily Wastewater Flow, gpd	Notes
Agricultural	0.2	5	43.89	8	2,080	Assumes 3 parcels are split into two parcels each
Low density residential	0.5	10	21.60	13	3,380	Assumes 1 parcel is split
Recreational conservation	0.1	5	108.80	11	2,860	Assumes 1 parcel is split
Single family residential	4.0	2	45.14	140	36,400	20 percent of area allotted for right-of-ways. Remaining area developed at 4 parcels per acre
Total	**-**	**22**	**219.43**	**172**	**44,720**	**-**

4.4 WHITMORE LAKE ROAD SAD

The Whitmore Lake Road SAD was established in 2013 to provide sewer service to 24 parcels along Whitmore Lake Road south of North Territorial Road. The Whitmore Lake SAD is tributary to the sewer improvements funded by the North Territorial SAD. No sewers have yet been constructed. Table 3 shows the estimated wastewater demand for the SAD. The basis of design for the Whitmore Lake Road district estimated a total of 76 REUs to be served.

Table 3: REUs and Average Daily Wastewater Flow in the Whitmore Lake Road SAD

Zoning	Parcel Density, REUs / acre	Current Parcels	Total Area, acres	Ultimate REUs	Average Daily Wastewater Flow, gpd
Agricultural	0.2	14	64.61	14	3,640
Limited industrial	1.0	8	45.27	43	11,180
Local commercial	3.0	2	6.52	19	4,940
Total	**-**	**24**	**116.40**	**76**	**19,760**

5.0 SUMMARY OF ADDITIONAL FLOWS TRIBUTARY TO THE WWTP

In the build-out condition, a total of 2,794 REUs were estimated to be served by the WWTP within the current SAD boundaries and growth areas within Green Oak Township. Of these 2,794 REUs, 56 are already connected to the sewer system leaving 2,738 to potentially connect. These REUs would increase the average daily flow beyond the existing WWTP capacity. Furthermore, as the existing treatment capacity is approached, there will be a greater need to provide storage for both daily fluctuations in the flow and wet weather peaks. A summary of the growth is provided in Table 4.

Table 4: Summary of Additional Flows Tributary to the Northfield Township WWTP

Community	Location	Additional REUs	Additional Average Daily Wastewater Flow, gpd
Green Oak Township	around Whitmore Lake (2001 agreement)	104	27,040
	west of US-23 (2004 agreement)	769	200,000
	Subtotal	**873**	**227,040**
Northfield Township	Lake Point SAD[1]	0	0
	North Territorial SAD	1,620	421,200
	Seven Mile Road SAD	169	43,940
	Whitmore Lake Road SAD	76	19,760
	Subtotal	**1,865**	**484,900**
Total		**2,738**	**711,940**

[1] These properties are already developed and connected to the WWTP.

6.0 ALTERNATIVES TO MANAGE NEW CONNECTIONS

Determining available capacity is not a straightforward determination. A wastewater utility must consider treatment capacity during dry weather, treatment capacity during wet weather, and sewer system capacity. Analysis of the sewer system capacity was not an objective of this evaluation, however, average and wet weather conditions are discussed below.

6.1 AVERAGE FLOWS

The average flow for existing conditions is approximately 0.7 MGD and 0.9 MGD during springtime highs. The WWTP's rated capacity is presently 1.3 MGD with the potential of 1.5 MGD if storage is provided. Thus, there is existing WWTP capacity during average conditions to accommodate new connections.

The Michigan Department of Environmental Quality (MDEQ) is generally reluctant to allow new connections to a WWTP when the flow approaches 85 percent of the facility's rated capacity. Assuming a treatment capacity of 1.3 MGD, this necessitates a decision on an expansion when rates reach 1.1 MGD (1.3 x 0.85). Assuming a treatment capacity of 1.5 MGD, this necessitates a decision on an expansion when rates reach 1.3 MGD (1.5 x 0.85).

In 2005, Northfield Township explored a WWTP expansion to address the new connections it committed to in the 2004 agreement with Green Oak Township. That expansion was conceived to construct a storage basin and expand the treatment capacity to 2.25 MGD. Development did not occur and this expansion was not implemented.

Available capacity calculations are found below for various scenarios. The first two calculations consider growth without differentiating new connections between Green Oak Township and Northfield Township. The last two scenarios were calculated assuming the capacity in the Green Oak contract is reserved.

A summary of potential capacity available during average conditions without reserving capacity for Green Oak Township follows (assuming no storage provided):

Allowable Rate before Expansion (MGD)	Springtime Rates (MGD)	Allowable Increase (MGD)	Allowable Increase (REU)
1.1	0.9	0.2	800

The summary of potential capacity available during average conditions without reserving capacity for Green Oak Township follows (assuming storage provided):

Allowable Rate before Expansion (MGD)	Springtime Rates (MGD)	Allowable Increase (MGD)	Allowable Increase (REU)
1.3	0.9	0.4	1,500

The summary of potential capacity available during average conditions and reserving 0.227 MGD for Green Oak Township follows (assuming no storage provided):

Allowable Rate before Expansion (MGD)	Springtime Rates (MGD)	Allowable Increase (MGD)	Allowable Increase (REU)
1.1	0.9	0	0

The summary of potential capacity available during average conditions and reserving 0.227 MGD for Green Oak Township follows (assuming storage provided):

Allowable Rate before Expansion (MGD)	Springtime Rates (MGD)	Allowable Increase (MGD)	Allowable Increase (REU)
1.3	0.9	0.173	700

6.2 WET WEATHER FLOWS

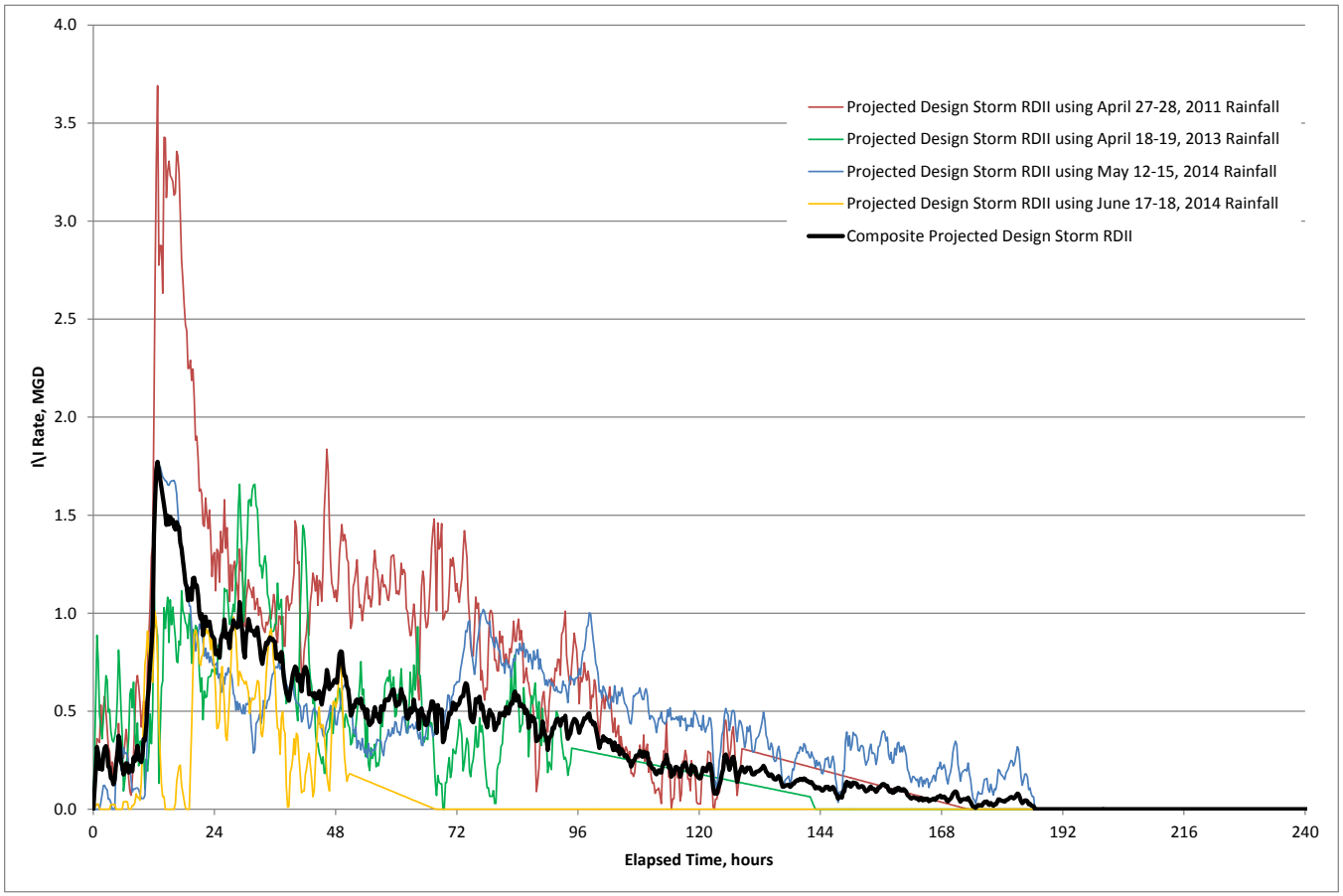
Storing wastewater during peak flow rates is a proven technique for managing flows in excess of the treatment capacity. Flows in excess of the treatment capacity are temporarily stored and returned to the system after the peak flows abate. Many, and perhaps most, wastewater treatment plants have storage tanks. The existing Northfield WWTP does not have any storage capacity. However, storage has been discussed for the WWTP since at least 1988 without the construction occurring.

In 2002, the State of Michigan adopted a policy on controlling untreated overflows from sewer systems. This policy requires that sewer systems control overflows for storms up to and including the 25-year, 24-hour storm. This storm is defined as 3.9 inches of rainfall in 24 hours throughout the state.

Flows measured at the WWTP for four severe storms between 2011 and 2014 were used to project a hydrograph for the 25-year, 24-hour storm, which can be added to a base flow to estimate the storage volume that would be necessary to eliminate overflows at the WWTP for events up to that size. The procedure used to create the hydrograph used for the 25-year, 24-hour storm followed these steps:

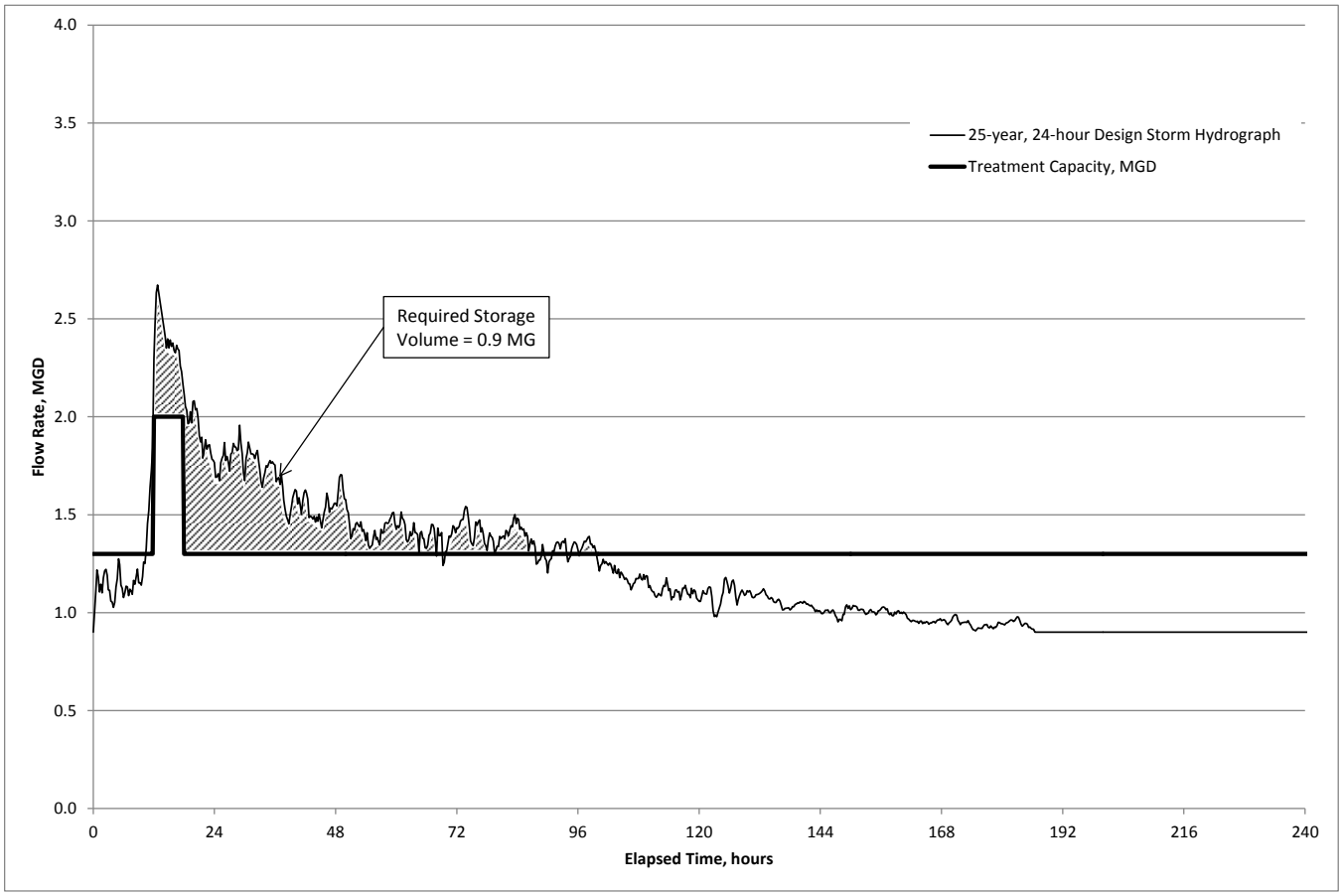
- The second through fifth most extreme events from 2011 to 2014 between April and October of each of those years, in terms of volume measured at the WWTP, were identified. The most extreme event, beginning on May 25, 2011, was excluded because it is known that inflow from Horseshoe Lake was occurring during and following this rainfall. The four rainfalls used in the analysis included:
    - April 27-28, 2011, 2.17 inches of rain, 3.0 million gallons (MG) of I/I estimated at the WWTP
    - April 18-19, 2013, 2.43 inches of rain, 1.7 MG of I/I
    - May 12-15, 2014, 4.30 inches of rain, 4.3 MG of I/I
    - June 17-18, 2014, 2.03 inches of rain, 0.5 MG of I/I
- The I/I and base flow components of the hydrograph were estimated. Plots of the components for each of the events are shown in Appendix B.
- The I/I component of the flow was projected to the 25-year, 24-hour design storm using a ratio of the design storm rainfall to the actual rainfall.
- The individual projections were averaged over an hourly period to smooth the peaks and valleys in the hydrograph using the 15-minute data from the WWTP.
- A composite of the four individual projections was created by averaging the four individual event projections. The composite projection is similar to the projection made for the May 12, 2014 event, which had the closest rainfall volume to the design storm. The individual and composite projections (with base flow removed) for the 25-year, 24-hour design storm is shown in Figure 2. The composite hydrograph was used for all analyses in this report. The tail of the hydrograph extends well beyond the end of the rainfall because of infiltration following the rainfall.

Figure 2: Composite 25-year, 24-hour I/I Hydrograph Constructed from Individual Event Projections



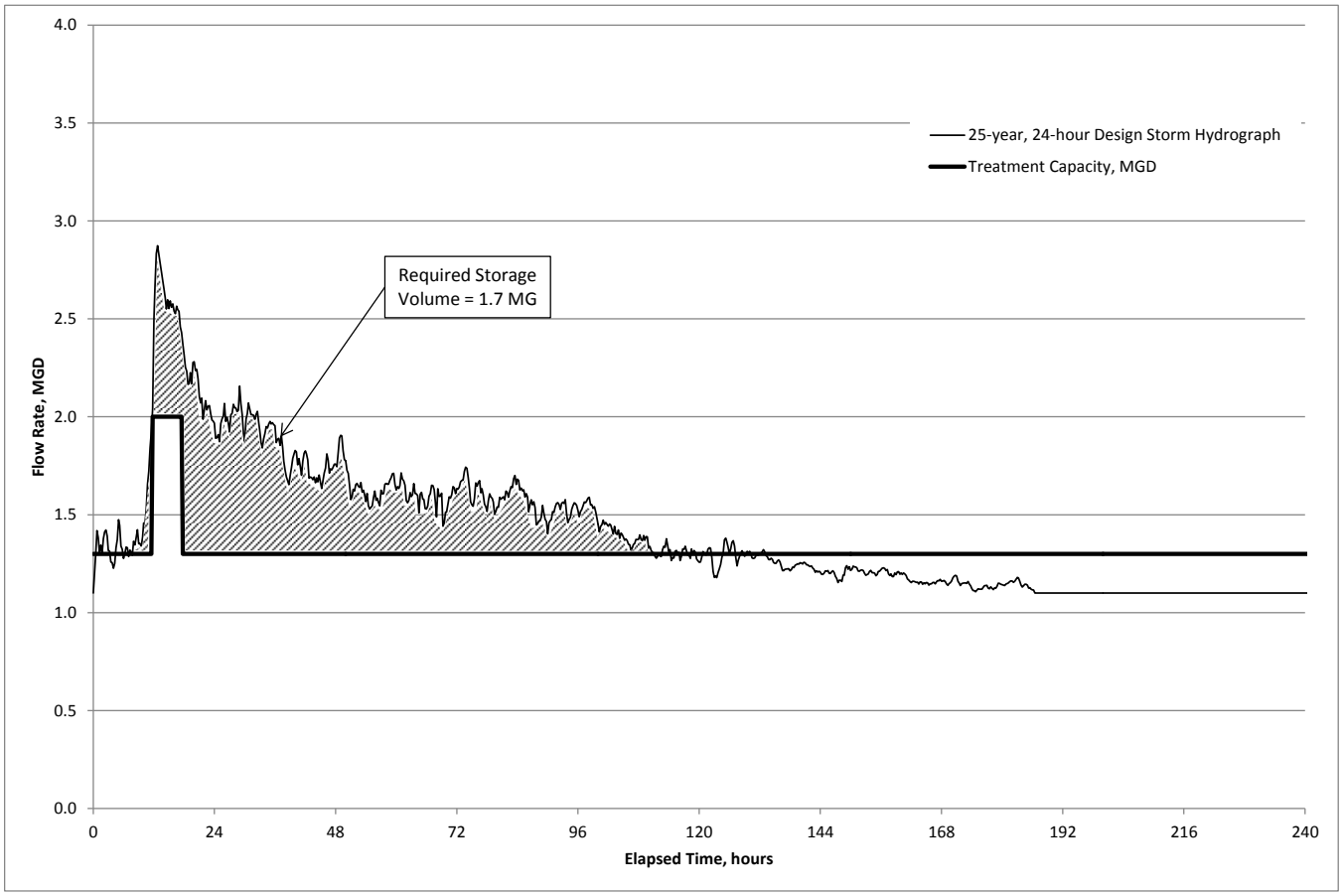
The required storage volume can now be estimated by adding the design storm I/I flows onto a base flow. For all the storage calculations it was assumed that the WWTP could treat 150 percent of its sustained treatment capacity for up to 6 hours and still meet its effluent limits. The remaining time, the WWTP could only treat its sustained capacity. For example, for the existing conditions, the WWTP could treat 2.0 MGD for 6 hours and 1.3 MGD for the remaining time. For existing conditions, we project that the required storage volume is 0.9 MG during spring (April and May) conditions. This is visually depicted in the hydrograph shown in Figure 3.

Figure 3: Spring Design Storm Hydrograph with Treatment Capacity of 1.3 MGD and No Growth



As growth occurs, the daily flow will increase and use more of the WWTP capacity. This will require that more of the flow during wet weather be stored. We project that the necessary storage volume will be 1.7 MG for an increase of 800 REUs or 0.2 MGD within the service area. This is visually depicted in the hydrograph shown in Figure 4.

Figure 4: Spring Design Storm Hydrograph with Treatment Capacity of 1.3 MGD, and 800 REUs Growth



Above this level of growth, the treatment capacity should be increased (see the *Average Flows* section), which will lessen the need for storage.

The MDEQ policy also provides an alternative methodology to demonstrate that the system will not overflow more than once every ten years. This analysis generally shows that a smaller basin size will meet the state's requirements, but requires a much more detailed approach and is best deferred as a preliminary design step if a storage project proceeds.

The cost for a storage tank will be dependent upon the type of construction (steel versus concrete) and features desired for the tank such as flushing or aeration. We suggest the Township budget $2.5 million to $3.0 million for a glass-lined steel tank. A concrete tank would have a higher initial cost but may also have a longer useful life.

7.0 GROWTH POLICY

Policy decisions on when to allow or deny new connections to the sewer system rest solely with the Northfield Township Board of Trustees. The MDEQ will occasionally deny new connections when there are obvious capacity problems with a sewer system (not presently the case with Northfield Township's system).

One important consideration is the SAD parcels. The Township has facilitated the construction of sewers in these areas. The property owners are paying an assessment for the construction of the sewers. However, these parcels are largely undeveloped and as such, have not connected to the sewer and have not paid the Township's system development charge (connection fee). This connection fee is established to recover the prorated share of the parcel's use of the treatment plant and downstream sewers.

A conservative policy decision could consider the 0.227 MGD commitment to Green Oak Township, the future SAD demands, and the higher springtime flows and determine that no other connections should be allowed until the wastewater plant is expanded. An alternate policy would be to consider that no significant development in Green Oak and the SADs has occurred in the last ten years, that new connections can be allowed and the WWTP will be expanded prior to the plant being overloaded.

Tetra Tech can appear at a future board meeting to answer any technical questions that will better allow the Board of Trustees to determine their policy regarding new connections.

8.0 PROJECT FUNDING

Wastewater utilities have the choice of financing capital projects with local funds (such as from reserves, connection fees and/or bonds) or from a state-funded loan. A self-financed project has few prerequisites and construction could be initiated within a few months of beginning.

The MDEQ administers a low interest, state funded loan program for wastewater improvements. This program is entitled the State Revolving Fund loan and abbreviated as SRF. A condition of receipt of the loan is that the loan monies are used to construct the cost-effective solution. This requires a series of studies to demonstrate that building storage is cost effective over removing the I/I at its source. Loan applications are due by July 1 each year and the prerequisite studies need to be completed ahead of this application date. Should Northfield Township begin the studies in the spring of 2015, it is likely that the loan could not be applied for until July 1, 2017, or later.

The first study that would be needed is termed an Infiltration/Inflow Study which measures flow throughout the system and makes projections regarding its likely sources and costs to remove. This study may cost $150,000 to $200,000 to complete. This study makes a recommendation that looking for I/I sources will likely be fruitful, but generally concludes that some level of detailed investigation is needed.

The second study is referred to as a Sewer System Evaluation Survey (SSES). It includes detailed investigations within the system to locate specific sources of I/I. This may involve inspecting manholes, sewer pipes, and quantifying illicit sump pumps among many other tasks. The cost of an SSES of Northfield Township's collection system cannot be determined until after completion of the I/I Study, but could range from $150,000 to $300,000.

9.0 SUMMARY AND RECOMMENDATIONS

9.1 SUMMARY

A capacity summary was completed that shows that Northfield Township has significant wastewater treatment obligations to both Green Oak Township and special assessment districts within Northfield Township. An additional 712,000 gallons per day (0.712 MGD) could be added to the system from these obligations.

Capacity determination in a wastewater system involves more than comparing a single set of numbers. An evaluation must be conducted that looks at the WWTP performance during average (dry weather), during wet weather, and in the sewer systems. This report evaluated conditions during average and wet weather conditions and deferred sewer analysis to a later time.

The Township has sufficient treatment capacity available to continue to accept new connections during average conditions (dry weather). Our analysis shows that approximately 800 REUs can be added until the WWTP flows will reach 1.1 MGD during the spring conditions and approximately 1,500 REUs until the WWTP reaches 1.3 MGD during these same spring conditions. A growth of 800 REUs is estimated to increase flows to 85 percent of the WWTP's permit limit during spring conditions, which is a typical threshold upon which the MDEQ may request

a WWTP expansion be considered. Past calculations suggest the WWTP may be able to treat 1.5 MGD if storage is built and thus the higher number of 1,500 REUs may be achievable.

However, during large storms, the Township's WWTP will struggle to treat the peak flow that arrives and meet permit limits. The Township has long discussed a storage basin to be constructed at the WWTP. The size of this basin is dependent upon the level of growth and the available WWTP capacity. A basin is significantly less expensive than a plant expansion. Therefore, the basin should be sized for a future flow condition to postpone a WWTP expansion as long as possible. The MDEQ requires that the basin be sized to contain wastewater for the 25-year, 24-hour storm of 3.9 inches. This condition suggests the basin be sized for 1.7 MG. As discussed in the report, a more sophisticated statistical analysis may show this size can be slightly reduced before it is built.

The basin will assist with existing WWTP operations and be even more critical as growth occurs. It is recommended that the basin be constructed prior to any large developments occurring. For the purpose of quantifying a threshold, it is suggested that the basin be constructed prior to allowing more than 100 REUs to connect.

Table 5 provides a timeline for recommended improvements to summarize the number of new connections (expressed as REUs) and thresholds that initiate new projects.

Table 5: Timeline of Recommended Improvements

Number of Additional REUs	Average Dry Weather Flow, MGD	Average Dry Weather Flow during Peak Months, MGD	Recommended Improvement
0 – 100	0.7	0.9	Construct 1.7 MG storage basin
800 – 1,500	0.9 – 1.1	1.1 – 1.3	Expand WWTP

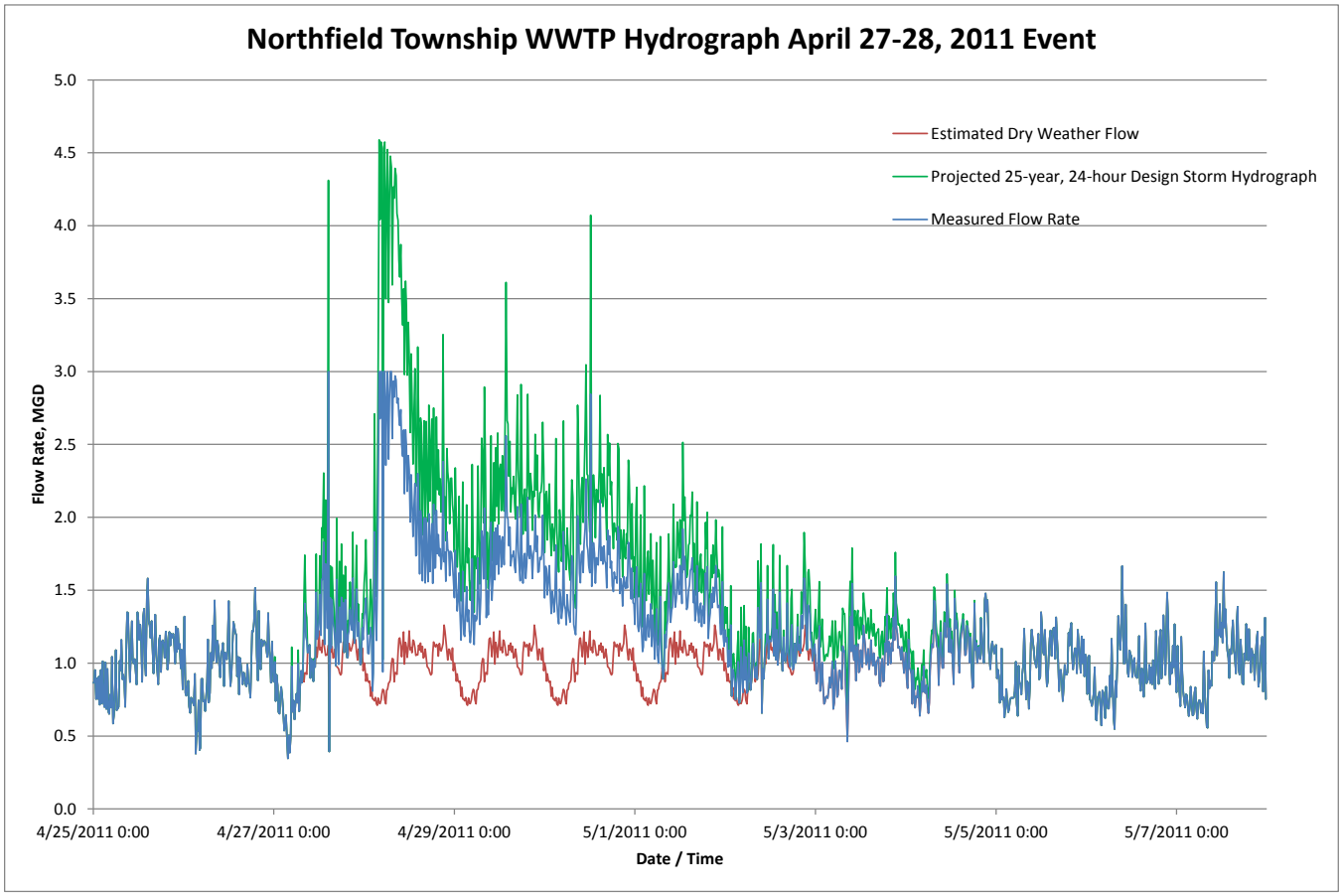
The REUs in Table 5 must consider new connections made from Green Oak Township and the 873 REUs committed to Green Oak. If Green Oak develops to the amounts included in the intergovernmental agreements, most or all of the surplus capacity in the existing wastewater treatment plant would be utilized.

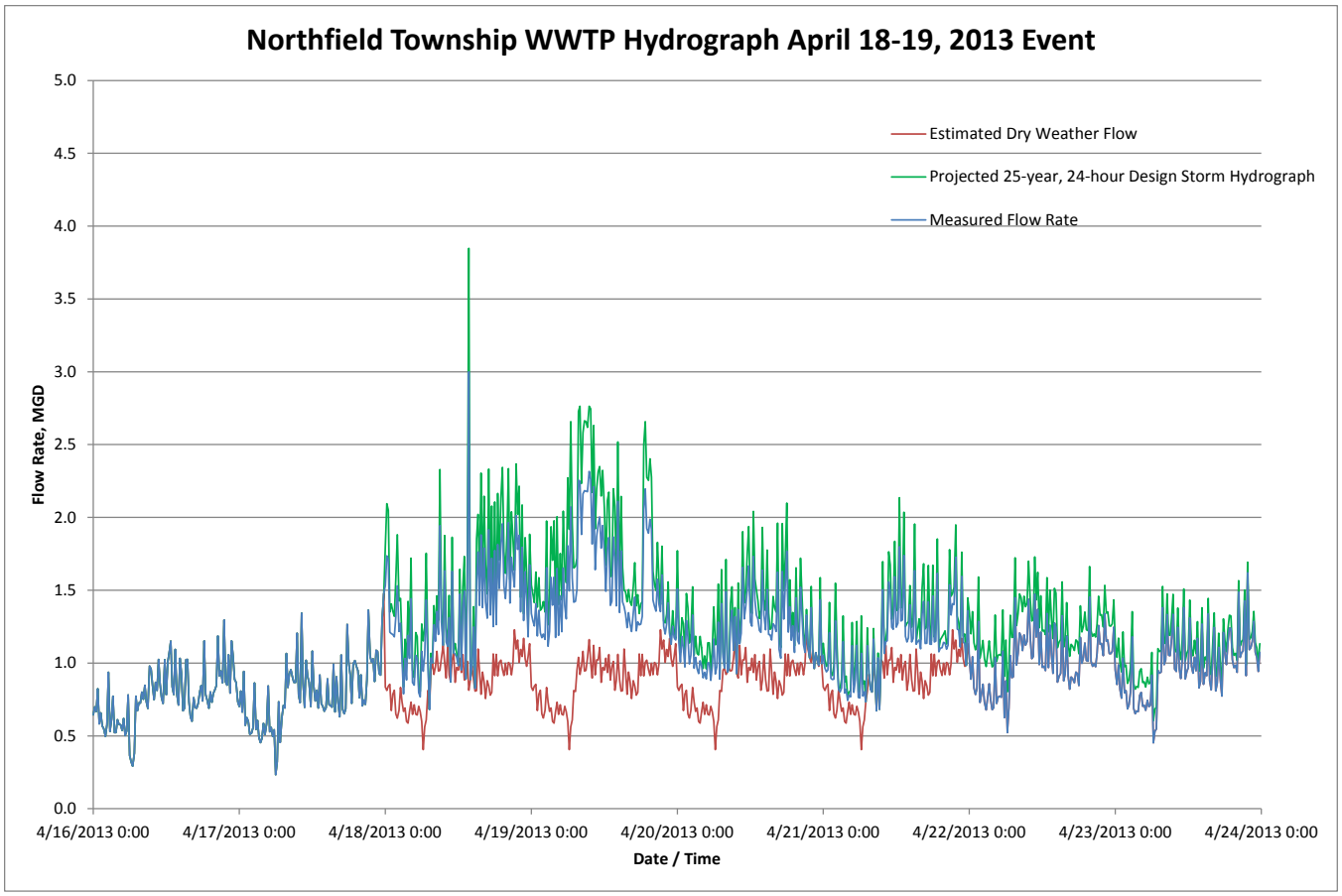
9.2 RECOMMENDATIONS

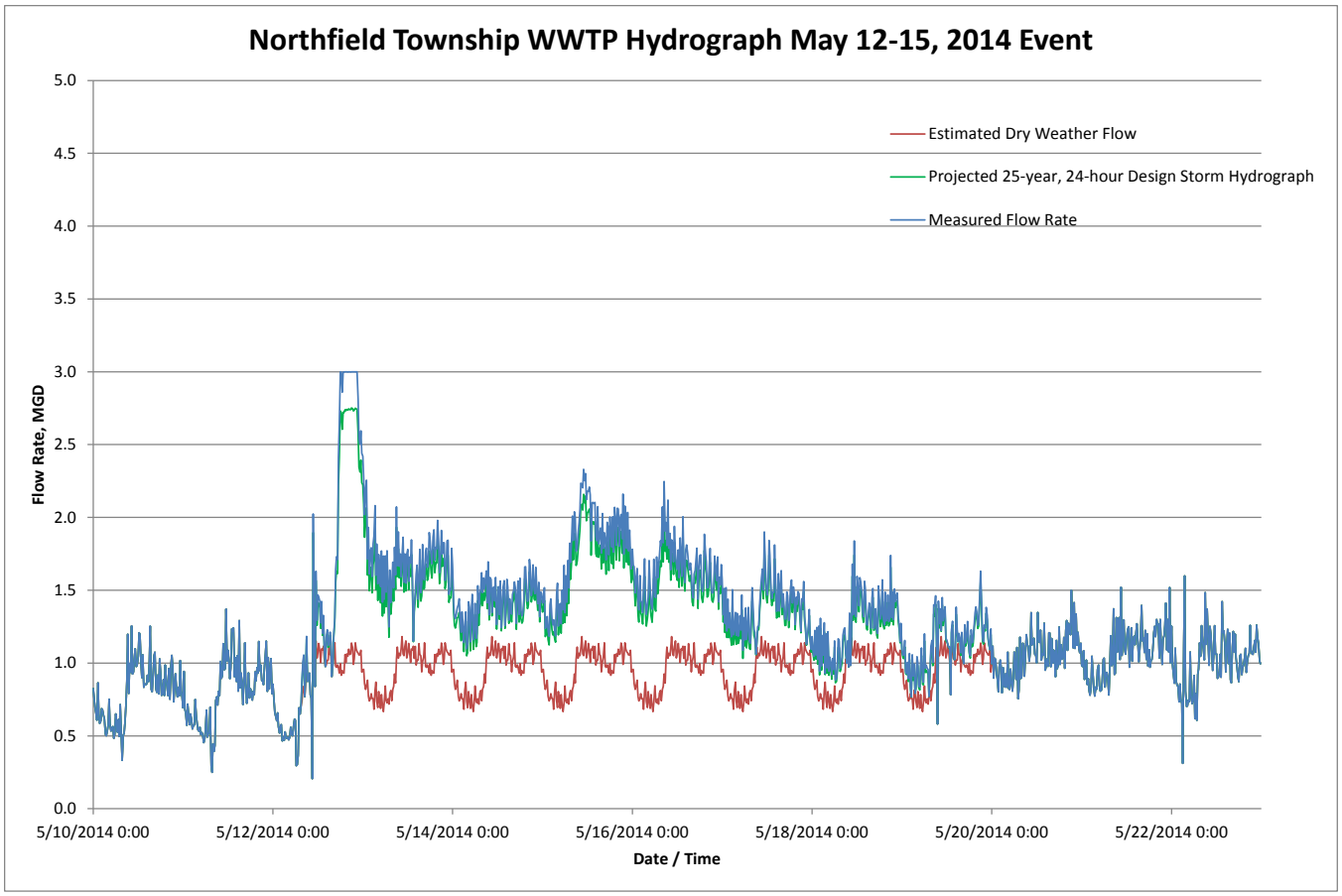
The Township should begin planning for the storage basin that has long been identified for the WWTP. The Township may also wish to revisit its 2005 thoughts about expanding the WWTP to confirm the size and cost of the expansion. The next step toward implementing the storage basin or WWTP expansion is to consider how these projects will be financed, because the method of financing may determine additional steps necessary. At a minimum, we recommend Northfield Township evaluate its system development charge (also referred to as connection fee) so that some of the cost of the basin and WWTP expansion is recovered through fees charged to new connections.

APPENDIX A: GREEN OAK TOWNSHIP AGREEMENTS

APPENDIX B: DATA USED FOR THE DEVELOPMENT OF THE 25-YEAR, 24-HOUR HYDROGRAPH




Northfield Township WWTP Hydrograph April 18-19, 2013 Event
Flow Rate, MGD
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4/16/2013 0:00
4/17/2013 0:00
4/18/2013 0:00
4/19/2013 0:00
4/20/2013 0:00
4/21/2013 0:00
4/22/2013 0:00
4/23/2013 0:00
4/24/2013 0:00
Date / Time
Estimated Dry Weather Flow
Projected 25-year, 24-hour Design Storm Hydrograph
Measured Flow Rate


Northfield Township WWTP Hydrograph May 12-15, 2014 Event
Flow Rate, MGD
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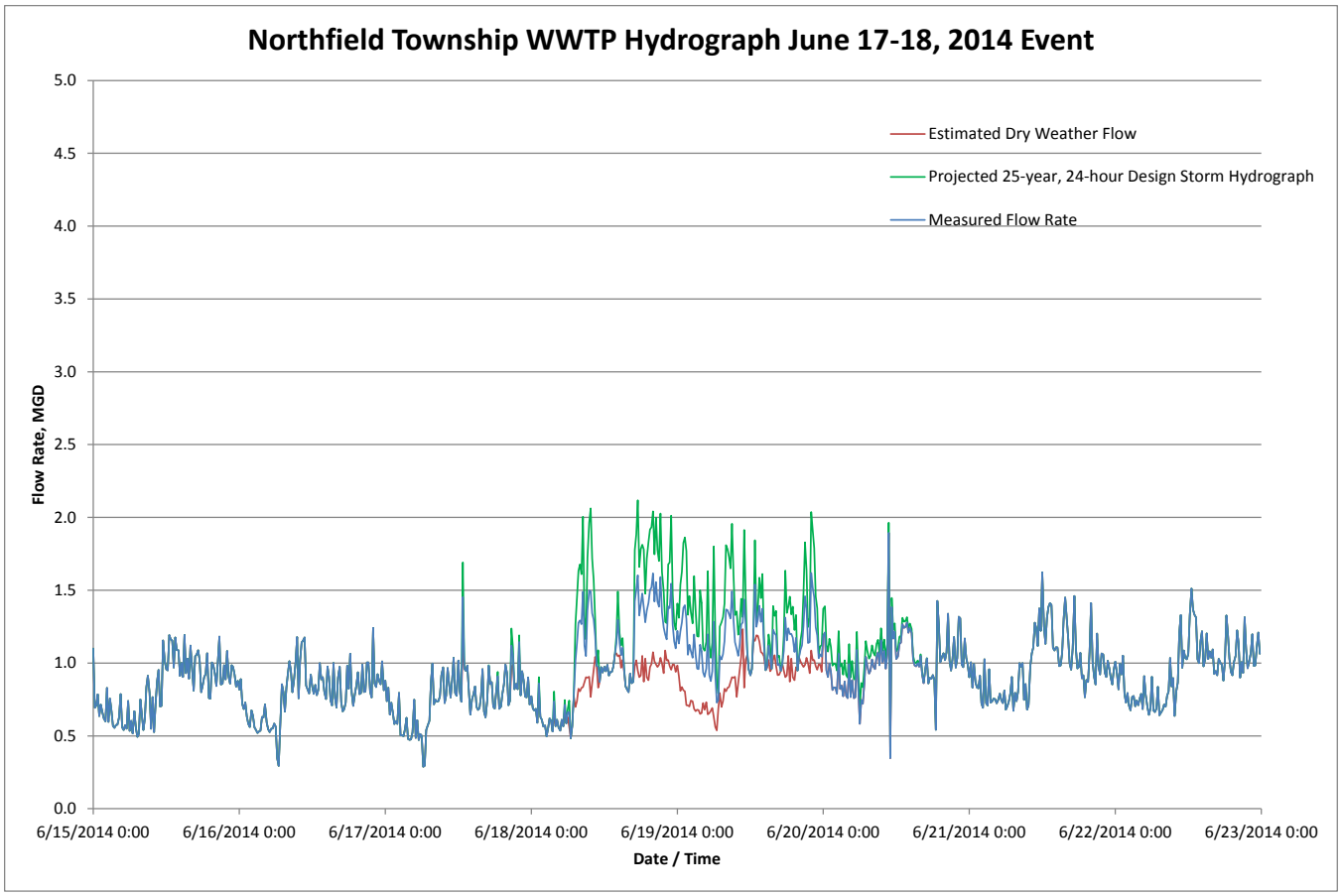
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5/10/2014 0:00
5/12/2014 0:00
5/14/2014 0:00
5/16/2014 0:00
5/18/2014 0:00
5/20/2014 0:00
5/22/2014 0:00
Date / Time
Estimated Dry Weather Flow
Projected 25-year, 24-hour Design Storm Hydrograph
Measured Flow Rate


Northfield Township WWTP Hydrograph June 17-18, 2014 Event
Flow Rate, MGD
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
6/15/2014 0:00
6/16/2014 0:00
6/17/2014 0:00
6/18/2014 0:00
6/19/2014 0:00
6/20/2014 0:00
6/21/2014 0:00
6/22/2014 0:00
6/23/2014 0:00
Date / Time
Estimated Dry Weather Flow
Projected 25-year, 24-hour Design Storm Hydrograph
Measured Flow Rate

TETRA TECH

MEMO

To:	File \\iers008fs1\projects\IER\12748\200-12748-15003\Docs\Memos\LTS_Memo.docx
Cc:	
From:	Justin Voss
Date:	October 12, 2015
Subject:	Northfield Township Long-Term Simulation Modeling Summary and Results

1.0 INTRODUCTION

In March 2015, Tetra Tech evaluated the capacity of the Northfield Township WWTP for current conditions and the planned development of four Special Assessment Districts (SADs). Flow data at the WWTP's influent meter was used to project the growing season 25-year, 24-hour design storm hydrograph and evaluate the need for storage at the site for the design storm and prevent overflows in accordance with the State's SSO Policy. The report recommended 1.7 million gallons of storage that would store wet weather flows during the design storm and allow the current plant to be used until the average dry weather flow reached 1.1 MGD, which is 85 percent of the rated treatment capacity of the WWTP (1.3 MGD). An expansion of the treatment capacity would occur after average dry weather flows reached 1.1 MGD.

Instead of using the 25-year, 24-hour design storm, the State's SSO Policy also allows communities to complete an alternative, but more detailed, analysis that shows that there will be no more than 1 overflow in 10 years from the system. On past projects with other communities, this approach has substantially reduced the amount of storage required. For this current phase of the project, a long-term simulation of rainfall versus flow rate was completed in EPA SWMM to evaluate the storage necessary to limit overflows at the WWTP to no more than 1 in 10 years. This memorandum documents the analysis and its results.

2.0 SCENARIOS

Two scenarios were simulated with EPASWMM. The first assumed the treatment capacity remains at 1.3 MGD. The second scenario assumed that with storage, the treatment capacity could potentially be increased to 1.5 MGD as indicated in the March 2015 report.

The model was set up such that dry and wet weather flow components were input at a node, which discharged into a storage basin that was sized until the overflow limit was met. The outflow from the storage basin was controlled by a fixed rate assumed to be the treatment rate of the WWTP.

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3.0 DRY WEATHER FLOWS

Currently, the average dry weather flow rate at the WWTP varies from 0.7 to 0.9 MGD depending on the time of year. Spring dry weather flows are higher, on average, than other times of the year, so a monthly pattern was used in the model based on the average flows at the plant between 2011 and 2014.

Furthermore, as indicated in the March 2015 report, any storage that is constructed would have to be sized to accommodate growth in the system. It was assumed in that report that an expansion of the treatment rate of the plant could be avoided until the springtime average dry weather flow rate reached 85 percent of the capacity of the WWTP. Therefore, the springtime average dry weather flow rates used in the model are 1.1 and 1.3 MGD for 1.3 and 1.5 MGD treatment capacities. According to the March 2015 report, a springtime average flow rate of 1.1 MGD represents 800 REUs of development in the system, and a springtime average flow rate of 1.3 MGD represents 1,500 REUs of development in the system. The monthly dry weather flow pattern used in the model is shown in Table 1.

Table 1: Monthly Dry Weather Flow Rate used in Long-Term Simulation

Month	Modeled Average Dry Weather Flow for 1.3 MGD Treatment Capacity Scenario, MGD	Modeled Average Dry Weather Flow for 1.5 MGD Treatment Capacity Scenario, MGD
January	0.90	1.10
February	0.90	1.10
March	1.03	1.23
April	1.07	1.27
May	1.10	1.30
June	0.98	1.18
July	0.90	1.10
August	0.90	1.10
September	0.90	1.10
October	0.90	1.10
November	0.90	1.10
December	0.90	1.10

A diurnal pattern was not used in the model, assuming that the largest wet weather flow volumes would occur during and following storms that have a duration near 24 hours or greater.

4.0 RAINFALL

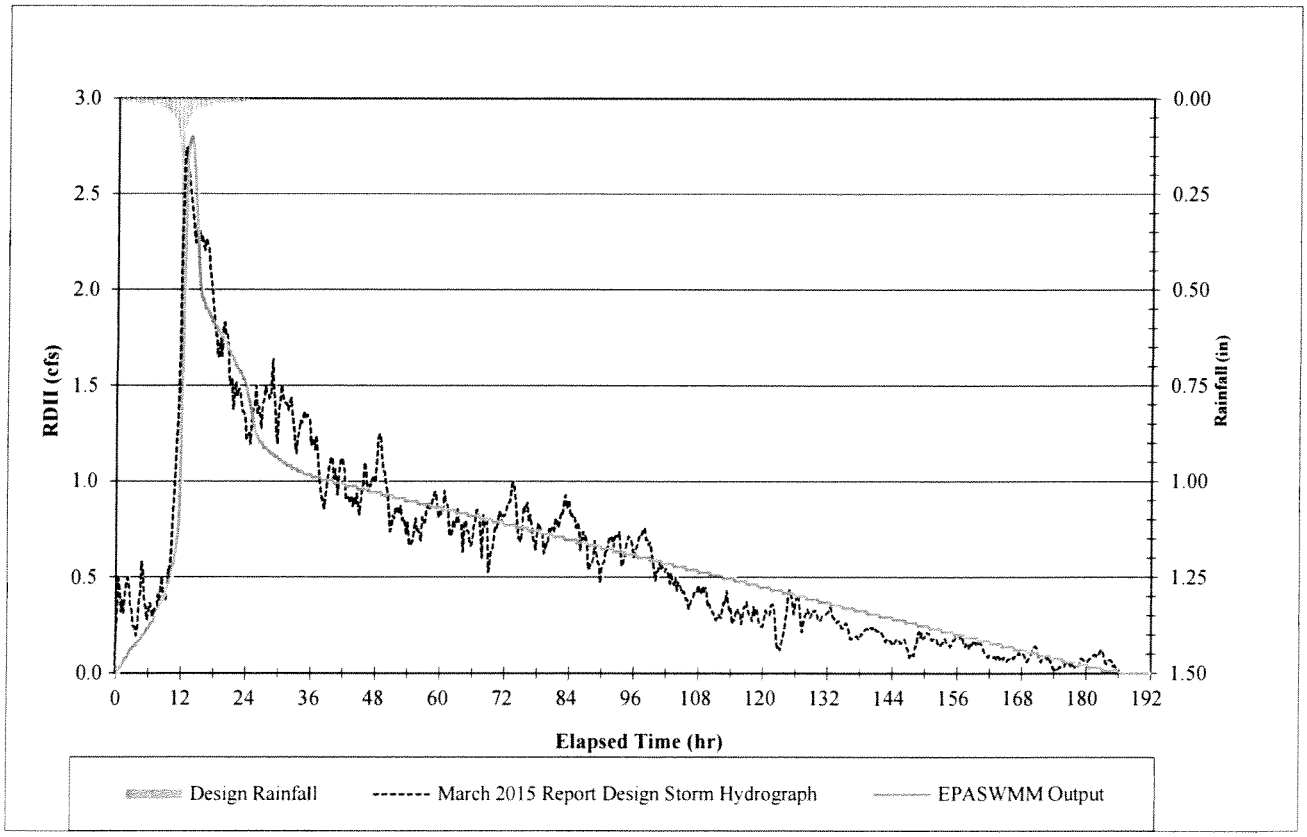
This is a long-term simulation, so hourly rainfall records from Detroit Metro Airport from October 1959 through December 2013 were imported into to the model. During this 54.25-year period, there was an average of 32.05 inches of precipitation per year. Even if individual events in the rainfall record are not identical, it was assumed that the long-term precipitation pattern at Detroit Metro Airport is similar to the long-term precipitation pattern in Northfield Township.

5.0 WET WEATHER UNIT HYDROGRAPH

A unit hydrograph approach was used to model the relationship between rainfall and wet weather flow rate in the model. A hydrograph was developed in the March 2015 report for the 25-year, 24-hour design storm and was used to develop unit hydrograph variables that would be compatible with the model. The design storm model output are shown with the hydrograph from the March 2015 report to show the two are similar. The EPA SWMM model has a 1 percent greater wet weather peak and volume than the hydrograph from the March 2015 report.

Increases in the wet weather flow component were not modeled because many of the main sewers in the areas of potential development are already constructed and new wet weather flow would have to come from direct sources, which would not be permitted, or from leaky local or private sewers or leads, which could be minimized by proper design and construction.

Figure 1: March 2015 Report Design Storm Wet Weather Composite Hydrograph Compared to EPASWMM Output



6.0 LONG-TERM SIMULATION RESULTS

For the 54-year simulation, the storage volume can be exceeded up to five times in the model and meet the State's SSO Policy. The ten largest events are summarized in Table 2. The storage volume would have to contain the sixth largest event, which is highlighted in red in the table.

Table 2: Monthly Dry Weather Flow Rate used in Long-Term Simulation

Rank	Event Date	Modeled Storage Volume Required with 1.1 MGD Springtime Dry Weather Flow and 1.3 MGD Treatment Rate, million gallons	Modeled Storage Volume Required with 1.3 MGD Springtime Dry Weather Flow and 1.5 MGD Treatment Rate, million gallons
1	May 24, 2004	1.91	1.92
2	May 28, 1968	1.64	1.65
3	May 4, 1983	1.27	1.27
4	September 1, 1975	1.26	1.26
5	July 30, 2011	1.26	1.26
6	**June 17, 1960**	**1.25**	**1.25**
7	September 13, 2000	1.22	1.22
8	April 23, 2000	1.12	1.12
9	June 4, 1989	1.11	1.11
10	May 30, 2011	1.01	1.01

As expected, the predicted storage volumes for both scenarios are roughly the same because, in both cases, the difference between the treatment rate and the dry weather flow and the magnitude of the wet weather flow did not change.

From a hydraulic standpoint, a 1.3 million gallon (minimum) storage basin is recommended after rounding the modeled storage volume for the sixth largest event up to the next 0.1 million gallons. The third through sixth largest events are very similar in size, so the model predicts that 1.3 million gallons of storage would limit overflows to two during the simulation period.

The long-term simulation decreases the recommended storage volume by 0.4 million gallons (24 percent) relative to the recommendation in the March 2015 report.