# SMOKE TESTING REPORT

**Submitted to:**
Green Charter Township

July 2019
839870

FLEIS&VANDENBRINK
DESIGN. BUILD. OPERATE.

# TABLE OF CONTENTS



**List of Attachments for Smoke Testing Report**

# EXECUTIVE SUMMARY

Green Charter Township retained Fleis & VandenBrink (F&V) to smoke test its wastewater collection system as part of an effort to locate sources of inflow and infiltration (I&I). I&I sources allow stormwater to enter the sanitary sewer system during rainfall events, which cause an increase in flow through the system. Green Charter Township pays the City of Big Rapids to treat their wastewater, and it has noticed a recent increase in metered flows through the Green Charter Township lift station. Because the City of Big Rapids charges the township based on metered flows, the increase in flow has caused an increase in treatment cost to the township. Smoke testing was selected as a method to locate sources of I&I in the sanitary sewer system. The results of the testing are summarized below.

**Study Details**

This report presents the results of the smoke testing that was completed on June 4 and June 5, 2019. Smoke testing is a relatively fast, economical, and effective method of locating potential sources of inflow and infiltration (I&I) into the sanitary sewer collection system. A map of the area tested, and the locations of smoke observations, can be found in Appendix A.

**Conclusions**

Fifteen instances of smoke exiting the wastewater collection system at inappropriate locations were found during smoke testing. The list below identifies each of these locations, the priority in fixing them and the recommended remediation action.

<u>Connected Storm Drains (High Priority)</u>

- 20868 Emerald Lane Driveway storm drain connected to sanitary sewer

<u>Leaking Manhole Structures (Medium Priority)</u>

- Township Sanitary Sewer Manhole #26
- Holland Drive Manhole #7 in the Country Manor Estates
- Holland Drive Manhole #6 in the Country Manor Estates
- Holland Drive Manhole #5 in the Country Manor Estates
- Holland Drive Manhole #4 in the Country Manor Estates
- Holland Drive Manhole #2 in the Country Manor Estates
- South Haven Drive Manhole #9 in the Country Manor Estates

<u>Open Sanitary Cleanout- Property owner to install new cleanout cap (Low Priority):</u>

- Cabin #1 Northland Drive
- Cabin #2 Northland Drive
- Broken Clean Out #3 of the Country Manor Estates
- Broken Clean Out on lot 225 of the Country Manor Estates
- Buried Clean Out at the River's Edge Condominium Development Entrance (in rock landscaping)
- Northeast corner of northeast building of Old Carter's Lumber

<u>Miscellaneous (Medium Priority):</u>

- Undeveloped lot 259/260 of the Country Manor Estates leaking lateral connection

# INTRODUCTION

## PROJECT BACKGROUND

In an effort to understand why Green Charter Township is experiencing elevated flow rates in its sanitary sewer system, the Township partnered with F&V. To determine if inflow and infiltration were responsible for the recent increase in flow, the Township and F&V conducted sanitary sewer smoke testing in June of 2019 in an effort to locate sources of I&I.

## TERMINOLOGY

Infiltration and Inflow (I&I) is a broad term that is often defined differently by different people and organizations. For the purposes of this report, the below list of types of I&I with their accompanying definitions is used.

- **Groundwater Infiltration** – groundwater entering the sanitary sewer through structural defects (e.g. cracks or separated joints) on a constant basis, regardless of precipitation or surface water elevations.
- **Inflow** – surface runoff from precipitation entering the sanitary sewer through direct connections (e.g. storm sewer connections, roof drains, open sewer cleanouts). It is characterized by a flow spike immediately following precipitation, especially intense periods of precipitation.
- **Storm-Induced I&I** – an increase in sewer flow starting 1-2 days after a precipitation event and lasting 1-2 days. Sources of storm-induced tend to be temporary storages of precipitation, such as the soil (e.g. elevated groundwater levels) or basements.
- **River-Induced I&I** – elevated flows in response to elevated Muskegon River water surface levels. During the study, periods of elevated river stage lasted 4-7 days. This form of I&I can be attributed to a number of causes, the major ones being, in order of likelihood:
    - Elevated groundwater levels causing increased infiltration through structural defects.
    - Exfiltration from storm sewers or overland drains travelling through the ground and infiltrating the sanitary sewers.
    - Direct connections between storm sewers or overland drains and the sanitary sewers.
    - Surface flooding entering manholes not adequately watertight.

Due to the nature of smoke testing, it has a tendency to identify inflow sources, but usually does not identify any of the other sources of I&I listed above. For instance, smoke testing is more likely to identify a catch basin connected to the sanitary sewer or a broken sewer lateral clean-out cap than structural defects in the buried piping system.

## OBJECTIVES

The objective of this study was to determine as many I&I sources as can be found by smoke testing as well as to present the findings in a manner in which each inflow point can be tracked for future confirmation of correction. The report also categorizes each inflow point into its relative priority based on the estimated volume of clean water inflow that might occur at that point. For instance, a catch basin connected to the sanitary sewer system will have a higher priority because it will discharge significantly more clean water into the sanitary sewer system than a broken cap on a sanitary lateral clean-out will.

# TESTING METHODOLOGY

Smoke Testing involves blowing a non-toxic synthetic smoke like gas into the sanitary sewer system at strategically located manholes and recording observations of where the smoke emerges from the sewer system at inappropriate locations such as catch basins, uncapped sewer lateral clean-outs, roof drains, etc. Smoke from these inappropriate locations indicates potential pathways of I&I entering the sanitary sewer system.

Prior to testing, affected businesses and homeowners were notified by the Township and Fleis & VandenBrink employees via printed notices on doors. The local police and fire department were informed of the testing, prior to testing, in the event that the artificial smoke might be interpreted as real smoke and reported to the authorities.

A portable blower specifically designed and built for use in smoke testing was utilized for the work. The smoke fluid used for the testing produces artificial smoke when pumped from a container onto the heating element of the blower manifold. The artificial smoke generated is white in color and leaves no residue. The smoke is non-toxic, non-explosive, and dissipates quickly once the blower is deactivated.

To perform the testing, the blower was positioned on a sanitary manhole and a visual inspection was conducted of the surrounding area as smoke was continuously introduced into the system. The effective area of coverage for each manhole set-up was defined by the observation of the smoke exiting home roof vents, sanitary manhole covers, and suspect locations of the sanitary sewer system noted in the field as potential sources of I&I.

Blower setup locations were selected to provide overlap within the coverage areas in order to facilitate testing of the entire target area of the sanitary sewer collection system without gap. The operation of the collection system was not interrupted, nor was it necessary to plug the sewer pipes.

# RESULTS & RECOMMENDATIONS

A total of 15 instances were noted where smoke exited the sanitary sewer system at an inappropriate location. Each of these instances were logged with a sketch of the area along with a written description of what was visually observed. Additionally, many instances were documented with pictures identifying the location where smoke was observed. The field logs and pictures are attached to this report in Attachment A.

Each instance where smoke was observed has been categorized into one of three categories based on how much clean water inflow it is felt likely to occur at that location. The priority classifications are identified by a visual inspection and are intended to help the City economically and efficiently prioritize correcting the problems. The three categories are:

- *Low Priority* – Small chance for inflow to occur due to natural runoff and infiltration of the area around the specified object.
- *Medium Priority* – Good chance for inflow to occur due to natural runoff and infiltration of the area around the specified object.
- *High Priority* – High chance for inflow to occur due to natural runoff and infiltration of the area around the specified object.

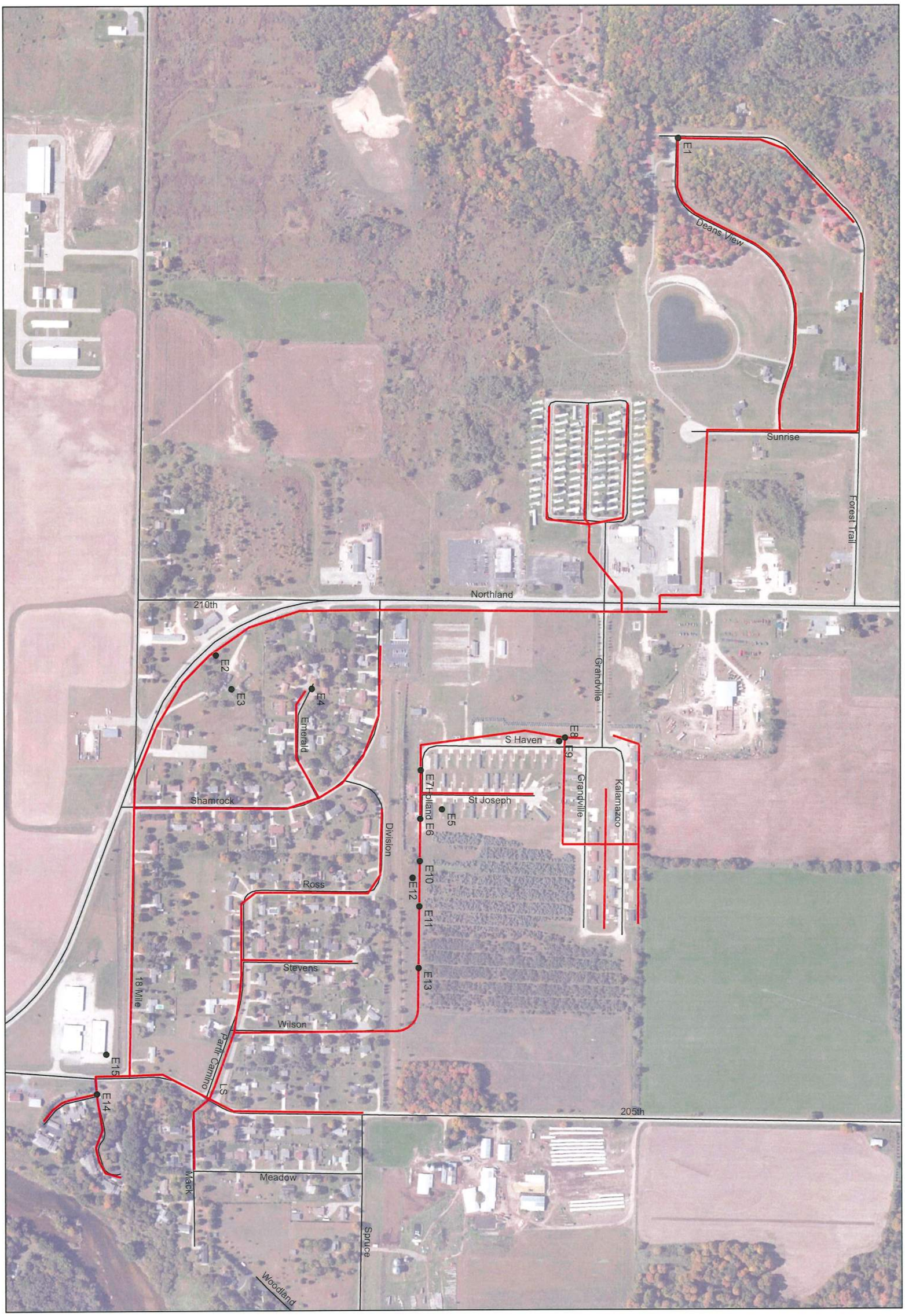
Recommended actions accompany each location where smoke was observed. Many of the locations are outside of the right-of-way and therefore privately owned by the property owner. The Township is not responsible for either making repairs or the associated cost for problems found on private property as ownership and maintenance responsibilities of the sewer system end at the right-of-way. However, the Township can enforce its sewer use ordinance and its rules and regulations of the sewer system. Therefore, it is recommended that the Township notify each of the private property owners in writing of the I&I issues discovered and require that repairs be made by the property owner within a timely manner.

The table below identifies each of the instances where smoke exited the sanitary sewer system at an inappropriate location and identifies the priority and recommended action.

**Table 1: Smoke Testing Observations**

| Event | Location | Observation | Priority | Remedy Recommendation |
|---|---|---|---|---|
| 1 | Sanitary Manhole #26 | Leaking around Base | Medium | Rehab Manhole |
| 2 | Cabin #1 Northland Drive | Open Cleanout | Low | Install Cap |
| 3 | Cabin #2 Northland Drive | Open Cleanout | Low | Install Cap |
| 4 | 20868 Emerald Lane | Storm Drain Connected to Sanitary Sewer | High | Disconnect Drain from Sanitary Sewer |
| 5 | Lot #225 of Country Manor Estates | Open Cleanout | Low | Install Cap |
| 6 | Manhole #6 on Holland Drive | Leaking around Base | Medium | Rehab Manhole |
| 7 | Manhole #7 on Holland Drive | Leaking around Base | Medium | Rehab Manhole |
| 8 | Manhole #9 on South Haven Drive | Leaking around Base | Medium | Rehab Manhole |
| 9 | Lot #3 of the Country Manor Estates | Broken Cleanout | Low | Replace Cleanout |
| 10 | Manhole #5 of the Country Manor Estates | Leaking around Base | Medium | Rehab Manhole |
| 11 | Manhole #4 of the Country Manor Estates | Leaking around Base | Medium | Rehab Manhole |
| 12 | Lateral Connection (Lots 259/260) | Leak | Low | Plug Lateral Connection until Lot is Developed |
| 13 | Manhole #2 of the Country Manor Estates | Leaking around Base | Medium | Rehab Manhole |
| 14 | River's Edge Condominium Entrance | Buried Open/Broken Cleanout | Low | Replace Cleanout |
| 15 | Northeast Corner of Northeast Building of Old Carter's Lumber | Open Cleanout (Missing Cap) | Low | Install Cap |

# ATTACHMENT A
# SMOKE TESTING MAP




PAGE

--

NORTH

0 200 400

SCALE IN FEET

SOURCES:
Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FILE LOCATION:
M:\Proj\839870-640\839870 Green Charter Twp - SSES_Approximate Leak Locations.mxd

| DRAWN BY | DATE |
|---|---|
| SWL | 6/26/2019 |
| PROJECT NO | SCALE |
| 839870 | 1:5,400 |

# Approximate Leak Locations

Green Charter Township, Michigan

- Smoke Testing Result/Event #
- Approximate Sanitary Main Location

FLEIS&VANDENBRINK
DESIGN. BUILD. OPERATE.

# ATTACHMENT B
# OBSERVATION PHOTO LOG

Event #1: Leaking Base on Sanitary Manhole 26 at the Corner of Dean’s View and Forest Trail

Event #2: Open Cleanout at Northland Drive Cabin #1

Event #3: Open Cleanout at Northland Drive Cabin #2

Event #4: Storm Drain in Driveway connected to Sanitary Sewer at 20868 Emerald Lane

Event #5: Broken Cleanout on Lot #225 of the Country Manor Estates

Event #6: Leaking Base on Manhole #6 on Holland Drive of the Country Manor Estates

Event #7: Leaking Base on Manhole #7 on Holland Drive of the Country Manor Estates

Event #8: Leaking Base on Manhole #9 South Haven Drive of the Country Manor Estates

Event #9: Broken Clean Out #3 of Country Manor Estates

Event #10: Leaking Base on Manhole #5 on Holland Drive of the Country Manor Estates

Event #11: Leaking Base on Manhole #4 on Holland Drive of the Country Manor Estates

Event #12: Leaking Lateral Connection for Undeveloped Lot 259/260 of the Country Manor Estates

Event #13: Leaking Base on Manhole #2 on Holland Drive of the Country Manor Estates

Event #14: Buried Clean Out at the River's Edge Comdominium Development Entrance

Event #15: Clean Out with no cap at the Northeast Corner of the Northeast Building of Old Carter’s Lumber