

INFLOW AND INFILTRATION PROJECT PLANNING



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Environmental Design Group Project

Prepared for:

The Village of Thornville

1 South Main Street

Thornville, Ohio 43076

November 22nd, 2023

Prepared By:



Table of Contents

EXECUTIVE SUMMARY..... 3

I. INTRODUCTION 3

 A. PROJECT GOAL 3

 B. EXISTING WASTEWATER FACILITIES..... 3

II. PROJECT PLANNING 4

 A. LOCATION..... 4

 B. POPULATION 4

 C. PLANNING AND SERVICE AREA 5

 D. ENVIRONMENTAL RESOURCES 6

 E. INFLOW & INFILTRATION (I/I) AUDIT 6

 F. INFLOW & INFILTRATION STUDY 8

 a. Review 8

 b. Recommendations..... 9

IV. PROJECT EVALUATION 10

 I/I Reduction 10

VII. CONCLUSIONS AND RECOMMENDATIONS 10

VIII. APPENDICES 11

EXECUTIVE SUMMARY

The Village of Thornville (Village) Wastewater Treatment Plant (WWTP) currently serves the Village and Northern Perry County (NPC) as a regional sewer provider operating at approximately seventy-five (75) percent of its EPA permitted flow. The last upgrade at the WWTP was conducted in the early 2000's including: clarifiers, tertiary filtration, UV Disinfection, and sludge handling. The WWTP still meets existing permit limits, but aging infrastructure, future flow capacity, reduced operational costs, improvement of maintenance accessibility prompted the investigation of what might be required in the future for the WWTP. Through the investigation of the WWTP an issue with I/I was identified. Although the collection system is a storm/sanitary separated system, there is a significant Inflow and Infiltration (I/I) problem.

This project involves the minimal improvements required for the Village system to improve WWTP operations. If the Village were to improve I/I flow the WWTP treatment capacity would increase because of reduced sewer flow. The I/I improvements would be completed and WWTP would continue normal operation with reduced costs in waste water treatment due to reduction in total flow from I/I.

I. INTRODUCTION

A. PROJECT GOAL

In discussions with the Village, they indicated the existing WWTP was operating at 75% of the EPA permitted limit of 0.40 MGD. On average the WWTP receives flow of 0.32 MGD with five of the last 36 months recording flows of more than 0.40 MG. Expected growth from development in the NPC service area triggered the need for a preliminary engineering report. Were flows to increase based on the expected growth, the WWTP would exceed the permitted daily flow.

This project was proposed to improve the collection system I/I, and operation and maintenance costs. A location map of the Village sewer service area including the NPC service tributary can be found in Exhibit A. Included are concept plans and cost estimates for the project.

B. EXISTING WASTEWATER FACILITIES

Ohio EPA NPDES number: OPD00045*ID

US EPA NPDES number: OH0027723

The existing WWTP is permitted for 0.40 MGD with a peak factor of 3.5 for a peak flow of 1.4 MGD. The WWTP capacity was designed for 1,000 Equivalent Residential Units (ERU) at 400 gallons per ERU per day. The existing WWTP is an activated sludge biological process based on a population of 1,000 with the following influent limits; 250 mg/L BOD₅, 200 mg/L BOD and 200 mg/L TSS. The Treatment process currently includes an influent screw screen, primary aeration tanks, secondary clarification, rapid gravity filtration, and Ultraviolet light disinfection (UV). The last major upgrade was conducted in 2001 including UV Disinfection, tertiary filtration, sludge processing, and a clarifier update.

II. PROJECT PLANNING

A. LOCATION

The WWTP service area includes the Village of Thornville and proportions of NPC. The Village is in northwestern Perry County on the southeastern end of Buckeye Lake approximately one mile south of the community of Thornport. The Village does not intend to extend their current corporation limits. However, sanitary sewer service is provided to the Thornport region through NPC utilities (See Exhibit A).

B. POPULATION

Village and regional community population data (Figure 1 below) was used to evaluate potential growth within the existing sewer service area. The Village's 2020 census recorded a population of 1,087, which is an increase of 96 people or 9.7% from the 2010 census population of 991. When you compare the population from 2010 to the 2000 census, there was growth of 260 people from the 2000 population of 731. Using the census data over the past 30 years, the Village has grown on average, by approximately 7 people each year. While the Village has indicated there is no interest in extending their corporation limits, there is natural growth within the village limits and additional growth within NPC.

NPC serves the Thornport region at Buckeye Lake which is expected to see growth based on its location being within a 30-minute commute to the proposed Intel corporation chip factory. The County has seen a growth of approximately 1,330 people or 3.7% (Figure 2) over the last 20 years. The anticipated expansion of sewage flow from the NPC sewer service area to the Village WWTP comes from developers interested in land near Buckeye Lake where an additional 800 to 1,000 homes are planned for construction to meet the current and anticipated housing demand.

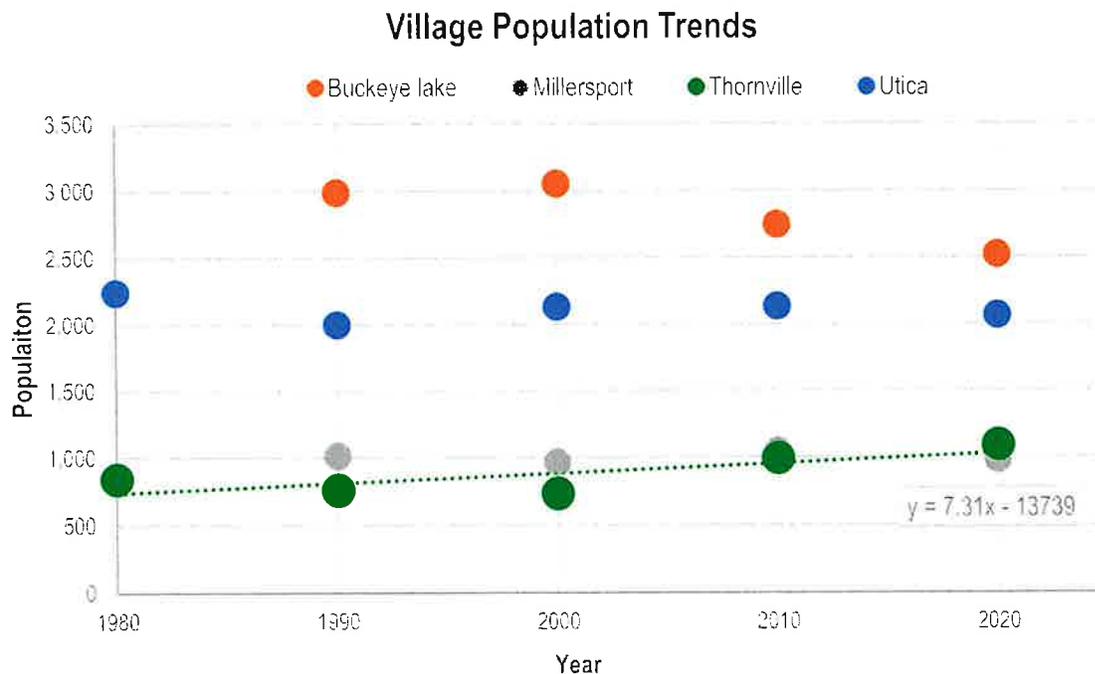


Figure 1: Village of Thornville population trends: Over the last 40 years.

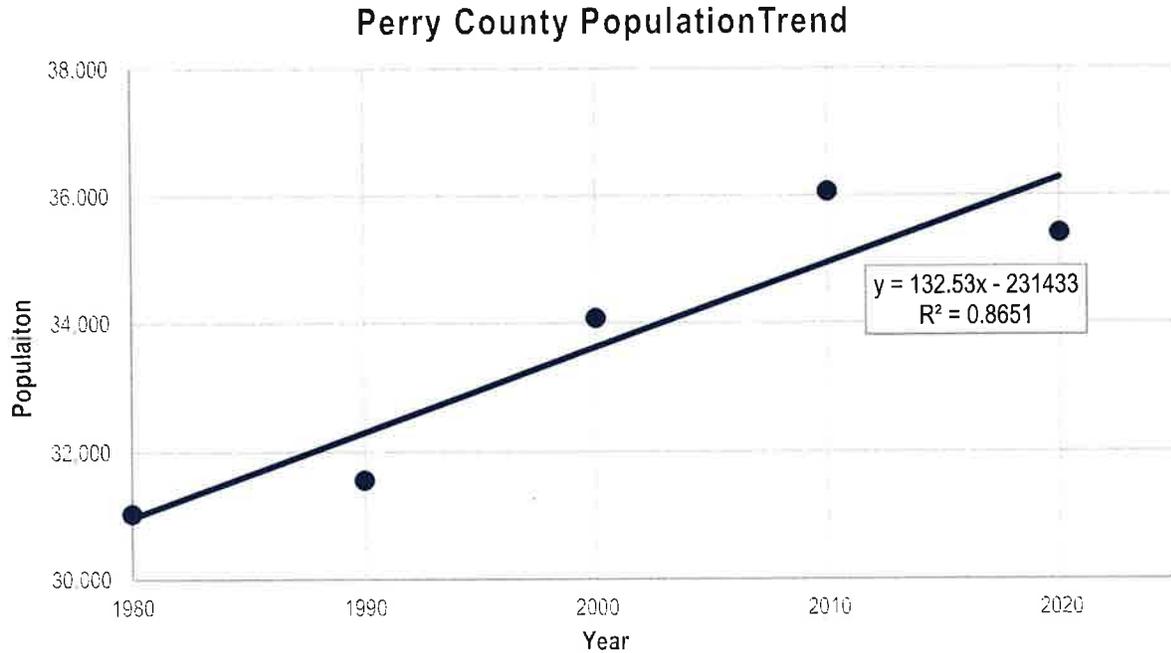


Figure 2: Perry County growth: Over the last 40 years

C. PLANNING AND SERVICE AREA

As described above, the existing WWTP services both the Village corporation area and north into Perry County to the County northern boundary. Growth projections do not indicate a significant change in the population within the service area of the Village. However, discussions between the County and the Village indicate interest in connecting approximately 800 – 1,000 possible homes to the Village WWTP through the NPC collection system.

This growth potential within the service area is shown in Table 1, including the current number of ERU's (1 home = 1 ERU) being serviced by the sewer system. The "Avg. Flow Per ERU" noted in Table 1 is an average across all existing equivalent residential units (ERU's) for both the Village and NPC. The proposed future ERU's (homes) are included, and the total flow was calculated using the existing average NPC flow per ERU. With the expected increased sewer flow to the WWTP, the Village will need to adjust their existing permitted effluent flow limit to accommodate future growth and development.

Table 1: ERU and Sewer analysis. For existing taps and proposed units in future development within NPC. Data from 2018-2022 from both Village and County of flow and total customers. Five-year WWTP Average Daily Effluent is 312,265 GPD.

	Avg. Flow Per ERU	ERU's	Flow GPD
Village of Thornville	418	496	207,533
Northern Perry County (Existing)	162	699	113,467
Northern Perry County (Proposed)	162	1,000	162,000
Total		2,195	483,650

D. ENVIRONMENTAL RESOURCES

Wetlands Inventory – The WWTP is not located within a defined wetland area. The sewer service network includes Freshwater ponds, and Riverine habitat, defined by the National Wetlands Inventory (s).

Discharge Source – The WWTP discharges into the nearby Honey Creek, a tributary to Buckeye Lake.

Flood Elevations – The Village is not in a flood hazard area. The WWTP is in Zone X according to FEMA FIRM maps, with Zone X being of minimal flood hazard and the safest zone. No base flood elevations or base flood depths are required or shown within this zone.

E. INFLOW & INFILTRATION (I/I) AUDIT

Initially the last 3 years of system flow data was evaluated and analyzed in Table 2 below. Using EPA 40 CFR 122.21 (g) (7)(ii) to define storm events as rainfall of greater than 0.1 inch; wet weather flow was defined as sewer flow data the day of, and up to 24 hours after, the storm event. Dry weather flow was recorded as sewer flow 24 hours after a storm event and up to the day of a storm with greater than 0.1 inches of rainfall. Rainfall and sewer flow data was recorded and provided by the WWTP. Percent of I/I was calculated in Table 2 as the difference between wet and dry weather ADF, or the total flow for the year divided by dry weather ADF for a given calendar year.

Table 2: Water Inflow and Infiltration: Storm events defined by EPA 40 CFR 122.21(g)(7)(ii). I/I calculated by the difference between wet and dry weather ADF over Wet weather ADF.

	2020 (gpd)	2021 (gpd)	2022 (gpd)	3-Year Average
Dry Weather Flow (ADF)	0.236 MG	0.249 MG	0.267 MG	0.251 MG
Wet Weather Flow (ADF)	0.360 MG	0.379 MG	0.425 MG	0.388 MG
Inflow & Infiltration	52.54%	52.20%	59.17%	54.58%

A second analysis was conducted to look at the potential I/I impact on the system. This was to help verify I/I data in Table 2 above, by considering water use against sewer flow data as an indicator of the health of the system. In a perfect system water and sewer data would show a similar correlation to the design flows EPA uses for drinking water and sanitary flow. Taking the projected water use from the sewer data provides the theoretical I/I. Table 3 shows the data. An analysis for the data was conducted and discrepancies were found. Those discrepancies were explained when we were informed that NPC sells water to customers that do not contribute sewer flow to the Thornville WWTP. Figure 3 provides a visual depiction of real time sewer and water data. The difference between the orange and blue line shows the assumed I/I.

Table 3: WWTP Flow and Water Production: I/I calculated by the difference between water production and wastewater treatment volume.

	Thornville	NPC	Future (Est)	Total
EPA Greenbook Flow Guideline (400 GPD/ERU)	198,400	279,600	400,000	878,000
Wastewater Flow GPD(Actual)	207,533	112,752	162,000	483,235
Sewer ERU's	496	696	1,000	2,195
Wastewater Flow / ERU (GPD)	418	162	162	
Water Flow GPD (Actual)	76,945	105,938	152,000	
Water ERU's	493	699		
Water Use / ERU	156	152	152	
I & I (WW flow -Water Use / Water Use)	170%	7%		

Average Monthly Flow Vs. Water



Figure 3: Average Monthly Sewage Flow VS. Drinking Water Production. Data in the table shows average monthly influent wastewater flow versus water production for the given months. Differences between the lines shows peaks during wet weather and dry weather seasons.

F. INFLOW & INFILTRATION STUDY

a. Review

In 2011 the Village of Thornville commissioned a Sanitary Sewer Evaluation Survey (SSES) by GGC Engineers for the Village sewer collection system to identify locations of inflow and infiltration (I/I). This study was completed and handed over with all data and recommendations for improvements of the system. The Village has indicated they have no knowledge of improvements to the collection system other than what was noted in the report. The report stated, "In 2008, prior to the regional connection of the NPCWW system, the dry weather flows in the Thornville system averaged 80,000 (GPD). WWTP record flow data shows that it is not uncommon for the system to receive over 800,000 GPD in very wet weather and over 500,000 in moderate wet weather."

The SSES divided the Village into "5-distinct," sewer sheds based on flow direction and lift station locations. A map of the Village collection system and sewer sheds is provided in Exhibit B – Thornville I/I Map.

- Sewer Shed 1: Drains to Lift Station 1 in the eastern portion of the Village with approximately 60 service connections.
- Sewer Shed 2: Drains to Lift Station 2 located on the northern edge of the Village with approximately 130 service connections.
- Sewer Shed 3: Drains to Lift Station 3 located in the northwest portion of the Village with approximately 32 service connections.
- Sewer Shed 4: Drains directly to the WWTP and is composed of the central and southeastern portion of the Village with approximately 190 service connections.
- Sewer Shed 5: Comprised of the sewers in the Thornhill Estates subdivision which is located on the southern edge of the village, containing approximately 37 service connections. This sewer shed was constructed after the year 2000 and was excluded from the SSES study due to it's age and construction with PVC pipe.

An initial flow monitoring program was conducted to identify areas of concern for I/I. This program included a lift station drawdown test that identified the approximate flows from individual sewer shed areas. Sewer sheds 2 and 4 were identified as the problem areas for I/I, contributing 40% and 47.8% respectively of Village total flow to the WWTP on an average annual basis.

The SSES study conducted Closed-Circuit Television program (CCTV), smoke testing, manhole inspection, and dye testing in the sewer sheds 1 through 4. CCTV inspection was conducted on 31,630 feet of the sanitary system. Breaks, cracks and replacement recommendations were made for the sewer pipe.

Smoke testing identified 14 cases of a collapsed or leaking lateral and a total of 12 downspout gutter connections to the sewer system. Manhole inspections found evidence of I/I coming through barrel joints and under castings with a few showing signs of surface water inflow.

Due to low public participation, only 50% of the buildings were inspected with only a few sources of cross connections identified. The SSES noted that the non-participant 50% of the buildings are buildings of concern as those that did participate are less likely to have non-compliant piping.

b. Recommendations

As a portion of this improvement project, I/I reduction should be a priority. Given our understanding that action on the recommended items in the 2011 SSES report were not taken, it is assumed the system requires the same improvements and more due to the time passed since the report and the continued deterioration of the collection system.

The following steps are recommended:

- A Village GIS system should be built to track and electronically document improvements made to the collection system based, in part, on the SSES report.
- Focus resources on what could be most impactful to Village I/I reduction, notwithstanding private property improvements i.e., removing gutter connections to the sanitary system, plugging/abandoning unused gravity mains, and the repair of collapsed laterals as detailed in this and the SSES report.
- Investigate private sewer laterals by CCTV lateral launching with dye testing. This could help identify problematic private sewer laterals as well as help to identify gutter and sump pump cross connections. Once documented and logged into the Village's GIS, Thornville will be better prepared to make improvements in the future.
- Use sewer, grant, and loan funds to line and repair gravity sewer and manholes within the problem sewer shed areas 2 and 4. Quantities of lined and unlined gravity were calculated from Village provided maps with operators' knowledge of previously lined gravity mains. As the contractor is investigating and cleaning these mains prior to lining if any deficiencies are found they will recommend additional repairs. As a result of a decade passing since the report was written, more repairs could be expected than what were originally recommended in the SSES report. A total estimated 2023 I/I project cost was approximately \$ 1,435,895.50 for the sewer sheds. Estimates for the sewer shed areas were conducted assuming an average gravity main diameter of 8" and an average manhole depth of 10'.
 - Sewer Shed 1 has approximately 504 feet of lined sewer and 6,622 feet of unlined sewer for a total of approximately 7,126 feet and 42 manholes.
 - Sewer Shed 2 has approximately 7,069 feet of lined sewer and 3,710 feet of unlined sewer for a total of approximately 10,800 feet and 50 manholes.
 - Sewer Shed 3 has approximately 1,359 feet of unlined sewer and 9 manholes.
 - Sewer Shed 4 has approximately 1,200 feet of lined sewer and 11,333 feet of unlined sewer for a total of approximately 12,531 feet and 68 manholes.
 - Sewer Shed 5 was not quantified due to the age of the collection system along with the lack of analysis in the SSES report.

IV. PROJECT EVALUATION

I/I Reduction

This alternative would be recommended if NPC diverted their sewer flow to another utility. The loss of the NPC flow would result in approximately a 33% reduction of flow to the existing WWTP therefore bringing the dry weather ADF within their EPA permitted flow in lieu of some months exceeding the permitted flow. The Village would still need to work on the reduction of I/I and the upgrade of individual aging facilities and treatment process equipment through their current budget process. If the Village were to lose the NPC they would lose the revenue of 696 customers.

i. Emergency Operation

The current WWTP has reported no overflows at the plant in the last three years. With I/I reduction the capacity of the plant would be increased and there will be a further reduction of potential overflows during wet weather events. Emergency backup power is sized to provide for the expected electrical demand of the WWTP equipment in order to continue operations to meet the discharge limits.

ii. Operation & Maintenance

Testing, sampling, and reporting are all conducted and reported regularly. The three existing Village pump stations operate with emergency backup generators.

iii. Cost Estimates

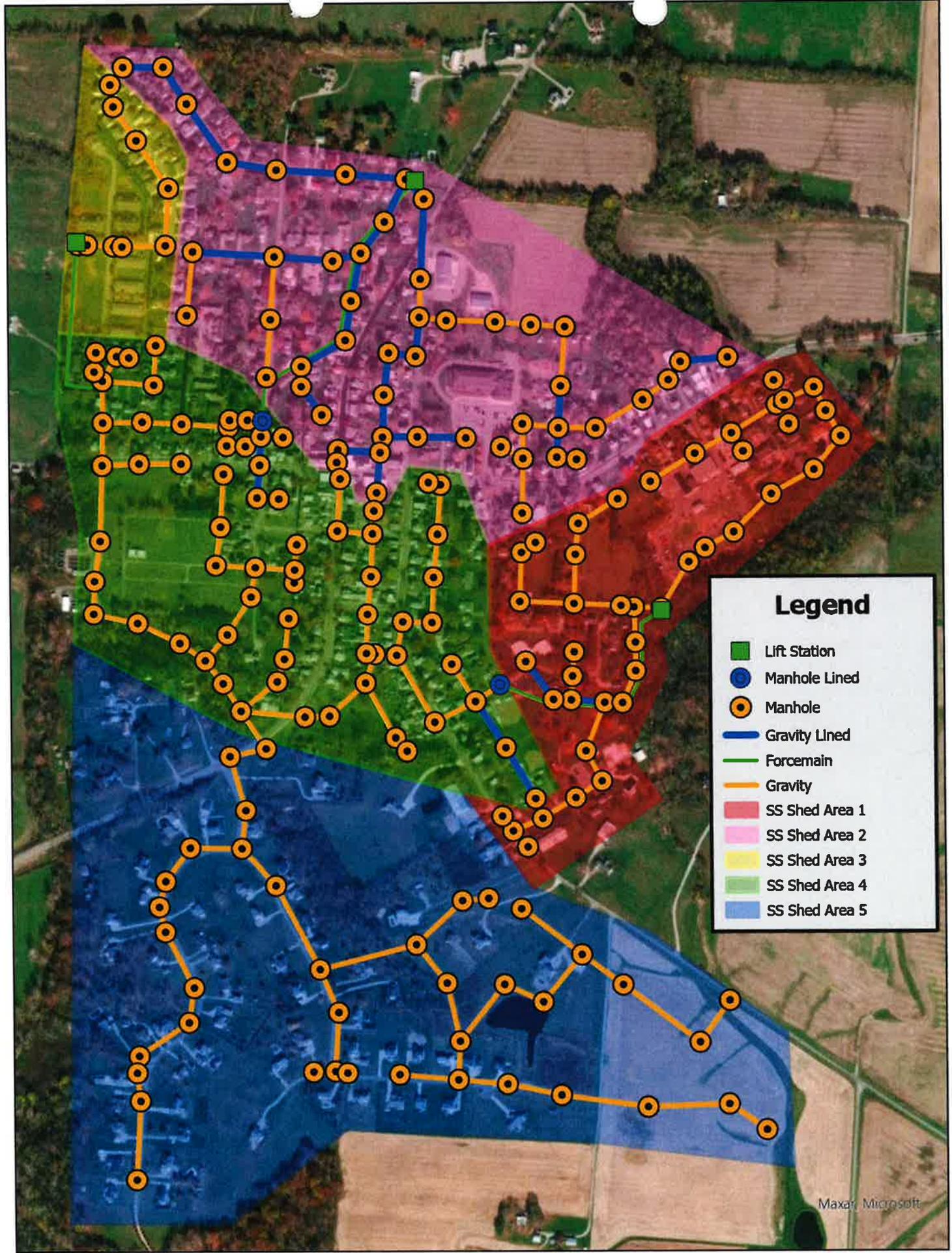
Estimated project Cost: \$ 1,435,895.50

iv. Environmental Review

With the removal of NPC the waste load allocation to the Honey Creek we will be improving the water quality.

VII. CONCLUSIONS AND RECOMMENDATIONS

This project involves the minimum required improvements for the Village system to improve WWTP operations. If the Village were to reduce I/I flow the WWTP treatment capacity would increase because of reduced sewer flow. The I/I improvements would be completed and WWTP updates would continue as currently planned.



Legend

- Lift Station
- Manhole Lined
- Manhole
- Gravity Lined
- Forcemain
- Gravity
- SS Shed Area 1
- SS Shed Area 2
- SS Shed Area 3
- SS Shed Area 4
- SS Shed Area 5

Maxar Microsoft

WTWP IMPROVEMENTS:
PHASE II INFILTRATION AND
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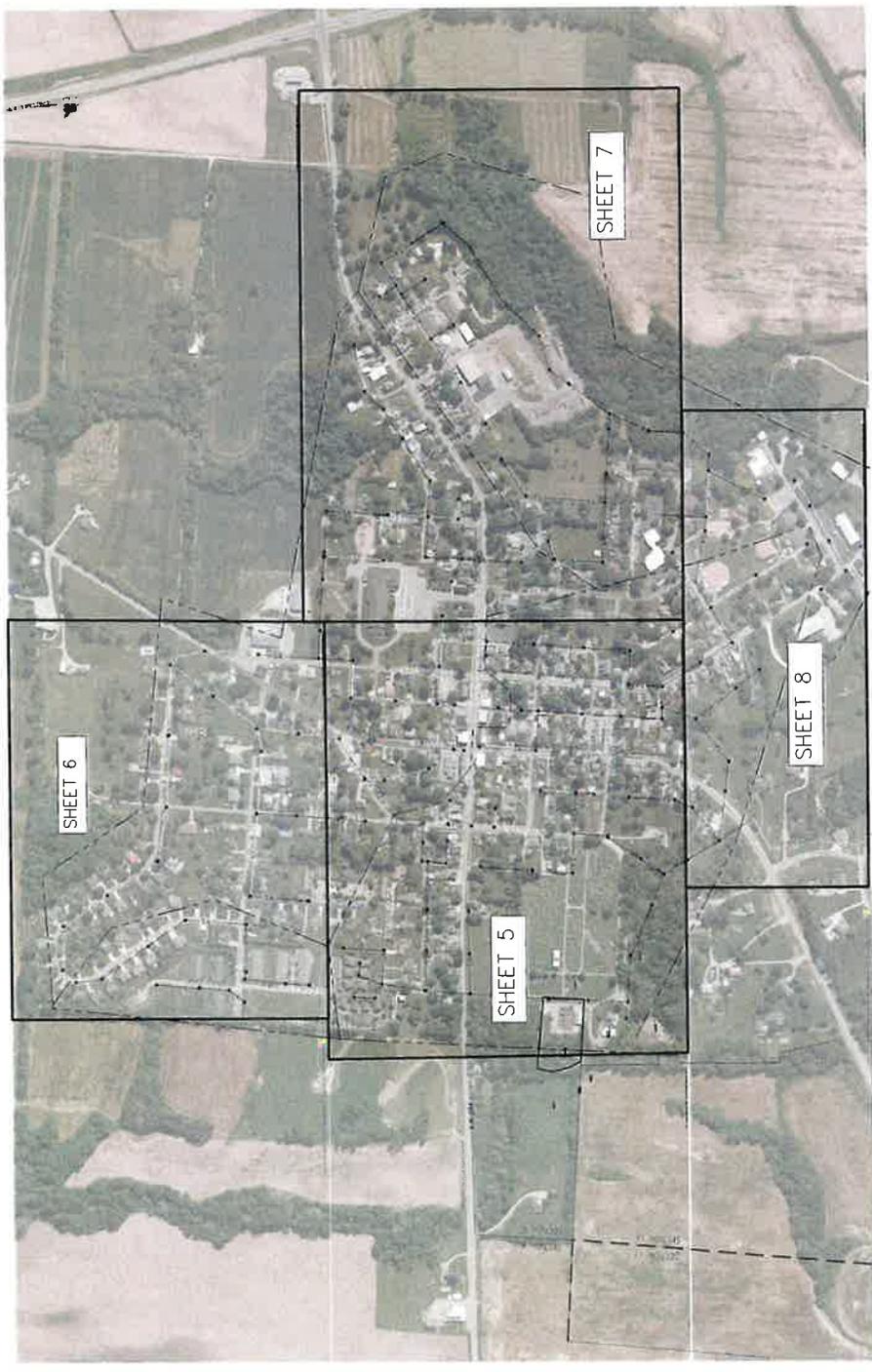
PROJECT NO.: 21-00000-010
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SHEET INDEX
 4 OF 8

LEGEND:

- PROPOSED PIPE LINING
- PIPE PREVIOUSLY LINED
- SEWER SEED BOUNDARY
- MANHOLE PREVIOUSLY LINED
- PROPOSED MANHOLE LINING



**WWTP IMPROVEMENTS:
PHASE II INFILTRATION AND
INFLOW PROJ**

VILLAGE OF THORNVILLE



LEGEND:

- PROPOSED SANITARY PIPE TO BE LINED
- EXISTING SANITARY PIPE
- SEWER SHED BOUNDARY
- EXISTING SANITARY MANHOLE
- SANITARY MANHOLE TO BE LINED

- NOTES:** THESE ARE BASED ON GIS PROJECT DATA. CONTRACTOR SHOULD VERIFY LENGTHS DURING PREPARATION, CLEANING, AND INSPECTION PHASE OF CIP PROCESS.
- SEE SHEET 3 FOR MANHOLE DEPTHS & ENGINEER CALCULATED DPT THICKNESS



MATCHLINE STA. SEE SHEET 6

MATCHLINE STA. SEE SHEET 7

MATCHLINE STA. SEE SHEET 8

DATE: _____

NO.	DATE	DESCRIPTION

PROJECT NO.: 23380100
 DRAWN BY: JAC
 CHECKED BY: JAC
 DATE ISSUED: 07/26/2018

WWT² IMPROVEMENTS: PH II
 INFILTRATION AND INFLOW
 REDUCTION PROJECT
 VILLAGE OF THORNHILL

DATE:	REVISIONS:	NO.	DATE	DESCRIPTION

PROJECT NO.: 21-0002-011
 DRAWN BY: JAC
 CHECKED BY: JAC
 DATE ISSUED: 05/17/2018

SCHEMATIC PLAN 2
 6 OF 8

LEGEND:

- SA — PROPOSED SANITARY PIPE TO BE UNID
- SB --- EXISTING SANITARY PIPE
- - - SC - SEWER SHED BOUNDARY
- EXISTING SANITARY MANHOLE
- SANITARY MANHOLE TO BE UNID

NOTES:

1. ALL PROPOSALS ARE BASED ON GPS SURVEY DATA. CONTRACTOR SHOULD VERIFY LENGTHS DURING PREPARATION, CLEANING, AND INSPECTION PHASE OF CIP PROCESS.
2. SEE SHEET 3 FOR MANHOLE DEPTHS & ENGINEER CALCULATED DPT THICKNESS

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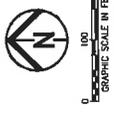
**WWTW IMPROVEMENTS:
 PHASE II INFILTRATION AND
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 VILLAGE OF THORNHILL

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- LEGEND:**
- PROPOSED SANITARY PIPE TO BE LINED
 - EXISTING SANITARY PIPE
 - SEWER SHED BOUNDARY
 - EXISTING SANITARY MANHOLE TO BE LINED
 - SANITARY MANHOLE TO BE NEW

NOTES:

1. PIPE LENGTHS ARE BASED ON GPS SURVEY DATA. CONTRACTOR SHOULD VERIFY LENGTHS IN THE FIELD AND REPORT TO THE INSPECTION PHASE OF CPP PROCESS.
2. SEE SHEET 4 FOR MANHOLE DEPTHS & ENGINEER CALCULATED CPP THICKNESS.



MATCHLINE STA, SEE SHEET 7

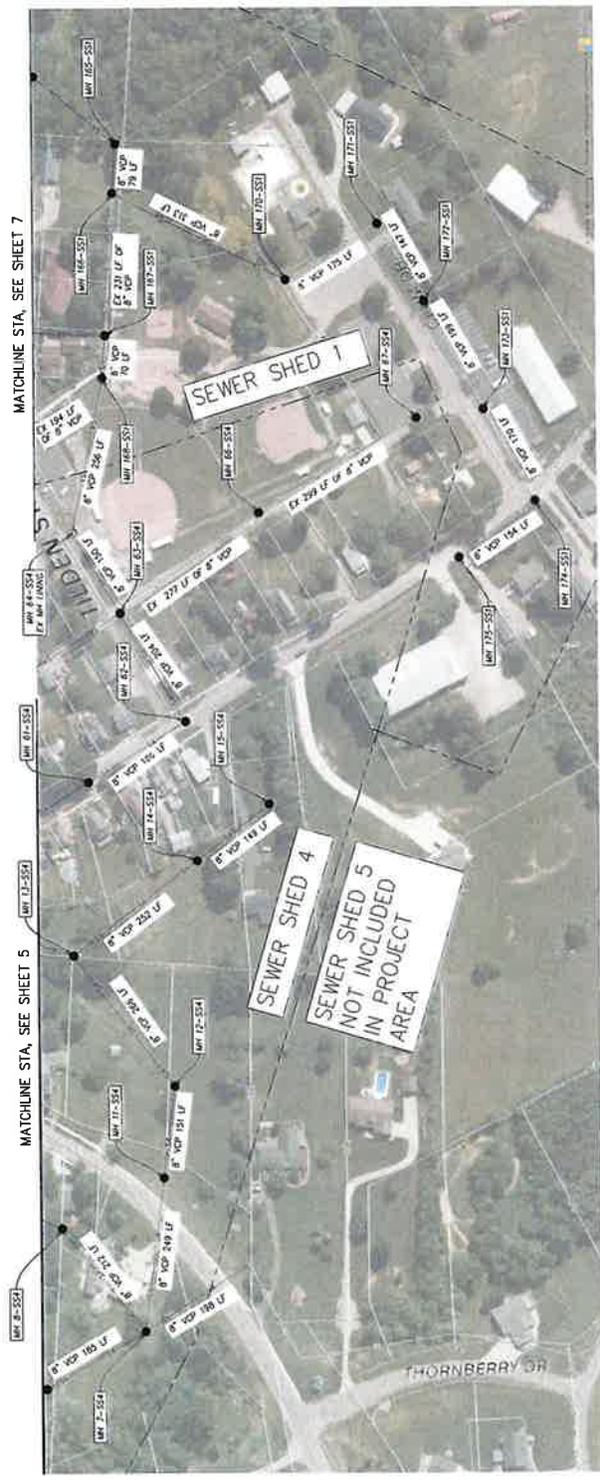
MATCHLINE STA, SEE SHEET 8

**WWTW IMPROVEMENTS:
 PHASE II INFILTRATION AND
 INFLOW PROJECT**

VILLAGE OF THORNBERRY

LEGEND:

- PROPOSED SANITARY PIPE TO BE LINED
- EXISTING SANITARY PIPE
- SEWER SHED BOUNDARY
- EXISTING SANITARY MANHOLE
- SANITARY MANHOLE TO BE LINED



NOTES:

- PIPE LENGTHS ARE BASED ON GPS SURVEY DATA. ALL PIPE LENGTHS ARE FOR PREPARATION, CLEANING, AND INSPECTION PHASE OF CPP PROCESS.
- SEE SHEET 3 FOR MANHOLE DEPTHS & ENGINEER CALCULATED CPP THICKNESS.



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PROJECT NO.: 310007010

DRAWN BY: JAC

CHECKED BY: JAC

DATE DDED: 11/11/2010

SCHEMATIC PLAN 4

8 OF 8