V4-CD-22-03

MCADAMS

AWH-20000> **MEMORANDUM**

September 19, 2023

To: Tim Beasley, City of Raleigh

From: Mike Sanchez, McAdams

RE: The Point
Sanitary Sewer Capacity Study – Revised Final
AWH-20000

Introduction and Revisions from Previous Versions:

This study was initially prepared in December 2020 in coordination with John Sorrell, PE (former CORPUD Development Services Manager) and Tim Beasley, CORPUD Senior Engineer. A revised version was then prepared in April 2021 to add an evaluation of just the CD Package #1 development and then revised once again per comments received from Tim Beasley. A further revision was completed in August 2022 to include an evaluation of the CD Package #1 and CD Package #2 development and removed the evaluation of the portion of the Harris Creek Interceptor (MH 32 through MH 22), as improvements for the ultimate sizing of that section of the Harris Creek Interceptor were completed by American Engineering and permitted through CORPUD. In summary, this latest revised version corrects and improves several elements:

- The Kalas Falls development will ultimately have 550 lots and the Wheeler Tract will ultimately have 360 lots. While these two developments were considered in previous versions of this study, they are no longer considered in this version as the flow from these neighborhoods will enter the Harris Creek Interceptor at the termination point (MH 32) of this study. As noted above, the termination point of this study coincides with the beginning of the improvements completed by American Engineering and permitted through CORPUD for the downstream section of the outfall beyond this study's termination. More specifically, those permitted improvements extend from MH 32 to MH 22 and accommodate the ultimate sizing of that section of the outfall needed to serve the entire sewage basin in which The Point is located. Exhibit 6, which defines the sewer basin, had not been previously updated. Exhibit 6 in this update no longer includes the portion of the basin that flowed to the section of the Harris Creek Interceptor that is being improved per the American Engineering construction drawings.
- In addition, Exhibit 6 now includes color coded areas and legend so that future development assumptions are indicated.
- Previously, the sewage from The Point CD Package 3 was assumed to enter the Harris Creek Interceptor at MH 29, which is along the section that American Engineering is improving. For that scenario a new outfall would have been required to reach MH 29. However, a more efficient approach was found and discussed with Jonathan Ham that will now direct the CD Package #3 sewage to the existing Harris Creek Interceptor where it will enter at MH 43. This revision updates the sewage generation and the relevant capacity calculation spreadsheets to reflect that change.

Background

This study was performed in accordance with City of Raleigh Department of Public Utilities (CORPUD) requirements to determine the sanitary sewer capacity of the existing sanitary sewer outfall that will serve The Point community in the Town of Rolesville. More specifically, this study evaluates whether the existing gravity system can accommodate the sewage generation from the proposed development of approximately 894 lots on The Point project site located along Highway 401 between Jonesville Road to the west and E. Young Street on the east. Approximately 800 lots will be on the south side of Highway 401 (referred to in this study as The Point South) and 94 lots on the north side of Highway 401 (referred to in this study as The Point North). This study also examines the interim conditions associated with the first phase of development proposed for The Point South (aka CD Package #1), the second phase of development proposed for The Point South (aka CD Package #2), and the final buildout, which will include The Point North (on the north side of Highway 401), and CD Package #3 (on the far west side of The Point). CD Package #1 includes 264 single family lots and the clubhouse, CD Package #2 includes 357 single family and townhome lots, The Point North includes 94 single family lots, and CD Package #3 includes 179 single family and townhome lots.

This study evaluates the following two segments of outfall both of which are identified on Exhibit 1:

1. Harris Creek Interceptor (HCI) outfall beginning at MH 54 (as identified on 1992 as-builts prepared by The Wooten Company). This outfall runs along the west side of The Point North and continues along the west side of The Point South down to the study termination point, MH 32, identified on Exhibit 1, and
2. Rolesville Sanitary Sewer Outfall (RSSO) beginning at MH 31 (as identified on 2007 as-builts prepared by BNK) near Rolesville High School and west to the connecting manhole, MH 1, along the Harris Creek Interceptor.

Exhibits 2, and 3 provide a more detailed view of the outfall segments evaluated in this study.

Approach

The following approach was used for completing this sanitary sewer capacity analysis:

1. Tributary flow shown in Table 1A is from water meter data obtained from the City of Raleigh for the developed area within the sewage basin north of The Point North and for Rolesville High School.
2. As noted by the City of Raleigh, water meter data was available for all but 43 lots. Therefore, based on the number of lots for which there was water meter data, an average flow per lot was determined for each area and applied to all lots in that area as shown on Table 1A.
3. In Appendix E of the City of Raleigh Public Utilities Handbook, the Sewer Capacity Study Departmental Operating Instructions (effective 12/03/2013) requires that peak flow pass through half full pipe. Table 1B provides the peak flow calculations for each flow entering the system for the full buildout. Where water meter data is used, no peak factor is applied. This table also includes the flow assumptions for future development within the basin. These values are only used for calculations in Table 7 described below.
4. For calculation of peak flow for The Point, the City of Raleigh sewage generation rate of 250 gpd / lot is used to calculate average daily flow for single-family and townhomes. The City of Raleigh standard operating

instructions referenced above also define the peaking factor as 2.5, which was applied to calculate the peak flow for The Point.

5. Table 1B identifies the manholes where the sewage generated by the existing lots, i.e., the anticipated sewage from The Point, and the anticipated sewage from future development within the sewer basin were assumed to enter the existing gravity sewer outfall. Table 1C identifies the anticipated sewage from only the lots in CD Package #1. Table 1D identifies the anticipated sewage from only the lots in CD Packages #1 and #2. Exhibits 4, 4A, 4B, and 5 graphically identify the discharge points to the existing outfall for lot segments within The Point.
6. For each pipe evaluated in this study, as-built data (diameter, material, slope, and length) were input into a capacity calculation spreadsheet that uses standard Manning's equations to calculate full and half full capacities. Per the City of Raleigh standard operating instructions referenced above, a Manning's roughness coefficient "*n*" of 0.013 was used for all pipes.
7. In addition, sewage flow rates determined as described above, were also input into the capacity calculation spreadsheet to determine cumulative flow rates and remaining capacities for each existing sewer line that is part of this study.
8. CORPUD requires that a sanitary sewer capacity study determine whether any pipes are projected to flow over 50% capacity when tributary, obligated, and peak flow for the proposed development are evaluated for the pipes included in the sewer study. For those pipes where that flow is projected to be less than 50% full, no fee in lieu or improvements are necessary. For those pipes where that sewage flow is projected to be greater than 50% but less than 65% full, a fee in lieu can be paid. For those pipes where that sewage flow is projected to be greater than 65%, improvements must be made.
9. To determine, the upsizing needed for the improvements, CORPUD requires that <u>for those pipes requiring improvements</u>, future growth within the entire sewage basin must be considered so that those areas that are currently undeveloped or underdeveloped based on the zoning can be developed without requiring future pipe size increases. Exhibit 6 shows the approximate sewer basin. Several areas within this sewage basin are currently undeveloped or underdeveloped. Exhibit 6 includes a color-coded legend that shows the size and indicates the receiving manhole for those undeveloped and underdeveloped areas
10. Per the Town of Rolesville Future Land Use Map, a variety of zoning classifications are projected for these areas including medium density residential, business park, and high density residential. For the purposes of this study, future development was projected to be most closely medium density residential. Using a peak flow (gpapd) from Section 7.1.7 of the Public Utilities Handbook Appendix E Sewer Capacity Study Departmental Operating Instructions (effective 12/03/2013) for Residential – 4 zoning, a peak flow of 2,000 gpapd was applied to these areas and the projected sewage flow from these areas were assumed to enter the gravity system considered in this study at the manholes indicated in Table 1B.
11. The results of these calculations are provided in the following Tables: (NOTE: RSSO = Rolesville Sanitary Sewer Outfall; HCI = Harris Creek Interceptor):
    a. Table 1 – Sewage Generation (includes tables for CD Package #1, CD Package #2, and full buildout)
    b. Table 2 – RSSO MH 31 to MH 01 Tributary Flow + The Point (CD Package #1 Lots Only)

c. Table 3 – RSSO MH 31 to MH 01 Tributary Flow + The Point (CD Package #1 and CD Package #2, which equals full buildout through RSSO)
d. Table 4 – HCI MH 54 to MH 32 Tributary + Obligated Flow + The Point (CD Package #1 Lots Only)
e. Table 5 – HCI MH 54 to MH 32 Tributary + Obligated Flow + The Point(CD Package #1 & #2 Lots Only)
f. Table 6 – HCI MH 54 to MH 32 Tributary + Obligated Flow + The Point(Full Buildout through HCI)
g. Table 7 – HCI MH 54 to MH 32 Tributary + Obligated Flow + The Point (Full Buildout through HCI) + Future Development within sewer basin with improvements
h. Table 8 – Rolesville Sanitary Sewer Outfall Summary of Improvements
i. Table 9 – Harris Creek Interceptor Summary of Improvements

Summary

This summary evaluates the results under two criteria established by CORPUD. First, for pipes where peak tributary and obligated flow plus the proposed development is predicted to exceed 50% of pipe capacity, a fee-in-lieu is owed by the developer to cover the costs associated with future improvements. Second, for pipes where the peak tributary and obligated flow plus the proposed development is predicted to exceed 65% capacity, the developer must install the necessary improvements to not only rectify the situation but to accommodate the ultimate size needed to serve anticipated future development within the sewage basin.

As shown in Table 2, with tributary and obligated flow and the anticipated flow for The Point CD Package #1, sewage flow does not exceed 50% capacity in any of the Rolesville Sewer outfall pipes.

As shown in in Table 3, when the remainder of the proposed lots in The Point that will flow through the Rolesville Sanitary Sewer Outfall (i.e., the lots in CD Package #1 and #2) are included in the analysis, there are two pipes (MH 7 to MH 06 and MH 05 to MH 04) that are predicted to flow right at 50% but no pipes that flow over 50% capacity.

As shown in Table 4, with tributary and obligated flow and the anticipated flow for The Point CD Package #1 through the Harris Creek Interceptor, eight pipes (MH 42 to MH 41, MH 40 to MH 39, MH 39 to MH 38, MH 38 to MH 37, MH 37 to MH 36, MH 36 to MH 35, MH 35 to MH 34, MH 34 to MH 33) are anticipated to flow over 50% capacity but under 65% capacity.

As shown in Table 5, with tributary and obligated flow and the anticipated flow for The Point CD Package #1 and #2 through the Harris Creek Interceptor, nine pipes (MH 01 from RSSO to MH 43, MH 42 to MH 41, MH 40 to MH 39, MH 39 to MH 38, MH 38 to MH 37, MH 37 to MH 36, MH 36 to MH 35, MH 35 to MH 34, MH 34 to MH 33) are anticipated to flow over 65% capacity with the highest anticipated percentage to be about 94%.

As shown in Table 6, when the remainder of the proposed lots for The Point that will flow through the section of the Harris Creek Interceptor evaluated in this study are included in the analysis, only the same nine pipes that are anticipated to flow over 65% when just CD Package #1 and #2 are considered are anticipated to flow over 65%

capacity at full buildout with the highest anticipated percentage to be about 117%. In addition, one pipe MH 43 to MH 42 is projected to flow over 50% but under 59%.

The nine pipes identified in Table 6 that must be improved are not contiguous. There are two pipes (MH 43 to MH 42 and MH 41 to MH 40) that do not require improvements that are located after the most upstream pipe requiring improvement and there is one additional pipe (MH 33 to MH 32) that also does not require improvement located immediately downstream of the last pipe requiring improvement. Although those three pipes (MH 43 to MH 42, MH 41 to MH 40, and MH 33 to MH 32) do not require improvements as they are not projected to flow over 65%, they are included in Table 7 as it is anticipated that CORPUD would rather not have larger improved pipe sizes discharging into downstream unimproved pipe sizes. Therefore, a total of 12 pipes are shown in Table 7. All of the pipes that require improvements will need to be improved from 10-inch to 24-inch and so it is anticipated that CORPUD will prefer to have all 12 pipes in Table 7 upsized accordingly to avoid larger pipes flowing into smaller pipes.

Conclusion

Based on the results of this study described above, the proposed improvements that will be required for both the Rolesville Sanitary Sewer Outfall and the Harris Creek Interceptor for development of The Point are summarized in Tables 8 and Table 9, respectively. Those tables include the results based on CD Package #1 only, CD Package #1 and #2 only, and for the full buildout of The Point.

ATTACHMENTS:

Exhibit 1 – The Point Overall Sanitary Sewer
Exhibit 2 – The Point Sanitary Sewer Outfall (1 of 2)
Exhibit 3 – The Point Sanitary Sewer Outfall (2 of 2)
Exhibit 4 – Sewage Discharge Points from The Point South to Existing Outfall
Exhibit 4A – Sewage Discharge Points from The Point South CD Package #1 to Existing Outfall
Exhibit 4B – Sewage Discharge Points from The Point South CD Package #2 to Existing Outfall
Exhibit 5 – Sewage Discharge Points from The Point North to Existing Outfall
Exhibit 6 – Sanitary Sewer Basin
Table 1 (A&B&C&D) – Sewage Generation
Table 2 – Sewer Capacity Spreadsheet - RSSO MH 31 to MH 01 Tributary Flow + The Point (CD Package #1 Lots Only)
Table 3 – Sewer Capacity Spreadsheet - RSSO MH 31 to MH 01 Tributary Flow + The Point (CD Package #1 & #2 Lots Only)
Table 4 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 32 Tributary + Obligated + The Point (CD Pkg #1 Lots Only)
Table 5 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 32 Tributary + Obligated + The Point (CD Pkg #1 & #2 Lots Only)
Table 6 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 32 Tributary + Obligated + The Point (Full Buildout through HCI)
Table 7 – Sewer Capacity Spreadsheet – HCI MH 54 to MH 32 Tributary + Obligated + The Point (Full Buildout through HCI) + Future Development within sewer basin with improvements
Table 8 – Rolesville Sanitary Sewer Outfall Summary of Improvements
Table 9 – Harris Creek Interceptor Summary of Improvements

HARRIS CREEK INTERCEPTOR

PORTION OF HARRIS CREEK INTERCEPTOR IMPROVEMENTS PREVIOUSLY COMPLETED AND PERMITTED BY AMERICAN ENGINEERING

STUDY TERMINATION

ROLESVILLE SEWER OUTFALL

EXHIBIT 1 - THE POINT OVERALL SANITARY SEWER

N

0 440 880 1,760 ft

1 inch = 400 feet

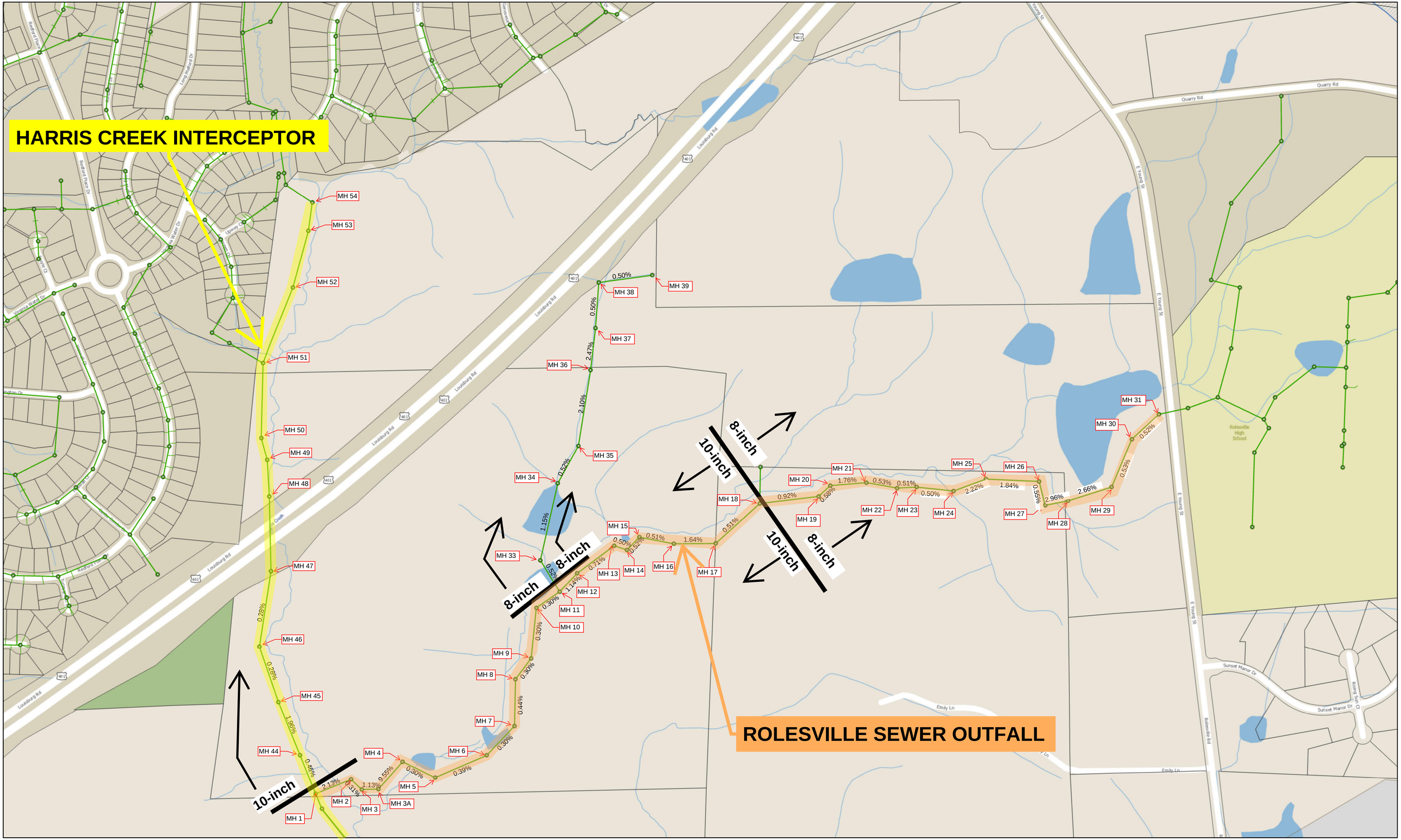


EXHIBIT 2 - THE POINT SANITARY SEWER OUTFALL (1 OF 2)

N

0 225 450 900 ft

1 inch = 200 feet

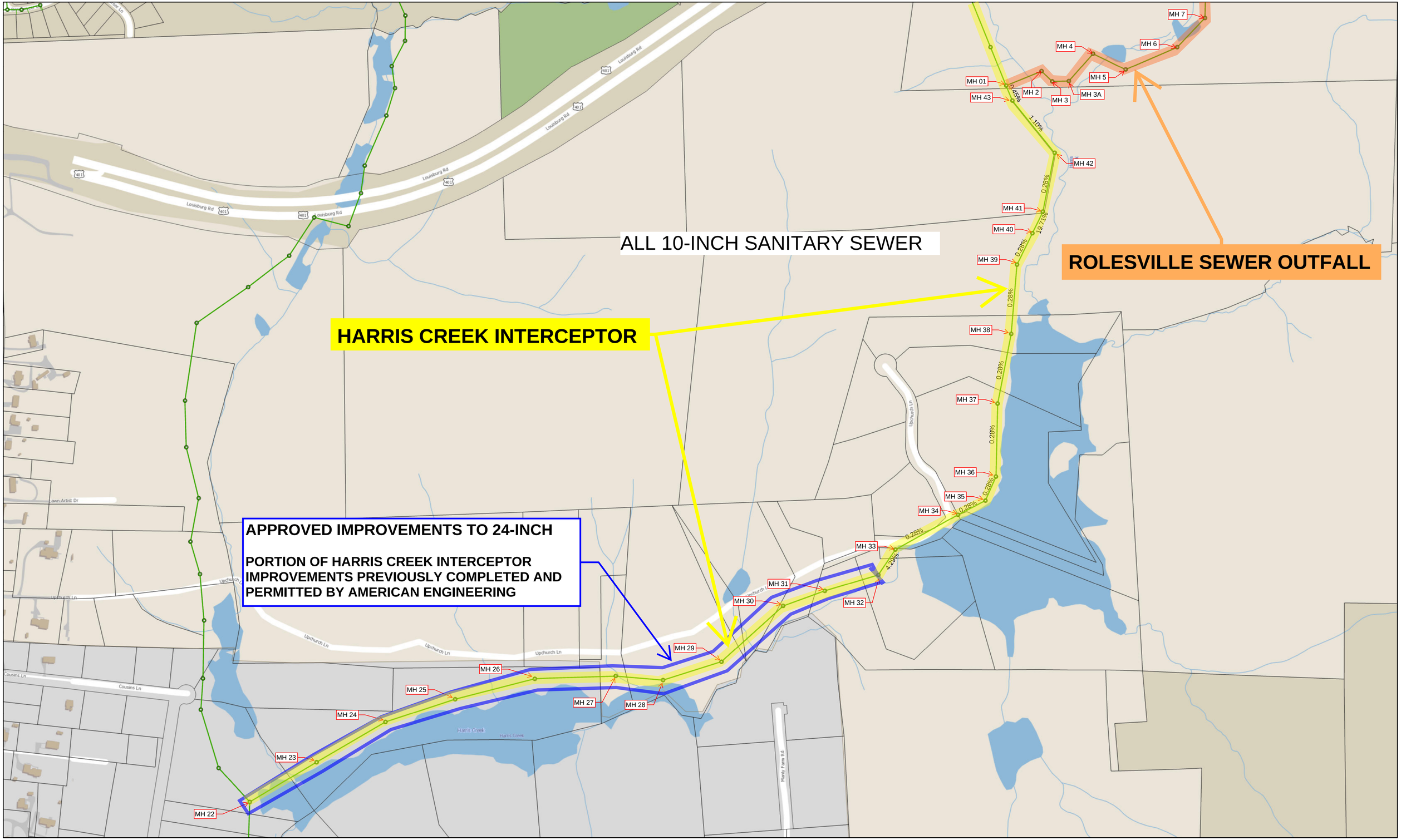


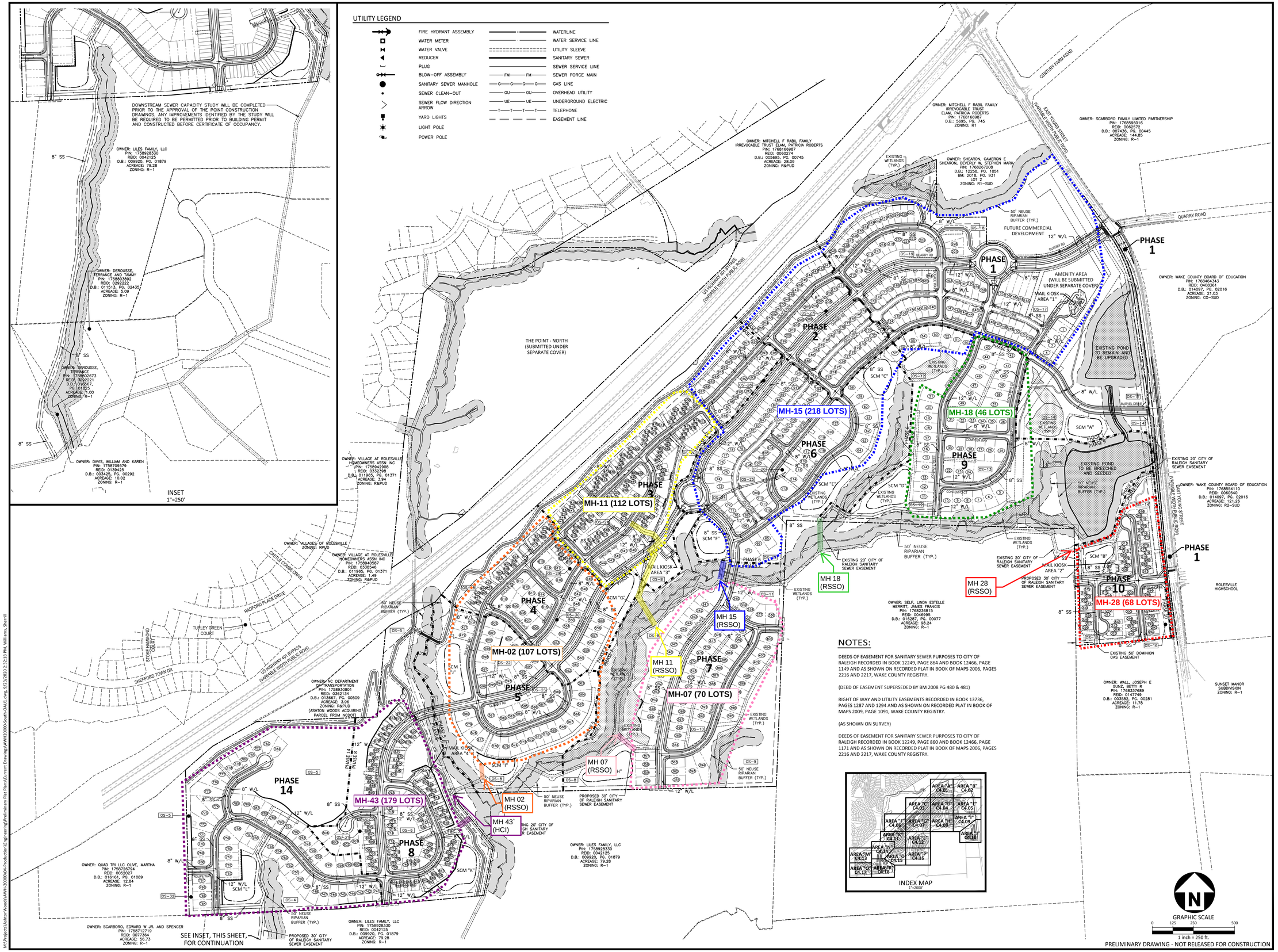
EXHIBIT 3 - THE POINT SANITARY SEWER OUTFALL (2 OF 2)

N

0 225 450 900 ft

1 inch = 200 feet

Disclaimer
iMaps makes every effort to produce and publish the most current and accurate information possible. However, the maps are produced for information purposes, and are **NOT** surveys. No warranties, expressed or implied, are provided for the data therein, its use,or its interpretation.



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CONTACT: BOB MISHLER

ASHTON WOODS

EXHIBIT 4

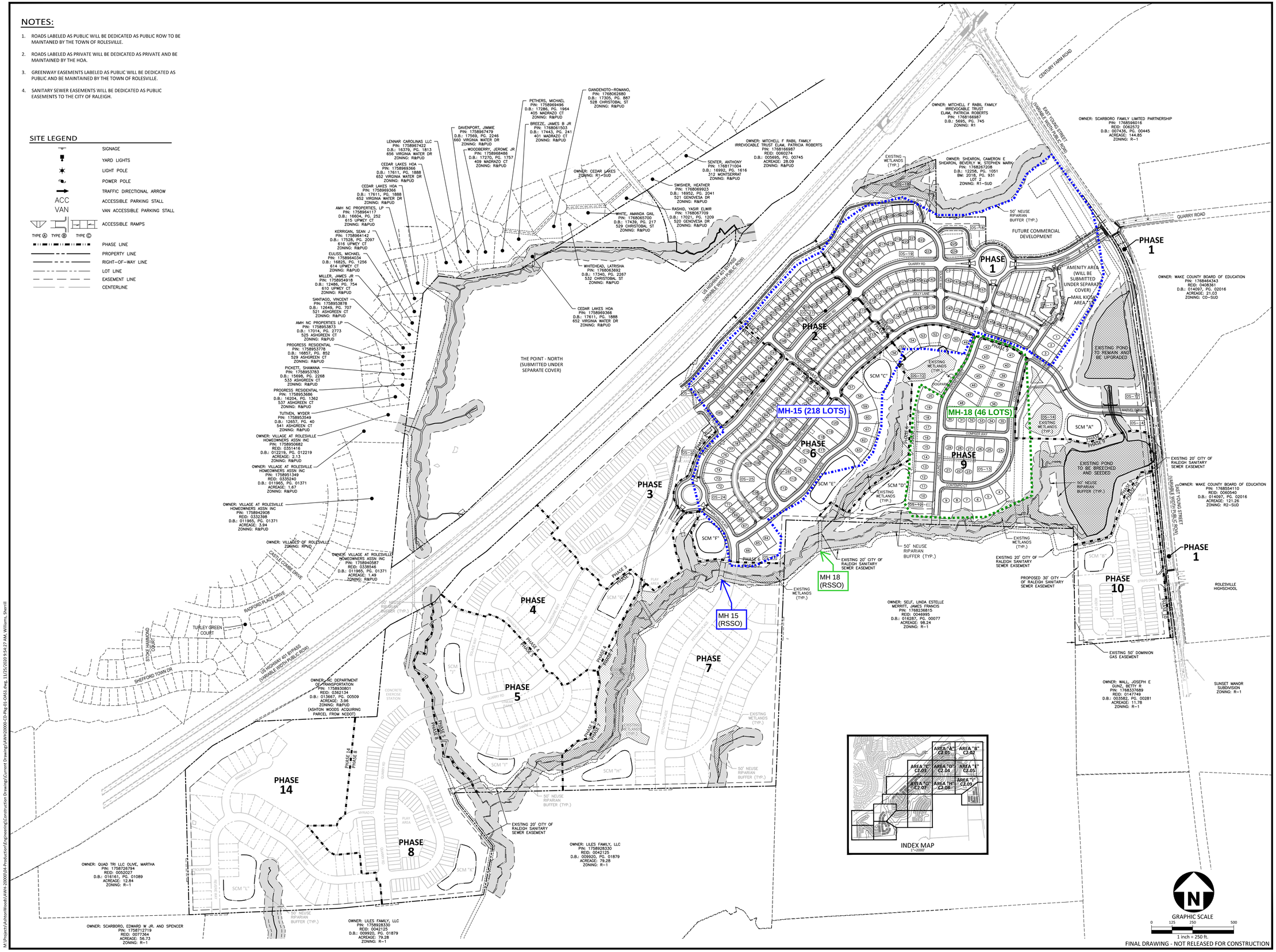
SEWAGE DISCHARGE POINTS FROM THE POINT SOUTH TO EXISTING OUTFALL

NOTES:

1. ROADS LABELED AS PUBLIC WILL BE DEDICATED AS PUBLIC ROW TO BE MAINTANED BY THE TOWN OF ROLESVILLE.
2. ROADS LABELED AS PRIVATE WILL BE DEDICATED AS PRIVATE AND BE MAINTAINED BY THE HOA.
3. GREENWAY EASEMENTS LABELED AS PUBLIC WILL BE DEDICATED AS PUBLIC AND BE MAINTAINED BY THE TOWN OF ROLESVILLE.
4. SANITARY SEWER EASEMENTS WILL BE DEDICATED AS PUBLIC EASEMENTS TO THE CITY OF RALEIGH.

SITE LEGEND

- SIGNAGE
- YARD LIGHTS
- LIGHT POLE
- POWER POLE
- TRAFFIC DIRECTIONAL ARROW
- ACC — ACCESSIBLE PARKING STALL
- VAN — VAN ACCESSIBLE PARKING STALL
- ACCESSIBLE RAMPS (TYPE A, TYPE B, TYPE C)
- PHASE LINE
- PROPERTY LINE
- RIGHT-OF-WAY LINE
- LOT LINE
- EASEMENT LINE
- CENTERLINE



FINAL DRAWING - NOT RELEASED FOR CONSTRUCTION

M:\Projects\AshtonWoods\AWH-20000\04-Production\Engineering\Construction Drawings\Current Drawings\AWH20000-CD-Pkg 01-04S1.dwg, 11/25/2020 9:54:27 AM, Williams, Sherrill

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EXHIBIT 4A

SEWAGE DISCHARGE POINTS FROM THE POINT SOUTH CD PACKAGE #1

CITY OF RALEIGH PUBLIC UTILITIES
STANDARD UTILITY NOTES (AS APPLICABLE)

1. ALL MATERIALS & CONSTRUCTION METHODS SHALL BE IN ACCORDANCE WITH CITY OF RALEIGH DESIGN STANDARDS, DETAILS & SPECIFICATIONS (REFERENCE: CORPUD HANDBOOK, CURRENT EDITION)

2. UTILITY SEPARATION REQUIREMENTS:

   a. A DISTANCE OF 100' SHALL BE MAINTAINED BETWEEN SANITARY SEWER & ANY PRIVATE OR PUBLIC WATER SUPPLY SOURCE SUCH AS AN IMPOUNDED RESERVOIR USED AS A SOURCE OF DRINKING WATER. IF ADEQUATE LATERAL SEPARATION CANNOT BE ACHIEVED, FERROUS SANITARY SEWER PIPE SHALL BE SPECIFIED & INSTALLED TO WATERLINE SPECIFICATIONS. HOWEVER, THE MINIMUM SEPARATION SHALL NOT BE LESS THAN 25' FROM A PRIVATE WELL OR 50' FROM A PUBLIC WELL.

   b. WHEN INSTALLING WATER &/OR SEWER MAINS, THE HORIZONTAL SEPARATION BETWEEN UTILITIES SHALL BE 10'. IF THIS SEPARATION CANNOT BE MAINTAINED DUE TO EXISTING CONDITIONS, THE VARIATION ALLOWED IS THE WATER MAIN IN A SEPARATE TRENCH WITH THE ELEVATION OF THE WATER MAIN AT LEAST 18" ABOVE THE TOP OF THE SEWER & MUST BE APPROVED BY THE PUBLIC UTILITIES DIRECTOR. ALL DISTANCES ARE MEASURED FROM OUTSIDE DIAMETER TO OUTSIDE DIAMETER.

   c. WHERE IT IS IMPOSSIBLE TO OBTAIN PROPER SEPARATION, OR ANYTIME A SANITARY SEWER PASSES OVER A WATERMAIN, DIP MATERIALS OR STEEL ENCASEMENT EXTENDED 10' ON EACH SIDE OF CROSSING MUST BE SPECIFIED & INSTALLED TO WATERLINE SPECIFICATIONS.

   d. 5.0' MINIMUM HORIZONTAL SEPARATION IS REQUIRED BETWEEN ALL SANITARY SEWER & STORM SEWER FACILITIES, UNLESS DIP MATERIAL IS SPECIFIED FOR SANITARY SEWER.

   e. MAINTAIN 18" MIN. VERTICAL SEPARATION AT ALL WATERMAIN & RCP STORM DRAIN CROSSINGS; MAINTAIN 18" MIN. VERTICAL SEPARATION AT ALL SANITARY SEWER & RCP STORM DRAIN CROSSINGS. WHERE ADEQUATE SEPARATIONS CANNOT BE ACHIEVED, SPECIFY DIP MATERIALS & A CONCRETE CRADLE HAVING 6" MIN. CLEARANCE (PER CORPUD DETAILS W-41 & S-49).

   f. ALL OTHER UNDERGROUND UTILITIES SHALL CROSS WATER & SEWER FACILITIES WITH 18" MIN. VERTICAL SEPARATION REQUIRED.

3. ANY NECESSARY FIELD REVISIONS ARE SUBJECT TO REVIEW & APPROVAL OF AN AMENDED PLAN &/OR PROFILE BY THE CITY OF RALEIGH PUBLIC UTILITIES DEPARTMENT PRIOR TO CONSTRUCTION.

4. CONTRACTOR SHALL MAINTAIN CONTINUOUS WATER & SEWER SERVICE TO EXISTING RESIDENCES & BUSINESSES THROUGHOUT CONSTRUCTION OF PROJECT. ANY NECESSARY SERVICE INTERRUPTIONS SHALL BE PRECEDED BY A 24 HOUR ADVANCE NOTICE TO THE CITY OF RALEIGH PUBLIC UTILITIES DEPARTMENT.

5. 3.0' MINIMUM COVER IS REQUIRED ON ALL WATER MAINS & SEWER FORCEMAINS. 4.0' MINIMUM COVER IS REQUIRED ON ALL REUSE MAINS.

6. IT IS THE DEVELOPER'S RESPONSIBILITY TO ABANDON OR REMOVE EXISTING WATER & SEWER SERVICES NOT BEING USED IN REDEVELOPMENT OF A SITE UNLESS OTHERWISE DIRECTED BY THE CITY OF RALEIGH PUBLIC UTILITIES DEPARTMENT. THIS INCLUDES ABANDONING TAP AT MAIN & REMOVAL OF SERVICE FROM ROW OR EASEMENT PER CORPUD HANDBOOK PROCEDURE.

7. INSTALL 3/4" COPPER WATER SERVICES WITH METERS LOCATED AT ROW OR WITHIN A 2'X2' WATERLINE EASEMENT IMMEDIATELY ADJACENT. NOTE: IT IS THE APPLICANT'S RESPONSIBILITY TO PROPERLY SIZE THE WATER SERVICE FOR EACH CONNECTION TO PROVIDE ADEQUATE FLOW & PRESSURE.

8. INSTALL 4" PVC SEWER SERVICES @ 1.0% MINIMUM GRADE WITH CLEANOUTS LOCATED AT ROW OR EASEMENT LINE & SPACED EVERY 75 LINEAR FEET MAXIMUM.

9. PRESSURE REDUCING VALVES ARE REQUIRED ON ALL WATER SERVICES EXCEEDING 80 PSI; BACKWATER VALVES ARE REQUIRED ON ALL SANITARY SEWER SERVICES HAVING BUILDING DRAINS LOWER THAN 1.0' ABOVE THE NEXT UPSTREAM MANHOLE.

10. ALL ENVIRONMENTAL PERMITS APPLICABLE TO THE PROJECT MUST BE OBTAINED FROM NCDWQ, USACE &/OR FEMA FOR ANY RIPARIAN BUFFER, WETLAND &/OR FLOODPLAIN IMPACTS (RESPECTIVELY) PRIOR TO CONSTRUCTION.

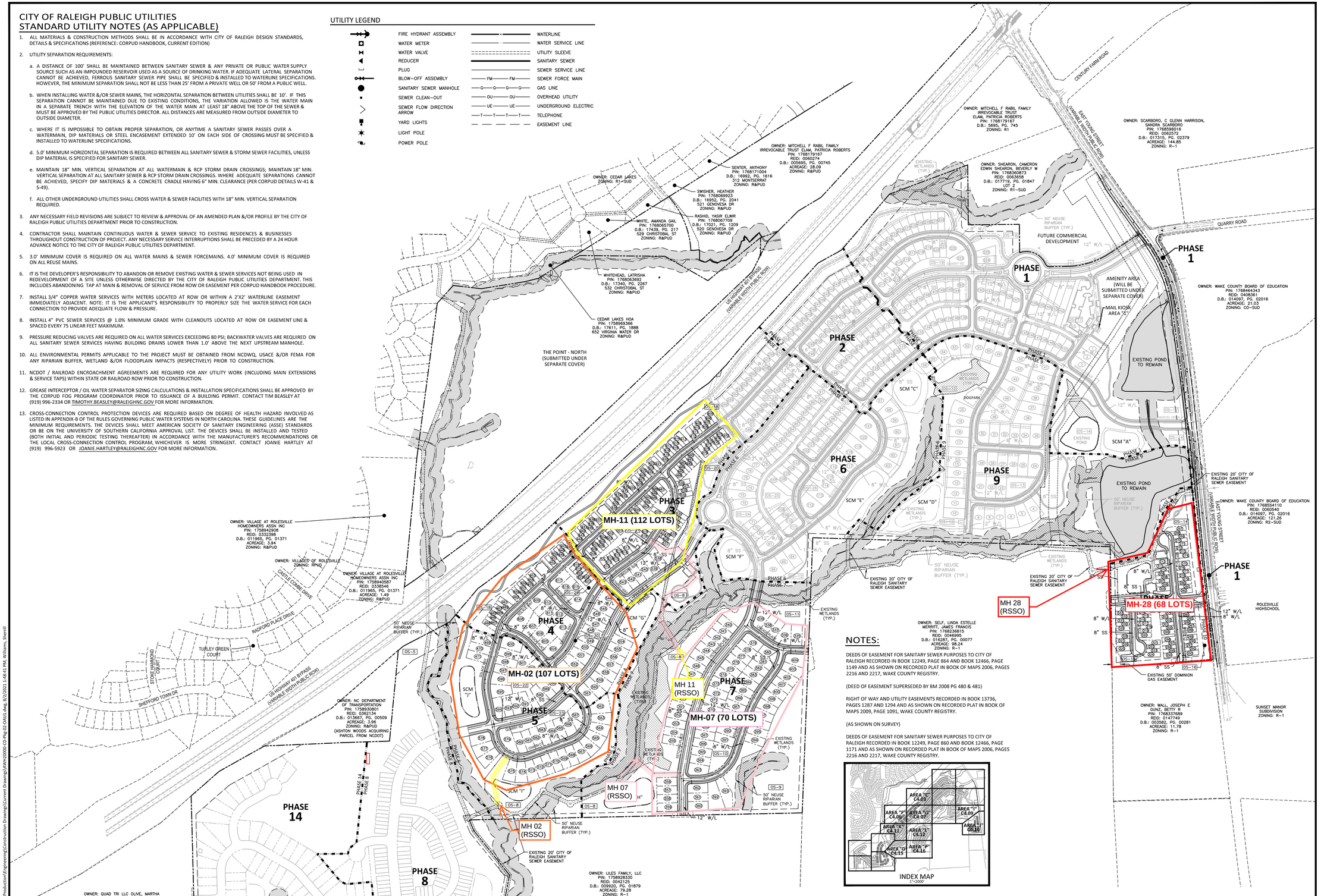
11. NCDOT / RAILROAD ENCROACHMENT AGREEMENTS ARE REQUIRED FOR ANY UTILITY WORK (INCLUDING MAIN EXTENSIONS & SERVICE TAPS) WITHIN STATE OR RAILROAD ROW PRIOR TO CONSTRUCTION.

12. GREASE INTERCEPTOR / OIL WATER SEPARATOR SIZING CALCULATIONS & INSTALLATION SPECIFICATIONS SHALL BE APPROVED BY THE CORPUD FOG PROGRAM COORDINATOR PRIOR TO ISSUANCE OF A BUILDING PERMIT. CONTACT TIM BEASLEY AT (919) 996-2334 OR TIMOTHY.BEASLEY@RALEIGHNC.GOV FOR MORE INFORMATION.

13. CROSS-CONNECTION CONTROL PROTECTION DEVICES ARE REQUIRED BASED ON DEGREE OF HEALTH HAZARD INVOLVED AS LISTED IN APPENDIX-B OF THE RULES GOVERNING PUBLIC WATER SYSTEMS IN NORTH CAROLINA. THESE GUIDELINES ARE THE MINIMUM REQUIREMENTS. THE DEVICES SHALL MEET AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE) STANDARDS OR BE ON THE UNIVERSITY OF SOUTHERN CALIFORNIA APPROVAL LIST. THE DEVICES SHALL BE INSTALLED AND TESTED (BOTH INITIAL AND PERIODIC TESTING THEREAFTER) IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS OR THE LOCAL CROSS-CONNECTION CONTROL PROGRAM, WHICHEVER IS MORE STRINGENT. CONTACT JOANIE HARTLEY AT (919) 996-5923 OR JOANIE.HARTLEY@RALEIGHNC.GOV FOR MORE INFORMATION.

UTILITY LEGEND

- FIRE HYDRANT ASSEMBLY
- WATER METER
- WATER VALVE
- REDUCER
- PLUG
- BLOW-OFF ASSEMBLY
- SANITARY SEWER MANHOLE
- SEWER CLEAN-OUT
- SEWER FLOW DIRECTION ARROW
- YARD LIGHTS
- LIGHT POLE
- POWER POLE
- WATERLINE
- WATER SERVICE LINE
- UTILITY SLEEVE
- SANITARY SEWER
- SEWER SERVICE LINE
- SEWER FORCE MAIN
- GAS LINE
- OVERHEAD UTILITY
- UNDERGROUND ELECTRIC
- TELEPHONE
- EASEMENT LINE



NOTES:

DEEDS OF EASEMENT FOR SANITARY SEWER PURPOSES TO CITY OF RALEIGH RECORDED IN BOOK 12249, PAGE 864 AND BOOK 12466, PAGE 1149 AND AS SHOWN ON RECORDED PLAT IN BOOK OF MAPS 2006, PAGES 2216 AND 2217, WAKE COUNTY REGISTRY.

(DEED OF EASEMENT SUPERSEDED BY BM 2008 PG 480 & 481)

RIGHT OF WAY AND UTILITY EASEMENTS RECORDED IN BOOK 13736, PAGES 1287 AND 1294 AND AS SHOWN ON RECORDED PLAT IN BOOK OF MAPS 2009, PAGE 1091, WAKE COUNTY REGISTRY.

(AS SHOWN ON SURVEY)

DEEDS OF EASEMENT FOR SANITARY SEWER PURPOSES TO CITY OF RALEIGH RECORDED IN BOOK 12249, PAGE 860 AND BOOK 12466, PAGE 1171 AND AS SHOWN ON RECORDED PLAT IN BOOK OF MAPS 2006, PAGES 2216 AND 2217, WAKE COUNTY REGISTRY.

CITY OF RALEIGH – PLANS AUTHORIZED FOR CONSTRUCTION

Electronic Approval: This approval is being issued electronically. This approval is valid only upon the signature of a City of Raleigh Review Officer below. The City will retain a copy of the approved plans. Any work authorized by this approval must proceed in accordance with the plans kept on file with the City. This electronic approval may not be edited once issued. Any modification to this approval once issued will invalidate this approval.

City of Raleigh Development Approval _____

City of Raleigh Review Officer

SITE PERMITTING APPROVAL

Water and Sewer Permits (if applicable)

The City of Raleigh consents to the connection and extension of the City's Public Sewer System as shown on this plan. The material and Construction methods used for this project shall conform to the standards and specifications of the City's Public Utilities Handbook. City of Raleigh Public Utilities Department Permit # _____

The City of Raleigh consents to the connection and extension of the City's Public Water System as shown on this plan. The material and Construction methods used for this project shall conform to the standards and specifications of the City's Public Utilities Handbook. City of Raleigh Public Utilities Department Permit # _____

The City of Raleigh consents to the connection to its public sewer system and extension of the private sewer collection system as shown on this plan. The material and constructions methods used for this project shall conform to the standards and specifications of the City's Public Utilities Handbook.

City of Raleigh Public Utilities Department Permit # _____

GRAPHIC SCALE
0 125 250 500
1 inch = 250 ft.

FINAL DRAWING - NOT RELEASED FOR CONSTRUCTION

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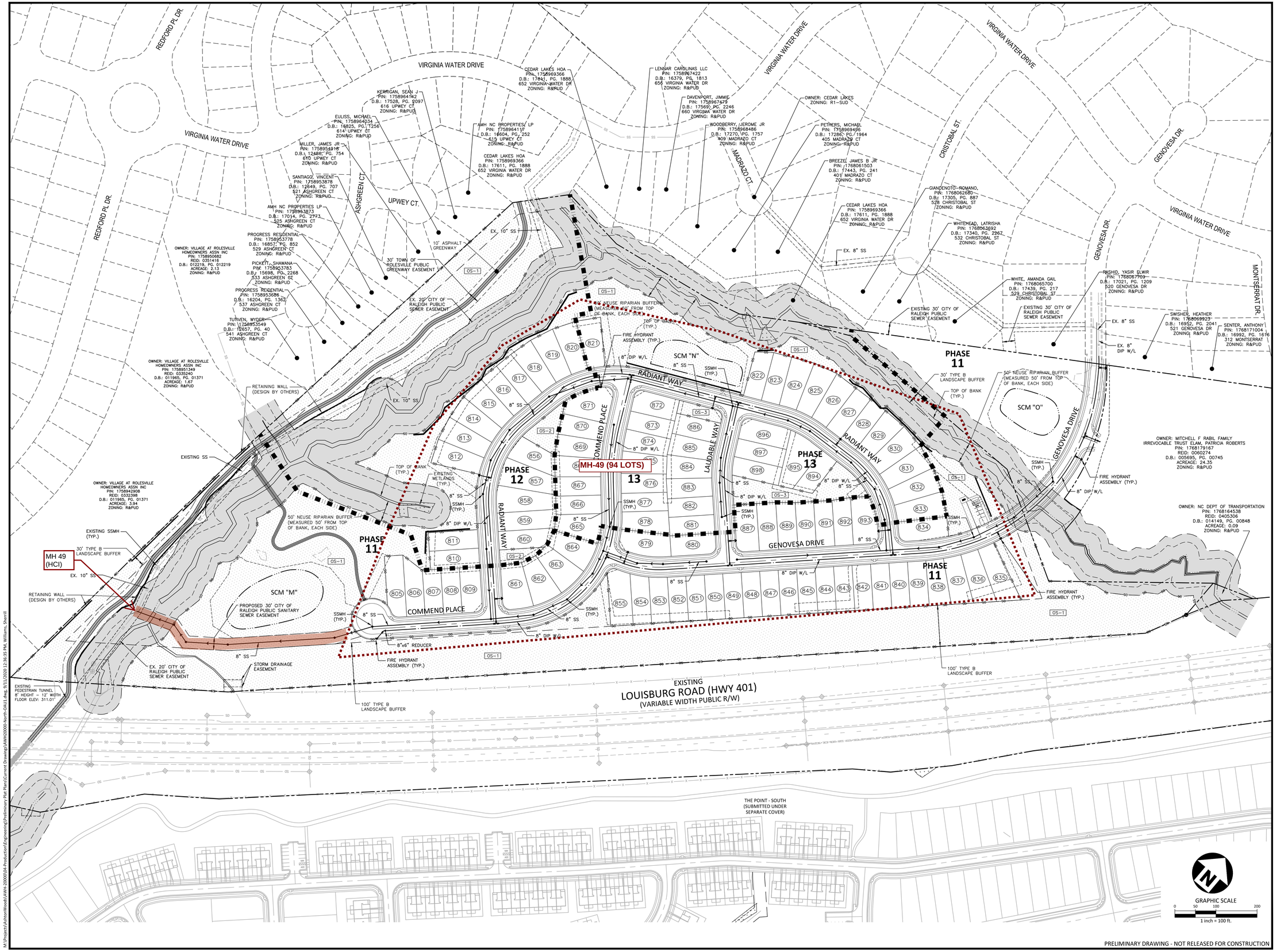
CONTACT: BOB MISHLER

ASHTON WOODS

EXHIBIT 4B

SEWAGE DISCHARGE POINTS FROM THE POINT SOUTH CD PACKAGE #2

M:\Projects\AshtonWoods\AWH-20000\04-Production\Engineering\Construction Drawing\Current Drawing\AWH20000-CD-Pkg-02-DAU1.dwg, 8/2/2021 1:48:41 PM, Williams, Sherrill



PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION

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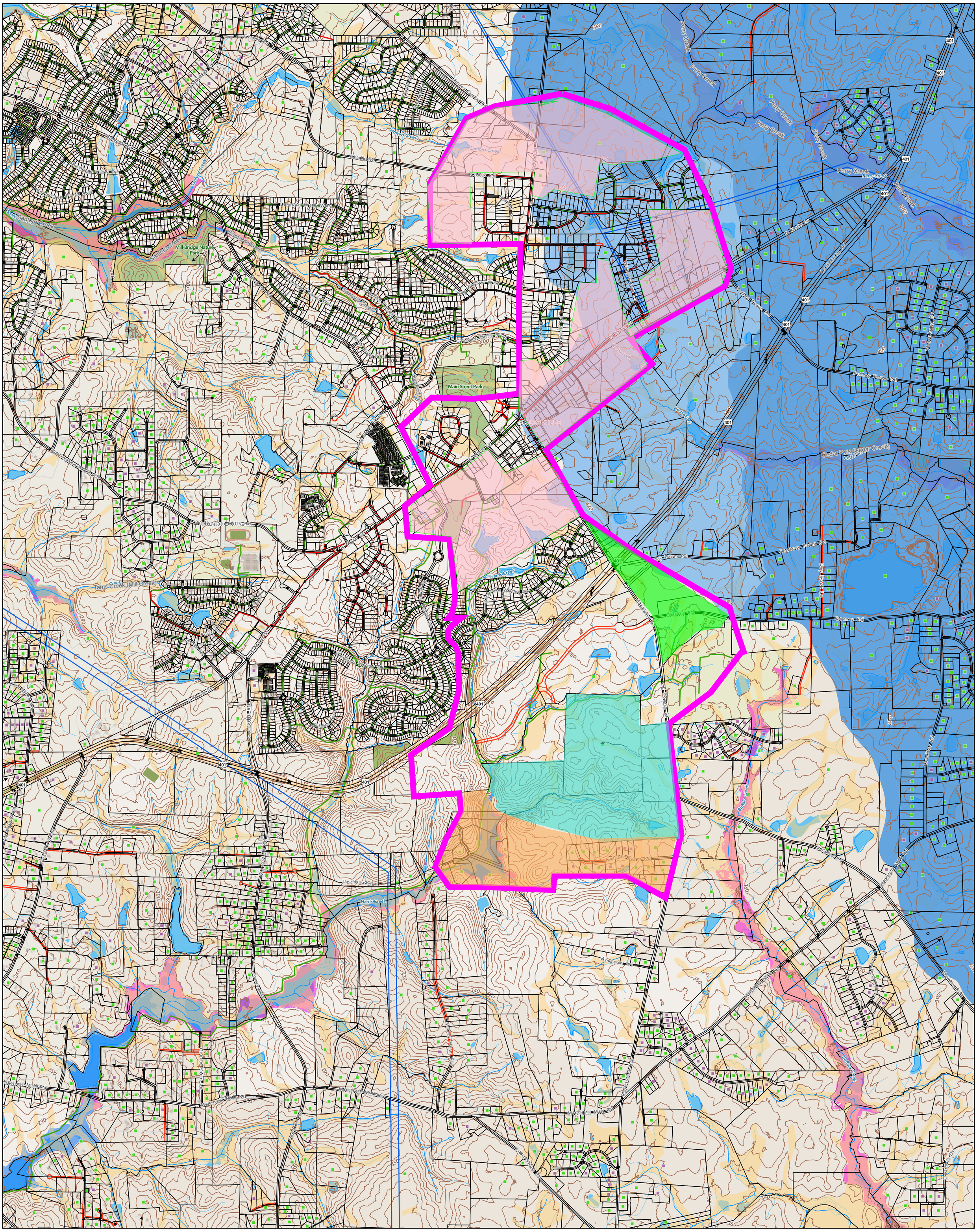
ASHTON WOODS

EXHIBIT 5

SEWAGE DISCHARGE POINTS FROM THE POINT NORTH TO EXISTING OUTFALL

Exhibit 6 - Sewage Basin



FUTURE DEVELOPMENT AREAS WITHIN BASIN

- TO MH 54 (HARRIS CREEK INTERCEPTOR) - 603 ACRES
- TO MH 31 (ROLESVILLE SANITARY SEWER OUTFALL) - 70 ACRES
- TO MH 42 (HARRIS CREEK INTERCEPTOR) - 244 ACRES
- TO MH 33 (HARRIS CREEK INTERCEPTOR) - 161 ACRES

N

0 1000 200 4000 ft

1 inch equals 1,000 feet

TABLES 1(A&B&C&D) - SEWAGE GENERATION

TABLE 1A - CALCULATION OF AVERAGE AND TOTAL FLOW PER LOT BASED ON METERED FLOW						
AREA	METERED FLOW (provided by CORPUD)		APPROXIMATE NO. OF METERED LOTS	APPROXIMATE NO. OF UNMETERED LOTS	AVG FLOW PER LOT (based on No. of metered lots)	PEAK FLOW (metered and unmetered)
	gpm	gpd			gpd	gpd
Blue Area (Water Billing Data from Tim Beasley Email 11/16/2020 - see image below)	160.273	230,793	507	43	455.21	250,367
Rolesville High School (Water Billing Data from Tim Beasley Email on 05/07/2020)	4.1	5,904	1	0	5,904	5,904
		-				
					TOTAL PEAK FLOW:	256,271

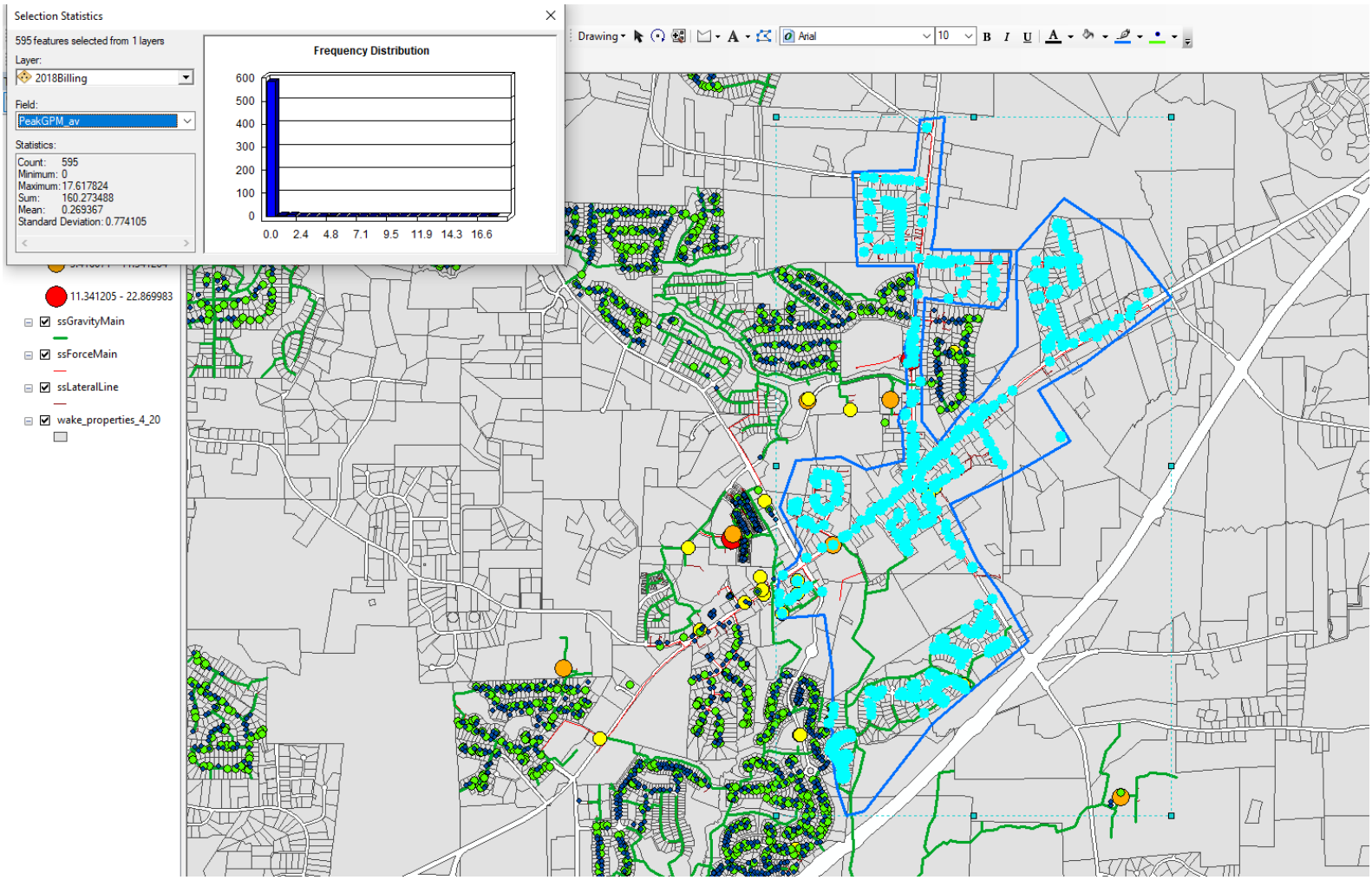


TABLE 1B - SUMMARY OF SEWAGE GENERATION BY AREA FOR FULL BUILDOUT				
Area	Lots	ADF/Lots	Peak Factor	Total Flow (gpd)
Rolesville High School				
MH 31 (Rolesville SS O/F)				5,904
The Point South				
MH 28 (Rolesville SS O/F)	68	250	2.5	42,500
MH 18 (Rolesville SS O/F)	46	250	2.5	28,750
MH 15 (Rolesville SS O/F)				
Lots	218	250	2.5	136,250
Clubhouse				5,000
Future Commercial[1]				58,500
MH 11 (Rolesville SS O/F)	112	250	2.5	70,000
MH 07 (Rolesville SS O/F)	70	250	2.5	43,750
MH 02 (Rolesville SS O/F)	107	250	2.5	66,875
Ex Dev (see Table A)				
MH 54 (Harris Creek Interceptor)				250,367
The Point North				
MH 49 (Harris Creek Interceptor)	94	250	2.5	58,750
The Point South				
MH 43 (Harris Creek Interceptor)	179	250	2.5	111,875
			TOTAL PEAK FLOW (Rolesville SS O/F):	457,529
			TOTAL PEAK FLOW (Harris Crk Interceptor):	878,521
Future Dev w/in Basin[2]	**Acres**	**Peak (gpad)***		
MH 31 (Rolesville SS O/F)	70	2000		140,549
MH 54 (Harris Creek Interceptor)	603	2000		1,206,901
MH 42 (Harris Creek Interceptor)	244	2000		487,795
MH 33 (Harris Creek Interceptor)	161	2000		321,754

CD Package #1 lots in blue; CD Package #2 lots in red; The Point North in purple; CD Package #3 in green.
[1]Future Commercial assumes 13 buildable acres (SW corner Hwy 401 and E. Young St)@4500 gpacd peak.
[2]Future Development w/in Basin flows only used for sizing improvements.
*Peak per acre flow is from City of Raleigh Public Utilities Handbook:
Appendix E - Sewer Capacity Study Section 7.1.7 for Residential - 4 zoning classification

TABLE 1C - SUMMARY OF SEWAGE GENERATION WITHIN THE POINT FOR CD PACKAGE #1 ONLY				
Area	Lots	ADF/Lots	Peak Factor	Total Flow (gpd)
Rolesville High School				
MH 31 (Rolesville SS O/F)				5,904
The Point South				
MH 28 (Rolesville SS O/F)	0	250	2.5	-
MH 18 (Rolesville SS O/F)	46	250	2.5	28,750
MH 15 (Rolesville SS O/F)				
Lots	218	250	2.5	136,250
Clubhouse				5,000
Future Commercial[1]				-
MH 11 (Rolesville SS O/F)	0	250	2.5	-
MH 07 (Rolesville SS O/F)	0	250	2.5	-
MH 02 (Rolesville SS O/F)	0	250	2.5	-
Ex Dev (see Table A)				
MH 54 (Harris Creek Interceptor)				250,367
The Point North				
MH 49 (Harris Creek Interceptor)	0	250	2.5	-
The Point South				
MH 42 (Harris Creek Interceptor)	0	250	2.5	-
Future Dev w/in Basin	**Acres**	**Peak (gpad)**		
MH 31 (Rolesville SS O/F)	0	2000		-
MH 54 (Harris Creek Interceptor)	0	2000		-
MH 42 (Harris Creek Interceptor)	0	2000		-
			TOTAL PEAK FLOW:	426,271

CD Package #1 lots in blue.
*Per information from CORPUD, only Kalas Falls Ph 1 and 2 (239 lots) should be considered "Obligated" for the CD Package No. 1 sanitary sewer capacity evaluation.

TABLE 1D-SUMMARY OF SEWAGE GENERATION WITHIN THE POINT FOR CD PACKAGE #1 & #2 ONLY				
Area	Lots	ADF/Lots	Peak Factor	Total Flow (gpd)
Rolesville High School				
MH 31 (Rolesville SS O/F)				5,904
The Point South				
MH 28 (Rolesville SS O/F)	68	250	2.5	42,500
MH 18 (Rolesville SS O/F)	46	250	2.5	28,750
MH 15 (Rolesville SS O/F)				
Lots	218	250	2.5	136,250
Clubhouse				5,000
Future Commercial[1]				58,500
MH 11 (Rolesville SS O/F)	112	250	2.5	70,000
MH 07 (Rolesville SS O/F)	70	250	2.5	43,750
MH 02 (Rolesville SS O/F)	107	250	2.5	66,875
Ex Dev (see Table A)				
MH 54 (Harris Creek Interceptor)				250,367
The Point North				
MH 49 (Harris Creek Interceptor)	0	250	2.5	-
The Point South				
MH 42 (Harris Creek Interceptor)	0	250	2.5	-
Future Dev w/in Basin	**Acres**	**Peak (gpad)**		
MH 31 (Rolesville SS O/F)	0	2000		-
MH 54 (Harris Creek Interceptor)	0	2000		-
MH 42 (Harris Creek Interceptor)	0	2000		-
			TOTAL PEAK FLOW:	707,896

CD Package #1 lots in blue; CD Package #2 lots in red.
[1]Future Commercial assumes 13 buildable acres (SW corner Hwy 401 and E. Young St)@4500 gpacd peak.

TABLE 2 - Sewer Capacity Spreadsheet
RSSO MH 31 to MH 01
Tributary Flow + The Point (CD Package #1 Lots Only)

November 20, 2020
Revised: September 19, 2023

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows	
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow /Full Pipe Flow Rate (%)
MH 31 TO MH 30	8	DIP	0.520	0.00520	239		0.013	0.67	0.33	0	0	0.013	0.0052	0.35	2.09	0.17	0.87	564,677	282,338	196	5,904	1.00
MH 30 TO MH 29	8	DIP	0.530	0.00530	209		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	5,904	1.00
MH 29 TO MH 28	8	DIP	2.660	0.02660	244		0.013	0.67	0.33	0	0	0.013	0.0266	0.35	2.09	0.17	1.98	1,277,141	523,628	364	5,904	0.50
MH 28 TO MH 27	8	PVC	2.960	0.02960	110		0.013	0.67	0.33	0	0	0.013	0.0296	0.35	2.09	0.17	2.08	1,347,237	552,367	384	5,904	0.40
MH 27 TO MH 26	8	PVC	0.550	0.00550	126		0.013	0.67	0.33	0	0	0.013	0.0055	0.35	2.09	0.17	0.90	580,737	290,368	202	5,904	1.00
MH 26 TO MH 25	8	PVC	1.840	0.01840	272		0.013	0.67	0.33	0	0	0.013	0.0184	0.35	2.09	0.17	1.64	1,062,202	531,101	369	5,904	0.06
MH 25 TO MH 24	8	PVC	2.220	0.02220	171		0.013	0.67	0.33	0	0	0.013	0.0222	0.35	2.09	0.17	1.81	1,166,741	583,371	405	5,904	0.05
MH 24 TO MH 23	8	PVC	0.500	0.00500	187		0.013	0.67	0.33	0	0	0.013	0.0050	0.35	2.09	0.17	0.86	553,711	276,855	192	5,904	1.10
MH 23 TO MH 22	8	PVC	0.510	0.00510	96		0.013	0.67	0.33	0	0	0.013	0.0051	0.35	2.09	0.17	0.87	559,221	229,280	159	5,904	1.10
MH 22 TO MH 21	8	PVC	0.530	0.00530	155		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	5,904	1.00
MH 21 TO MH 20	8	PVC	1.760	0.01760	182		0.013	0.67	0.33	0	0	0.013	0.0176	0.35	2.09	0.17	1.61	1,038,854	425,930	296	5,904	0.60
MH 20 TO MH 19	8	PVC	0.580	0.00580	80		0.013	0.67	0.33	0	0	0.013	0.0058	0.35	2.09	0.17	0.92	596,365	244,510	170	5,904	1.00
MH 19 TO MH 18	8	PVC	0.920	0.00920	300		0.013	0.67	0.33	0	0	0.013	0.0092	0.35	2.09	0.17	1.16	751,090	307,947	214	5,904	0.80
MH 18 TO MH 17	10	PVC	0.510	0.00510	295		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	34,654	3.40
MH 17 TO MH 16	10	PVC	1.640	0.01640	213		0.013	0.83	0.42	0	0	0.013	0.0164	0.55	2.62	0.21	2.81	1,818,221	745,471	518	34,654	1.90
MH 16 TO MH 15	10	PVC	0.510	0.00510	175		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	34,654	3.40
MH 15 TO MH 14	10	PVC	0.520	0.00520	87		0.013	0.83	0.42	0	0	0.013	0.0052	0.55	2.62	0.21	1.58	1,023,827	419,769	292	175,904	17.20
MH 14 TO MH 13	10	PVC	0.500	0.00500	69		0.013	0.83	0.42	0	0	0.013	0.0050	0.55	2.62	0.21	1.55	1,003,945	411,617	286	175,904	17.50
MH 13 TO MH 12	10	PVC	0.710	0.00710	227		0.013	0.83	0.42	0	0	0.013	0.0071	0.55	2.62	0.21	1.85	1,196,338	490,499	341	175,904	14.70
MH 12 TO MH 11	10	PVC	1.140	0.01140	136		0.013	0.83	0.42	0	0	0.013	0.0114	0.55	2.62	0.21	2.35	1,515,923	621,529	432	175,904	11.60
MH 11 TO MH 10	10	PVC	0.300	0.00300	141		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	175,904	22.60
MH 10 TO MH 09	10	PVC	0.300	0.00300	252		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	175,904	22.60
MH 09 TO MH 08	10	PVC	0.300	0.00300	133		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	175,904	22.60
MH 08 TO MH 07	10	PVC	0.440	0.00440	234		0.013	0.83	0.42	0	0	0.013	0.0044	0.55	2.62	0.21	1.46	941,784	386,131	268	175,904	18.70
MH 07 TO MH 06	10	DIP	0.300	0.00300	205		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	175,904	22.60
MH 06 TO MH 05	10	PVC	0.390	0.00390	280		0.013	0.83	0.42	0	0	0.013	0.0039	0.55	2.62	0.21	1.37	886,660	363,531	252	175,904	19.80
MH 05 TO MH 04	10	DIP	0.300	0.00300	175		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	175,904	22.60
MH 04 TO MH 03A	10	PVC	9.550	0.09550	192		0.013	0.83	0.42	0	0	0.013	0.0955	0.55	2.62	0.21	6.79	4,387,595	1,798,914	1,249	175,904	4.00
MH 03A TO MH 03	10	PVC	1.130	0.01130	87		0.013	0.83	0.42	0	0	0.013	0.0113	0.55	2.62	0.21	2.34	1,509,260	618,797	430	175,904	11.70
MH 03 TO MH 02	10	PVC	0.310	0.00310	71		0.013	0.83	0.42	0	0	0.013	0.0031	0.55	2.62	0.21	1.22	790,507	324,108	225	175,904	22.30
MH 02 TO MH 01	10	DIP	2.130	0.02130	193		0.013	0.83	0.42	0	0	0.013	0.0213	0.55	2.62	0.21	3.21	2,072,119	849,569	590	175,904	8.50

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2 \arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

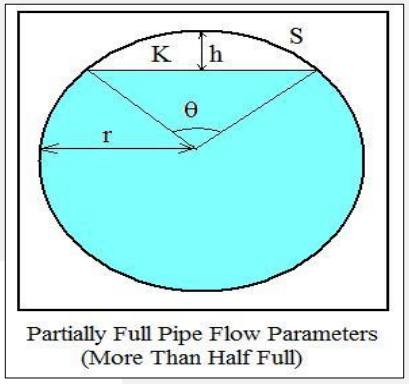
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 3 - Sewer Capacity Spreadsheet
RSSO MH 31 to MH 01
Tributary Flow + The Point (CD Package #1 and #2 Lots Only)

November 20, 2020
Revised: September 19, 2023

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows	
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow /Full Pipe Flow Rate (%)
MH 31 TO MH 30	8	DIP	0.520	0.00520	239		0.013	0.67	0.33	0	0	0.013	0.0052	0.35	2.09	0.17	0.87	564,677	282,338	196	5,904	1.00
MH 30 TO MH 29	8	DIP	0.530	0.00530	209		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	5,904	1.00
MH 29 TO MH 28	8	DIP	2.660	0.02660	244		0.013	0.67	0.33	0	0	0.013	0.0266	0.35	2.09	0.17	1.98	1,277,141	523,628	364	5,904	0.50
MH 28 TO MH 27	8	PVC	2.960	0.02960	110		0.013	0.67	0.33	0	0	0.013	0.0296	0.35	2.09	0.17	2.08	1,347,237	552,367	384	48,404	3.60
MH 27 TO MH 26	8	PVC	0.550	0.00550	126		0.013	0.67	0.33	0	0	0.013	0.0055	0.35	2.09	0.17	0.90	580,737	290,368	202	48,404	8.30
MH 26 TO MH 25	8	PVC	1.840	0.01840	272		0.013	0.67	0.33	0	0	0.013	0.0184	0.35	2.09	0.17	1.64	1,062,202	531,101	369	48,404	0.46
MH 25 TO MH 24	8	PVC	2.220	0.02220	171		0.013	0.67	0.33	0	0	0.013	0.0222	0.35	2.09	0.17	1.81	1,166,741	583,371	405	48,404	0.41
MH 24 TO MH 23	8	PVC	0.500	0.00500	187		0.013	0.67	0.33	0	0	0.013	0.0050	0.35	2.09	0.17	0.86	553,711	276,855	192	48,404	8.70
MH 23 TO MH 22	8	PVC	0.510	0.00510	96		0.013	0.67	0.33	0	0	0.013	0.0051	0.35	2.09	0.17	0.87	559,221	229,280	159	48,404	8.70
MH 22 TO MH 21	8	PVC	0.530	0.00530	155		0.013	0.67	0.33	0	0	0.013	0.0053	0.35	2.09	0.17	0.88	570,080	233,733	162	48,404	8.50
MH 21 TO MH 20	8	PVC	1.760	0.01760	182		0.013	0.67	0.33	0	0	0.013	0.0176	0.35	2.09	0.17	1.61	1,038,854	425,930	296	48,404	4.70
MH 20 TO MH 19	8	PVC	0.580	0.00580	80		0.013	0.67	0.33	0	0	0.013	0.0058	0.35	2.09	0.17	0.92	596,365	244,510	170	48,404	8.10
MH 19 TO MH 18	8	PVC	0.920	0.00920	300		0.013	0.67	0.33	0	0	0.013	0.0092	0.35	2.09	0.17	1.16	751,090	307,947	214	48,404	6.40
MH 18 TO MH 17	10	PVC	0.510	0.00510	295		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	77,154	7.60
MH 17 TO MH 16	10	PVC	1.640	0.01640	213		0.013	0.83	0.42	0	0	0.013	0.0164	0.55	2.62	0.21	2.81	1,818,221	745,471	518	77,154	4.20
MH 16 TO MH 15	10	PVC	0.510	0.00510	175		0.013	0.83	0.42	0	0	0.013	0.0051	0.55	2.62	0.21	1.57	1,013,935	415,713	289	77,154	7.60
MH 15 TO MH 14	10	PVC	0.520	0.00520	87		0.013	0.83	0.42	0	0	0.013	0.0052	0.55	2.62	0.21	1.58	1,023,827	419,769	292	276,904	27.00
MH 14 TO MH 13	10	PVC	0.500	0.00500	69		0.013	0.83	0.42	0	0	0.013	0.0050	0.55	2.62	0.21	1.55	1,003,945	411,617	286	276,904	27.60
MH 13 TO MH 12	10	PVC	0.710	0.00710	227		0.013	0.83	0.42	0	0	0.013	0.0071	0.55	2.62	0.21	1.85	1,196,338	490,499	341	276,904	23.10
MH 12 TO MH 11	10	PVC	1.140	0.01140	136		0.013	0.83	0.42	0	0	0.013	0.0114	0.55	2.62	0.21	2.35	1,515,923	621,529	432	276,904	18.30
MH 11 TO MH 10	10	PVC	0.300	0.00300	141		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	346,904	44.60
MH 10 TO MH 09	10	PVC	0.300	0.00300	252		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	346,904	44.60
MH 09 TO MH 08	10	PVC	0.300	0.00300	133		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	346,904	44.60
MH 08 TO MH 07	10	PVC	0.440	0.00440	234		0.013	0.83	0.42	0	0	0.013	0.0044	0.55	2.62	0.21	1.46	941,784	386,131	268	346,904	36.80
MH 07 TO MH 06	10	DIP	0.300	0.00300	205		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	390,654	50.20
MH 06 TO MH 05	10	PVC	0.390	0.00390	280		0.013	0.83	0.42	0	0	0.013	0.0039	0.55	2.62	0.21	1.37	886,660	363,531	252	390,654	44.10
MH 05 TO MH 04	10	DIP	0.300	0.00300	175		0.013	0.83	0.42	0	0	0.013	0.0030	0.55	2.62	0.21	1.20	777,652	318,837	221	390,654	50.20
MH 04 TO MH 03A	10	PVC	9.550	0.09550	192		0.013	0.83	0.42	0	0	0.013	0.0955	0.55	2.62	0.21	6.79	4,387,595	1,798,914	1,249	390,654	8.90
MH 03A TO MH 03	10	PVC	1.130	0.01130	87		0.013	0.83	0.42	0	0	0.013	0.0113	0.55	2.62	0.21	2.34	1,509,260	618,797	430	390,654	25.90
MH 03 TO MH 02	10	PVC	0.310	0.00310	71		0.013	0.83	0.42	0	0	0.013	0.0031	0.55	2.62	0.21	1.22	790,507	324,108	225	390,654	49.40
MH 02 TO MH 01	10	DIP	2.130	0.02130	193		0.013	0.83	0.42	0	0	0.013	0.0213	0.55	2.62	0.21	3.21	2,072,119	849,569	590	457,529	22.10

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

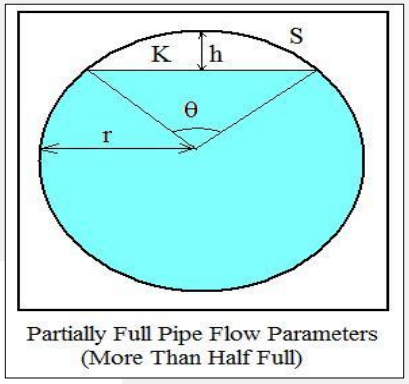
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 4 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 32
Tributary + Obligated Flow + The Point (CD Package #1 Lots Only)

November 20, 2020
Revised: September 19, 2023

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows	
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow / Full Pipe Flow Rate (%)
MH 54 TO MH 53	10	DIP	1.070	0.01070	147		0.013	0.83	0.42	0	0	0.013	0.0107	0.55	2.62	0.21	2.27	1,468,645	734,322	510	250,367	17.00
MH 53 TO MH 52	10	PVC	0.280	0.00280	298		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 52 TO MH 51	10	PVC	0.270	0.00270	410		0.013	0.83	0.42	0	0	0.013	0.0027	0.55	2.62	0.21	1.14	737,746	368,873	256	250,367	33.90
MH 51 TO MH 50	10	PVC	0.840	0.00840	376		0.013	0.83	0.42	0	0	0.013	0.0084	0.55	2.62	0.21	2.01	1,301,261	533,517	370	250,367	19.20
MH 50 TO MH 49	10	PVC	8.800	0.08800	114		0.013	0.83	0.42	0	0	0.013	0.0880	0.55	2.62	0.21	6.52	4,211,785	1,726,832	1,199	250,367	5.90
MH 49 to MH 48	10	DIP	0.280	0.00280	160		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 48 to MH 47	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 47 TO MH 46	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 46 TO MH 45	10	PVC	0.280	0.00280	292		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	250,367	33.30
MH 45 TO MH 44	10	PVC	1.960	0.01960	292		0.013	0.83	0.42	0	0	0.013	0.0196	0.55	2.62	0.21	3.08	1,987,709	814,961	566	250,367	12.60
MH 44 TO MH 01	10	PVC	0.464	0.00464	209		0.013	0.83	0.42	0	0	0.013	0.0046	0.55	2.62	0.21	1.50	967,571	396,704	275	250,367	25.90
MH 01 TO MH 43	10	PVC	0.452	0.00452	82		0.013	0.83	0.42	0	0	0.013	0.0045	0.55	2.62	0.21	1.48	954,181	391,214	272	426,271	44.70
MH 43 TO MH 42	10	PVC	1.100	0.01100	388		0.013	0.83	0.42	0	0	0.013	0.0110	0.55	2.62	0.21	2.30	1,489,091	610,527	424	426,271	28.60
MH 42 TO MH 41	10	PVC	0.280	0.00280	295		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 41 TO MH 40	10	DIP	19.710	0.19710	118		0.013	0.83	0.42	0	0	0.013	0.1971	0.55	2.62	0.21	9.75	6,303,302	2,584,354	1,795	426,271	6.80
MH 40 TO MH 39	10	PVC	0.280	0.00280	184		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 39 TO MH 38	10	PVC	0.280	0.00280	351		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 38 TO MH 37	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 37 TO MH 36	10	PVC	0.280	0.00280	366		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 36 TO MH 35	10	PVC	0.280	0.00280	132		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 35 TO MH 34	10	PVC	0.280	0.00280	155		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 34 TO MH 33	10	PVC	0.280	0.00280	359		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	426,271	56.70
MH 33 TO MH 32	10	DIP	4.290	0.04290	153		0.013	0.83	0.42	0	0	0.013	0.0429	0.55	2.62	0.21	4.55	2,940,719	1,205,695	837	426,271	14.50

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

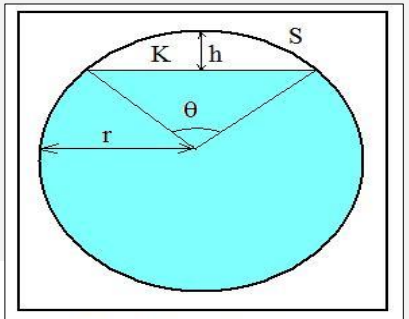
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 5 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 32
Tributary + Obligated Flow + The Point (CD Package #1 and #2 Lots Only)

November 20, 2020
Revised: September 19, 2023

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows	
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow / Full Pipe Flow Rate (%)
MH 54 TO MH 53	10	DIP	1.070	0.01070	147		0.013	0.83	0.42	0	0	0.013	0.0107	0.55	2.62	0.21	2.27	1,468,645	734,322	510	250,367	17.00
MH 53 TO MH 52	10	PVC	0.280	0.00280	298		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 52 TO MH 51	10	PVC	0.270	0.00270	410		0.013	0.83	0.42	0	0	0.013	0.0027	0.55	2.62	0.21	1.14	737,746	368,873	256	250,367	33.90
MH 51 TO MH 50	10	PVC	0.840	0.00840	376		0.013	0.83	0.42	0	0	0.013	0.0084	0.55	2.62	0.21	2.01	1,301,261	533,517	370	250,367	19.20
MH 50 TO MH 49	10	PVC	8.800	0.08800	114		0.013	0.83	0.42	0	0	0.013	0.0880	0.55	2.62	0.21	6.52	4,211,785	1,726,832	1,199	250,367	5.90
MH 49 to MH 48	10	DIP	0.280	0.00280	160		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 48 to MH 47	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 47 TO MH 46	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 46 TO MH 45	10	PVC	0.280	0.00280	292		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	250,367	33.30
MH 45 TO MH 44	10	PVC	1.960	0.01960	292		0.013	0.83	0.42	0	0	0.013	0.0196	0.55	2.62	0.21	3.08	1,987,709	814,961	566	250,367	12.60
MH 44 TO MH 01	10	PVC	0.464	0.00464	209		0.013	0.83	0.42	0	0	0.013	0.0046	0.55	2.62	0.21	1.50	967,571	396,704	275	250,367	25.90
MH 01 TO MH 43	10	PVC	0.452	0.00452	82		0.013	0.83	0.42	0	0	0.013	0.0045	0.55	2.62	0.21	1.48	954,181	391,214	272	707,896	74.20
MH 43 TO MH 42	10	PVC	1.100	0.01100	388		0.013	0.83	0.42	0	0	0.013	0.0110	0.55	2.62	0.21	2.30	1,489,091	610,527	424	707,896	47.50
MH 42 TO MH 41	10	PVC	0.280	0.00280	295		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 41 TO MH 40	10	DIP	19.710	0.19710	118		0.013	0.83	0.42	0	0	0.013	0.1971	0.55	2.62	0.21	9.75	6,303,302	2,584,354	1,795	707,896	11.20
MH 40 TO MH 39	10	PVC	0.280	0.00280	184		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 39 TO MH 38	10	PVC	0.280	0.00280	351		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 38 TO MH 37	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 37 TO MH 36	10	PVC	0.280	0.00280	366		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 36 TO MH 35	10	PVC	0.280	0.00280	132		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 35 TO MH 34	10	PVC	0.280	0.00280	155		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 34 TO MH 33	10	PVC	0.280	0.00280	359		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	707,896	94.20
MH 33 TO MH 32	10	DIP	4.290	0.04290	153		0.013	0.83	0.42	0	0	0.013	0.0429	0.55	2.62	0.21	4.55	2,940,719	1,205,695	837	707,896	24.10

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

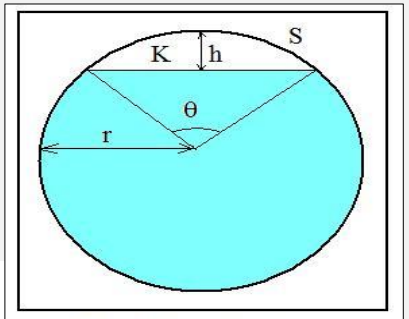
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 6 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 32
Tributary + Obligated Flow + The Point (Full Buildout)

November 20, 2020
Revised: September 19, 2023

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows	
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow / Full Pipe Flow Rate (%)
MH 54 TO MH 53	10	DIP	1.070	0.01070	147		0.013	0.83	0.42	0	0	0.013	0.0107	0.55	2.62	0.21	2.27	1,468,645	734,322	510	250,367	17.00
MH 53 TO MH 52	10	PVC	0.280	0.00280	298		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	250,367	33.30
MH 52 TO MH 51	10	PVC	0.270	0.00270	410		0.013	0.83	0.42	0	0	0.013	0.0027	0.55	2.62	0.21	1.14	737,746	368,873	256	250,367	33.90
MH 51 TO MH 50	10	PVC	0.840	0.00840	376		0.013	0.83	0.42	0	0	0.013	0.0084	0.55	2.62	0.21	2.01	1,301,261	533,517	370	250,367	19.20
MH 50 TO MH 49	10	PVC	8.800	0.08800	114		0.013	0.83	0.42	0	0	0.013	0.0880	0.55	2.62	0.21	6.52	4,211,785	1,726,832	1,199	250,367	5.90
MH 49 to MH 48	10	DIP	0.280	0.00280	160		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	309,117	41.10
MH 48 to MH 47	10	PVC	0.280	0.00280	396		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	309,117	41.10
MH 47 TO MH 46	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	375,642	261	309,117	41.10
MH 46 TO MH 45	10	PVC	0.280	0.00280	292		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	309,117	41.10
MH 45 TO MH 44	10	PVC	1.960	0.01960	292		0.013	0.83	0.42	0	0	0.013	0.0196	0.55	2.62	0.21	3.08	1,987,709	814,961	566	309,117	15.60
MH 44 TO MH 01	10	PVC	0.464	0.00464	209		0.013	0.83	0.42	0	0	0.013	0.0046	0.55	2.62	0.21	1.50	967,571	396,704	275	309,117	31.90
MH 01 TO MH 43	10	PVC	0.452	0.00452	82		0.013	0.83	0.42	0	0	0.013	0.0045	0.55	2.62	0.21	1.48	954,181	391,214	272	766,646	80.30
MH 43 TO MH 42	10	PVC	1.100	0.01100	388		0.013	0.83	0.42	0	0	0.013	0.0110	0.55	2.62	0.21	2.30	1,489,091	610,527	424	878,521	59.00
MH 42 TO MH 41	10	PVC	0.280	0.00280	295		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 41 TO MH 40	10	DIP	19.710	0.19710	118		0.013	0.83	0.42	0	0	0.013	0.1971	0.55	2.62	0.21	9.75	6,303,302	2,584,354	1,795	878,521	13.90
MH 40 TO MH 39	10	PVC	0.280	0.00280	184		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 39 TO MH 38	10	PVC	0.280	0.00280	351		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 38 TO MH 37	10	PVC	0.280	0.00280	385		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 37 TO MH 36	10	PVC	0.280	0.00280	366		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 36 TO MH 35	10	PVC	0.280	0.00280	132		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 35 TO MH 34	10	PVC	0.280	0.00280	155		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 34 TO MH 33	10	PVC	0.280	0.00280	359		0.013	0.83	0.42	0	0	0.013	0.0028	0.55	2.62	0.21	1.16	751,283	308,026	214	878,521	116.90
MH 33 TO MH 32	10	DIP	4.290	0.04290	153		0.013	0.83	0.42	0	0	0.013	0.0429	0.55	2.62	0.21	4.55	2,940,719	1,205,695	837	878,521	29.90

Equations used for calculations:

$r = D/2$

$h = 2r - y$

$$\theta = 2\arccos\left(\frac{r-h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r*\theta$$

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

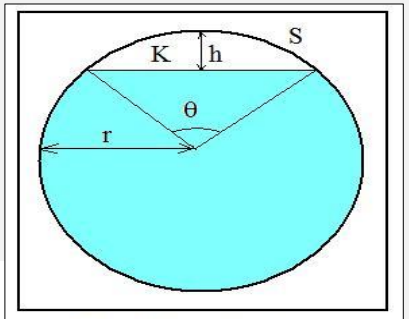
Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)



Partially Full Pipe Flow Parameters
(More Than Half Full)

TABLE 7 - Sewer Capacity Spreadsheet
HCI MH 54 to MH 32
Tributary + Obligated Flow + The Point (Full Buildout) + Future Development within Sewer Basin with Improvements

November 20, 2020
Revised: September 19, 2023

BASE DATA - *INPUT REQUIRED*								Q Full/Half-Full Pipe *Calculations*												Estimated Flows	
PIPE ID	DIAMETER (INCHES)	MATERIAL	PIPE SLOPE %	PIPE SLOPE	*LENGTH (FT)*	Comment	*n*	Pipe Diameter, D (ft)	Pipe Radius, r (ft)	Height of flow, h (ft)	Angle, θ (radians)	Manning's n value	Slope (ft/ft)	Cross-sectional Area, A (ft²)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Full Pipe Flow Rate, Q (cfs)	Full Pipe Flow Rate, Q (gpd)	Flow Rate Q (gpd) @ Half Pipe Depth	Flow Rate Q (gpm) @ Half Pipe Depth	Flow, Q (gpd)	Flow / Full Pipe Flow Rate (%)
MH 01 TO MH 43	24	PVC	0.290	0.00290	82		0.013	2.00	1.00	0	0	0.013	0.0029	3.14	6.28	0.50	12.22	7,894,424	3,236,714	2,248	2,114,096	26.80
MH 43 TO MH 42	24	PVC	1.010	0.01010	336		0.013	2.00	1.00	0	0	0.013	0.0101	3.14	6.28	0.50	22.80	14,732,693	6,040,404	4,195	2,225,971	15.10
MH 42 TO MH 41	24	PVC	4.380	0.04380	301		0.013	2.00	1.00	0	0	0.013	0.0438	3.14	6.28	0.50	47.47	30,680,224	12,578,892	8,735	2,713,765	8.80
MH 41 TO MH 40	24	PVC	9.500	0.09500	124		0.013	2.00	1.00	0	0	0.013	0.0950	3.14	6.28	0.50	69.91	45,183,854	18,525,380	12,865	2,713,765	6.00
MH 40 TO MH 39	24	PVC	1.050	0.01050	172		0.013	2.00	1.00	0	0	0.013	0.0105	3.14	6.28	0.50	23.24	15,021,597	6,158,855	4,277	2,713,765	18.10
MH 39 TO MH 38	24	PVC	0.560	0.00560	349		0.013	2.00	1.00	0	0	0.013	0.0056	3.14	6.28	0.50	16.97	10,970,224	4,497,792	3,123	2,713,765	24.70
MH 38 TO MH 37	24	PVC	0.250	0.00250	357		0.013	2.00	1.00	0	0	0.013	0.0025	3.14	6.28	0.50	11.34	7,329,789	3,005,213	2,087	2,713,765	37.00
MH 37 TO MH 36	24	PVC	0.250	0.00250	366		0.013	2.00	1.00	0	0	0.013	0.0025	3.14	6.28	0.50	11.34	7,329,789	3,005,213	2,087	2,713,765	37.00
MH 36 TO MH 35	24	PVC	0.250	0.00250	131		0.013	2.00	1.00	0	0	0.013	0.0025	3.14	6.28	0.50	11.34	7,329,789	3,005,213	2,087	2,713,765	37.00
MH 35 TO MH 34	24	PVC	0.250	0.00250	155		0.013	2.00	1.00	0	0	0.013	0.0025	3.14	6.28	0.50	11.34	7,329,789	3,005,213	2,087	2,713,765	37.00
MH 34 TO MH 33	24	PVC	0.960	0.00960	360		0.013	2.00	1.00	0	0	0.013	0.0096	3.14	6.28	0.50	22.22	14,363,394	5,888,992	4,090	2,713,765	18.90
MH 33 TO MH 32	24	PVC	4.910	0.04910	153		0.013	2.00	1.00	0	0	0.013	0.0491	3.14	6.28	0.50	50.26	32,483,455	13,318,216	9,249	3,035,520	9.30

Equations used for calculations:

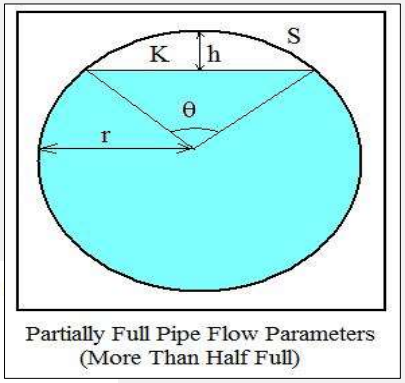
$r = D/2$

$h = 2r - y$

$$\theta = 2 \arccos\left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$



Partially Full Pipe Flow Parameters
(More Than Half Full)

$$Q = \frac{(1.486)(A)(R^{2/3})(S^{1/2})}{n}$$

Where:

Q = pipe capacity, (cfs)
n = Manning's "n"
A = cross-sectional flow area of the pipe ($ft.^2$)
R = hydraulic radius (ft.):

$$R = \frac{A}{P}$$

P = Wetted perimeter (ft); Pipe inside circumference, or (π)(inside diameter) for full flowing pipe conditions

S = pipe slope (feet/foot)

TABLE 8 - Rolesville Sanitary Sewer Outfall Summary of Proposed Improvements

April 21, 2021
Revised: August 19, 2022

PIPE	EXISTING SIZE	PROPOSED IMPROVEMENTS	
		CD PACKAGE #1	FULL BUILDOUT (= CD Package #1 and #2)
MH 31 TO MH 30	8 -INCH	NONE	NONE
MH 30 TO MH 29	8 -INCH	NONE	NONE
MH 29 TO MH 28	8 -INCH	NONE	NONE
MH 28 TO MH 27	8 -INCH	NONE	NONE
MH 27 TO MH 26	8 -INCH	NONE	NONE
MH 26 TO MH 25	8 -INCH	NONE	NONE
MH 25 TO MH 24	8 -INCH	NONE	NONE
MH 24 TO MH 23	8 -INCH	NONE	NONE
MH 23 TO MH 22	8 -INCH	NONE	NONE
MH 22 TO MH 21	8 -INCH	NONE	NONE
MH 21 TO MH 20	8 -INCH	NONE	NONE
MH 20 TO MH 19	8 -INCH	NONE	NONE
MH 19 TO MH 18	8 -INCH	NONE	NONE
MH 18 TO MH 17	10-INCH	NONE	NONE
MH 17 TO MH 16	10-INCH	NONE	NONE
MH 16 TO MH 15	10-INCH	NONE	NONE
MH 15 TO MH 14	10-INCH	NONE	NONE
MH 14 TO MH 13	10-INCH	NONE	NONE
MH 13 TO MH 12	10-INCH	NONE	NONE
MH 12 TO MH 11	10-INCH	NONE	NONE
MH 11 TO MH 10	10-INCH	NONE	NONE
MH 10 TO MH 09	10-INCH	NONE	NONE
MH 09 TO MH 08	10-INCH	NONE	NONE
MH 08 TO MH 07	10-INCH	NONE	NONE
MH 07 TO MH 06	10-INCH	NONE	NONE
MH 06 TO MH 05	10-INCH	NONE	NONE
MH 05 TO MH 04	10-INCH	NONE	NONE
MH 04 TO MH 03A	10-INCH	NONE	NONE
MH 03A TO MH 03	10-INCH	NONE	NONE
MH 03 TO MH 02	10-INCH	NONE	NONE
MH 02 TO MH 01	10-INCH	NONE	NONE

TABLE 9 - HARRIS CREEK INTERCEPTOR
Summary of Proposed Improvements

April 21, 2021

Revised: August 19, 2022

HARRIS CREEK INTERCEPTOR (MH 54 TO MH 32)									
PIPE	EXISTING SIZE (inch)	CD PACKAGE #1		CD PACKAGE #2			FULL BUILDOUT		
		% Full Existing	Proposed Improvement	% Full Existing	Proposed Improvement	% Full (w/Improvement)	% Full Existing	Proposed Improvement	% Full (w/Improvement)
MH 54 TO MH 53	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 53 TO MH 52	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 52 TO MH 51	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 51 TO MH 50	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 50 TO MH 49	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 49 TO MH 48	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 48 TO MH 47	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 47 TO MH 46	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 46 TO MH 45	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 45 TO MH 44	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 44 TO MH 01	10	≤ 50%	NONE	≤ 50%	NONE	N/A	≤ 50%	NONE	N/A
MH 01 TO MH 43	10	≤ 50%	NONE	74%	12-INCH	46%	80%	24-INCH	27%
MH 43 TO MH 42	10	≤ 50%	NONE	48%	12-INCH	29%	59%	24-INCH	15%
MH 42 TO MH 41	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	9%
MH 41 TO MH 40	10	≤ 50%	NONE	11%	15-INCH	4%	14%	24-INCH	6%
MH 40 TO MH 39	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	18%
MH 39 TO MH 38	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	25%
MH 38 TO MH 37	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	37%
MH 37 TO MH 36	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	37%
MH 36 TO MH 35	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	37%
MH 35 TO MH 34	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	37%
MH 34 TO MH 33	10	57%	FEE IN LIEU	94%	15-INCH	32%	117%	24-INCH	19%
MH 33 TO MH 32	10	≤ 50%	NONE	24%	15-INCH	8%	30%	24-INCH	9%
	FEE IN LIEU								
	PROPOSED IMPROVEMENT INDICATES PIPE SIZE NEEDED TO REDUCE PERCENT FLOW CAPACITY BELOW 50% FOR DEVELOPMENT STAGE INDICATED AT TOP OF COLUMN								