SUB-BASIN PLANNING ADDENDUM

COMPREHENSIVE WATER & WASTEWATER MASTER PLAN

TECHNICAL MEMORANDUM

Union County, North Carolina

DECEMBER 2014

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Introduction

PROJECT DESCRIPTION AND OBJECTIVES

Union County Public Works (UCPW) requested that Black & Veatch (B&V) determine future collection system infrastructure needs in three sub-basins in the northwest area of Union County that are experiencing the greatest influx of new development. Union County's Water and Sewer Line Extension Ordinance provides for developers to construct off-site improvements, necessary to serve their development, in accordance with the County's adopted Water and Sewer Master Plan. For some of the larger undeveloped sub-basins, multiple sewer alignments are possible and it is UCPW's desire to evaluate optimum solutions for providing sewer service to these areas within a consistent policy frame work. The three sub-basins are:

- Sub-Basin 1: Lake Providence Sub-Basin (Twelve Mile Creek Basin)
- Sub-Basin 2: Tarkill Creek Sub-Basin (Six Mile Creek Basin)
- Sub-Basin 3: Mundy's Run Sub-Basin (Twelve Mile Creek Basin)

The sub-basins were evaluated using UCPW's Innovyze InfoWorks CS hydraulic model. The primary objectives of the study were to:

- Determine approximate alignment and size of future sewer interceptors to serve each sub-basin.
- Evaluate the potential future average day and wet weather flows in each sub-basin.
- Estimate the construction cost of the future sewer interceptor projects.

INTERCEPTOR ALIGNMENT PLANNING

Preliminary gravity sewer alignments were developed for each sub-basin and reviewed with UCPW. In each sub-basin, a preferred alignment was established that would eventually serve all customers in the most cost effective manner. The preferred alignments were planned using the following criteria:

1. The alignment will serve any and all potential future public sewer customers via gravity connections to the planned interceptor. Potential customers and developments were determined using the updated parcel data and aerial photography that was added to the model.
2. The alignment will follow natural streams and swales wherever possible to maximize the area that can connect to the interceptor by gravity flow. Following the natural drainage paths will also minimize the depth of the sewers. A 3D layer of the topographic ground surface was used in the hydraulic model to determine the drainage patterns and sewer depths in each sub-basin.
3. Alignments were also planned to minimize pumping, and the associated long-term maintenance and power costs, whenever possible. Wastewater flows could not be pumped to other basins where the existing infrastructure was not planned for those additional flows.

Lake Providence Sub-Basin

The Lake Providence Sub-Basin is located on the east side of Weddington. The sub-basin is bordered on the west by Beulah Church Rd and by Antioch Church Rd on the eastern side. There are several existing subdivisions in this sub-basin. The Preserve at Brookhaven is served by gravity sewer that flows by gravity to the existing Brookhaven Pump Station. All other existing neighborhoods in the sub-basin use septic systems.

HYDRAULIC MODEL EXPANSIONS

The existing wastewater hydraulic model developed during the 2011 Comprehensive Master Plan was expanded to include planned sewers upstream and downstream of the three sub-basins that utilize interceptor capacity common with the study sub-basins. All UCPW infrastructure downstream of the Lake Providence Sub-basin was included in the 12 Mile Basin model and calibrated during the Comprehensive Master Plan. The model catchment areas were adjusted to route the projected average daily dry-weather and wet weather flows within the sub-basin through the new Lake Providence sewer alignments.

ALIGNMENT

The Lake Providence Sub-Basin is served by one main gravity sewer interceptor. The upstream area of the sub-basin is served by a gravity interceptor that follows a tributary to 12 Mile Creek located in this sub-basin. Near the middle of the sub-basin, at the Gatewood neighborhood, the average slope of the ground surface decreases. In order to maintain reasonable sewer depths, a minimum diameter of 10 inches is recommended to lower the required gravity sewer minimum slope, but maintain a sufficient scour velocity.

At the downstream end of the sub-basin, the gravity sewer must be constructed on either the east or west side of Lake Providence. The Lake Providence neighborhood is located on the west side of the lake. Most of the homes in the Lake Providence neighborhood were built in the 1990s and are served by septic systems. The proximity of the existing structures to the edge of the water would cause constructability issues and disruption to the home owners. In order to serve all upstream customers by gravity, the sewers in this area would also need to be buried very deep. On the eastern side of the lake, an existing power line easement can be utilized to minimize the disruption to existing homeowners. The planned interceptor routed to the eastern side of Lake Providence will serve all the potential future upstream customers. Also, the length of sewer on the east side to the Union County interceptor is shorter. The shorter length and shallow depths make routing the interceptor to the eastern side of the lake the more economical choice. The sewer will connect to the planned 18-inch gravity sewer (CIP Project TM-G-07).

Routing the planned interceptor to the eastern side of the lake will allow all existing and future neighborhoods north of Huntington Drive to connect to the interceptor by gravity. However, the Lake Providence Neighborhood will not be able to connect to the planned interceptor. As the neighborhood was built in the 1990s and lots are greater than 1 acre, individual homeowners are unlikely to want to connect to the public sewer system in the near future. In the future, if the entire neighborhood chooses to convert to public sewer, the neighborhood could be served by gravity and connect to the Union County 12 Mile Creek Interceptor.

FLOW PROJECTIONS

Average Daily Dry-Weather Flows

Average Daily Dry-weather Flows (ADDF) were developed using two methods. Future flows for 2030 were developed using the same methodology as the 2011 Comprehensive Master Plan. The 2030 projections include population growth through the year 2030, but growth was anticipated to continue beyond 2030 within the sub-basin.

New planning level projections were developed to try to determine the additional flows that would be contributed to each sub-basin beyond the 2030 window. The new projections were developed using the parcel data from each sub-basin. The existing parcels were classified as either septic use or undeveloped land. The undeveloped area in each sub-basin was anticipated to be developed in the future into one acre residential lots in accordance with current land use ordinances. 30% of the undeveloped area has been reserved for open space for roads, easements, commons spaces, and for existing streams and buffers. 25% of existing septic systems were anticipated to convert to public sewer. Future loadings were based on assumptions consistent with the 2011 Comprehensive Master Plan regarding residential development in each sub-basin. The per capita wastewater loading rate was anticipated to be 80 gpcd and the average occupancy was anticipated to be 2.7 persons per dwelling unit.

Wet Weather Flows

Wet weather flows were developed using the same procedure and methodology established for new developments in the 2011 Comprehensive Master Plan. The resulting peak wet weather flow is dependent on the individual characteristics of each basin (e.g. time of concentration, topography).

PEAK FLOWS AND SEWER SIZES

Gravity sewers were sized based on the peak flows simulated by the updated model and following the Performance Criteria established for the 2011 Comprehensive Master Plan. The performance criteria established a service goal for new or replacement sewers of less than 18 inches in diameter to be sized based on a maximum depth/Diameter (d/D) ratio of less than or equal to 0.65. The low ratio is to preserve a capacity buffer in these smaller local pipes. Also, all planned gravity sewers should maintain diameter continuity, downstream sewers should have the same or larger diameter than upstream sewers, and the minimum slope for each sewer should conform to NCDENR system minimum design guidance.

The wet weather flows and resulting sewer interceptor diameters for the sub-basin planning level projections were compared to the results from the 2030 planning year model. Overall, the resulting diameters were very similar. In the Lake Providence Sub-Basin, the planned diameter was governed by the minimum slope requirements. The flows and the planned diameter for each segment of sewer are shown in Table 1. The peak wet weather flow of 0.544 MGD in the Lake Providence Sub-Basin could have been carried by an 8-inch sewer at the NC DENR recommended minimum slope of 0.4%. However, the downstream end of the sub-basin is much flatter than the upper sections. Using a slope of 0.4% would lead to deeper sewers at the downstream end of the sub-basin. Deep sewers create more excavation costs and are more difficult to maintain. By planning a 10-inch diameter sewer at the minimum slope of 0.28%, the planned sewer will follow the natural ground topography and minimize the required sewer depths. The average daily flow at the outlet of the

sub-basin is 0.135 MGD. The segment IDs in Table 1 correspond to Figure 1. The flow values in the table are total flows including all flows upstream of each referenced Manhole.

Table 1 Lake Providence Sub-Basin Gravity Flows and Diameters

MANHOLE LOCATION	TOTAL AVERAGE DAILY FLOW (MGD)	TOTAL WET WEATHER FLOW (MGD)	DOWNSTREAM DIAMETER (IN)
LP-1	0.135	0.544	18
LP-2	0.124	0.448	10
LP-3	0.082	0.341	8
LP-4	0.031	0.205	8
LP-5	0.037	0.108	8
LP-5a	0.051	0.150	8

DOWNSTREAM CAPACITY CONSTRAINTS

The modeled peak wet weather flows for the Lake Providence sub-basin did not have a significant impact on downstream infrastructure. The sub-basin interceptor connects to a planned 18-inch interceptor project. The project, TM-G-07, was slated for the 2016-2020 planning horizon in the Master Plan.

PROJECT COSTS

Wastewater unit costs by pipe diameter per linear foot were developed as part of the Comprehensive Master Plan project. The costs for gravity sewer pipe are shown in Table 2.

Table 2 Union County Master Plan Gravity Sewer Unit Costs

DIAMETER (IN)	DEPTH TO INVERT			
	10 FT	15 FT	20 FT	25 FT
8	$68	$80	$98	$118
10	$75	$87	$105	$125
12	$85	$96	$114	$134
15	$101	$111	$128	$147
18	$113	$145	$169	$196
21	$127	$157	$181	$208
24	$158	$187	$211	$238
27	$185	$210	$233	$260
30	$213	$236	$259	$286
36	$270	$320	$350	$386
42	$333	$383	$413	$449
48	$421	$466	$496	$532
54	$514	$552	$583	$618

A construction contingency of 20% was applied to the construction cost. Also, engineering costs for design, planning and permitting as well as the engineering required during construction were assumed to be 15% of the total construction cost including the contingencies. The project costs are shown in Table 3. The total cost opinion for the Lake Providence Sub-Basin projects is approximately $2.11 million.

Table 3 Lake Providence Sub-Basin Project Cost Opinions

UPSTREAM MANHOLE ID	DOWNSTREAM MANHOLE ID	CONSTRUCTION COST	CONSTRUCTION CONTINGENCY	ENGINEERING COST	TOTAL PROJECT COST
LP-2	LP-1	$693,000	$138,600	$124,740	**$956,340**
LP-3	LP-2	$208,000	$41,600	$37,440	**$287,040**
LP-4	LP-3	$100,000	$20,000	$18,000	**$138,000**
LP-5	LP-3	$527,000	$105,400	$94,860	**$727,260**
Sub-Basin Total		$1,528,000	$305,600	$275,040	**$2,108,640**

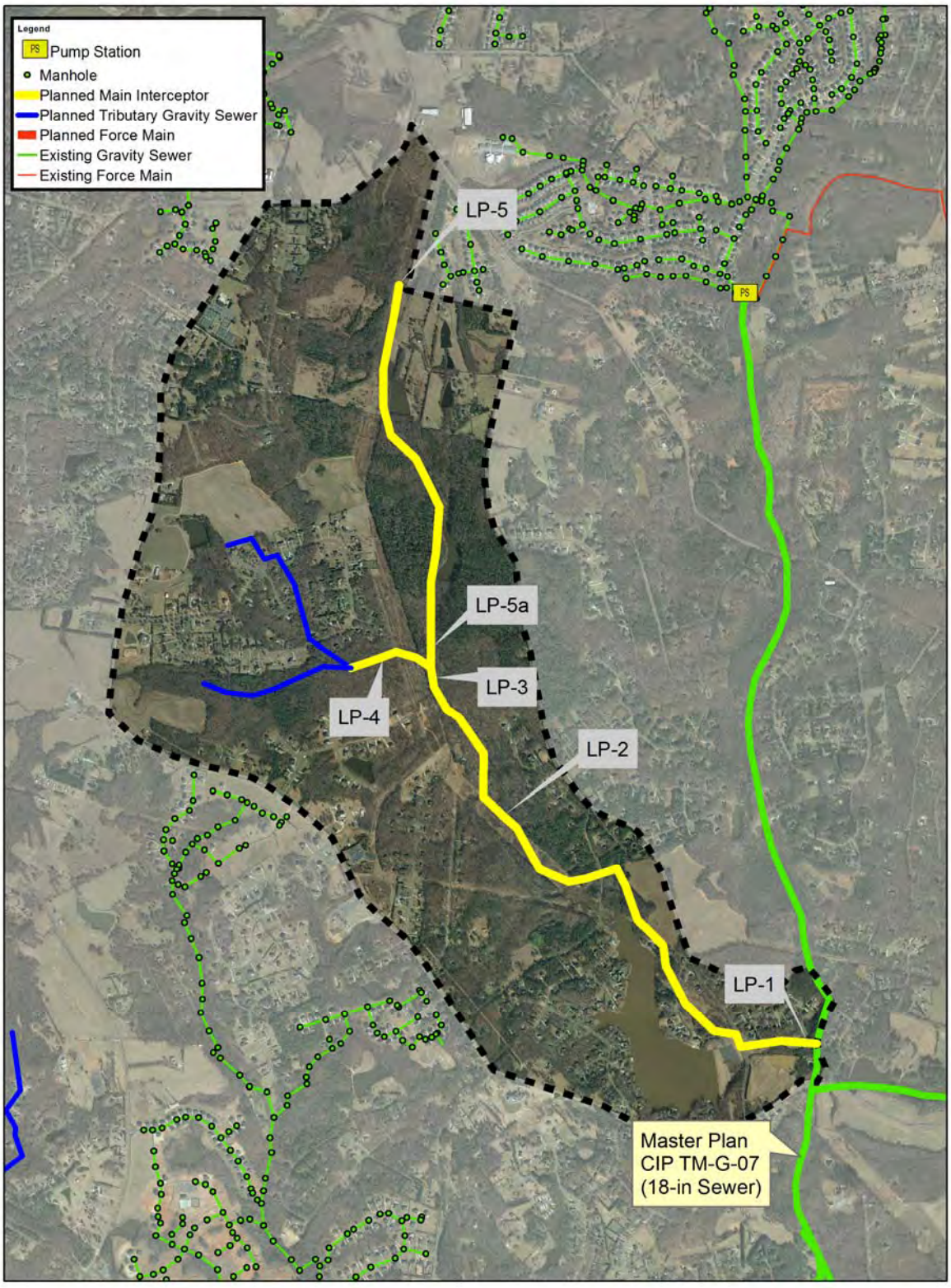

Figure 1 Lake Providence Sub-Basin Manhole Locations

Tarkill Sub-Basin

The Tarkill Sub-basin is located southwest of Weddington and east of Marvin. The sub-basin is bordered on the west by Crane Rd and by South Providence Rd on the eastern side. There are several existing subdivisions in this sub-basin. The Reserve, located off of Crane Rd, is served by gravity sewer in the Cowhorn Branch Sub-Basin. Flow from the Crane Valley, Drayton Hall Estates, and The Gardens on Providence subdivisions are pumped into the Six Mile Basin. The Marvin Ridge High School is also served by a pump station that pumps to the Cowhorn Branch gravity interceptor.

HYDRAULIC MODEL EXPANSIONS

The existing wastewater hydraulic model developed during the 2011 Comprehensive Master Plan was expanded to include sewers upstream and downstream of the Tarkill sub-basin that utilize the common downstream interceptor capacity. The hydraulic model was expanded during this task order to include existing sewers in the Six Mile Creek Basin tributary to the Tarkill and Millbridge Pumping Stations. The Tarkill Creek Sub-basin was then calibrated in the model using flow meter data from the Marvin Road permanent flow meter collected during the 2011 Comprehensive Master Plan project.

ALIGNMENT

The main drainage path in the Tarkill sub-basin follows the Tarkill stream from the upstream end of the sub-basin to the existing 18-inch sewer near Marvin Ridge High School. The Marvin Ridge Pumping Station can be removed from service and replaced by a gravity sewer that will connect to the existing gravity sewer downstream.

Based on the planning criteria, the Tarkill interceptor alignment should follow the Tarkill Creek down the sub-basin in order to serve all the future customers in the sub-basin. An interceptor along Tarkill Creek would pass through the existing Walden Pond neighborhood which is currently served by septic and has no long-term plans to convert to public sewer. The Walden Pond neighborhood is located in the middle of the sub-basin with many potential future customers located both upstream and downstream of the established neighborhood.

To avoid disruption to the Walden Pond neighborhood, all upstream flows would have to be pumped to an adjacent basin or the flow would need to be pumped around the neighborhood. After analyzing the available capacity in nearby sewers, four alternatives were developed to route the wastewater flows from the upper Tarkill basin to existing Union County infrastructure:

- **Alternative 1:** Gravity sewer along Tarkill Creek through the Walden Pond neighborhood. The proposed interceptor would pass between the existing homes on Yellow Pine Ct and the pond in order to minimize the depth of the sewers. The planned alignment would impact 11 property owners in the Walden Pond neighborhood.
- **Alternative 2:** Pump around the Walden Pond houses and pond through the neighborhood. The pump around option would require a pumping station situated north of the Walden Pond neighborhood and a force main that may be routed along Yellow Pine Ct as shown in Figure 1. The force main routing would impact the same 11 homeowners as the gravity line and six

additional homeowners. Unlike a gravity sewer, existing homeowners would not be able to connect a force main in the event of a septic failure.

- **Alternative 3:** Pump the Upper Tarkill sub-basin flows to the 12-Mile interceptor. A pump station would be located upstream of Walden Pond. The proposed pump station location is 500 feet north of the existing neighborhood and would be accessed by an approximately 700 foot long driveway from New Town Rd. The location should serve most of the future Upper Tarkill Sub-Basin customers by gravity flow to the PS. Given the upstream location of the pump station, there is a possibility that some future customers in between the PS and Walden Pond might not be able to connect. The force main could be routed along New Town Rd and Providence Rd before heading east to the 12-Mile Interceptor through the electrical line easement. The 15,470-foot force main should be sized at 6 inches. The receiving sewer is 30 inches in diameter.
- **Alternative 4:** Pump the upper Tarkill Sub-Basin flows to the existing Tarkill force main. The pump station could be located in the same place as alternative 3. The force main would extend north to New Town Rd, then follow the road to meet up with the Tarkill force main. The two force mains will manifold at the intersection of New Town Rd and Waxhaw-Marvin Rd. The 11,000-foot force main should be sized at 6 inches.

The four alternatives are shown in Figure 2.

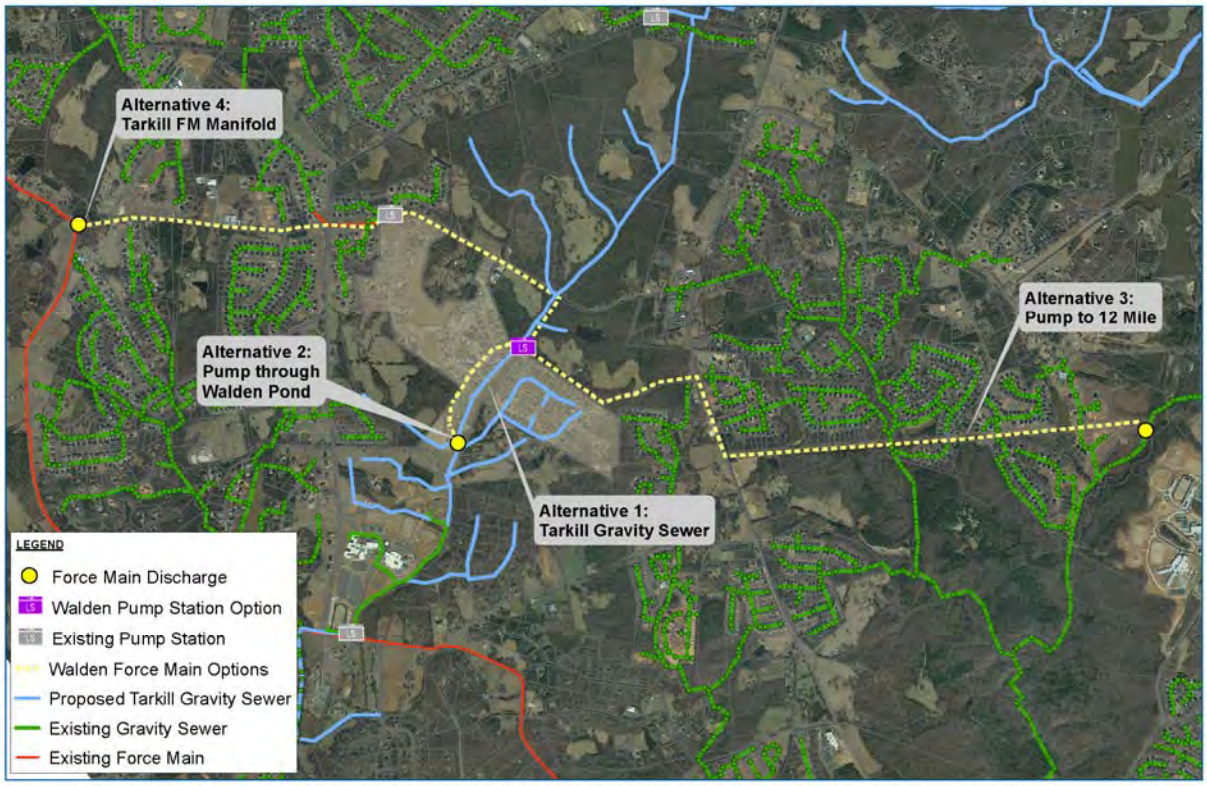

Figure 2 Upper Tarkill Sub-Basin Alternatives

Although Alternatives 1 and 2 were less expensive than the other alternatives, both significantly impacted homeowners in the existing Walden Pond neighborhood. At the November 3rd, 2014 county commissioners meeting, the decision was made to avoid the Walden Pond neighborhood

entirely and move forward with evaluating pumping solutions to other nearby Union County infrastructure.

Following a thorough evaluation, alternative 3 was selected because there are multiple options for treating the wastewater flows from the sub-basin. Alternative 3 discharges to the 12-Mile Creek Basin. Flow received at the 12-Mile WWTP can be treated on site or diverted to the 6-Mile Creek basin to be treated at McAlpine WWTP. If the upper Tarkill sub-basin flows were pumped directly to the Tarkill force main in the Six Mile Basin, as in Alternative 4, none of the future flow from that sub-basin could be treated at the 12-Mile WWTP. Alternative 3 was chosen since it provides for more operational flexibility in treating future flows from this sub-basin.

FLOW PROJECTIONS

Average Daily Dry-Weather Flows

The projected average daily dry-weather wastewater flows for the Tarkill Sub-basin were developed using the same methods as described for the Lake Providence Sub-Basin.

Wet Weather Flows

The peak wet weather flows for the Tarkill Sub-Basin were developed using the same procedure and methodology described in the Lake Providence Sub-Basin flow projections section.

PEAK FLOWS AND SEWER SIZES

Gravity sewers were sized based on the peak flows simulated by the updated model and following the Performance Criteria established for the 2011 Comprehensive Master Plan. The wet weather flows and resulting sewer interceptor diameters for the sub-basin planning level projections were compared to the results from the 2030 planning year model. An 8-inch sewer will convey the 2030 peak flows. For the planning level projections, the sewer had to be upsized to 10 inches in diameter upstream of the Upper Tarkill Pump Station. However, increasing the sewer size for the required 10-inch sewers did not significantly increase the project cost opinion. Installing the larger diameter initially will negate the need for future parallel 8-inch sewers. Given the small increase to the total cost, the planning level projections are recommended as the basis for sizing the future sewers in this sub-basin.

The planning level projection flows and the planned diameter for each segment of sewer are shown in Tables 4 and 5. The Upper and Lower Sub-Basins are shown separately. The segment IDs correspond to the marked locations in Figure 3. The flow values in the tables are total flows including all flows upstream of each referenced Manhole.

Table 4 Lower Tarkill Sub-Basin Gravity Flows and Diameters

MANHOLE LOCATION	TOTAL AVERAGE DAILY FLOW (MGD)	TOTAL WET WEATHER FLOW (MGD)	DOWNSTREAM DIAMETER (IN)
LT-1	0.187	1.355	12
LT-2	0.072	0.263	18
LT-3	0.025	0.073	18
LT-4	0.019	0.049	8
LT-5	0.012	0.027	8

Table 5 Upper Tarkill Sub-Basin Gravity Flows and Diameters

MANHOLE LOCATION	TOTAL AVERAGE DAILY FLOW (MGD)	TOTAL WET WEATHER FLOW (MGD)	DOWNSTREAM DIAMETER (IN)
UT-PS	0.208	0.689	6
UT-1	0.152	0.582	10
UT-2	0.114	0.481	10
UT-3	0.099	0.440	10
UT-4	0.053	0.310	8
UT-5	0.014	0.118	8

DOWNSTREAM CAPACITY CONSTRAINTS

The upper Tarkill sub-basin flows will be pumped to an existing 30-inch interceptor in the 12-Mile basin. There is no adverse impact on the 30-inch interceptor due to the additional flows from Tarkill.

In the lower Tarkill sub-basin, the existing main gravity sewer interceptor near Marvin Ridge High School is sized at 18 inches in diameter. Since the flows from the Upper sub-basin will be pumped to an adjacent basin, these 18-inch sewers are oversized for the projected flows. Further downstream of the high school and upstream of the Tarkill pump station, the existing sewer is only 12 inches in diameter. With the lower build out flows from the Lower Tarkill sub-basin, the 12-inch sewer should be able to accommodate the future flows with only minor surcharge (surcharge is less than 1 foot of depth at one manhole).

PROJECT COSTS

Cost opinions were developed for the Tarkill Sub-Basin using the unit costs and contingencies from the 2011 Comprehensive Master Plan. A summary of the assumptions is given in the Lake Providence Sub-Basin Project Costs section of this report. The project costs are shown in Tables 6 and 7. The total cost opinion for the Lower Tarkill Sub-Basin projects is approximately $0.95

million. The total cost opinion for the Upper Tarkill Sub-Basin projects is approximately $2.14 million. The combined Tarkill Sub-basin total cost opinion is $3.09 million.

Table 6 Lower Tarkill Sub-Basin Project Cost Opinions

UPSTREAM MANHOLE ID	DOWNSTREAM MANHOLE ID	CONSTRUCTION COST	CONSTRUCTION CONTINGENCY	ENGINEERING COST	TOTAL PROJECT COST
LT-2	LT-1	$573,000	$114,600	$103,140	**$790,740**
LT-4	LT-3	$53,000	$10,600	$9,540	**$73,140**
LT-5	LT-4	$64,000	$12,800	$11,520	**$88,320**
Lower Sub-Basin Total		$690,000	$138,000	$124,200	**$952,200**

Table 7 Upper Tarkill Sub-Basin Project Cost Opinions

UPSTREAM MANHOLE ID	DOWNSTREAM MANHOLE ID	CONSTRUCTION COST	CONSTRUCTION CONTINGENCY	ENGINEERING COST	TOTAL PROJECT COST
UT-1	UT-PS	$53,000	$10,600	$9,540	**$73,140**
UT-2	UT-1	$155,000	$31,000	$27,900	**$213,900**
UT-3	UT-2	$119,000	$23,800	$21,420	**$164,220**
UT-4	UT-3	$247,000	$49,400	$44,460	**$340,860**
UT-5	UT-4	$75,000	$15,000	$13,500	**$103,500**
UT-PS		$206,700	$41,300	$37,200	**$285,200**
UT-PS FM	12-Mile	$696,100	$139,200	$125,300	**$960,600**
				Sub-Basin Total	**$2,141,420**

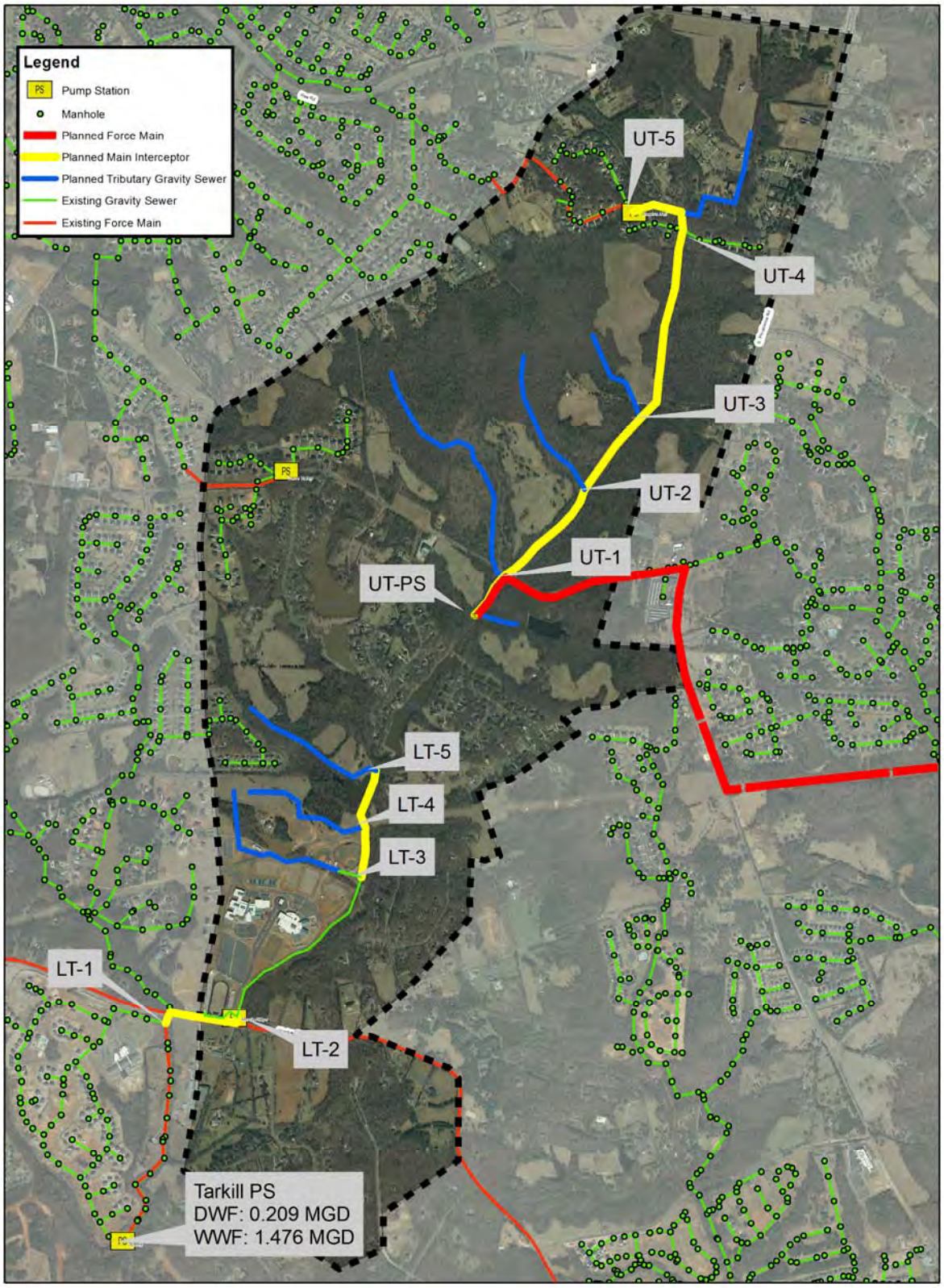

Figure 3 Tarkill Sub-Basin Manhole Locations

Mundy's Run Sub-Basin

The Mundy's Run Sub-Basin is on the south side of Weddington. The sub-basin is bordered on the west by Providence Rd and by Cox Rd and Weddington Rd on the eastern side. There are several existing subdivisions in this sub-basin. Devonridge is the only existing neighborhood served by the public sewer system. All other existing neighborhoods in the sub-basin have septic systems.

HYDRAULIC MODEL EXPANSIONS

The existing wastewater hydraulic model developed during the 2011 Comprehensive Master Plan was expanded to include sewers upstream and downstream of the three sub-basins that utilize interceptor capacity common with the study sub-basins. All UCPW infrastructure downstream of the Mundy's Sub-basin was included in the 12 Mile Basin model and calibrated during the Comprehensive Master Plan. The model catchment areas were adjusted to route the projected average daily dry-weather and wet weather flows within the sub-basin through the new Mundy's Run sewer alignments.

ALIGNMENT

In the Mundy's Run Sub-Basin, all potential future customers are served by three major gravity sewer branches that extend throughout the sub-basin. The three sewer alignments follow the natural swales and converge to a single gravity interceptor just upstream of the Aero Plantation Lake. The majority of the sub-basin downstream of this point belongs to the Aero Plantation neighborhood.

The Aero Plantation neighborhood is fully developed with homes with septic systems. The property sizes in the Aero Plantation neighborhood are large and the need to connect to public sewer service is not anticipated. Even though some homes in the neighborhood were built before 1980, the lots are greater than 2 acres, so individual homeowners are unlikely to need to connect to the public sewer system. In the future, if the entire neighborhood chooses to convert to public sewer, the neighborhood could be served by gravity and connect to the Union County 12 Mile Creek Interceptor.

All potential future customers of the sub-basin can be served by the planned interceptors upstream of the Aero Plantation neighborhood. The primary purpose of any infrastructure downstream of this location is to transport the wastewater flow from the upstream sub-basin to the Union County 12 Mile Creek Interceptor. Multiple options were considered to connect the planned interceptor to the existing 12 Mile Creek Interceptor. The flow can either be transported by a gravity sewer or pumped through a force main. A gravity sewer could be extended along the banks of the lake, but the interceptor would need to be constructed close to existing septic homes near the water's edge and would be very deep in some areas. No existing or future customers will need to connect to the gravity sewer downstream of Aero Plantation. The proximity of the existing structures to the edge of the water would cause constructability issues and disruption to the homeowners. Alternatively, a pump station could transfer the flows to an existing interceptor in the adjacent sub-basin. The pump station solution is less costly and disruptive than the gravity interceptor. The incremental pumped flows from the Mundy's Run Sub-Basin do not cause capacity concerns to the receiving existing interceptor.

The Pump Station alternative was chosen as the most cost effective way to serve all potential future customers in the sub-basin. The gravity sewer alternative could cost twice the amount of the pump station alternative, due to the length and alignment of the gravity interceptor and easements through lake front property. The flow transfer is not expected to negatively impact any of the Union County infrastructure downstream of the planned pump station and force main.

FLOW PROJECTIONS

Average Daily Dry-Weather Flows

The projected average daily dry-weather wastewater flows for the Mundy's Run Sub-Basin were developed using the same methods as described for the Lake Providence Sub-Basin.

Wet Weather Flows

The projected peak wet weather wastewater flows for the Mundy's Run Sub-Basin were developed using the same methods as described for the Lake Providence Sub-Basin.

PEAK FLOWS AND SEWER SIZES

Gravity sewers were sized based on the peak flows simulated by the updated model and following the Performance Criteria established for the 2011 Comprehensive Master Plan. The wet weather flows and resulting sewer interceptor diameters for the sub-basin planning level projections were compared to the results from the 2030 planning year model. However, since the sub-basin is divided into three major swales, the total flows in each branch for both projections are relatively small. The total peak wet weather flow at the pump station location, including the flow contribution from all three main branches, was estimated to be 0.763 mgd.

Overall, the resulting diameters were very similar between the planning level projection and 2030 flow projections. The only difference in planned diameter was the segments flowing into the planned Mundy's Run Pump Station. While an 8-inch sewer could accommodate the 2030 peak flows, a 12-inch sewer is recommended for the planning level projection flows. Given the short length (less than 130 feet) and small difference in construction cost for this segment of sewer, a 12-inch sewer is recommended upstream of the Mundy's Run Pump Station to prevent the need for parallel 8-inch sewers in the future. The flows and the planned diameter for each segment of sewer are shown in Table 8. The flow values in the table are total flows including all flows upstream of each referenced Manhole. The segment IDs correspond to locations in Figure 4.

Table 8 Mundy's Run Sub-Basin Gravity Flows and Diameters

MANHOLE LOCATION	TOTAL AVERAGE DAILY FLOW (MGD)	TOTAL WET WEATHER FLOW (MGD)	DOWNSTREAM DIAMETER (IN)
MR-1	0.219	0.710	12
MR-2	0.026	0.084	8
MR-2a	0.050	0.220	8
MR-3	0.013	0.051	8
MR-3a	0.026	0.077	8
MR-4	0.097	0.367	8
MR-4a	0.129	0.418	8
MR-5	0.026	0.092	8
MR-PS	0.248	0.763	-

DOWNSTREAM CAPACITY CONSTRAINTS

The modeled peak wet weather flows for the Mundy's Run sub-basin did not have a significant impact on downstream infrastructure. The Mundy's Run force main was connected to an existing 15-inch interceptor. Shortly downstream, the interceptor increases to 24 inches in diameter.

PROJECT COSTS

Cost opinions were developed for the Mundy's Run Sub-Basin using the unit costs and contingencies from the 2011 Comprehensive Master plan. A summary of the assumptions is given in the Lake Providence Sub-Basin Project Costs section of this report. For the pump station, a unit cost of $0.30/GPD was used for the pump station and a cost of $45/feet was used for the 6-inch force main. The segment costs are shown in Table 9. The total cost opinion for the Mundy's Run Sub-Basin projects is approximately $2.51 million.

Table 9 Mundy's Run Sub-Basin Project Cost Opinions

UPSTREAM MANHOLE ID	DOWNSTREAM MANHOLE ID	CONSTRUCTION COST	CONSTRUCTION CONTINGENCY	ENGINEERING COST	TOTAL PROJECT COST
MR-1	MR PS	$36,000	$7,200	$6,480	**$49,680**
MR-2	MR-2a	$377,000	$75,400	$67,860	**$520,260**
MR-3	MR-1	$214,000	$42,800	$38,520	**$295,320**
MR-4	MR-1	$402,000	$80,400	$72,360	**$554,760**
MR-5	MR-4	$138,000	$27,600	$24,840	**$190,440**
MR PS		$228,900	$45,800	$41,200	**$315,900**
MR FM	FM Discharge	$420,000	$63,000	$96,600	**$579,600**
Sub-Basin Total		$1,815,900	$342,200	$347,860	**$2,505,960**

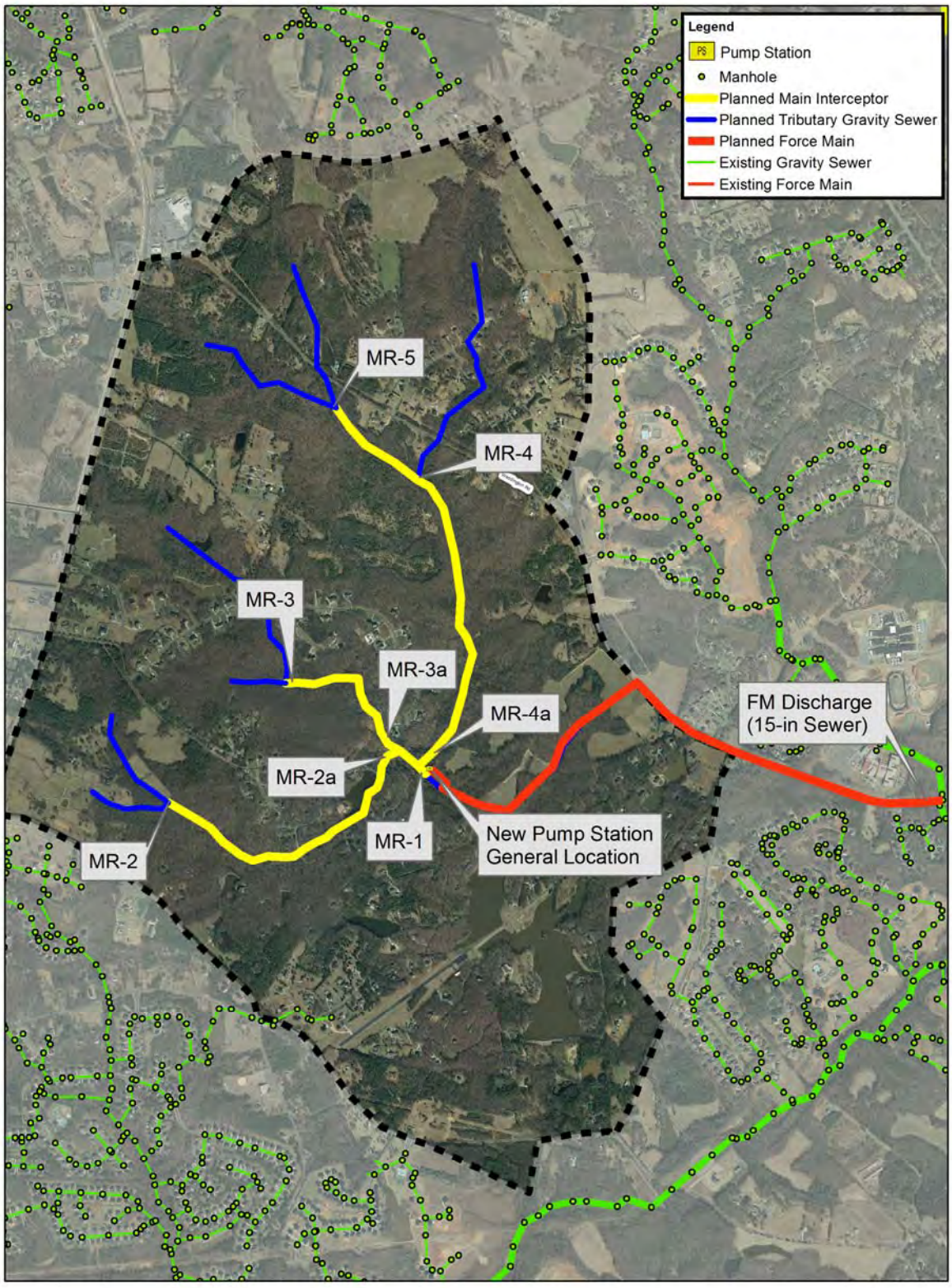

Figure 4 Mundy's Run Sub-basin Manhole Locations

Conclusions and Recommendations

The planned sub-basin infrastructure should accommodate all future wastewater flows in the sub-basins. The infrastructure was sized based on the planning level projections which assumed that 70 percent of the vacant land is developed into 1-acre lots and 25% of septic users convert to public sewer. In some areas, the planning level infrastructure exceeds the 2030 needs, but the difference in cost was minimal and provides the benefit of avoiding future replacement/paralleling sewers projects. The sewer depths were effectively minimized by following natural drainage paths. The average depths in the three sub-basins ranged from 12 to 14 feet deep. The planned alignments in each sub-basin successfully meet the outlined planning criteria, except in the Tarkill Sub-basin where the commission gave the direction to go outside of the criteria.