Wastewater Collection System Master Plan Update - Chatham County Sewer Basin Planning

PREPARED FOR: Town of Cary

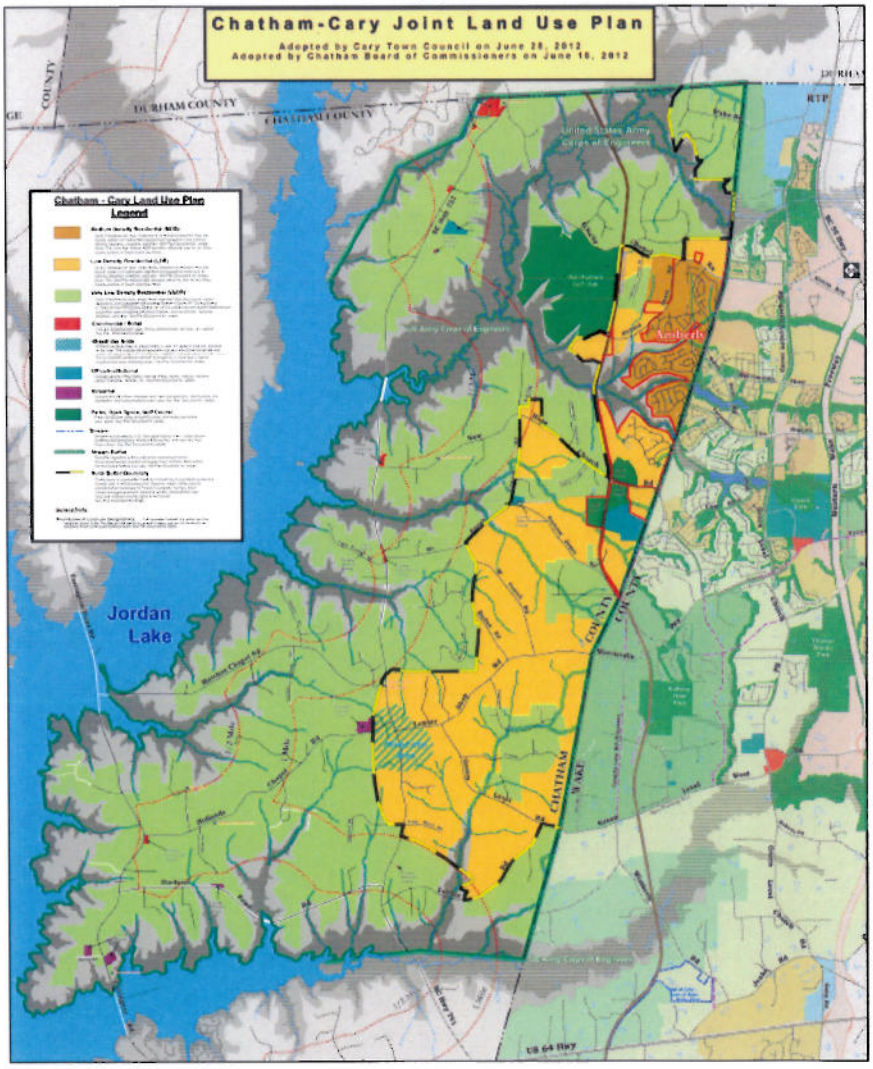
PREPARED BY: CH2M HILL

DATE: May 1, 2015

Introduction

The Town of Cary (Town) requested CH2M HILL's support to develop master planning level infrastructure details for the extension of sanitary sewer service for the Chatham County portion of the Town's wastewater collection system service area, as defined in the Chatham County-Town of Cary Joint Land Use Plan (effective July 1, 2012) and including only the parcels within the defined Rural Buffer Boundary. It is specifically stated in the Joint Land Use Plan that: *"Areas west of the (Rural Buffer) Boundary line should not be eligible to receive public sewer or wastewater utilities, regardless of provider".* The Rural Buffer Boundary area is identified by the yellow and black dashed line in Figure 1. The Joint Land Use Plan does include a provision for locating system infrastructure west of the Rural Buffer Boundary: *"Certain types of public water and sewer infrastructure may be located west of the Rural Buffer Boundary, provided that service is not provided west of the boundary."* With the objective of ensuring the efficient provision of sewer service.

FIGURE 1
Chatham-Cary Joint Land Use Plan Map (Effective July 1, 2012)



Data Source: Chatham-Cary Joint Land Use Plan, 2012

The ultimate objective of this planning effort was to identify the most effective system configuration to convey wastewater from Chatham County to the Town's existing wastewater collection system under build-out conditions, with a recognition of the potential transitional infrastructure needs to provide service to new development that will occur before full build-out conditions.

The infrastructure identified as part of this planning has been laid out to

guide the effective long-term development of wastewater facilities, in a predominantly undeveloped area, ensuring that there is a strategy for how infrastructure will be constructed for this portion of the Town's sewer service area. The identified infrastructure will not necessarily be projects that will be included in the Town's capital improvement plan (CIP). Per the Town's utility extension policies (Policy Statement 23), the owner or developer of a parcel or tract of land is required by the Town's Code of Ordinances to construct, at no expense to the Town, all utility facilities. This includes the utility infrastructure extensions from the current wastewater system to the parcel or tract of land to be developed.

The Town's 2010 Wastewater Collection System Master Plan (WWCSMP) (Hazen & Sawyer, 2013) defines the wastewater collection system infrastructure needs through build-out conditions for the Town's entire wastewater service area. In the WWCSMP, wastewater flows were included for areas within Chatham County not previously included in the Town's wastewater service area. These flows were estimated so that the sizing of major conveyance infrastructure in West Cary included capacity for these flows; no infrastructure was identified in the WWCSMP for the new Chatham County service area. Figure 2 provides a comparison of the sanitary sewer sub-basins as developed for WWCSMP to the additional service area in Chatham County.

In addition to identifying the infrastructure requirements for sewer service within Chatham County, the influence of the additional wastewater flow from Chatham County on the current and planned infrastructure to convey wastewater to the West Cary pump station (PS), which pumps wastewater to the Western Wake Regional Wastewater Reclamation Facility (WWRWRF), was reviewed.

To develop the infrastructure requirements for sewer service to the Chatham County service area the following activities were required: sanitary sewer sub-basin delineation, projection of build-out wastewater flows based on land use, hydraulic modeling and the identification of collection system infrastructure. The following sections summarize each one of these activities leading to the recommended system configuration for the Chatham County service area, also referred to as the Chatham County basin within this technical memorandum.

Sewer Sub-basin Delineation and Wastewater Flows

Sewer Sub-basin Delineation

Much of the West Cary sewer basin area west of NC-55, including Chatham County, hydrologically drains towards Jordan Lake within five individual drainage areas. Therefore, wastewater flow originating in this portion of the Town's service area requires the pumping of wastewater from these drainage areas to the main wastewater conveyance infrastructure to the West Cary PS in the vicinity of Green Level Church Rd. The West Cary PS pumps wastewater to the WWRWRF, which lies within the Shearon Harris Lake watershed. Figure 2 presents the WWCSMP sewer sub-basins, the new Chatham County service area, and the major streams within the area. The streams help to visualize the natural flow path (gravity flow) for each individual drainage area.

For the delineation of the sewer sub-basins within the Chatham County Rural Buffer Boundary area, watershed boundaries, parcel boundaries, and roads were used to identify natural flow paths and man-made boundaries. Once the Chatham County sub-basins were delineated they were combined with existing West Cary sub-basins, presented in Figure 2, based on the natural drainage patterns and to support the identification of the most efficient system for conveying wastewater from Chatham County by allowing the wastewater to predominantly flow by gravity and eliminate multiple pump stations within a single sub-basin.

Figure 3 presents the delineated Chatham County sub-basins, with the original West Cary sub-basin boundaries overlaid. The delineated boundaries are representative of build-out conditions and there will likely need to be transitional boundaries between the existing West Cary sub-basins and the future Chatham County sub-basins, as land develops in these sub-basins over time.

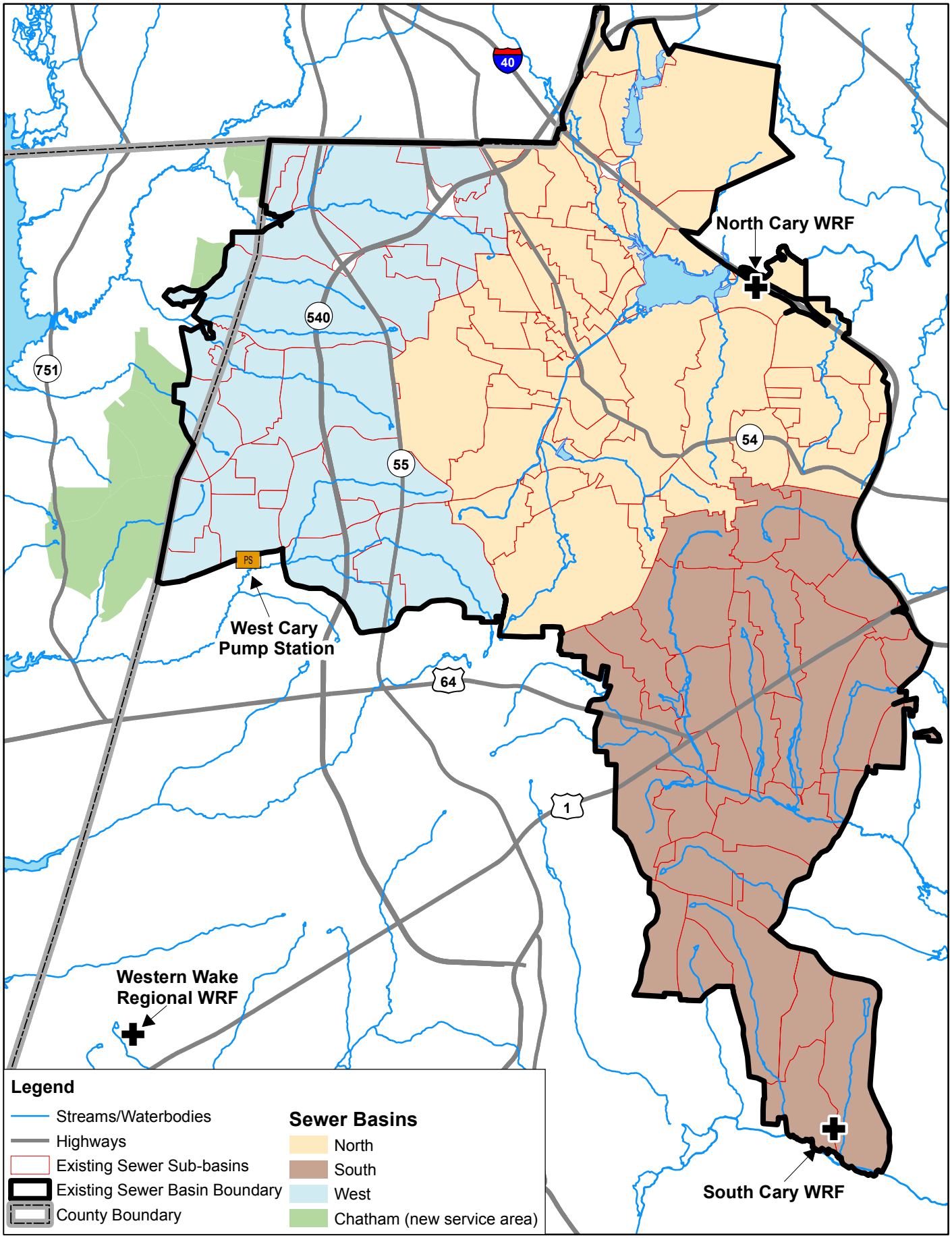


Figure 2
Sewer Service Area
Chatham County Sewer Basin Planning
CH2MHILL

This page has been intentionally left blank.

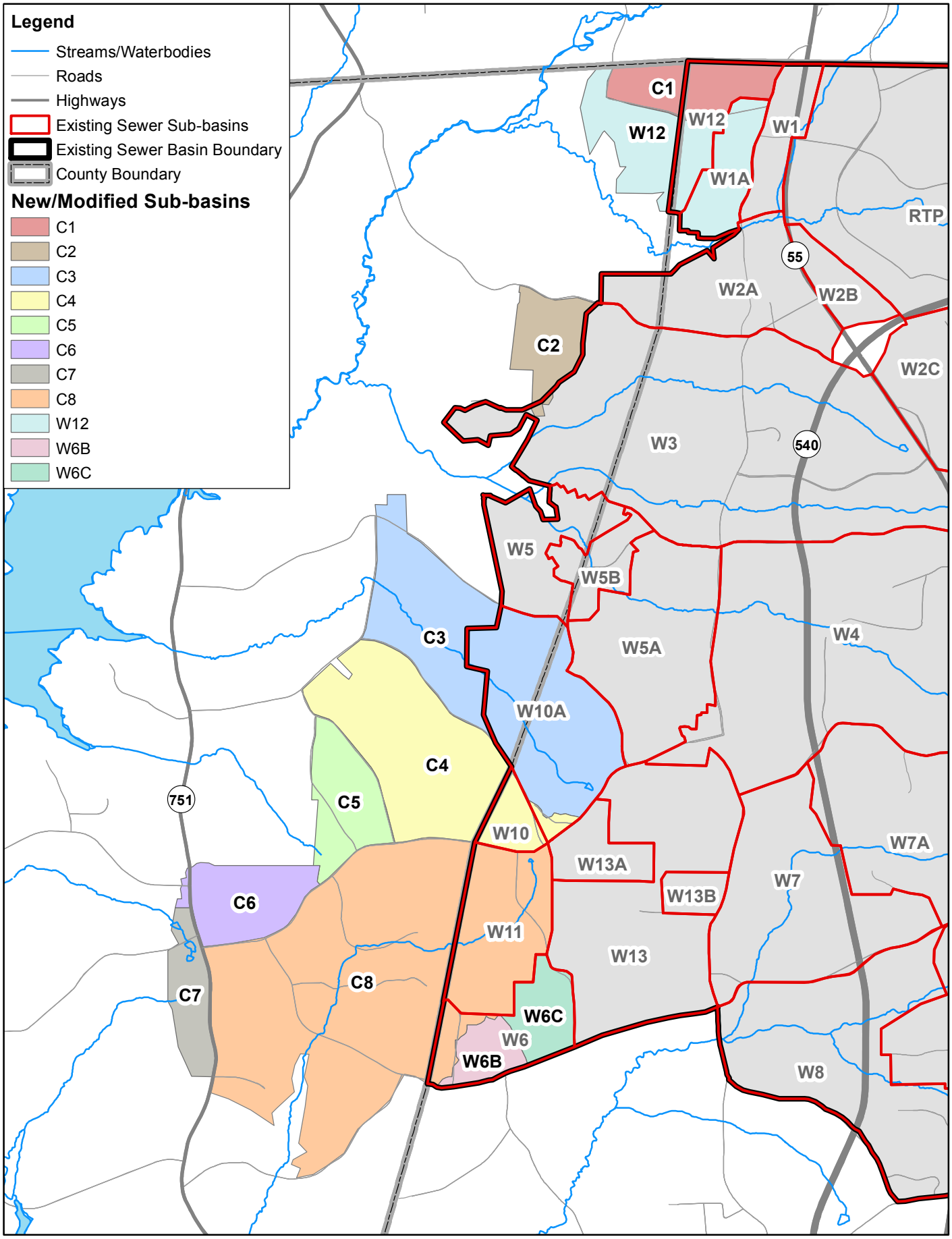


Figure 3
New/Modified Sewer Sub-basins
Chatham County Sewer Basin Planning

CH2MHILL

This page has been intentionally left blank.

Wastewater Flow Projections

Average Base Flow

The latest Town guidance document on flow projections is the 2013 Long Range Water Resources Plan (LRWRP) (CH2M HILL, 2013); therefore the LRWRP was used to define the future year average base flows (ABF) used as the basis for this planning effort. The following bullets outline the projection approach for both:

- Existing West Cary sub-basins
  - ABF values were taken directly from the parcel based data used for the LRWRP.
- New/Modified Chatham County sub-basins (as identified in Figure 3)
  - ABF values were derived based on Town-provided parcel level finished water demand projections. These projections were developed in support of the Water Distribution System Master Plan Update for Chatham County Technical Memorandum (CDM Smith, 2014) and developed based on the projection methodology set forth in the LRWRP.
    - A 72 percent wastewater return factor, same as was used in the 2013 LRWRP, was applied to finished water demand projections to derive the ABF values by parcel.
    - It should be noted that the Water Distribution System Master Plan Update for Chatham County Technical Memorandum projection data used a water use unit consumption value of 280 gallon per day per account (gpd/account) for single family residential homes versus the 218 gpd/account value used for the LRWRP. The 280 gpd/account value results in 0.4 mgd of greater ABF, as compared to the flow derived from the LRWRP's assumed unit demand value.

Table 1 presents the future build-out ABF in million gallons per day (mgd) for West Cary sub-basins and the new/modified Chatham County sub-basins, as well as a comparison of flow for the new/modified Chatham County sub-basins that were a portion of the West Cary sub-basins used in the WWCSMP analyses. As part of the sub-basin delineation, a number of sub-basins identified in the WWCSMP were consolidated with the new/modified sub-basins; these include sub-basins W1A, W6, W10, W10A and W11. Sub-basins W3 and W12 were modified in spatial extent from the sub-basin areas presented in the WWCSMP.

TABLE 1
West Cary and Chatham County Sewer Sub-basins – Existing and Future Build-out Average Base Flows (ABF)

Sewer Sub-basin	WWCSMP Sewer Sub-basin	Current Flow Monitoring Basin	Existing ABF (mgd)	Future Build-out ABF (mgd)	Total Build-out ABF (mgd) (Existing + Future) (mgd)
New/Modified Sub-basins (Identified in Figure 3)					
C1	--	n/a	0.00	0.02	0.10
	W12	Unmetered	0.00	0.08	
C2	--	n/a	0.00	0.08	0.08
	W3	Unmetered	0.00	<0.01	
C3	--	n/a	0.00	0.18	0.32
	W10A	14	0.03	0.11	
C4	--	n/a	0.00	0.18	0.22
	W10	Unmetered	0.00	0.04	
	W10A	14	0.00	<0.01	
C5	--	n/a	0.00	0.09	0.09

TABLE 1
West Cary and Chatham County Sewer Sub-basins – Existing and Future Build-out Average Base Flows (ABF)

Sewer Sub-basin	WWCSMP Sewer Sub-basin	Current Flow Monitoring Basin	Existing ABF (mgd)	Future Build-out ABF (mgd)	Total Build-out ABF (mgd) (Existing + Future) (mgd)
C6	--	n/a	0.00	0.12	0.12
C7	--	n/a	0.00	0.16	0.16
C8	--	n/a	0.00	0.55	0.61
	W6	Unmetered	0.00	0.01	
	W11	Unmetered	0.00	0.05	
W12	--	n/a	0.00	0.05	0.13
	W12	Unmetered	0.01	0.07	
W6B	W6	n/a	0.00	0.01	0.01
W6C	W6	n/a	0.00	0.01	0.01
Sub-total			**0.04**	**1.81**	**1.85**
Existing (Un-Modified) Sub-basins					
M20	M20	18	0.05	0.06	0.11
M20A	M20A	18	0.04	0.19	0.23
M20B	M20B	18	0.00	0.00	0.00
M21	M21	18	0.12	0.03	0.15
M21A	M21A	18	0.03	0.03	0.06
RTP	RTP	18	0.28	1.58	1.86
W1	W1	18	0.04	0.04	0.08
W13	W13	Unmetered	0.00	0.16	0.16
W13A	W13A	14	0.03	0.01	0.04
W13B	W13B	26	0.01	0.01	0.02
W2A	W2A	Unmetered	0.06	0.16	0.22
W2B	W2B	Unmetered	0.00	0.11	0.11
W2C	W2C	18	0.02	0.33	0.35
W3	W3	Unmetered	0.22	1.06	1.28
W4	W4	14	0.11	0.51	0.62
W5	W5	Unmetered	0.03	0.04	0.07
W5A	W5A	14	0.19	0.06	0.25
W5B	W5B	14	0.03	0.03	0.06
W7	W7	26	0.02	0.21	0.23
W7A	W7A	26	0.19	0.17	0.36
W8	W8	26	0.01	0.29	0.30
W8A	W8A	26	0.40	0.11	0.51

TABLE 1
West Cary and Chatham County Sewer Sub-basins – Existing and Future Build-out Average Base Flows (ABF)

Sewer Sub-basin	WWCSMP Sewer Sub-basin	Current Flow Monitoring Basin	Existing ABF (mgd)	Future Build-out ABF (mgd)	Total Build-out ABF (mgd) (Existing + Future) (mgd)
Sub-Total			**1.88**	**5.19**	**7.07**
Total			**1.92**	**7.00**	**8.92**

n/a – not applicable (no flow monitoring in new/modified sub-basins).
-- – New sewer basin area not included in the WWCSMP.

Hydraulic Model

The Town's InfoWorks CS model, as developed for the Upper Crabtree Creek Pump Station (UCCPS) & Force Main and Interceptor Capacity Enhancements Preliminary Engineering Report (PER) (CH2M HILL, 2014), was used to complete the hydraulic analyses for this planning effort.

Model Update

The hydraulic model was modified to reflect current and future operations within the West Cary basin, including the summer 2014 transition of wastewater flow from the West Cary basin being directed to the WWRWRF. This included routing of wastewater flows from the Kit Creek PS and Morris Branch PS to pump to the 48-inch interceptor that parallels Green Level Church Road and serves as one of the main interceptors to the West Cary PS.

The model was also updated with the addition of the flow monitoring basin M29, representing the Nancy Branch Interceptor basin draining to the Morris Branch PS. This meter basin was added by the Town in mid-2013. The data record did not contain enough data points for updating the model calibration but did assist in allocating flow in this basin and establishing the baseline ABF for this flow monitoring basin.

Model Calibration

The calibrated model developed for the UCCPS & Force Main and Interceptor Capacity Enhancements PER (CH2M HILL, 2014) was used for the modeling analysis completed for this planning effort; this model was calibrated to flow monitoring data (2010 through 2013) for meter locations M14, M18 and M26 using the RTK (modified unit hydrograph) method. The UCCPS & Force Main and Interceptor Capacity Enhancements PER (CH2M HILL, 2014) presents the results of that calibration effort; the West Cary basin flow meter locations calibrated well to the observed dry weather flows and predominantly calibrated to two of three wet weather flow events for the calibration criteria (flow and volume).

Future West Cary Basin Capital Projects Incorporated in the Hydraulic Model

The following capital projects as recommended in the 2010 WWCSMP (Hazen and Sawyer, 2013) were included in the hydraulic model for the simulation of build-out conditions for the Chatham County and West Cary basins:

- Kit Creek PS force main parallel (4,491 linear feet of 20-inch force main)
- Kit Creek PS capacity expansion (increase in capacity from 10.1 mgd to 13.8 mgd)
- Morris Branch PS capacity expansion (increase in capacity from 4.2 mgd to 7.5 mgd)
- Nancy Branch Interceptor parallel (5,429 linear feet of 16-inch gravity interceptor)

All model simulations of future conditions were run with these planned future capital projects in place.

Simulation of Peak Wet Weather Flows in Hydraulic Model

The build-out peak wet weather flows (PWWF) were simulated in the Town's hydraulic model using the following data:

- 2013 flow monitoring data – to establish the existing ABF for meter basins M14, M16, M26 and M29.
  - For unmetered areas the existing ABF was established by using the 2013 water demand data and a 0.72 wastewater return ratio, as discussed in the preceding Wastewater Flow Projections section.
- Projected future wastewater flows – build-out ABF as described in the preceding Wastewater Flow Projections section.
- Peaking factors to calculate the PWWFs:
  - Existing West Cary sub-basins
    - The 2011-2013 flow monitoring data was used to derive peaking factors (peak hour flow [PHF]:ABF) to calculate the PWWF from the existing and future ABF.
      - Peaking Factors:
        - Flow monitoring basin M14: 2.32
        - Flow monitoring basin M18: 2.25 (excluded 2013 outlying data point)
        - Flow monitoring basin M26: 2.72
        - Unmetered areas: 3.1 (based on WWCSMP)
          - Including flow monitoring basin M29
  - New/Modified Chatham County sub-basins
    - A peaking factor of 3.1, based on the WWCSMP, was applied to all ABF for the new/modified sub-basins since no flow monitoring data exists for these largely undeveloped areas.
- RTK calibration (unit hydrograph) results, as described in the preceding Model Calibration section.

The use of peaking factors to derive the PWWF from the ABF provides a single estimate of future PWWF. The hydraulic model was calibrated using the RTK methodology, which represents WWF as an event over a period of time. The simulation of PWWF in the hydraulic model was completed using the same methodology as described in the UCCPS & Force Main and Interceptor Capacity Enhancements PER (CH2M HILL, 2014). This method aimed to match the PWWF value derived from the peaking factor to the calibrated model hydrograph, ensuring there was a reasonable match between the PWWF value and the peak of the hydrograph used in the hydraulic model, as well as maintaining the entire hydrograph representative of the system response to a PWWF event.

Infrastructure Requirements

Infrastructure requirements for each sub-basin were defined based on the projected flows and the topography within each sub-basin. Typically, gravity lines within the sub-basins follow the major streams and pump stations are located at the most downstream point of each sub-basin. In some cases pump stations are configured as regional stations which collect flow from other sub-basins to minimize the total length of force main required for the new/modified sub-basins.

Two system configurations were considered. The base configuration, which is depicted in Figure 4, would collect flow from sub-basins C3 and C5 at a regional pump station in sub-basin C4 and from there the combined flow would be pumped to the existing West Cary collection system in sub-basin W13. In an alternate configuration, depicted in Figure 5, flow from C3, C4 and C6 would be pumped to a regional pump station in sub-basin C5 and from there it would again be pumped to sub-basin W13. This alternate configuration was conceived to provide an

understanding of how the infrastructure needs would change depending on the relative timing of development within the sub-basins.

FIGURE 4
Base System Configuration Schematic

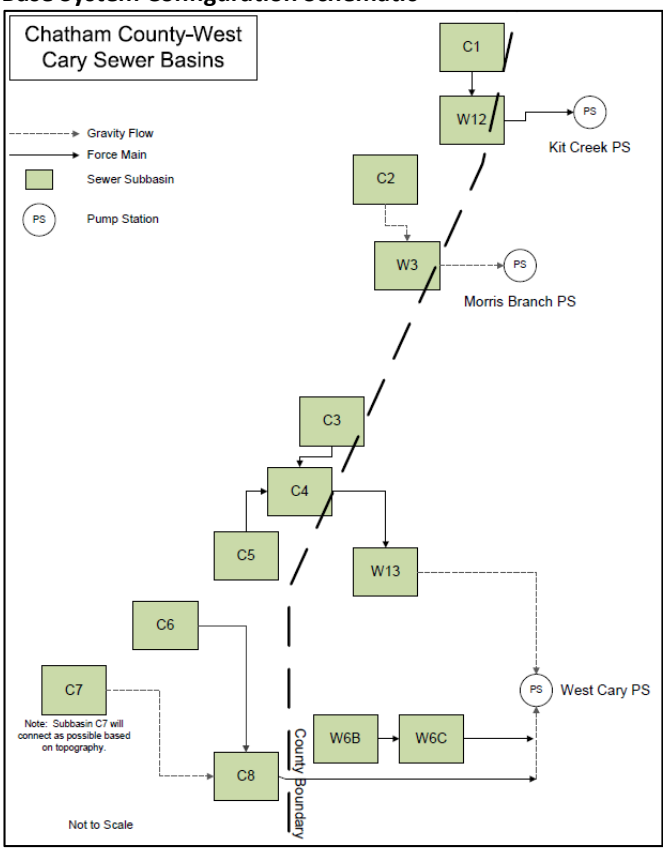
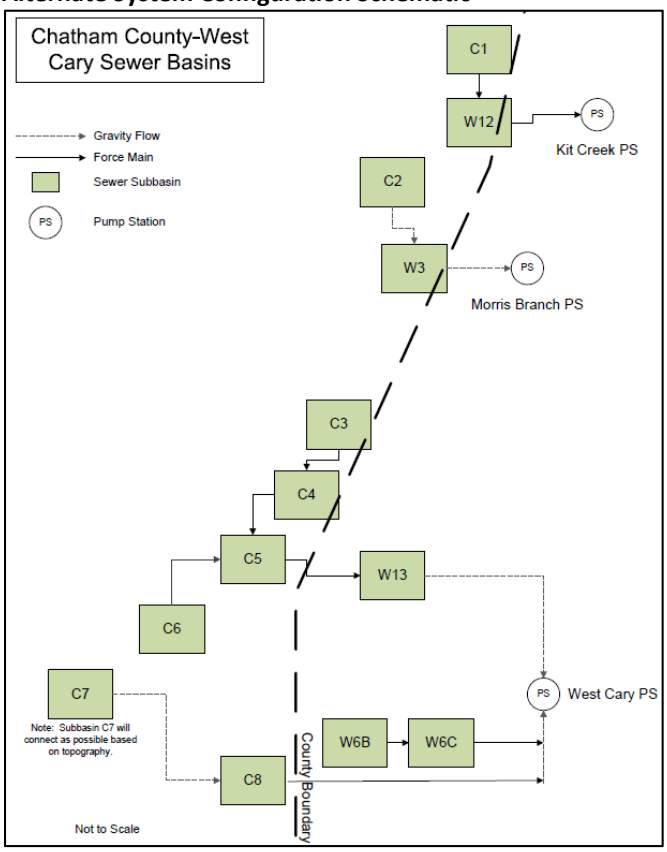


FIGURE 5
Alternate System Configuration Schematic



Infrastructure Sizing

Projected flows and topography were used to determine infrastructure sizing. Gravity lines were sized based on the Town's design standard for pipes being no more than two-thirds full at PWWF. Force main diameters were estimated such that they maintained a reasonable system total dynamic head for the given flow and system characteristics.

Pump stations were sized to pump PWWF (peak hourly flow) and the wet wells were sized with diameter of a least 6 feet, per Town design standard, with a configuration that would allow the pumps to operate with an appropriate number of starts per hour.

All infrastructure sizing was done outside the hydraulic model based on the conditions and criteria described in the preceding paragraphs and then confirmed or updated based on the build-out PWWF simulation run using the hydraulic model for the West Cary basin, inclusive of the new/modified Chatham County sub-basins.

An important note for the pipeline sizing is that, since the new/modified Chatham County sub-basins are all primarily undeveloped and without any infrastructure, the gravity lines were incorporated into the hydraulic model as long segments, rather than individual manhole-to-manhole segments similar to the portion of the model for the existing system that has a lot greater detail. This, coupled with the nature of how flow was applied at the upstream end of these long segments, results in the model potentially indicating pipe sizes greater than (typically one pipe size increment) what might be required when a more detailed evaluation of each sub-basin's infrastructure is undertaken in the future. For example, the model might show that a whole pipe segment needs to be 10 inches in diameter, but a more refined analysis might show that at least part of the pipe length could be

an 8-inch diameter pipe. This approach does lead to a certain amount of conservatism in the sizing and cost estimates.

Infrastructure Capital Cost Estimates

Planning level capital cost estimates were developed for each sub-basin; as discussed in the Introduction section the identified infrastructure and associated costs will not necessarily be included in the Town's CIP. Per the Town's utility extension policies (Policy Statement 23), the owner or developer of a parcel or tract of land is required by the Town's Code of Ordinances to construct, at no expense to the Town, all utility facilities. The cost estimates were generated for each sub-basin infrastructure component: pump stations and pipelines. In generating these estimates it was assumed that gravity lines would be polyvinyl chloride (PVC) and force mains would be ductile iron (DI). Each PS was assumed to include submersible pumps and the following major components:

- A wet well with triplex pumps and pump control system
- A valve vault with check valves, isolation plug valves, and a surge relief valve
- A diesel fueled standby generator with belly style fuel tank and automatic transfer switch
- An electrical building with pump control panel, motor controllers, and supervisory control and data acquisition (SCADA) remote terminal unit (RTU)
- Liquid phase odor control facilities (Bioxide)
- Vapor phase odor control facilities

For the smallest PSs (<0.1 mgd) an above grade, packaged PS solution was assumed; including all of the above components.

Capital cost estimates for the proposed capital projects were developed using CH2MHILL's Parametric Cost Estimating System (CPES). CPES is a proprietary conceptual design and cost estimating tool built on a Microsoft Excel platform that generates quick, accurate, and detailed cost estimates at the conceptual stage of a project. Based on input design criteria, such as diameter, depth and material, CPES uses algorithms to generate project-specific construction cost estimates.

The capital cost estimates provided for this planning study are considered to be Class 4 – Planning Level estimates, as defined by the Estimate Classification Systems from the Association for the Advancement of Cost Engineering International (AACEI) 17r-97 and as designated in American Society for Testing and Materials (ASTM) E 2516-06. It is considered accurate to +50 percent to -30 percent based on 5 percent to 15 percent complete project definition. The capital costs presented are in 2015 dollars.

The following supplemental assumptions were made for the capital cost estimates:

- Additional construction costs for pump stations:
  - Overall site work, non-structure related: 1 percent of estimated construction cost
  - Yard piping: 5 percent of estimated construction cost
  - Yard electrical: 1 percent of estimated construction cost
  - SCADA/plant computer: 1 percent of estimated construction cost
- Construction costs for pipelines:
  - Manholes: included in pipeline construction costs
  - Appurtenances: included in pipeline construction costs
- Construction cost markups:
  - Contractor overhead and profit: 15 percent
  - General conditions such as mobilization, demobilization, bond, and insurance: 5 percent

  - Contingency: 30 percent
- Non-construction costs:
  - Engineering, Legal and Administration: 10 percent
  - Permitting and Service During Construction: 12 percent
  - Permanent Easements: $35,000 per acre, assuming a 30-foot wide easement for the length of each line.

Costs in the following section are presented in two parts as described in the preceding bullets: construction costs and non-construction (or project) costs. Construction costs are inclusive of markups and a 30 percent contingency. Project costs are inclusive of engineering, permitting, services during construction, and easement acquisitions.

Infrastructure Details: Base Configuration

The base configuration infrastructure for each Chatham County sub-basin, as required for build-out conditions, is presented in Figure 6 and described in the following sections. Sub-basin infrastructure details are presented in order from north to south.

Sub-Basin C1

Sub-basin C1 is in the northern Chatham County portion of the Town's service area, adjacent to Durham County. It is a small sub-basin with a projected ADF at build-out of 0.10 mgd and a PWWF of 0.31 mgd. Sewer service would be provided to this sub-basin with 8-inch diameter gravity lines and pump station with a short force main that would discharge into a gravity line within sub-basin W12.

Components of the basin infrastructure are summarized in Table 2.

TABLE 2
Sub-Basin C1 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C1 Gravity 1	C1-G-1	8-inch diameter	2,280	$476,000	$636,000	$4,923,000
C1 Gravity 2	C1-G-2	8-inch diameter	5,040	$1,050,000	$1,404,000	
C1 Pump Station	C1	0.31 mgd	N/A	$2,041,000	$2,490,000	
C1 Force Main	C1-F-1	4-inch diameter	1,290	$297,000	$393,000	

[a] Map ID presented in Figure 6

Sub-Basin W12

Sub-basin W12 lies to the south of C1, and is projected to have an ADF at build-out of 0.12 mgd and a PWWF flow of 0.37 mgd. Cumulatively with C1, the projected ADF is 0.22 mgd, and the PWWF is 0.68 mgd. A gravity sewer would convey flow from C1 and the western part of the sub-basin to a pump station in the south of the sub-basin. A second gravity line would collect flow from the central and eastern parts of the sub-basin. The force main from the W12 PS would discharge directly to the existing Kit Creek PS.

Components of the basin infrastructure are summarized in Table 3.

It should be noted that the Town currently has a capital budget request that identifies the potential to decommission the Kit Creek PS with the construction of a new gravity sewer line. The new line would convey flows from the Kit Creek PS location to a W12 pump station location slightly further south than what is shown in Figure 6 and 7. The W12 pump station would then pump south to the interceptor that parallels the Green Level Church Rd., as well as allowing for the pumping of flows to the Durham County Triangle WWTP and the North Cary WRF basin. A detailed study of a new W12 pump station location would be required due to the operational requirements of this pump station.

TABLE 3
Sub-Basin W12 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
W12 Gravity 2	W12-G-1	8-inch diameter	2,370	$508,000	$677,000	
W12 Pump Station	W12	0.68 mgd	N/A	$2,275,000	$2,776,000	$4,296,000
W12 Force Main	W12-F-1	4-inch diameter	2,410	$644,000	$844.000	

[a] Map ID presented in Figure 6

Sub-Basin C2

Sub-basin C2 lies to the north of the existing Nancy Branch Interceptor and west of Pittard Sears Road and is projected to have an ADF at build-out of 0.08 mgd and a PWWF of 0.26 mgd. The sub-basin requires only a gravity line to convey flows to the existing infrastructure. Flow from this basin is ultimately conveyed to the Morris Branch PS.

Components of the basin infrastructure are summarized in Table 4.

TABLE 4
Sub-Basin C2 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C2 Gravity	C2-G-1	8-inch diameter	3,480	$735,000	$981,000	$981,000

[a] Map ID presented in Figure 6

Sub-Basin C3

Sub-basin C3 is bounded by New Hope Church Road to the north and Earnest Jones Road to the south. It includes the currently sewered area that drains to the existing Forest Oaks PS. This sub-basin is projected to have an ADF at build-out of 0.32 mgd and a PWWF of 1.00 mgd.

The Forest Oaks PS currently conveys flow to the north into the collection system that drains to the Morris Branch PS. Under the build-out condition, the Forest Oaks PS would be taken off-line and the gravity sewer would be extended further downstream to a new PS at the downstream extent of the sub-basin. This PS would discharge flow to the proposed regional PS in the adjacent C4 sub-basin.

Components of the basin infrastructure are summarized in Table 5.

TABLE 5
Sub-Basin C3 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C3 Gravity	C3-G-1	12-inch diameter	4,290	$988,000	$1,309,000	
C3 Pump Station	C3	1.00 mgd	N/A	$2,366,000	$2,887,000	$5,322,000
C3 Force Main	C3-F-1	8-inch diameter	3,230	$860,000	$1,127,000	

[a] Map ID presented in Figure 6

Sub-Basin C4

Sub-basin C4 lies to the south of sub-basin C3 and is bounded by Earnest Jones Road to the north-east, Morrisville Parkway to the South and NC 1738 to the west. This sub-basin is projected to have an ADF at build-out of 0.22

mgd and a PWWF of 0.70 mgd. Flows from both C3 and C5 would be conveyed by the C4 regional pump station, which could see a cumulative ADF of 0.63 mgd and a cumulative PWWF of 1.96 mgd.

This PS would discharge flow to the site of the Copperleaf PS in sub-basin W13, which would be taken off-line, and wastewater would flow by gravity to the existing 48-inch line that discharges directly to the West Cary PS.

Components of the basin infrastructure are summarized in Table 6

TABLE 6
Sub-Basin C4 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C4 Gravity 1	C4-G-1	10-inch diameter	5,070	$1,102,000	$1,467,000	$12,245,000
C4 Gravity 2	C4-G-2	10-inch diameter	3,430	$758,000	$1,007,000	
C4 Pump Station	C4	1.96 mgd	N/A	$2,483,000	$3,029,000	
C4 Force Main	C4-F-1	16-inch diameter	13,980	$5,250,000	$6,742,000	

[a] Map ID presented in Figure 6

Sub-Basin C5

Sub-basin C5 lies to the west of sub-basin C4 and is bounded by NC 1738 to the east and Morrisville Parkway to the south. This sub-basin is projected to have an ADF at build-out of 0.09 mgd and a PWWF of 0.27 mgd. Flows from the C5 pump station would be conveyed to the C4 regional PS.

Components of the basin infrastructure are summarized in Table 7.

TABLE 7
Sub-Basin C5 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C5 Gravity	C5-G-1	8-inch diameter	3,460	$717,000	$958,000	$4,511,000
C5 Pump Station	C5	0.28 mgd	N/A	$2,041,000	$2,490,000	
C5 Force Main	C5-F-1	6-inch diameter	3,920	$794,000	$1,063,000	

[a] Map ID presented in Figure 6

Sub-Basin C6

Sub-basin C6 lies to the south-west of sub-basin C5 and is bounded by Lewter Shop Road to the south and US 751 to the west. This sub-basin is projected to have an ADF at build-out of 0.12 mgd and a PWWF of 0.38 mgd. Given the topography, two main gravity lines are proposed, both of which drain to a new PS to the north of the sub-basin. Flows from the C6 PS would be discharged into a proposed gravity line within sub-basin C8.

Components of the basin infrastructure are summarized in Table 8.

TABLE 8
Sub-Basin C6 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C6 Gravity 1	C6-G-1	8-inch diameter	3,640	$755,000	$1,009,000	$6,790,000
C6 Gravity 2	C6-G-2	8-inch diameter	2,990	$632,000	$843,000	
C6 Pump Station	C6	0.38 mgd	N/A	$2,171,000	$2,649,000	

TABLE 8
Sub-Basin C6 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C6 Force Main	C6-F-1	6-inch diameter	7,760	$1,723,000	$2,289,000	

[a] Map ID presented in Figure 6

Sub-Basin C7

Sub-basin C7 lies to the west of US 751 and is projected to have an ADF at build-out of 0.16 mgd and a PWWF of 0.50 mgd. The primary strategy for providing service to sub-basin C7 is via a gravity sewer line, any areas that cannot flow by gravity to sub-basin C8 would likely not be connected to the collection system. For the purposes of this evaluation it has been assumed that a gravity line would convey all of sub-basin C7 flow to the proposed gravity line in sub-basin C8, to ensure sufficient capacity in that line.

Components of the basin infrastructure are summarized in Table 9.

TABLE 9
Sub-Basin C7 Infrastructure Summary

Infrastructure ID	Map ID	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C7 Gravity	No ID[a]	10-inch diameter	4,700	$987,000	$1,204,000	$1,204,000

[a] No specific Sub-basin C7 infrastructure has been identified in Figure 6.

Sub-Basin C8

Sub-basin C8 is the largest of the Chatham County sub-basins and lies to the south of Morrisville Parkway/Lewter Shop Road and to the north of Luther Road. It is bounded on its western extent by US 751. This sub-basin is projected to have an ADF at build-out of 0.61 mgd and a PWWF of 1.88 mgd. The gravity sewer required for this area also collects the flow from sub-basins C6 and C7 to give a cumulative ADF of 0.89 mgd and a cumulative PWWF of 2.76 mgd. This flow would be conveyed to a PS in the southern extent of the sub-basin. The force main from this PS would discharge to the existing 48-inch interceptor immediately upstream of the West Cary Regional PS.

Components of the basin infrastructure are summarized in Table 10.

TABLE 10
Sub-Basin C8 Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C8 Gravity 1	C8-G-1	21-inch diameter	4,660	$1,341,000	$1,750,000	$14,308,000
C8 Gravity 2	C8-G-2	21-inch diameter	5,200	$1,490,000	$1,943,000	
W11 Gravity	W11-G-1	10-inch diameter	3,310	$737,000	$979,000	
W13 Gravity	W13-G-2	16-inch diameter	1,650	$460,000	$601,000	
C8 Pump Station	C8	2.76 mgd	N/A	$2,561,000	$3,124,000	
C8 Force Main	C8-F-1	16-inch diameter	12,040	$4,607,000	$5,911,000	

[a] Map ID presented in Figure 6

Sub-Basin W6B

Sub-basin W6B is a small sub-basin that lies to east of sub-basin C8. This sub-basin is projected to have an ADF at build-out of 0.01 mgd and a PWWF of 0.03 mgd. Flows from the W6B PS would be discharged to the PS in the adjacent W6C sub-basin.

Components of the basin infrastructure are summarized in Table 11.

TABLE 11
Sub-Basin W6B Infrastructure Summary

Infrastructure ID	Map ID	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
W6B Gravity	W6B-G-1	8-inch diameter	1,720	$374,000	$498,000	$1,542,000
W6B Pump Station	W6B	0.03 mgd	N/A	$322,000	$400,000	
W6B Force Main	W6B-F-1	4-inch diameter	2,360	$482,000	$644,000	

[a] Map ID presented in Figure 6

Sub-Basin W6C

Like W6B, sub-basin W6C is a small basin, which itself lies to the east of sub-basin W6B. This sub-basin is projected to have an ADF at build-out of 0.01 mgd and a PWWF of 0.05 mgd. The cumulative flow to be conveyed from the W6C PS is 0.02 mgd on an average day basis, and 0.07 mgd on a PWWF basis. Flow from the W6C PS, inclusive of W6B flow, would combine with the flow from sub-basin C8 discharging to the existing 48-inch interceptor immediately upstream of the West Cary PS, via the gravity line W13-G-2.

Components of the basin infrastructure are summarized in Table 12.

TABLE 12
Sub-Basin W6C Infrastructure Summary

Infrastructure ID	Map ID	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
W6C Gravity	W6C-G-1	8-inch diameter	1,160	$258,000	$343,000	$1,274,000
W6C Pump Station	W6C	0.07 mgd	N/A	$322,000	$400,000	
W6C Force Main	W6C-F-1	4-inch diameter	1,880	$398,000	$531,000	

[a] Map ID presented in Figure 6

Sub-Basin W13

Sub-basin W13 is a currently sewered area within the West Cary portion of the service area. Under the build-out scenario for the Chatham County sub-basins, the existing Copperleaf PS would be taken off-line, and a gravity line provided to take flow from W13 and the C4 pump station to the 48-inch interceptor that discharges directly to the West Cary PS.

Components of the basin infrastructure are summarized in Table 13.

TABLE 13
Sub-Basin W13 Infrastructure Summary

Infrastructure ID	Map ID	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
W13 Gravity	W13-G-1	16-inch diameter	3,890	$1,018,000	$1,336,000	$1,336,000

[a] Map ID presented in Figure 6

Infrastructure Details: Alternate Configuration

Under the alternate system configuration previously described, much of the infrastructure is the same as in the base configuration. The alternate configuration does change the location of the primary Chatham County basin regional PS from sub-basin C4 to sub-basin C5 and alters the force main routing as reflected in Figure 7. The following sections describe the changes.

Sub-Basin C4-Alternate

The sub-basin C4 configuration is as previously described but under an alternate configuration, the alternate force main routing would be from a sub-basin C4 PS, conveying flows from sub-basins C3 and C4, to a regional PS located in sub-basin C5.

The cumulative ADF at build-out is projected to be 0.55 mgd and the cumulative PWWF is projected to be 1.70 mgd.

Components of the basin infrastructure are summarized in Table 14. The major difference compared to the base configuration is that the force main is much shorter, which results in a lower cost for this sub-basin in the alternate configuration.

TABLE 14
Sub-Basin C4-Alternate Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C4 Gravity 1	C4-G-1	10-inch diameter	5,070	$1,102,000	$1,467,000	$7,026,000
C4 Gravity 2	C4-G-2	10-inch diameter	3,430	$758,000	$1,007,000	
C4-ALT Pump Station	C4	1.70 mgd	N/A	$2,470,000	$3,013,000	
C4-Alt Force Main	C4-ALT-F-1	10-inch diameter	3,910	$1,184,000	$1,539,000	

[a] Map ID presented in Figure 7

Sub-Basin C5-Alternate

The sub-basin C5 configuration is as previously described but under the alternate configuration, the alternate force main routing would be from the sub-basin C5 PS, conveying flow from sub-basins C3, C4, C5 and C6, discharging to a gravity line in sub-basin W13 at the site of the existing Copperleaf PS. This is the same discharge location as described for sub-basin C4 in the base configuration.

The cumulative ADF at build-out is projected to be 0.76 mgd and the cumulative PWWF is projected to be 2.35 mgd.

Components of the basin infrastructure are summarized in Table 15. The major difference compared to the base configuration is that the force main is much longer, which results in a higher cost for this sub-basin in the alternate configuration.

TABLE 15
Sub-Basin C5-Alternate Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C5 Gravity	C5-G-1	8-inch diameter	3,460	$717,000	$958,000	$10,374,000
C5-ALT Pump Station	C5	2.35 mgd	N/A	$2,522,000	$3,077,000	
C5-ALT Force Main	C5-ALT-F-1	16-inch diameter	13,040	$4,938,000	$6,339,000	

[a] Map ID presented in Figure 7

Sub-Basin C6-Alternate

The sub-basin C6 configuration is as previously described but under the alternate configuration, the alternate force main routing would be from sub-basin C6 to the regional PS in sub-basin C5.

Components of the basin infrastructure are summarized in Table 16. The major difference compared to the base configuration is that the force main is much shorter, which results in a lower cost for this sub-basin in the alternate configuration.

TABLE 16
Sub-Basin C6-Alternate Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C6 Gravity 1	C6-G-1	8-inch diameter	3,640	$755,000	$1,009,000	$5,927,000
C6 Gravity 2	C6-G-2	8-inch diameter	2,990	$632,000	$843,000	
C6-ALT Pump Station	C6	0.38 mgd	N/A	$2,171,000	$2,649,000	
C6-ALT Force Main	C6-ALT-F-1	6-inch diameter	4,610	$1,078,000	$1,426,000	

[a] Map ID presented in Figure 6

Sub-Basin C8-Alternate

The sub-basin C8 configuration is as previously described, but under the alternate configuration some of the flow from the base configuration is not routed to this sub-basin such that the cumulative ADF at build-out is projected to be 0.77 mgd and the cumulative PWWF is projected to be 2.38 mgd. While there is a reduction in flow from the base configuration, the gravity line and force main sizing remain the same. The recommended PS size is slightly smaller.

Components of the basin infrastructure are summarized in Table 17. The major difference compared to the base configuration is that the pump station is slightly smaller, which results in a slightly lower cost for this sub-basin in the alternate configuration.

TABLE 17
Sub-Basin C8-Alternate Infrastructure Summary

Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Basin Cost
C8 Gravity 1	C8-G-1	21-inch diameter	4,660	$1,341,000	$1,750,000	$14,259,000
C8 Gravity 2	C8-G-2	21-inch diameter	5,200	$1,490,000	$1,943,000	
W11 Gravity	W11-G-1	10-inch diameter	3,310	$737,000	$979,000	
W13 Gravity	W13-G-2	16-inch diameter	1,650	$460,000	$601,000	
C8-ALT Pump Station	C8	2.38 mgd	N/A	$2,522,000	$3,077,00	
C8 Force Main	C8-F-1	16-inch diameter	12,040	$4,607,000	$5,911,000	

[a] Map ID presented in Figure 7

Transitional Infrastructure

While the main objective of this planning study was to identify the infrastructure required to provide sewer service to the new Chatham County service areas under build-out conditions, there is also a recognition that this area will incrementally develop over time. The pattern and timing of development will ultimately determine the infrastructure required to provide service to these new areas between current day and build-out conditions. While not all possible scenarios of development patterns were explored, Town staff knew of a number of developments currently in the planning and preliminary engineering stages which informed the identified

transitional (or interim) infrastructure in Figures 6 and 7. The following bullets provide a summary for this infrastructure:

- **Sub-basin C3**: The Forest Oaks PS and force main are currently in operation and could in the future, as sub-basin C3 develops further, be taken offline when the C3-G-1 gravity line and C3 PS are constructed. If a regional PS in one of the more southern sub-basins is not constructed at the time the C3 pump station is brought online, a 6,540-foot force main to the Morris Branch PS from C3 would be necessary.
- **Sub-basin C8**: The Town has a preliminary engineering report (provided by a developer) that has identified the location of the W11 PS and its associated force main route, as presented in Figure 6. This PS and force main would provide sewer service to developments in the eastern portion of sub-basin C8. In the future, as C8 develops, the W11 PS and force main could be taken offline when the C8-G-1 and C8-G-2 gravity lines, as well as the C8 PS, are constructed.
- **Copperleaf PS**: The Copperleaf PS and force main are currently in operation and with the construction of the 48-inch interceptor to the West Cary PS this PS could be taken offline. In order to be taken offline, the construction of the gravity line W13-G-1 would be required. For this planning study the W13-G-1 gravity line was sized to handle the current Copperleaf PS service area flows as well as the flows from sub-basins C3, C4, and C5.

In addition to the transitional infrastructure discussed in the preceding bullets, the identified alternate configuration reviewed provides a configuration for a scenario where the southern portions of the Chatham County sub-basins develop at a faster rate than the more northern sections, siting the regional PS in sub-basin C5. Ultimately there are number of infrastructure scenarios between the current system, the identified transitional infrastructure, and the build-out infrastructure. The configurations identified herein provide for an optimal system layout under build-out conditions and can serve as the guideposts for any decisions the Town needs to make on interim infrastructure that may be required to provide service for a portion of an individual sub-basin.

Impact on Existing West Cary Basin Infrastructure

The addition of flow from the Chatham County sub-basins has the potential to impact existing and proposed infrastructure in the West Cary basin. In the WWCSMP, an allocation of flow of approximately 1.5 mgd on an average day basis was included for the Chatham County sub-basins in calculating the flows to the West Cary PS. Peak wet weather flows in that analysis were based on a 2.5 peaking factor; these flows were used to size major conveyance infrastructure to the PS as well as the West Cary PS itself. For the Chatham County sub-basins, this planning study calculated an annual average flow similar to that in the WWCSMP, but calculated peak flow based on a 3.1 peaking factor which resulted in approximately 1.8 mgd of additional projected PWWF.

The impact of the increased build-out PWWF was assessed using the hydraulic model and the following observations can be made:

- **Kit Creek Pump Station and Force Main Parallel:** The Kit Creek PS expansion and force main parallel recommended in the WWCSMP were determined to adequately account for added PWWF from C1 and W12.
- **Morris Branch Pump Station and Force Main Parallel:** The Morris Branch PS expansion recommended in the WWCSMP was determined to adequately account for added PWWF from C2.

Legend

Proposed Chatham Pump Stations

- Proposed Pump Stations
- Proposed Pump Stations-Interim

Current Pump Stations

- Existing Pump Stations
- Existing Pump Stations - Interim

Proposed Chatham Sewer Lines

- Force Main
- Force Main-Interim
- Gravity Sewer
- Gravity Sewer - Interim
- Current Flow Meters

Cary Sewer Lines

- Existing, Force Main
- Existing, Gravity Sewer Line
- Existing (Interim), Force Main
- Proposed, Force Main
- Proposed, Gravity Sewer Line
- Streams/Waterbodies
- Roads
- Highways
- County Boundary
- Existing Sewer Sub-basins

New/Modified Sub-basins

- C1
- C2
- C3
- C4
- C5
- C6
- C7
- C8
- W12
- W6B
- W6C

C1
C1-F-1
C1-G-1
C1-G-2
W12
Wake Rd
W1
Kit Creek Rd
W1A
W12-G-1
W12-F-1
W12
Kit Creek
55
W2A
O'Kelley Chapel Rd
C2-G-1
W3
Morris Branch
McCrimmon Pkwy
540
New Hope Church Rd
W5
Carpenter Fire Station Rd
C3
W5B
Cary Glen
C3-F-1
C3-G-1
W4
C4
Forest Oaks
W5A
C5-F-1
C4-G-2
C4-F-1
W10A
C4-G-1
Earnest Jones Rd
Morrisville Pkwy
C5
C5-G-1
Barbee Rd
751
Green Hope School Rd
W10
C6
W13A
Copperleaf
C6-G-2
W7
W11
White Oak Church Rd
W13B
Green Level Church Rd
W13
W13-G-1
C6-G-1
W11-G-1
C8-G-1
C6-F-1
Green Level Rd
West Cary
W6C-G-1
W6C-F-1
W13-G-2
W6
W8
W6B-G-1
W6B-F-1
C8-F-1
W6C
Roberts Rd
W6B
C8-G-2
C8
Luther Rd

0 0.25 0.5 1 Miles

N

Figure 6
Base Configuration Infrastructure
Chatham County Sewer Basin Planning

CH2MHILL

This page has been intentionally left blank.

Legend

Proposed Chatham Pump Stations

- Proposed Pump Stations
- Proposed Pump Stations-Interim

Current Pump Stations

- Existing Pump Stations
- Existing Pump Stations - Interim

Proposed Chatham Sewer Lines

- Force Main Alternative
- Force Main
- Force Main-Interim
- Gravity Sewer
- Gravity Sewer - Interim
- Current Flow Meters

Cary Sewer Lines

- Existing, Force Main
- Existing, Gravity Sewer Line
- Existing (Interim), Force Main
- Proposed, Force Main
- Proposed, Gravity Sewer Line
- Streams/Waterbodies
- Roads
- Highways
- County Boundary
- Existing Sewer Sub-basins

New/Modified Sub-basins

- C1
- C2
- C3
- C4
- C5
- C6
- C7
- C8
- W12
- W6B
- W6C

C1
C1-F-1
C1-G-1
W12
Wake Rd
C1-G-2
W12-G-1
W12-F-1
W12
W1
Kit Creek Rd
W1A
RTP
Kit Creek
55
W2A
O'Kelley Chapel Rd
C2-G-1
W3
Morris Branch
McCrimmon Pkwy
540
New Hope Church Rd
W5
Carpenter Fire Station Rd
W5B
Cary Glen
C3
C3-F-1
C3-G-1
Forest Oaks
W4
C4
C4-ALT-F-1
C4-G-2
W5A
W10A
C5
C4-G-1
Earnest Jones Rd
Morrisville Pkwy
Green Hope School Rd
C5-G-1
Barbee Rd
751
C6
C6-ALT-F-1
W10
C5-ALT-F-1
W13A
Copperleaf
W7
C6-G-2
C6-G-1
W11
W13B
Green Level Church Rd
White Oak Church Rd
W13
W13-G-1
W11
W11-G-1
C8-G-1
Green Level Rd
West Cary
W13-G-2
W6C-G-1
W6C-F-1
W6
W8
W6B-G-1
W6B-F-1
C8-F-1
W6C
C8-G-2
W6B
Roberts Rd
C8
Luther Rd

0 0.25 0.5 1 Miles

N

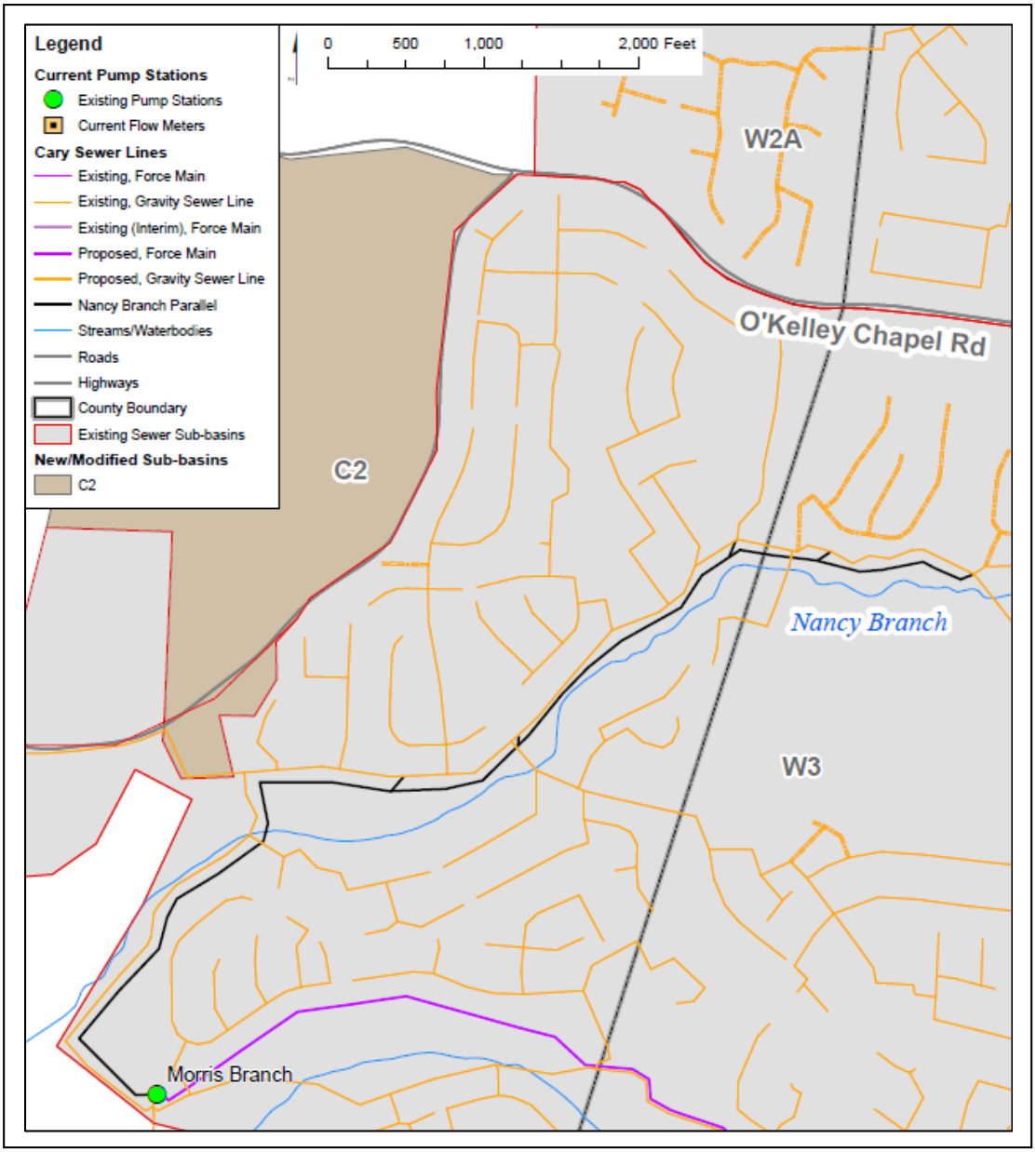
Figure 7
Alternate Configuration Infrastructure
Chatham County Sewer Basin Planning

CH2MHILL

This page has been intentionally left blank.

- **Nancy Branch Interceptor Parallel:** The WWCSMP identified the need for a parallel to the Nancy Branch interceptor. Based on the hydraulic modeling completed for this planning study, inclusive of model updates for the M29 flow monitoring basin delineation and flow allocation, it was identified that a number of interconnections between the existing interceptor and the WWCSMP recommended parallel interceptor are needed. There is also the need to extend the parallel all the way to the Morris Branch PS. The interconnections and extension of the parallel were required to reduce potential surcharge conditions and flow levels greater than two-thirds the diameter of the pipeline for the build-out flows. Figure 8 provides a map depicting the Nancy Branch interceptor parallel with the addition of the interconnections and the extended parallel to the Morris Branch PS. There are likely other options for this parallel, for example the parallel line could be located on the south side of Nancy Branch allowing the elimination of a number of stream crossings and still provide the hydraulic capacity relief for build-out conditions. A more detailed study of the options for the Nancy Branch interceptor parallel would be appropriate to determine their feasibility.

FIGURE 8
Nancy Branch Interceptor Parallel



- **48-Inch Interceptor to the West Cary Pump Station:** The 48-inch interceptor that parallels, in part, Green Level Church Road and discharges to the West Cary PS has sufficient capacity to convey the additional PWWF from the new/modified Chatham County sub-basins in addition to the flow originating from the West Cary sub-basins.
- **West Cary Pump Station:** The build-out PWWF at the West Cary PS, with the additional PWWF from the Chatham County sub-basins and the flow from the North Basin via the UCCPS, is projected to exceed the 33 mgd capacity of the PS. This would necessitate a future expansion. The next phase of expansion of the West Cary PS is to 45 mgd, as identified in the West Cary Regional Pump Station PER (Brown and Caldwell, 2004).

Chatham County Sub-basin Infrastructure Summary

The collection system infrastructure required for the projected build-out conditions for the Chatham County sub-basins, described in the preceding sections, is summarized in Table 18 for the base configuration and Table 19 for the alternate configuration.

TABLE 18
Base Configuration Infrastructure Summary

Sub-Basin	Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Sub-Basin Cost
C1	C1 Gravity 1	C1-G-1	8-inch diameter	2,280	$476,000	$636,000	$4,923,000
	C1 Gravity 2	C1-G-2	8-inch diameter	5,040	$1,050,000	$1,404,000	
	C1 Pump Station	C1	0.31 mgd	N/A	$2,041,000	$2,490,000	
	C1 Force Main	C1-F-1	4-inch diameter	1,290	$297,000	$393,000	
W12	W12 Gravity 2	W12-G-1	8-inch diameter	2,370	$508,000	$677,000	$4,296,000
	W12 Pump Station	W12	0.68 mgd	N/A	$2,275,000	$2,776,000	
	W12 Force Main	W12-F-1	4-inch diameter	2,410	$644,000	$844.000	
C2	C2 Gravity	C2-G-1	8-inch diameter	3,480	$735,000	$981,000	$981,000
C3	C3 Gravity	C3-G-1	12-inch diameter	4,290	$988,000	$1,309,000	$5,322,000
	C3 Pump Station	C3	1.00 mgd	N/A	$2,366,000	$2,887,000	
	C3 Force Main	C3-F-1	8-inch diameter	3,230	$860,000	$1,127,000	
C4	C4 Gravity 1	C4-G-1	10-inch diameter	5,070	$1,102,000	$1,467,000	$12,245,000
	C4 Gravity 2	C4-G-2	10-inch diameter	3,430	$758,000	$1,007,000	
	C4 Pump Station	C4	1.96 mgd	N/A	$2,483,000	$3,029,000	
	C4 Force Main	C4-F-1	16-inch diameter	13,980	$5,250,000	$6,742,000	
C5	C5 Gravity	C5-G-1	8-inch diameter	3,460	$717,000	$958,000	$4,511,000
	C5 Pump Station	C5	0.28 mgd	N/A	$2,041,000	$2,490,000	
	C5 Force Main	C5-F-1	6-inch diameter	3,920	$794,000	$1,063,000	
C6	C6 Gravity 1	C6-G-1	8-inch diameter	3,640	$755,000	$1,009,000	$6,790,000
	C6 Gravity 2	C6-G-2	8-inch diameter	2,990	$632,000	$843,000	
	C6 Pump Station	C6	0.38 mgd	N/A	$2,171,000	$2,649,000	
	C6 Force Main	C6-f-1	6-inch diameter	7,760	$1,723,000	$2,289,000	
C7	C7 Gravity	No ID[a]	10-inch diameter	4,700	$987,000	$1,204,000	$1,204,000
C8	C8 Gravity 1	C8-G-1	21-inch diameter	4,660	$1,341,000	$1,750,000	$14,308,000
	C8 Gravity 2	C8-G-2	21-inch diameter	5,200	$1,490,000	$1,943,000	
	W11 Gravity	W11-G-1	10-inch diameter	3,310	$737,000	$979,000	
	W13 Gravity	W13-G-2	16-inch diameter	1,650	$460,000	$601,000	
	C8 Pump Station	C8	2.76 mgd	N/A	$2,561,000	$3,124,000	
	C8 Force Main	C8-F-1	16-inch diameter	12,040	$4,607,000	$5,911,000	

TABLE 18
Base Configuration Infrastructure Summary

Sub-Basin	Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Sub-Basin Cost
W6B	W6B Gravity	W6B-G-1	8-inch diameter	1,720	$374,000	$498,000	$1,542,000
	W6B Pump Station	W6B	0.03 mgd	N/A	$322,000	$400,000	
	W6B Force Main	W6B-F-1	4-inch diameter	2,360	$482,000	$644,000	
W6C	W6C Gravity	W6C-G-1	8-inch diameter	1,160	$258,000	$343,000	$1,274,000
	W6C Pump Station	W6C	0.07 mgd	N/A	$322,000	$400,000	
	W6C Force Main	W6C-F-1	4-inch diameter	1,880	$398,000	$531,000	
W13	W13 Gravity	W13-G-1	16-inch diameter	3,890	$1,018,000	$1,336,000	$1,336,000
						TOTAL – BASE CONFIGURATION	**$58,732,000**

[a] Map ID presented in Figure 6

TABLE 19
Alternate Configuration Infrastructure Summary

Sub-Basin	Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Sub-Basin Cost
C1	C1 Gravity 1	C1-G-1	8-inch diameter	2,280	$476,000	$636,000	$4,923,000
	C1 Gravity 2	C1-G-2	8-inch diameter	5,040	$1,050,000	$1,404,000	
	C1 Pump Station	C1	0.31 mgd	N/A	$2,041,000	$2,490,000	
	C1 Force Main	C1-F-1	4-inch diameter	1,290	$297,000	$393,000	
W12	W12 Gravity 2	W12-G-1	8-inch diameter	2,370	$508,000	$677,000	$4,296,000
	W12 Pump Station	W12	0.68 mgd	N/A	$2,275,000	$2,776,000	
	W12 Force Main	W12-F-1	4-inch diameter	2,410	$644,000	$844.000	
C2	C2 Gravity	C2-G-1	8-inch diameter	3,480	$735,000	$981,000	$981,000
C3	C3 Gravity	C3-G-1	12-inch	4,290	$988,000	$1,309,000	$5,322,000
	C3 Pump Station	C3	1.00 mgd	N/A	$2,366,000	$2,887,000	
	C3 Force Main	C3-F-1	8-inch diameter	3,230	$860,000	$1,127,000	
C4-ALT	C4 Gravity 1	C4-G-1	10-inch diameter	5,070	$1,102,000	$1,467,000	$7,026,000
	C4 Gravity 2	C4-G-2	10-inch diameter	3,430	$758,000	$1,007,000	
	C4-ALT Pump Station	C4	1.70 mgd	N/A	$2,470,000	$3,013,000	
	C4-Alt Force Main	C4-Alt-F-1	10-inch diameter	3,910	$1,184,000	$1,539,000	
C5-ALT	C5 Gravity	C5-G-1	8-inch diameter	3,460	$717,000	$958,000	$10,374,000
	C5-ALT Pump Station	C5	2.35 mgd	N/A	$2,522,000	$3,077,000	
	C5-ALT Force Main	C5-ALT-F-1	16-inch diameter	13,040	$4,938,000	$6,339,000	
C6-ALT	C6 Gravity 1	C6-G-1	8-inch diameter	3,640	$755,000	$1,009,000	$5,927,000
	C6 Gravity 2	C6-G-2	8-inch diameter	2,990	$632,000	$843,000	
	C6-ALT Pump Station	C6	0.38 mgd	N/A	$2,171,000	$2,649,000	
	C6-ALT Force Main	C6-ALT-F-1	6-inch diameter	4,610	$1,078,000	$1,426,000	
C7	C7 Gravity	No ID[a]	10-inch diameter	4,700	$987,000	$1,204,000	$1,204,000
C8	C8 Gravity 1	C8-G-1	21-inch diameter	4,660	$1,341,000	$1,750,000	$14,259,000
	C8 Gravity 2	C8-G-2	21-inch diameter	5,200	$1,490,000	$1,943,000	
	W11 Gravity	W11-G-1	10-inch diameter	3,310	$737,000	$979,000	
	W13 Gravity	W13-G-2	16-inch diameter	1,650	$460,000	$601,000	
	C8-ALT Pump	C8	2.38 mgd	N/A	$2,522,000	$3,077,00	
	C8 Force Main	C8-F-1	16-inch diameter	12,040	$4,607,000	$5,911,000	

TABLE 19
Alternate Configuration Infrastructure Summary

Sub-Basin	Infrastructure ID	Map ID[a]	Infrastructure Size	Infrastructure Length (feet)	Infrastructure Cost	Project Cost	Total Sub-Basin Cost
W6B	W6B Gravity	W6B-G-1	8-inch diameter	1,720	$374,000	$498,000	$1,542,000
	W6B Pump Station	W6B	0.03 mgd	N/A	$322,000	$400,000	
	W6B Force Main	W6B-F-1	4-inch diameter	2,360	$482,000	$644,000	
W6C	W6C Gravity	W6C-G-1	8-inch diameter	1,160	$258,000	$343,000	$1,274,000
	W6C Pump Station	W6C	0.07 mgd	N/A	$322,000	$400,000	
	W6C Force Main	W6C-F-1	4-inch diameter	1,880	$398,000	$531,000	
W13	W13 Gravity	W13-G-1	16-inch diameter	3,890	$1,018,000	$1,336,000	$1,336,000
					TOTAL – ALTERNATE CONFIGURATION		**$58,464,000**

[a] Map ID presented in Figure 7

References

Brown and Caldwell. 2004. West Cary Regional Pump Station Preliminary Engineering Report. Prepared for the Town of Cary.

CDM Smith. 2014. Water Distribution System Master Plan Update for Chatham County Technical Memorandum. Prepared for the Town of Cary.

CH2M HILL. 2014. Upper Crabtree Creek Pump Station (UCCPS) & Force Main and Interceptor Capacity Enhancements Preliminary Engineering Report. Prepared for the Town of Cary.

CH2M HILL and Brown & Caldwell. 2013. Long Range Water Resources Plan. Prepared for the Town of Cary and Town of Apex.

Hazen & Sawyer. 2013. Wastewater Collection System Master Plan. Prepared for the Town of Cary.

Town of Cary. 2012. Chatham County-Town of Cary Joint Land Use Plan.