WATER SYSTEM PLANNING UPDATE

B&V PROJECT NO. 187730
B&V FILE NO. 186110.41.1100

PREPARED FOR

Union County Public Works

27 JUNE 2016

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1.0 Water Demands and Model Updates

1.1 MODEL UPDATE AND WATER DEMANDS

1.1.1 Model Inventory

The skeletal hydraulic model used to complete the 2011 Comprehensive Master Plan contained approximately 675 miles of pipe, with only 95 miles of smaller diameter (less than 8-inch) pipe. During the Distribution System Water Quality Analyses completed by Black & Veatch in 2013, the skeletal model was updated using Union County's GIS to include an additional 450 miles of smaller (less than 8-inch) pipe. This "all-pipes reduced" model contained over 950 miles of pipe represented by approximately 9,500 model pipe segments and serves as the basis for the modeling conducted during this distribution system planning update.

As part of the model inventory update, all pipelines previously identified as required improvement projects to deliver increased (greater than 3 mgd) water supply from Anson County were eliminated to reflect the current plan for future supply, which includes construction of a new Yadkin River Water Treatment Plant to be located in the northeastern portion of Union County.

1.1.2 Elevations

During the Distribution System Water Quality Analyses in 2013, an elevation extraction based on the digital elevation model (DEM), provided by UCPW GIS staff, was used to assign elevation to each node in the model, effectively capturing the customer elevations throughout the system. Node elevations were not changed as part of this project.

1.1.3 Base Demand Allocation

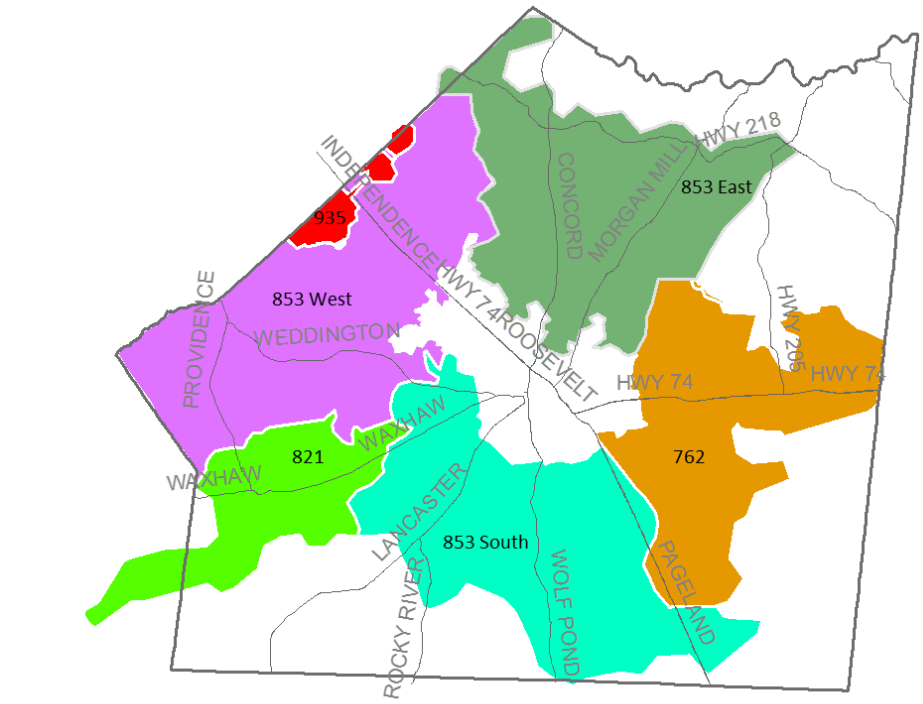
Base demands were developed from the 2012 monthly billing records for Union County water customers. The allocation was completed for the all-pipes reduced model during the Distribution System Water Quality Analyses in 2013. A review of the demand allocation previously completed is included below:

- **Geocoded Consumption**: 90.0% of the average annual consumption for 2012 was directly located spatially based on customer meter location through a direct Account ID match.
- **Address-Matched Consumption:** 9.6% of 2012 consumption was located spatially using an address locator to identify customer locations based on their service address.
- **Non-Geocoded Consumption:** 0.4% of 2012 consumption was unable to be located spatially and was spread evenly amongst the distribution system model nodes.
- **Non-Revenue Water (NRW)**: NRW was calculated by comparing annual production records for the Catawba River WTP and the Anson County supply to the average annual (day) consumption. NRW was calculated to be 9.8% in the Anson supplied portion of the system (762 and 853 East zones) and 11.6% in the Catawba supplied portion of the system (821, 880, 935, 853 South and 853 West zones). Because adequate flow metering between pressure zones was not available, NRW from each supply source was spread evenly amongst distribution system model nodes based on their source of supply.

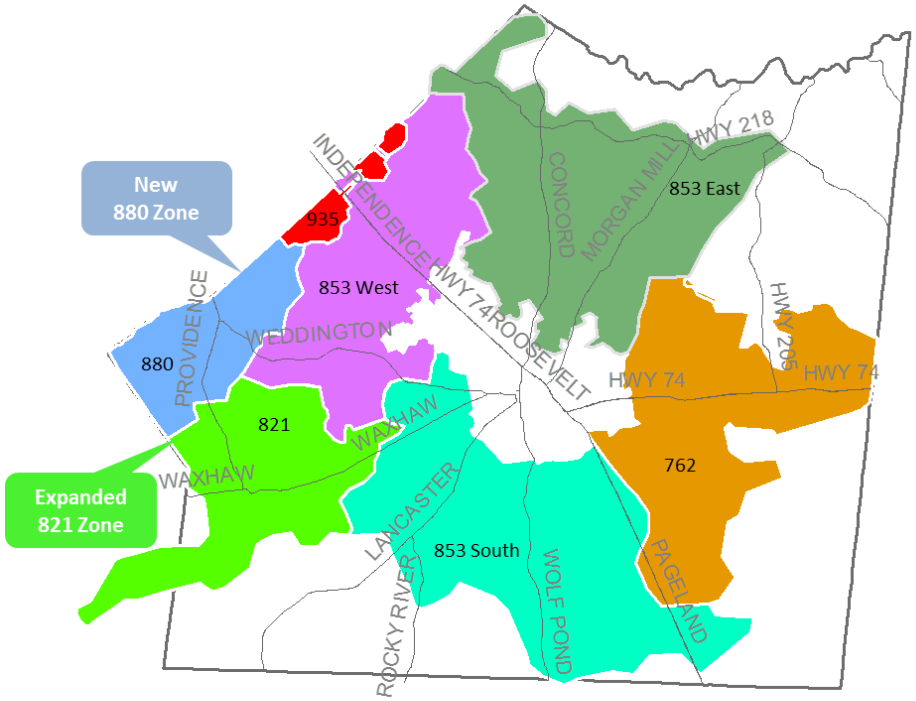
Table 1-1 summarizes the Base demand (customer consumption and NRW) allocation completed during the Distribution System Water Quality Analyses in 2013. It is noted that the zone-specific demands have changed due to the planned addition of the 880 Zone and expansion of the 821 Zone following the retirement of the Waxhaw-Marvin Booster Pump Station (BPS), which is scheduled to be completed in 2016. Figure 1-1 displays the planned pressure zone alignments changes which will allow formation of the 880 Zone and expanded 821 Zone following completion of the 880 Zone Booster Pumping Station and 880 Zone Tank.

Table 1-1 Base Average Day Demand Breakdown by Pressure Zone

USAGE TYPE	762	821	880	935	853 SOUTH	853 EAST	853 WEST	TOTAL
Geocoded Consumption (mgd)	0.80	1.08	1.86	0.62	0.53	0.55	3.51	**8.95**
Address-Matched Consumption (mgd)	0.33	0.02	0.02	0.05	0.02	0.05	0.45	**0.96**
Non-Geocoded Consumption (mgd)	0.00	0.00	0.01	0.00	0.00	0.00	0.02	**0.04**
Non-Revenue Water (mgd)	0.05	0.18	0.21	0.11	0.09	0.14	0.50	**1.27**
Total (mgd)	**1.18**	**1.29**	**2.09**	**0.78**	**0.65**	**0.74**	**4.48**	**11.22**



Existing



880 Zone Online

Figure 1-1 Existing and Planned New 880 Pressure Zone Configurations

1.1.4 Future-Year Demand Allocation

1.1.4.1 Future-Year Demand Projection Adjustments

In early 2015, work was completed by HDR related to the Yadkin to Rocky River Interbasin Transfer (IBT). During this work, underlying assumptions related to the demand projections were updated. For consistency between the current and ongoing regulatory and planning projects, Union County directed the demand projections of this planning project be updated to reflect the more recent updates of the regulatory project. The future-year demand projections were modified as summarized below:

- **Per Capita Water Demand:** Gallons per capita per day (gpcd) were reduced from the 125 gpcd used for the 2011 Comprehensive Master Plan to 120 gpcd, a reduction of 4%.
- **MDD:ADD Peaking Factor:** The MDD:ADD peaking factor was reduced from the 1.9 factor used for the 2011 Comprehensive Master Plan to 1.7, a reduction of 11%.
- **Growth Percentage:** The 2011 Comprehensive Master Plan projected an annual growth rate of 2.4% throughout the planning horizon. This growth rate percentage was changed as follows:
  - Catawba Basin: 2.6% until 2020, reducing to 2.0% between 2020 and 2030
  - Yadkin Basin: 3.7% through 2030

The projected future-year demands were reduced based on the assumptions detailed above for each planning year and are summarized in Table 1-2. For this project, hydraulic analyses were based on four planning years:

- **2015:** Projected 2015 Demands (Analyses included in this report which represent 2015 Demands utilize the planned 2016 pressure zone alignment shown in Figure 1-2, which is the year that the new 880 Zone is planned to be online)
- **2020:** Projected 2020 Demands
- **2022:** Scaled 2022 Demands representing the anticipated system demands when the new Yadkin River Water Treatment Plant (YRWTP) is planned to come online. Demands were scaled using linear interpolation between the 2020 and 2030 planning year demands. The 2022 planning year is also referred to as the "Initial Capacity Year."
- **2030:** Projected 2030 Demands

Table 1-2 Adjusted Future-Year Demands by Planning Year

PLANNING YEAR	2011 COMP MP ADD (MGD)	ADJUSTED ADD (MGD)	DIFF.	2011 COMP MP MDD (MGD)	ADJUSTED MDD (MGD)	DIFF.
2015	12.98	**12.77**	-2%	24.66	**23.70**	-4%
2020	15.73	**15.24**	-3%	29.87	**27.90**	-7%
2022[1]	N/A	**16.23**	N/A	N/A	**29.57**	N/A
2030	22.30	**20.83**	-7%	42.30	**37.41**	-12%

[1]The 2022 "Initial Capacity Year" was not part of the 2011 Comprehensive Master Plan.

For the 2011 Comprehensive Master Plan, a projection shapefile (PopulationFlow_Projections) was developed to estimate when and where projected population growth was predicted to occur throughout the Union County service area through 2030 at a parcel level. At the time, a total of 11.76 mgd of additional ADD (including 15% NRW) was projected between 2011 and 2030 and distributed spatially consistent with the population growth distribution. Based on the demand adjustments described above, the projected additional ADD for each planning year was scaled down such that Base Demand + Planning Year ADD would equal the adjusted ADD shown in Table 1-2.

After scaling the projected additional ADD contained in the PopulationFlow_Projections shapefile to match the adjusted ADD values for each planning year shown in Table 1-3, these Future-Year Demands were allocated to the hydraulic model on a zone-specific basis using Thiessen polygons to accurately assign these future demands to model nodes.

Table 1-3 Adjusted Additional Future-Year ADD

	ADDITIONAL 2015 ADD (MGD)	ADDITIONAL 2020 ADD (MGD)	ADDITIONAL 2030 ADD (MGD)	TOTAL ADDITIONAL ADD (MGD)
2011 Comp MP	2.40	2.74	6.61	11.76
Adjusted	1.54	2.50	5.59	9.63
Difference	**-0.86**	**-0.24**	**-1.02**	**-2.13**

1.1.4.2 Future-Year Pressure Zone Boundaries and Demands

Pressure zone boundary changes are recommended to improve system pressures and/or water service reliability to customers throughout the distribution system as described below:

- **2016**

  As shown in Figure 1-2, the recommended pressure zones boundaries in 2016 reflect the addition of the 880 Zone and the corresponding increase in size of the 821 Zone following the retirement of the Waxhaw-Marvin Booster Pump Station. Currently the 880 Zone is planned to be operational in 2016.

- **2020**

  As shown in Figure 1-3, the 853 West and 853 East Zones are recommended to be combined into a single 853 West / East Zone by opening the existing zone boundary valves between 2016 and 2020. The 935 Zone boundary is proposed to be modified to enhance customer pressures and minimize energy usage. Demands will be shifted from the 935 Zone to the 853 West / East Zone.

- **2022**

  As shown in Figure 1-4, following construction of the YRWTP in 2022, the 762 Zone is proposed to be expanded to include low elevation customers in the 853 West / East Zone, reducing high pressures. Demands will be shifted from the 853 West / East Zone to the 762 Zone.

- **2030**

  As shown in Figure 1-5, no pressure zone boundary modifications are currently recommended between 2022 and 2030.

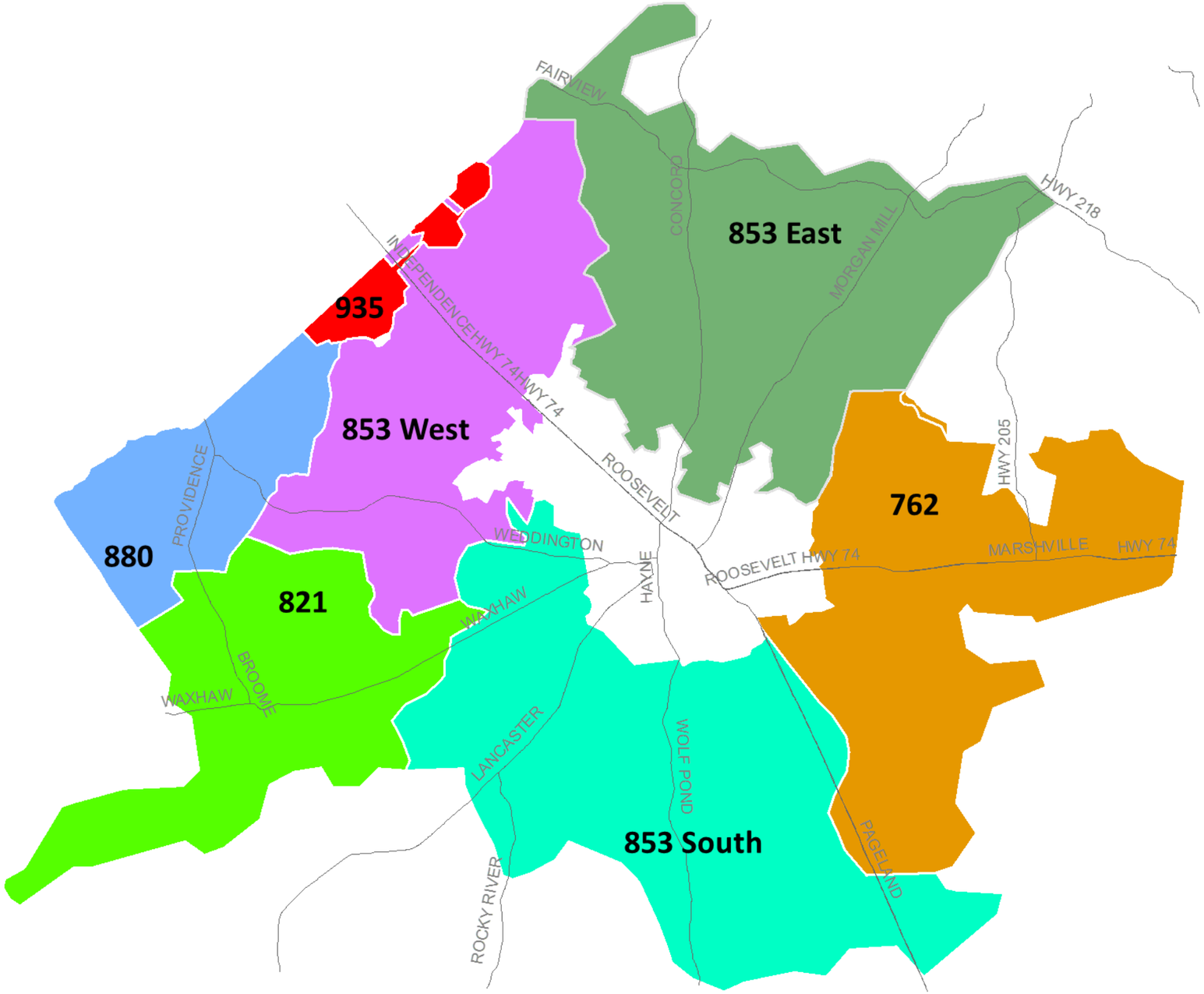


Figure 1-2 Recommended Pressure Zone Boundaries in 2016

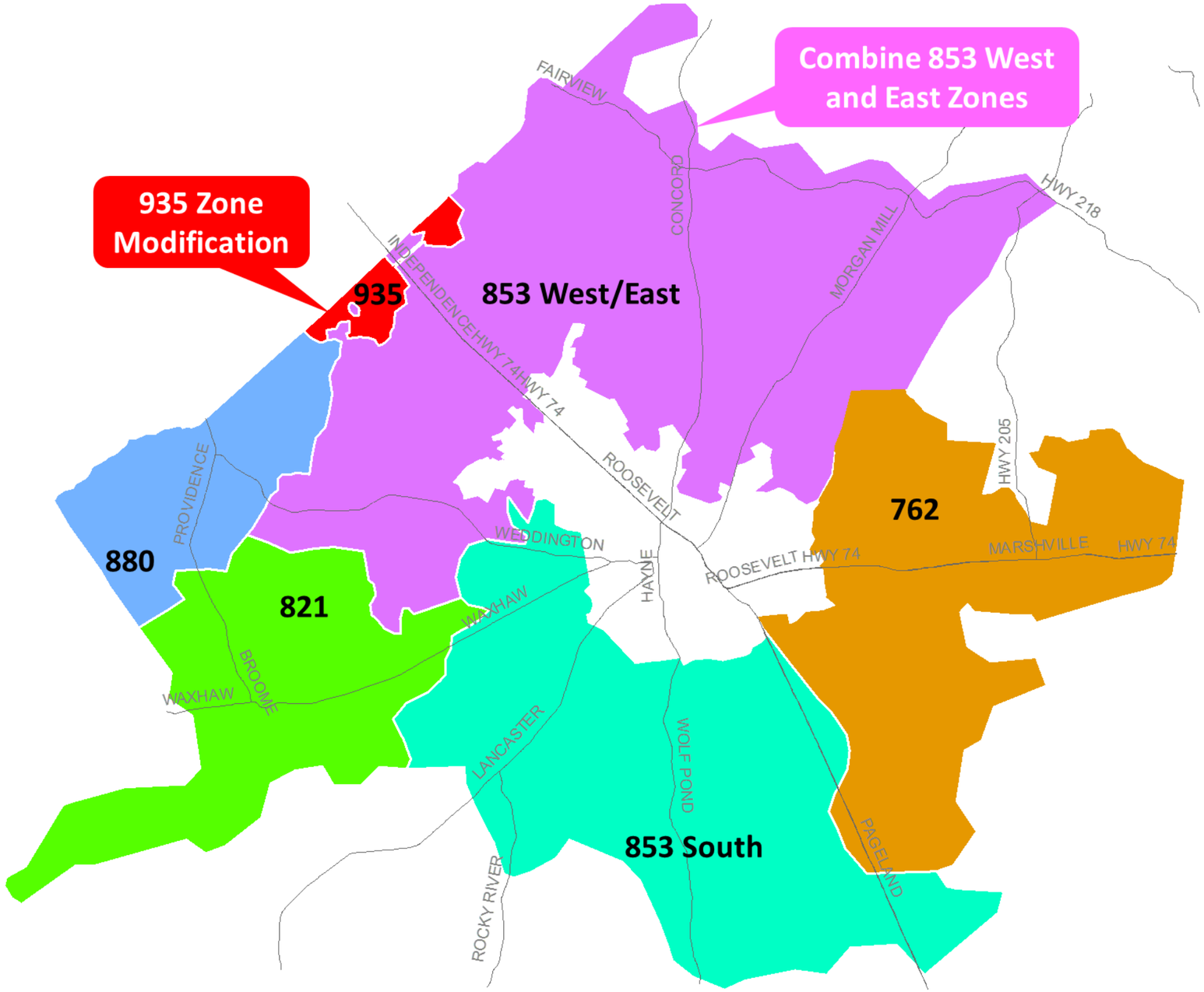


Figure 1-3 Recommended Pressure Zone Boundaries in 2020

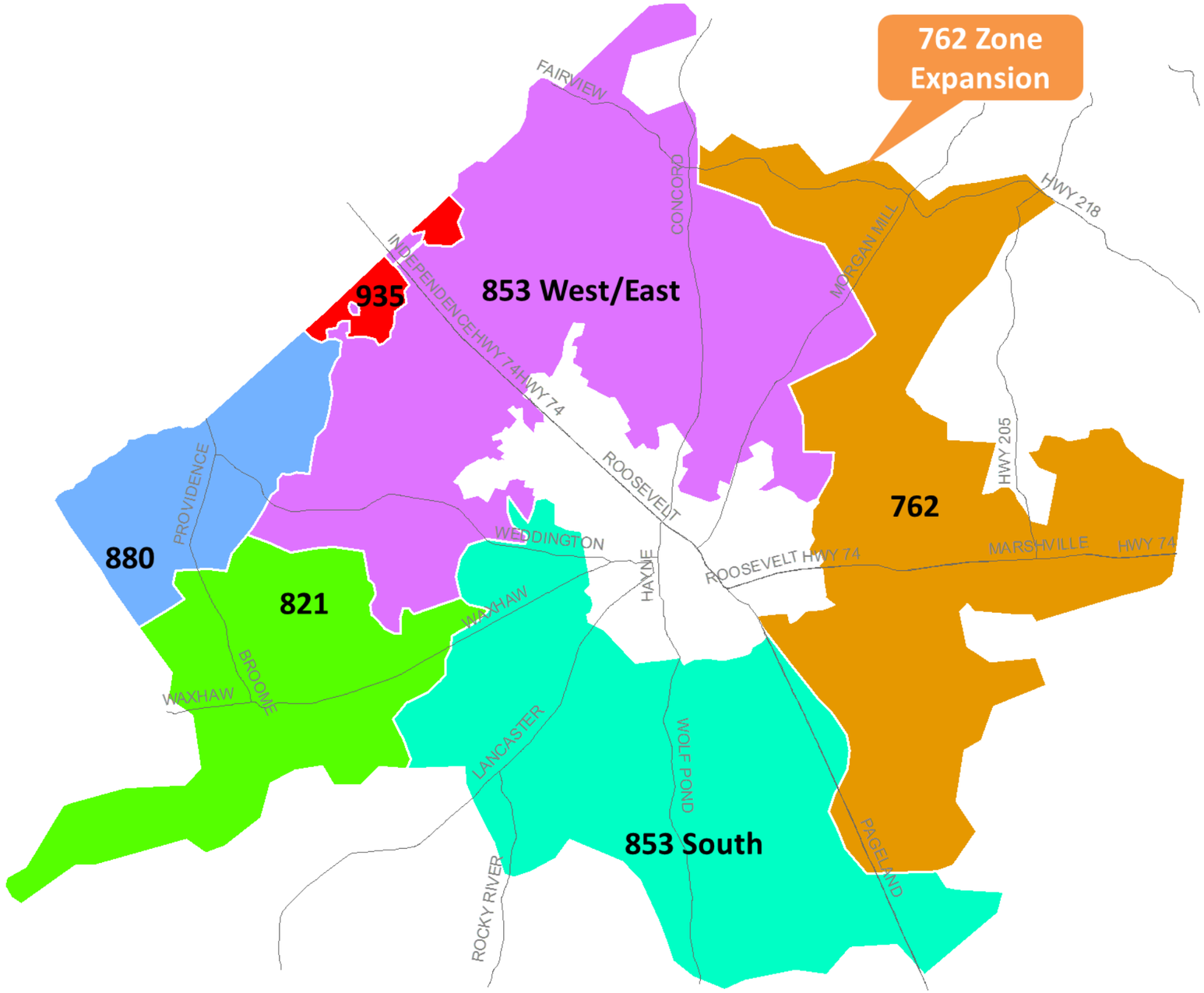


Figure 1-4 Recommended Pressure Zone Boundaries in 2022

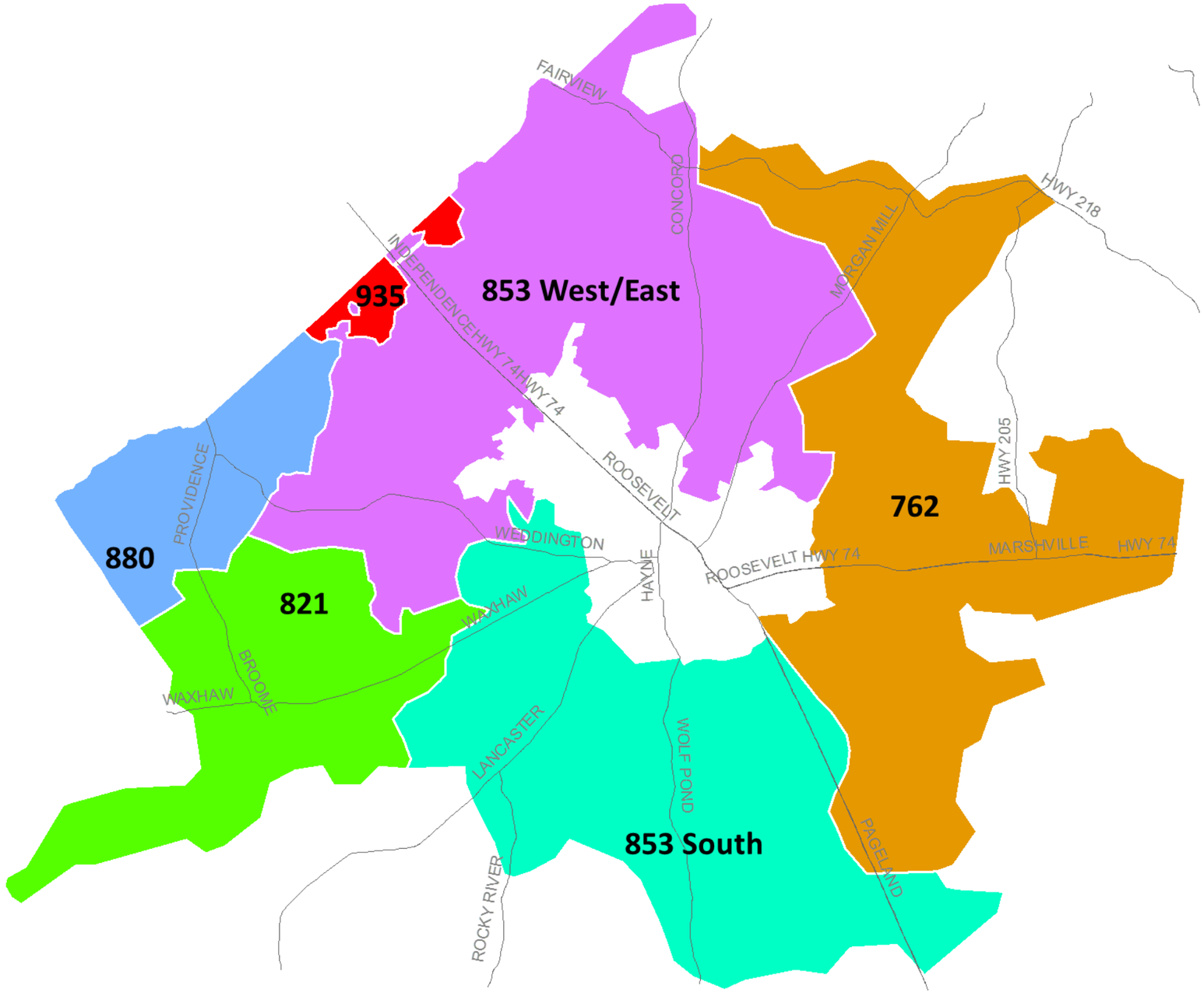


Figure 1-5 Recommended Pressure Zone Boundaries in 2030

The impacts of the pressure zone changes described above as well as the adjusted Future-Year ADD are detailed for each pressure zone below:

762 Zone

Figure 1-6 displays the 762 Zone Future-Year ADD by planning year. ADD in the 762 Zone is projected to increase through customer growth in 2015 and 2020. As shown in **Error! Reference source not found.**, the 762 Zone is planned to be expanded in 2022 to include a portion (0.28 mgd ADD) of the 853 East Zone to improve system pressures. Customer growth is also projected to occur in 2022 and 2030, with the 762 Zone ADD increasing by 180% between 2015 and 2030.

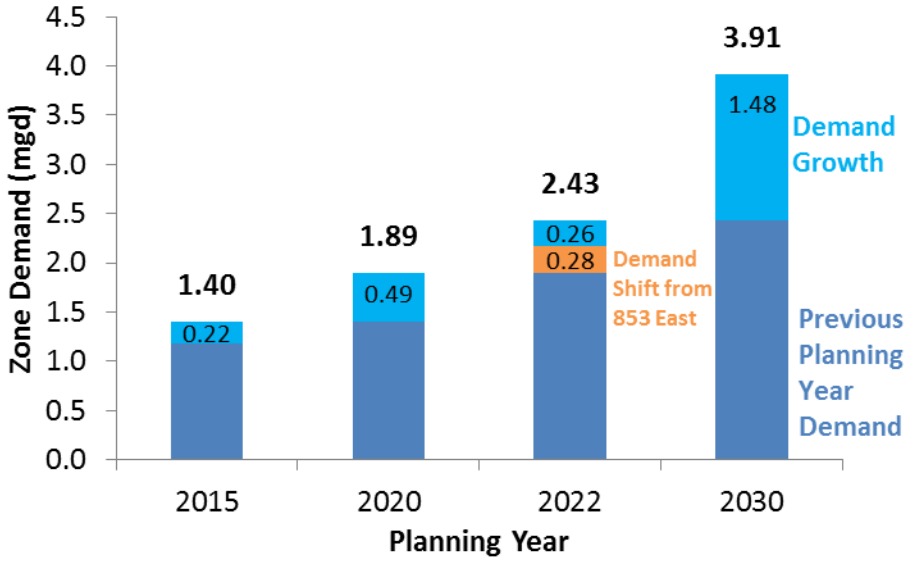


Figure 1-6 762 Zone Projected Average Day Demand

821 Zone

Figure 1-7 displays the 821 Zone Future-Year ADD by planning year. 2015 ADD in the 821 Zone represents the expanded 821 Zone following the addition of the 880 Zone and the retirement of the Waxhaw-Marvin Booster Pump Station. After 2015, 821 ADD is projected to increase through customer growth, increasing by more than 90% between 2015 and 2030.

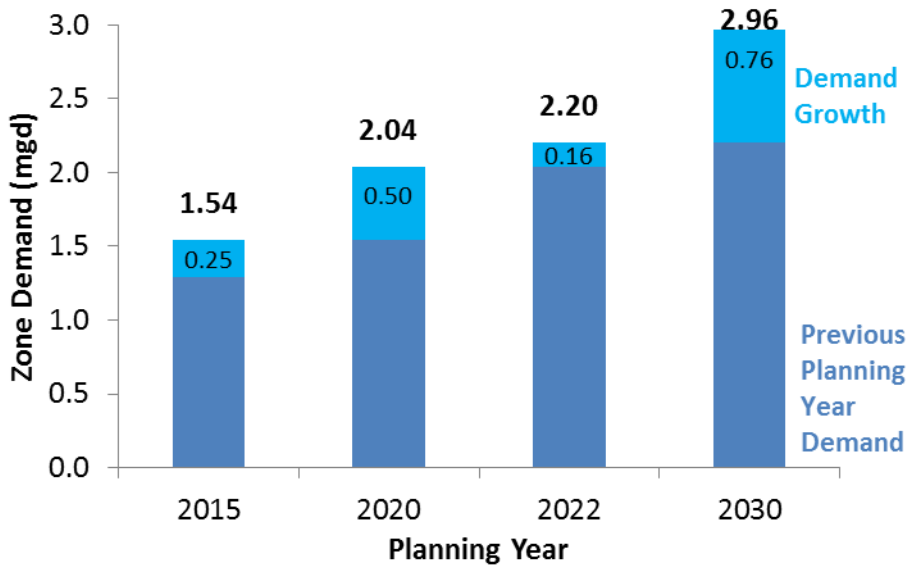


Figure 1-7 821 Zone Projected Average Day Demand

880 Zone

Figure 1-8 displays the 880 Zone Future-Year Demands by planning year. 2015 demands in the 880 Zone represent the new 880 Zone. After 2015, the 880 Zone ADD is projected to increase through customer growth, increasing by approximately 16% between 2015 and 2030.

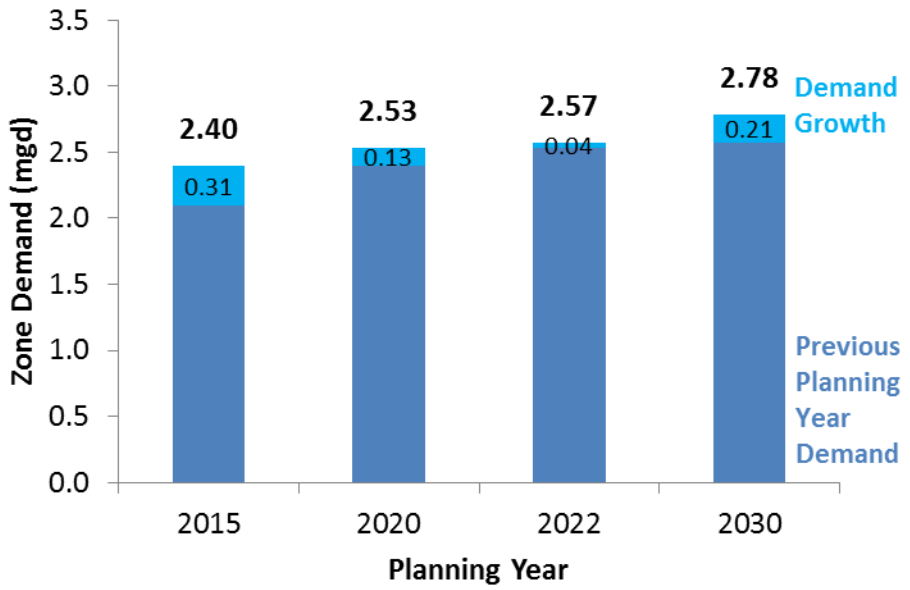


Figure 1-8 880 Zone Projected Average Day Demand

935 Zone

Figure 1-9 displays the 935 Zone Future-Year ADD by planning year. ADD in the 935 Zone is projected to increase through customer growth in 2015. As shown in Figure 1-3**Error! Reference source not found.**, the 935 Zone boundary is proposed to be modified by 2020 to enhance customer pressures and minimize energy usage. Approximately 0.26 mgd (including projected demand growth) are planned to be shifted from the 935 Zone to the 853 West / East Zone. Overall, ADD in the 935 Zone is projected to remain flat throughout the planning horizon as demand growth is mitigated by the reduction is pressure zone size. The exact extents of the modified 935 Zone should be confirmed with the 935 Zone Servicing Study recommended in the CIP.

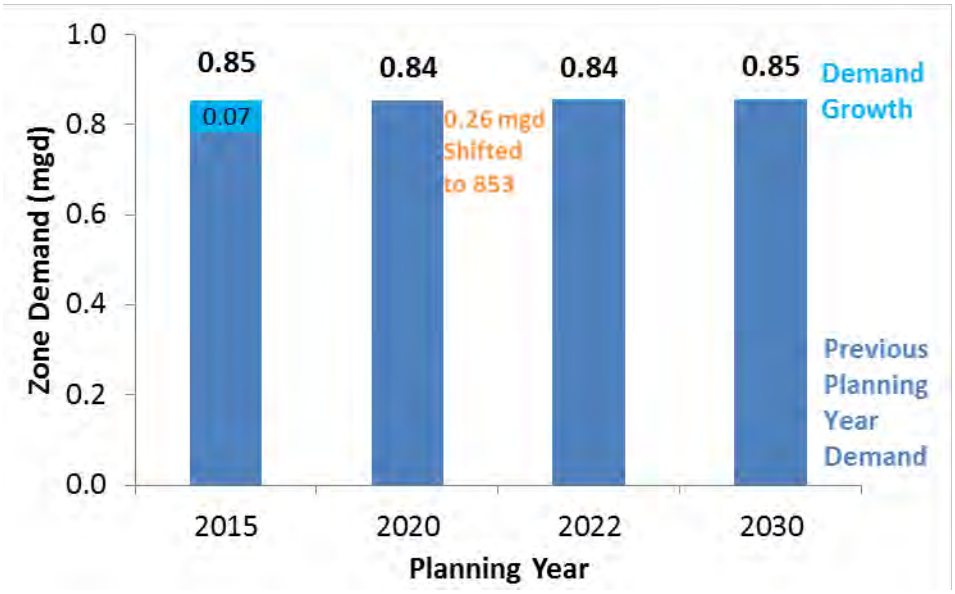


Figure 1-9 935 Zone Projected Average Day Demand

853 South Zone

Figure 1-10 displays the 853 South Zone Future-Year ADD by planning year. ADD in the 853 South Zone is projected to increase through customer growth, increasing by 95% between 2015 and 2030.

Based on discussions with UCPW, demand growth in recent years in the 853 South Zone has been significantly lower than the projections of the 2011 Comprehensive Master Plan and future growth in this zone is anticipated to remain flat through the next planning period. The analyses conducted as part of this planning update did not account for these significant reductions in demands and identified several CIP projects to be completed before 2020. These CIP projects previously identified to be required immediately have been deferred until after 2020. UCPW should continue to monitor demands in the 853 South Zone and initiate improvement projects as appropriate based on observed demand levels in the 853 South Zone.

It is noted that the demands shown in Figure 1-10 do not reflect a reduction below the projected demands summarized in Table 1-2.

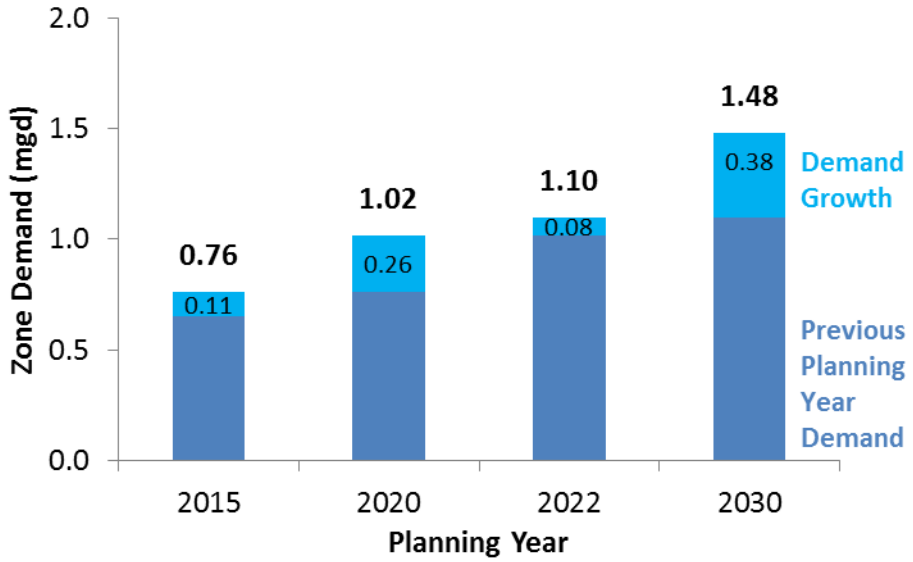


Figure 1-10 853 South Zone Projected Average Day Demand

853 West / East Zone

Due to supply limitations, which are discussed in detail in Chapter 4, and to improve water service reliability to customers in these zones, the 853 West and 853 East Zones may be combined into a single 853 West / East Zone by opening the zone boundary valves which currently isolate them. It is assumed that the two zones will be combined between 2016 and 2020. Figure 1-11 displays the projected ADD of the combined 853 West / East Zone by planning year. For 2015, the 853 West and East Zone ADD are shown separately, with the two zones ADD combined from 2020 onward. It is noted that the 853 West / East ADD in 2020 was increased by the 0.26 mgd planned to be shifted from the 935 Zone and reduced by the 0.28 mgd planned to be shifted to the 762 Zone in 2022.

ADD in the combined 853 West / East Zone is projected to increase through customer growth (and decrease by zone boundary shifts), overall increasing the zone demand by approximately 50% between 2015 and 2030.

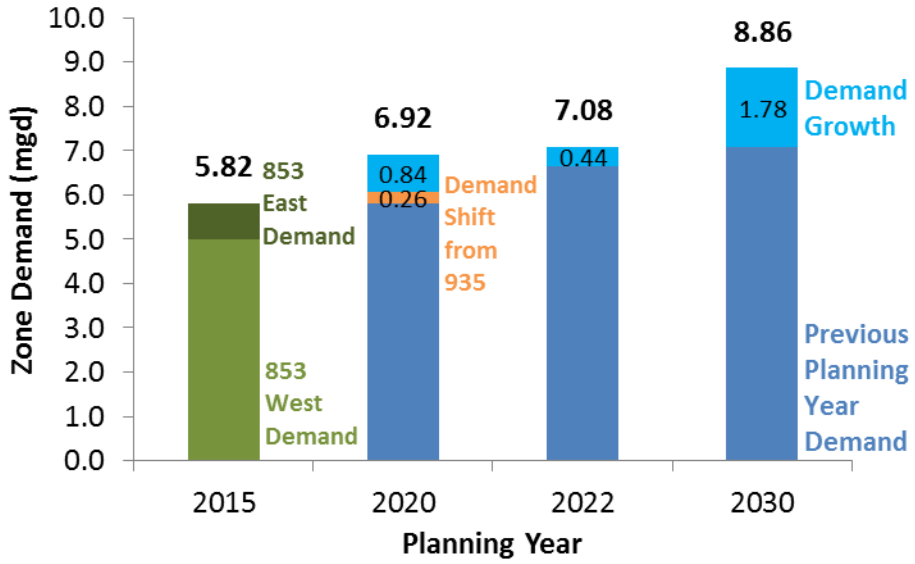


Figure 1-11 Combined 853 West / East Zone Projected Average Day Demand

1.1.4.3 Planning Year Demands

The projected ADD and MDD demands in each pressure zone are summarized in Table 1-4 and Table 1-5, respectively. Demands for 2022 were calculated by scaling the adjusted Future-Year ADD Growth to match the adjusted Future-Year Demand of 16.23 mgd shown in Table 1-2.

Table 1-4 Projected Average Day Demand by Pressure Zone

PRESSURE ZONE	2015	2020	2022[1]	2030
762	1.40	1.89	2.43	3.91
821	1.54	2.04	2.20	2.96
880	2.40	2.53	2.57	2.78
935	0.85	0.84	0.84	0.85
853 South	0.76	1.02	1.10	1.48
853 East	0.81	N/A	N/A	N/A
853 West	5.01	N/A	N/A	N/A
853 West / East	N/A	6.92	7.08	8.86
Total	**12.77**	**15.24**	**16.23**	**20.84**

[1]Demands for 2022 were calculated by scaling the adjusted Future-Year ADD Growth to match the adjusted Future-Year Demand of 16.23 mgd shown in Table 1-2.

Maximum Day Demands (MDD) were calculated using the 1.7 MDD:ADD peaking factor selected by HDR in the IBT Project. Based on information provided by UCPW, an additional MDD of 1.99 mgd (2.59 peak instantaneous) should also be planned for at the supply connection point to the City of Monroe in the 853 West Zone at the intersection of Rocky River Road and Highway 74 (Model Junction: J-10415).

Table 1-5 Projected Maximum Day Demand by Pressure Zone

PRESSURE ZONE	2015	2020	2022	2030
762	2.38	3.21	4.13	6.64
821	2.62	3.47	3.74	5.04
880	4.08	4.30	4.38	4.73
935	1.46	1.43	1.44	1.44
853 South	1.29	1.73	1.87	2.52
853 East	1.38	N/A	N/A	N/A
853 West[1]	10.51	N/A	N/A	N/A
853 West / East[1]	N/A	13.76	14.03	17.05
Total	**23.69**	**27.90**	**29.57**	**37.42**

[1]Includes 1.99 mgd supply to the City of Monroe

An average day Demand Alternative was created in the hydraulic model for each of the planning years. The names of the Demand Alternatives are shown below:

- *2015 ADD – IBT Adjusted (12.8 mgd)*
- *2020 ADD – IBT Adjusted (15.2 mgd)*
- *2022 ADD – IBT Adjusted (16.2 mgd)*
- *2030 ADD – IBT Adjusted (20.8 mgd)*

Maximum day demands were simulated by applying an Active Demand Adjustment of 1.7 to all model nodes.

For each pressure zone, demands were assigned to model nodes with up to five categories to allow for transparency of the water usage type which make up the total demand for each node. The demand category names are summarized below, using the 821 Zone as an example:

- *821 – Consumption (2012):* Base Average Day Demand
- *821 – NRW (2012):* Base NRW
- *821 – Proj. Consum. (2015):* Adjusted demand growth (including NRW) between 2012 and 2015
- *821 – Proj. Consum. (2020):* Adjusted demand growth (including NRW) between 2015 and 2020
- *821 – Proj. Consum. (2030):* Adjusted demand growth (including NRW) between 2020 and 2030

1.1.5 Diurnal Demand Curves

The diurnal demand curves developed during the 2011 Comprehensive Master Plan were utilized and are summarized below and shown in Figure 1-12.

- **Pressure Zones:** "Best-fit" diurnal peaking factor curve based on historical hourly SCADA data
- **Wingate:** Since the Wingate water system includes their own storage facilities, it was assumed that water storage to equalize their peak demands is available within the Wingate system and not required to be provided by Union County
- **Pilgrim's Pride: It was assumed that** Pilgrim's Pride operates two eight-hour shifts per day (6am to 10pm) and was peaked assuming a constant demand rate during the 16 hours of operation per day and zero demand during the remaining 8 hours

Diurnal demand curves were assigned to the model as "Hydraulic Patterns" and followed the nomenclature of the Demand Categories described in the previous section.

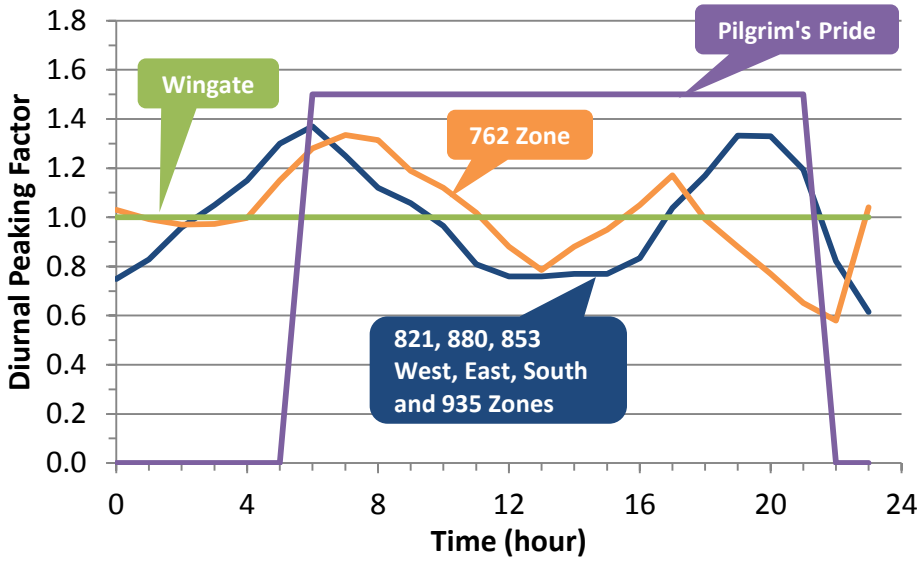


Figure 1-12 Diurnal Demand Curves Assumed for System Modeling

1.2 COMBINED 853 WEST / EAST ZONE MODEL CALIBRATION VERIFICATION

A full model calibration was completed as part of the Distribution System Water Quality Analyses in 2013, however, at that time the calibration was completed with the 853 West and 853 East Zone boundary closed. As part of the model update for this system planning update, a model calibration verification was performed which focused on the ability of the model to accurately reflect actual system conditions when the 853 West / East Zone boundary is open.

1.2.1 Calibration Day Selection

UCPW provided system-wide SCADA data for a 12-day period from March 10, 2015 to March 21, 2015. During this time period, the 853 West and East Boundary was open and the Olive Branch BPS was not operating. The criteria for selecting the day used for model calibration included:

- High demands to "stress" the system
- Weekday demands to reflect typical system demands that include commercial usage
- Reasonable tank operations between the Indian Trail, Stallings and Northwest Tanks

Each day of available SCADA data was evaluated with respect to the criteria as shown in Table 1-6. March 16th, 2015 – a day with a total system demand of 11.7 mgd – was selected as the calibration day.

Table 1-6 Calibration Day Selection

DATE	CATAWBA SUPPLY (MGD)	ANSON SUPPLY (MGD)	TOTAL DEMAND (MGD)	DAY OF WEEK	CALIBRATION DAY SELECTION NOTES
3/10/2015	9.9	3.1	13.0	Tuesday	Anomalous tank operations
3/11/2015	9.2	2.1	11.3	Wednesday	Lower demand than 3/16/15
3/12/2015	8.3	1.6	9.9	Thursday	Lower demand than 3/16/15
3/13/2015	8.2	1.6	9.9	Friday	Lower demand than 3/16/15
3/14/2015	8.8	0.7	9.5	Saturday	Weekend
3/15/2015	8.7	0.8	9.5	Sunday	Weekend
3/16/2015	9.6	2.0	11.7	Monday	Selected Calibration Day
3/17/2015	8.8	1.5	10.3	Tuesday	Lower demand than 3/16/15
3/18/2015	8.8	1.6	10.4	Wednesday	Lower demand than 3/16/15
3/19/2015	8.3	1.5	9.8	Thursday	Lower demand than 3/16/15
3/20/2015	8.8	1.3	10.0	Friday	Lower demand than 3/16/15
3/21/2015	9.0	0.7	9.7	Saturday	Weekend

Figure 1-13 displays the 853 West / East Zone tank levels on the selected calibration day of March 16th, 2015. As shown, the SCADA system recorded a significant (12 to 15 ft) difference between the Indian Trail/Stallings Tank levels and the Northwest Tank level, which is located at the far northern portion of the pressure zone as shown (as shown in Figure 1-14). This is due to the fact that when the Olive Branch BPS is not operating, water flowing to the Northwest Tank must travel a long distance across the county, resulting in significant total head losses in the 12-inch and 16-inch mains. A primary goal of this calibration was to ensure that the model accurately predicts this difference in operation between the Indian Trail/Stallings Tanks and the Northwest Tank.

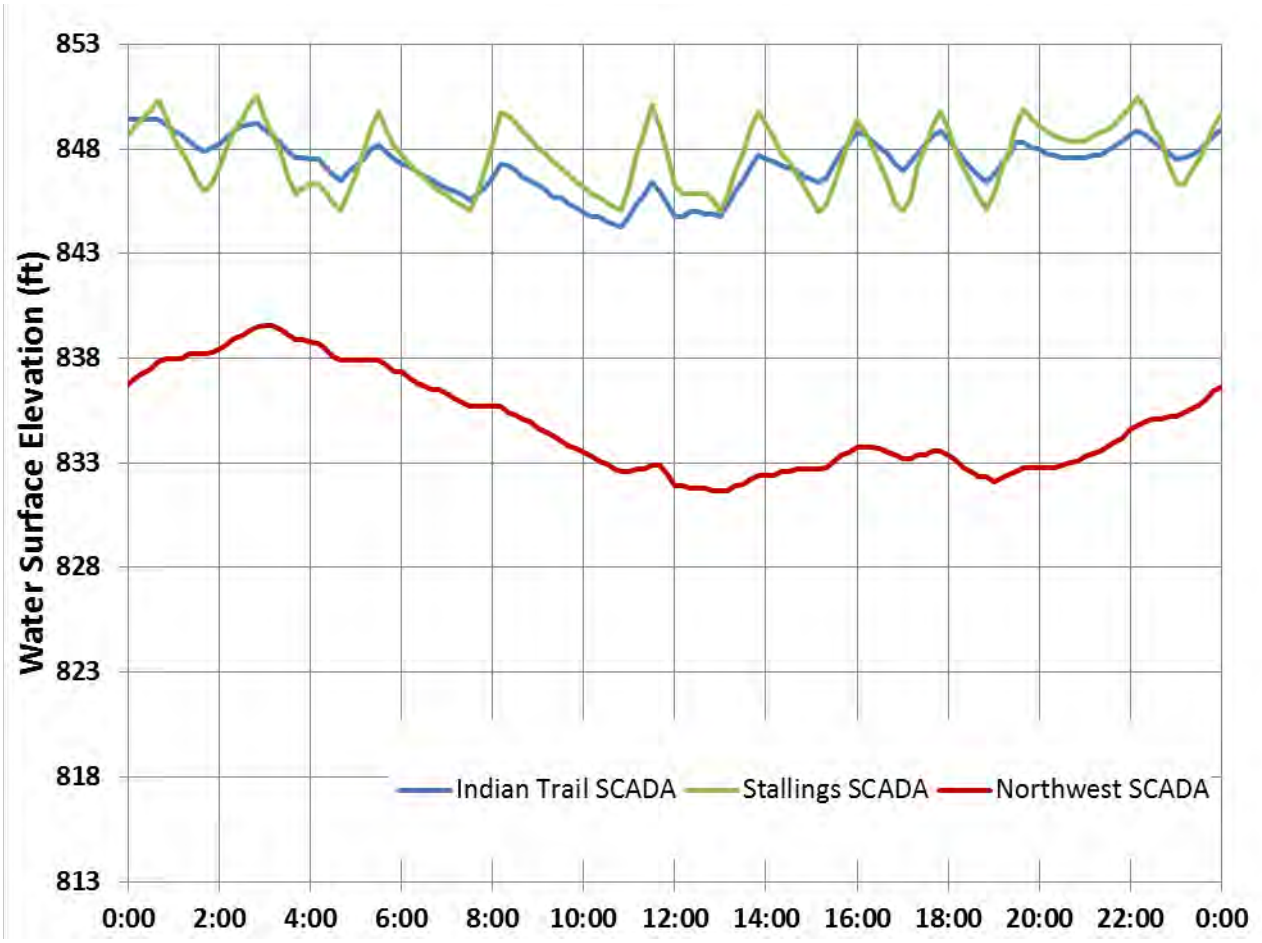


Figure 1-13 853 West / East Zone Tank Levels on Calibration Day

1.2.2 Active Model Topology

The goal of the model calibration for this project was to verify that the model accurately reflects the operation of the combined 853 West / East Zone. The calibration was focused using active topology to activate only the combined 853 West / East and 935 Zones (which is supplied from the 853 West / East Zone by the New Stallings BPS), as shown in Figure 1-14. With this active topology, the Watkins BPS, Waxhaw-Marvin BPS and New Stalling BPS were active, as well as the Indian Trail Tank, Stallings Tank, Northwest Tank and 935 Tank. It is noted that at the time of SCADA data collection, the 880 Zone was not yet established. In the future the 853 West / East Zone will be smaller than was reflected in this calibration.

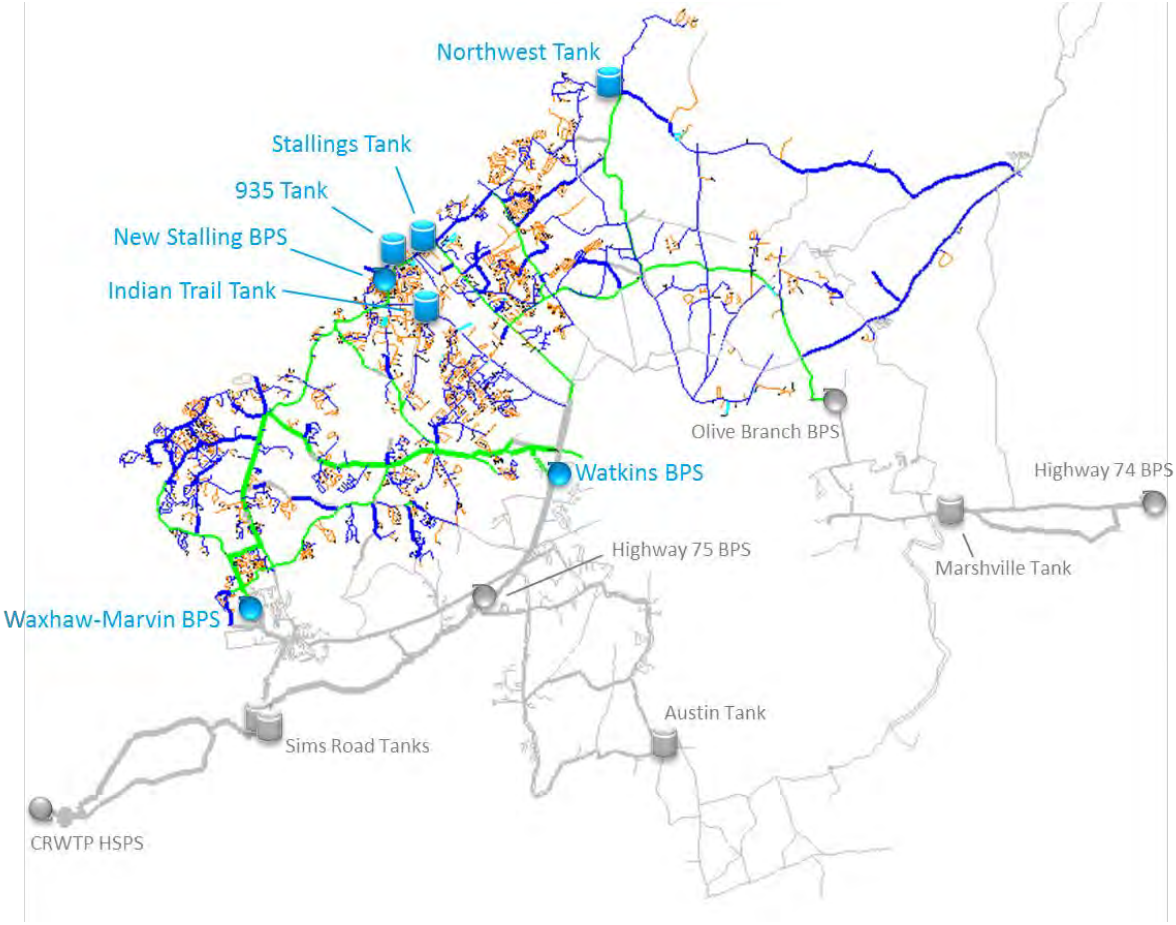


Figure 1-14 Active Model Topology for Calibration

1.2.3 Model C-Factors

During the all-pipes model calibration as part of the Distribution System Water Quality Analyses conducted in 2013, the following C-Factor Assignments were made in the model:

- Mains < 16-inch: C-Factor = 130
- Mains ≥ 16-inch: C-Factor = 140
- 24-inch Highway 74 BPS Discharge Main (to Marshville Tank): C-Factor = 150

The above C-Factors were utilized as the initial C-Factor assignments for this calibration verification.

1.2.4 Pump Station Flows

Ideally, each pump station in the distribution system would be equipped with a flow meter which would allow flows to be measured, recorded, and utilized in the calculation of zone-specific demands and peaking factors for use in model calibration. The Union County pump stations, however, (with the exception of the Watkins BPS) are not currently equipped with flow meters that are tied into the SCADA system. In order to estimate pump station flows at the Waxhaw-Marvin BPS and New Stallings BPS for use in calibration, SCADA records reporting pump status and suction and discharge pressures were used in conjunction with the available pump curves to estimate flows during the calibration period.

Because the combined 853 West / East Zone was the focus of this calibration and the 821 Zone was not active, suction pressures at the Watkins BPS and Waxhaw-Marvin BPS were modeled as varying hydraulic grade lines based on the SCADA data.

1.2.4.1 Watkins BPS Pump Curve Adjustment

Based on a review of the suction pressure, discharge pressure and flow meter SCADA data provided by UCPW, it was observed that the Watkins BPS was not producing flows as predicted by the manufacturer pump curve. Using the suction and discharge pressure in conjunction with the flow meter readings, Total Dynamic Head (TDH) versus Flow data points were plotted as shown in Figure 1-15. As the data indicates, the original Watkins BPS pump curve does not pass through any of the plotted Flow/TDH points. In order to adjust the model to simulate how the Watkins BPS was operating, the Watkins BPS pump curves were corrected by subtracting 22 ft from each point on the pump curve, as shown by the orange line in Figure 1-15.

A variety of factors could explain the observed reduction in the Watkins BPS pump curve, including worn impellers and/or partially throttled suction or discharge valves. Closer study of the Watkins BPS, including in-situ pump testing, should be completed as part of the Watkins BPS Pump Modifications (853W-P-01) project in the CIP.

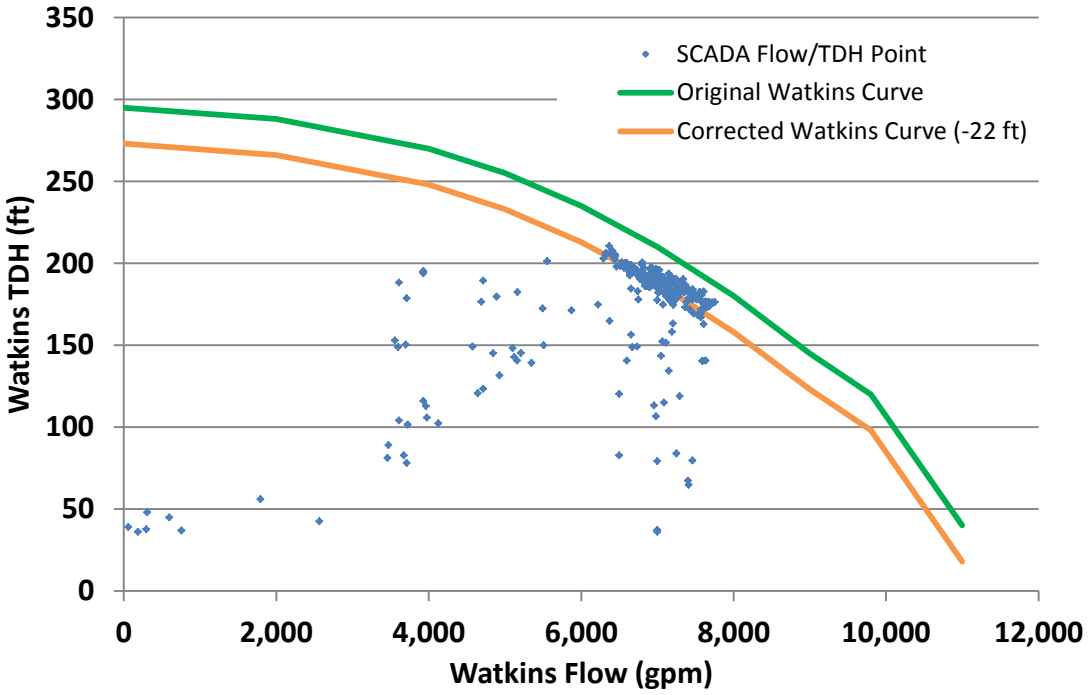


Figure 1-15 Watkins BPS Pump Curve Adjustment

1.2.5 Diurnal Demand Curve Development

Because the SCADA data was available in 10 minute intervals, Extended Period Simulation (EPS) calibration was likewise conducted at 10 minute time steps. In order to conduct a 24-hour EPS calibration, it was necessary to calculate the system demands (853 West / East and 935 zones only) at each of the 144 distinct simulation time steps. This was accomplished through a mass-balance calculation utilizing the available SCADA data to relate estimated pump station flows and changing tank levels (converted to flow rates) to zone-specific demands:

Combined 853 West / East Zone Demand =

Watkins BPS Flow + Waxhaw-Marvin BPS Flow+ ΔIndian Trail Tank Level + ΔStallings Tank Level + ΔNorthwest Tank Level – New Stallings BPS Flow

935 Zone Demand =

New Stallings BPS Flow + Δ935 Tank Level

Based on the mass balance calculations above, time-specific zone demands were calculated for each of the time steps during the calibration day of March 16th, 2015 as shown in Figure 1-16.

	Watkins Road BPS (Flow)	Watkins Estimated Flow	Waxhaw Marvin Estimated Flow	New Stallings Estimated Flow Rate	Olive Branch Estimated Flow Rate	Indian Trail Tank Flow	Stallings Tank Flow	Northwest Tank Flow	853 West/East Zone Demand	853 West/East Peaking Factor
	[gpm]	*[gpm]*	*[gpm]*	*[gpm]*	*[gpm]*	*[gpm]*	*[gpm]*	*[gpm]*	*[gpm]*	
3/16/2015 0:00	0	0	5,286	-1,219	0	-76	-677	-804	2,509	0.418
3/16/2015 0:10	0	0	5,274	-1,215	0	0	-903	-965	2,190	0.365
3/16/2015 0:20	0	0	5,269	-1,214	0	0	-903	-804	2,348	0.392
3/16/2015 0:30	0	0	5,269	-1,212	0	0	-790	-643	2,623	0.438
3/16/2015 0:40	0	0	4,497	-1,208	0	0	-1,129	-1,126	1,034	0.173
3/16/2015 0:50	0	0	0	-1,112	0	152	1,807	-483	365	0.061
3/16/2015 1:00	0	0	0	-576	0	228	2,371	0	2,023	0.338
3/16/2015 1:10	0	0	0	0	0	152	1,355	0	1,507	0.251
3/16/2015 1:20	0	0	0	0	0	228	1,355	-643	940	0.157
3/16/2015 1:30	0	0	0	0	0	228	1,807	0	2,035	0.339
3/16/2015 1:40	0	0	3,225	0	0	152	1,129	0	4,507	0.752
3/16/2015 1:50	0	0	5,382	0	0	-152	-790	-322	4,118	0.687
3/16/2015 2:00	0	0	5,391	0	0	-114	-1,920	-483	2,874	0.479
3/16/2015 2:10	0	0	5,391	0	0	-228	-2,032	-643	2,486	0.415
3/16/2015 2:20	0	0	5,372	0	0	-228	-1,694	-965	2,484	0.414
3/16/2015 2:30	0	0	5,372	0	0	-190	-1,242	-483	3,457	0.577
3/16/2015 2:40	0	0	5,372	0	0	-76	-1,581	-643	3,071	0.512
3/16/2015 2:50	0	0	4,132	0	0	-38	-1,016	-643	2,434	0.406
3/16/2015 3:00	0	0	0	0	0	228	2,371	-322	2,278	0.380

Figure 1-16 Example 853 West / East Zone Demand Calculation

Based on the zone-specific demand calculations described above, diurnal peaking factor curves were developed by dividing the demand in each time step by the average zone-specific demand on that day. These curves are shown in Figure 1-17 and Figure 1-18 for the combined 853 West / East Zone and 935 Zone, respectively.

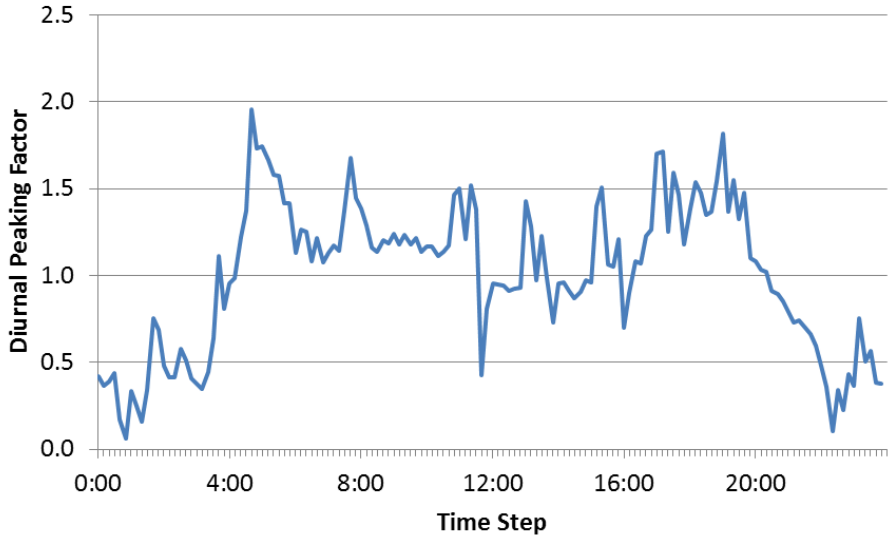


Figure 1-17 Combined 853 West / East Zone Calibration Diurnal Peaking Factor Curve

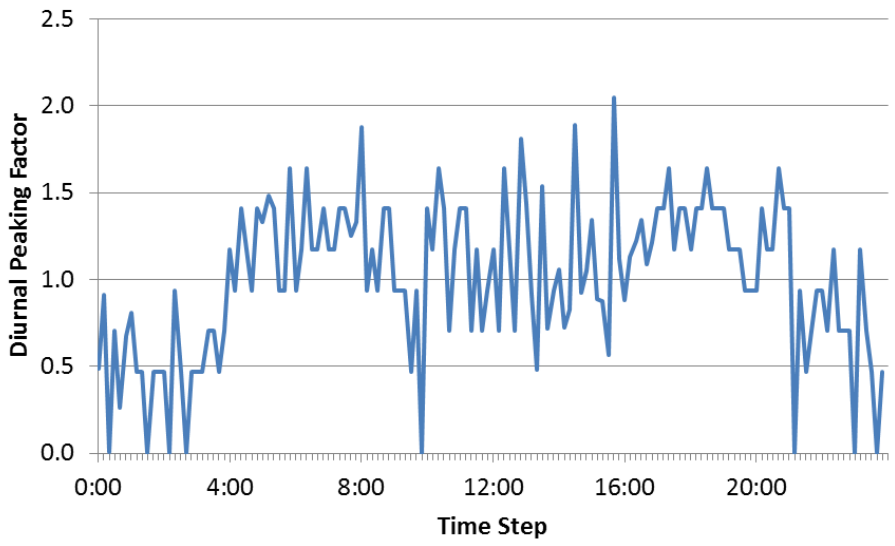


Figure 1-18 935 Zone Calibration Diurnal Peaking Factor Curve

1.2.6 EPS Calibration Model System Set-Up

In order to simulate the actual system conditions in the combined 853 West / East Zone on March 16th, 2015, the hydraulic model was updated as follows:

- A new model scenario, *2015 MP – Calibration 3/16/*15 was created in the WaterGEMS hydraulic model.
- C-Factors were initialized for all pipes as described in Model C-Factors section.
- Active topology was adjusted such that only the combined 853 West / East Zone and 935 Zone were active.
- The adjusted 2015 average day demand alternative (*2015 ADD – IBT Reduced (12.8 mgd)*) were scaled to match the zone-specific demands calculated on the Calibration Day: 8.63 mgd in the 853 West / East Zone and 0.45 mgd in the 935 Zone. A new demand alternative was created: *Calibration 3/16/15*.
- Calculated diurnal demand curves were entered into the model as Hydraulic Patterns: *853 West / East – Calibration (3/16/15)* and *935 – Calibration (3/16/15)*.
- Reservoirs were added to simulate suction hydraulic grade lines at the Waxhaw-Marvin and Watkins BPS. The suction grades were entered into the model as Reservoir Patterns: *Watkins Suction Grade (Calibration 3/16/15)* and *Waxhaw Suction Grade (Calibration 3/16/15).*
- Pumps were set to operate using time of day controls to pump during the hours which they operated (as indicated by pump status records and pump station flows in the SCADA data).
- Watkins BPS pumps were updated with a new pump curve, *Watkins PS (Adj. Down 22 ft)*, to reflect the observed reduction in the pump curve as described in the Pump Station Flows section.
- Tank levels at the Indian Trail, Stallings, Northwest and New Stallings Tanks were set to their initial starting level per the SCADA data.

1.2.7 Combined 853 West / East Zone Calibration Verification Model Adjustments

Following the updates outlined above, the hydraulic model was used to assess the current state of calibration. Based on iterative analysis the following adjustments to model parameters were found to be required:

1.2.7.1 C-Factors

Model C-Factors were not required to be adjusted as part of this calibration verification and remained the same as determined by the Distribution System Water Quality Analyses Calibration completed in 2013:

- Mains < 16-inch: C-Factor = 130
- Mains ≥ 16-inch: C-Factor = 140
- 24-inch Highway 74 BPS Discharge Main (to Marshville Tank): C-Factor = 150

1.2.7.2 Minor Losses

Based on previous conversations with UCPW, it was determined that it is likely that partially closed and/or closed valves exist in the vicinity of the Indian Trail Tank on some of the small diameter (6 and 8-inch) pipelines. Through iterative analysis, using the model calibration fill/drain rates of the Indian Trail Tank, the following minor losses were identified and added to the model:

- 8-inch Pipe to the East of the Indian Trail Tank (P-12165): Minor Loss of 200
- 6-inch Pipe to the West of the Indian Trail Tank (P-12175): Minor Loss of 2,000

Based on these finding and previous conversations with UCPW, all valves in the vicinity of the Indian Trail Tank should be field-verified and adjusted to be fully open to minimize hydraulic restrictions.

1.2.7.3 Pump Curves

As described in the Pump Station Flows section, the Watkins BPS pump curves were adjusted down 22 ft to match the Flow/TDH points recorded by the SCADA system.

1.2.8 Combined 853 West / East Zone Calibration Verification Results

Following the model adjustments described above, the model results were compared to the available SCADA data to verify the calibration of the combined 853 West / East Zone. For this calibration verification, a total of 10 points of calibration (Tank Levels, Pressures, Flows) were available throughout the combined 853 West / East and 935 Zones.

1.2.8.1 Tank Level Calibration Verification

Figure 1-19 displays a comparison of recorded SCADA data and model-predicted tank levels at the three tanks in the 853 West / East Zone. As shown, the model predicts the tank level variations very well, including simulation of the lower levels at the Northwest Tank as compared to the Indian Trail and Stallings Tanks. This is the key observation that indicates the model accurately simulates the combined 853 West / East Zone.

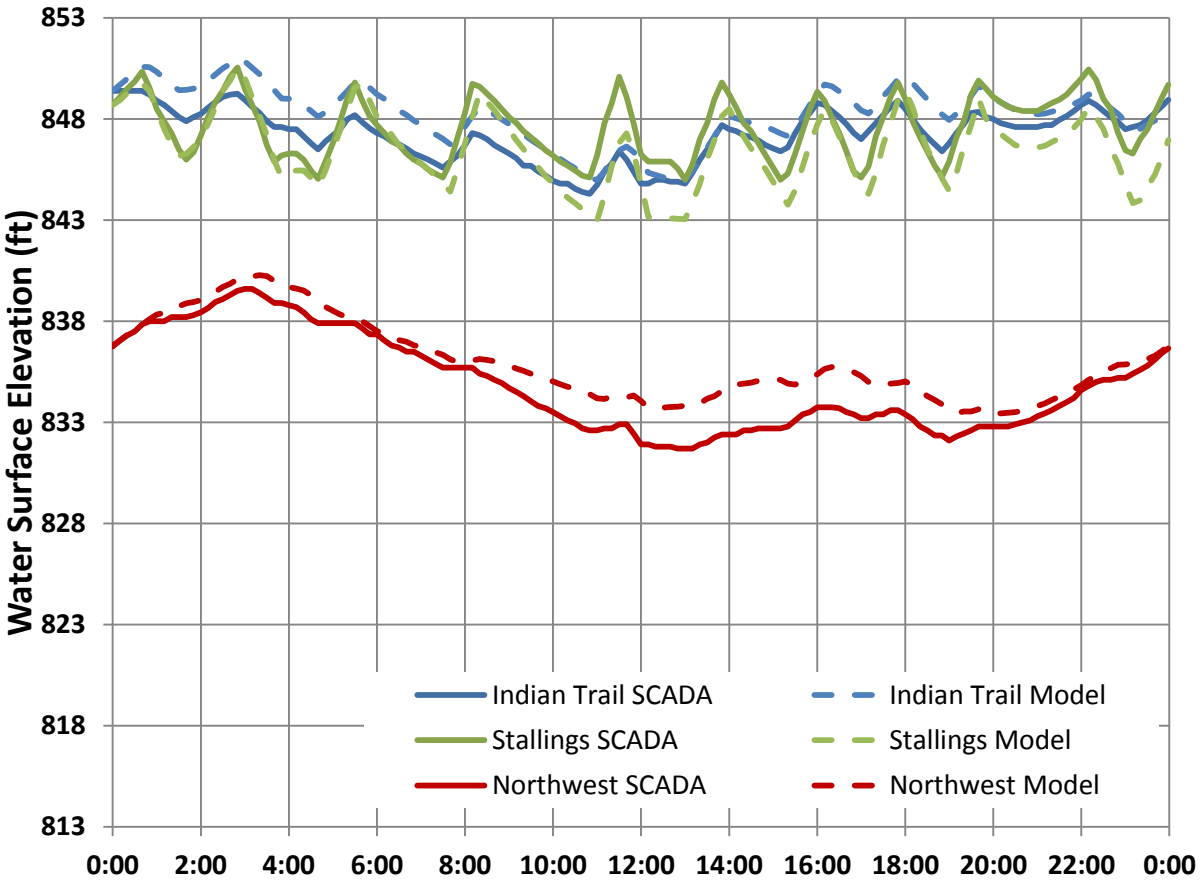


Figure 1-19 853 West / East Tank Level Calibration Verification

1.2.8.2 Pump Station Flow Calibration Verification

Figure 1-20, Figure 1-21 and Figure 1-22 display a comparison of recorded SCADA data and model-predicted pump station flows at the Waxhaw-Marvin, Watkins and New Stallings BPS, the three pump stations which either supplied or drew from the combined 853 West / East Zone during the calibration day. As shown, the model predicts the pump station flows throughout the day to satisfactory degree of accuracy. Further enhancement to model calibration could be attained by UCPW in the future following the completion of in-situ pump tests for the distribution system pumps.

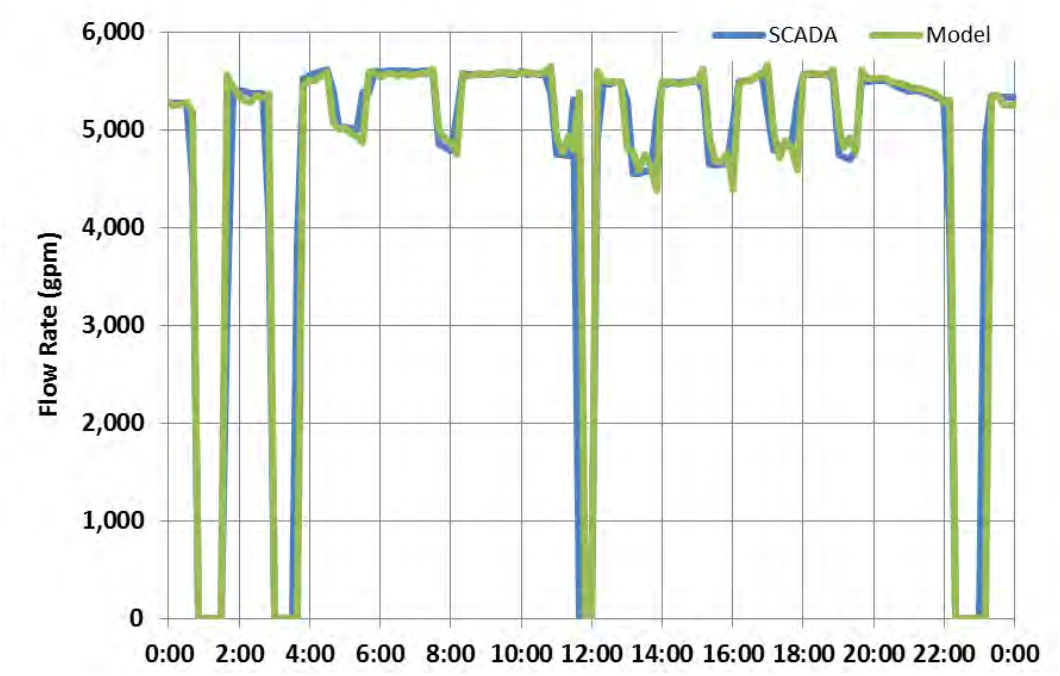


Figure 1-20 Waxhaw-Marvin BPS Flow Calibration Verification

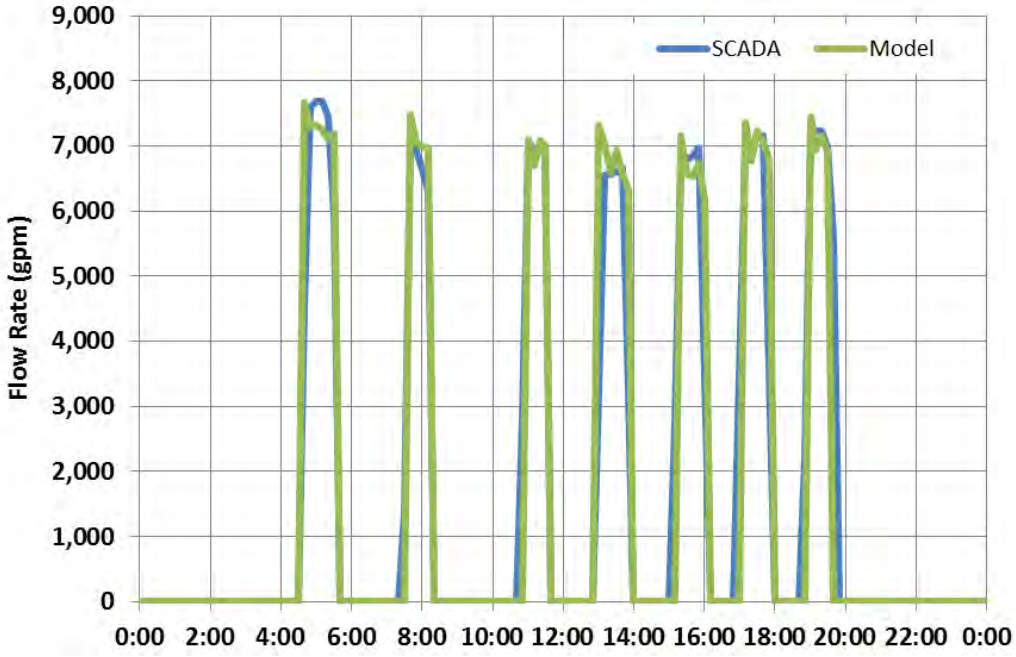


Figure 1-21 Watkins BPS Flow Calibration Verification

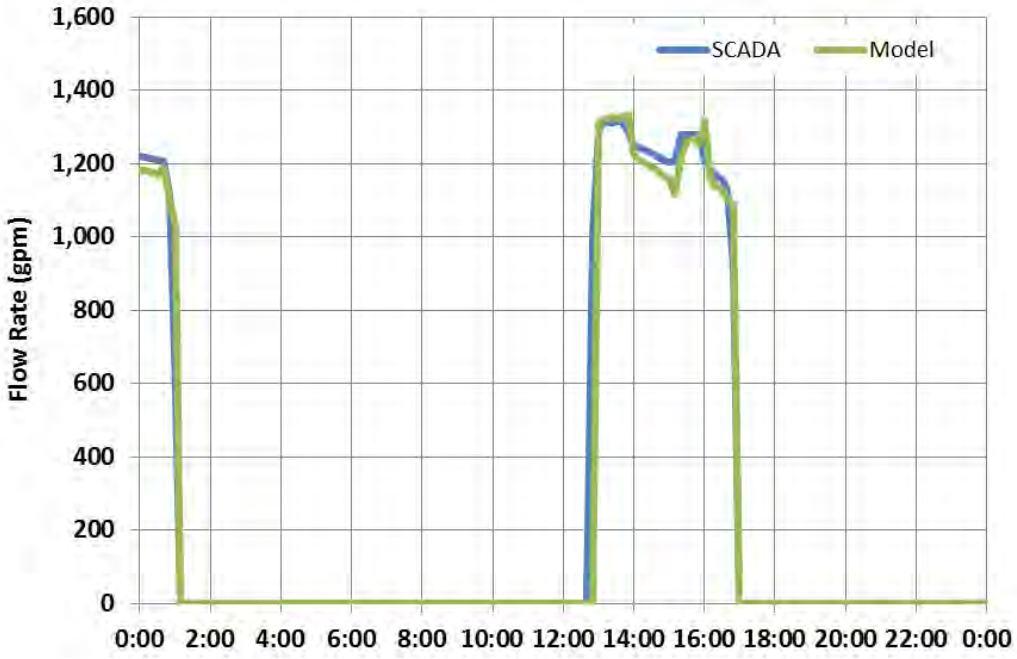


Figure 1-22 New Stalling BPS Flow Calibration Verification

1.2.8.3 Hydraulic Grade Line Calibration Verification

Figure 1-23, Figure 1-24, Figure 1-25 and Figure 1-26 display a comparison of recorded SCADA data and model-predicted hydraulic grade lines (HGLs) at the Waxhaw-Marvin BPS discharge, New Stallings BPS suction, Watkins BPS discharge and Olive Branch BPS discharge, the four locations in the combined 853 West / East Zone where SCADA pressures are recorded. As shown, the model predicts HGLs throughout the day to a satisfactory degree of accuracy. Further enhancement to model calibration could be attained by UCPW in the future following the completion of in-situ pump tests for distribution system pumps, pressure monitoring throughout the system, and hydrant capacity testing.

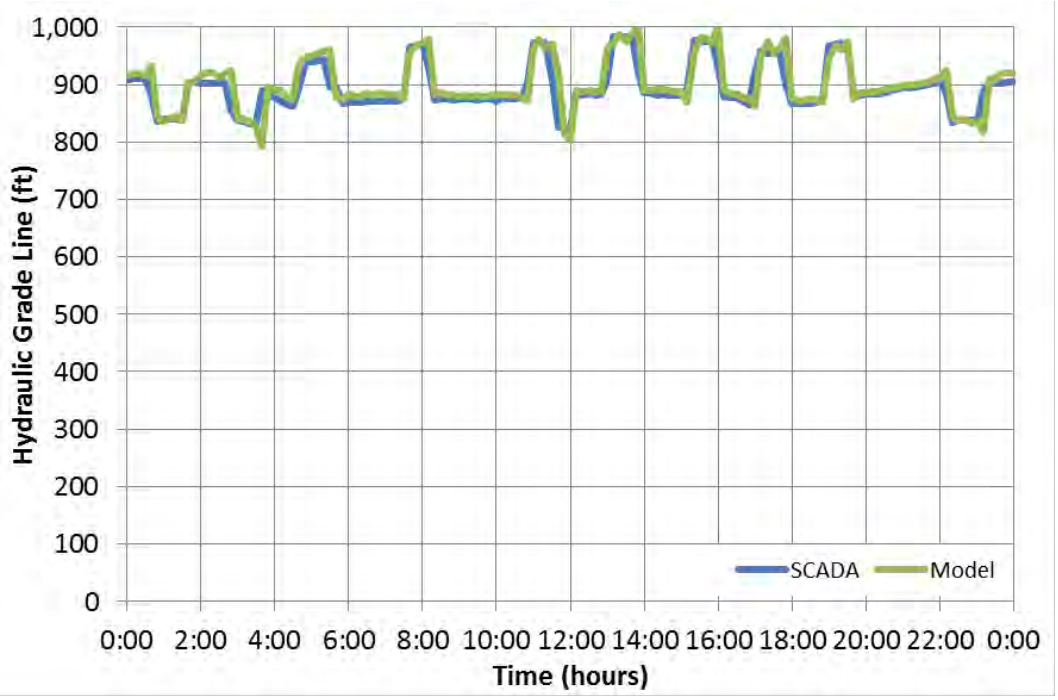


Figure 1-23 Waxhaw-Marvin BPS Discharge HGL Calibration Verification

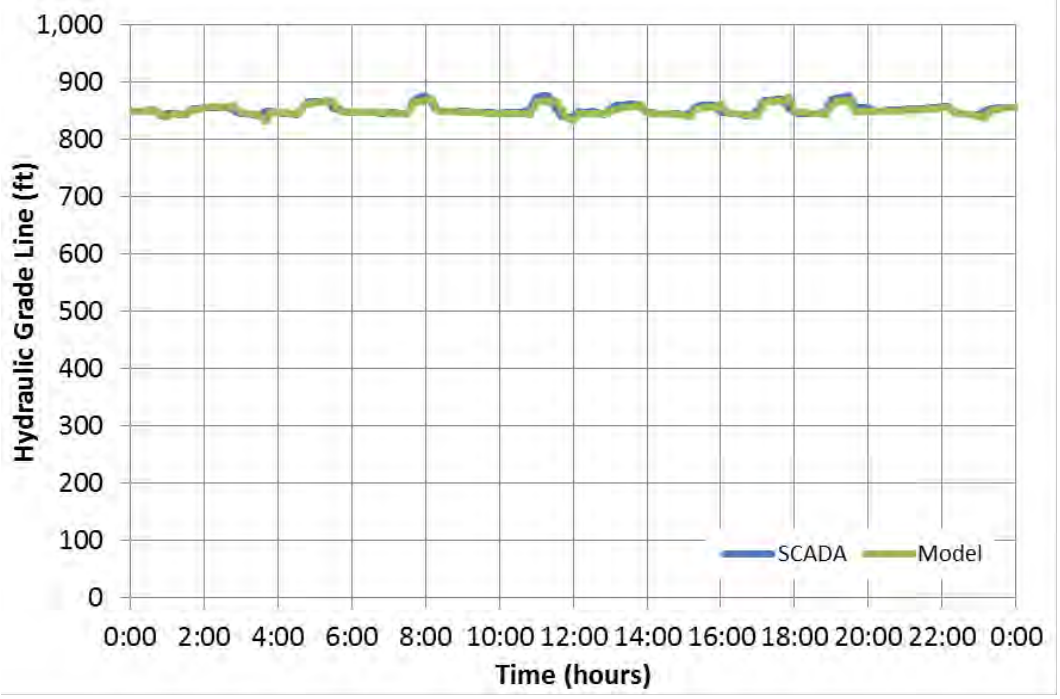


Figure 1-24 New Stalling BPS Suction HGL Calibration Verification

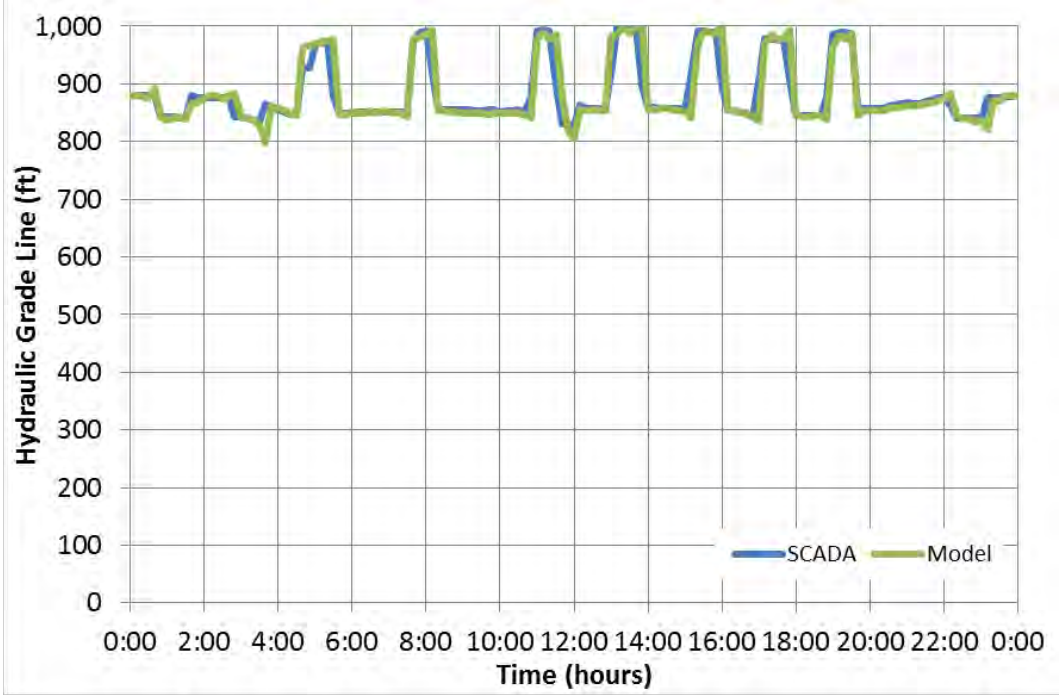


Figure 1-25 Watkins BPS Discharge HGL Calibration Verification

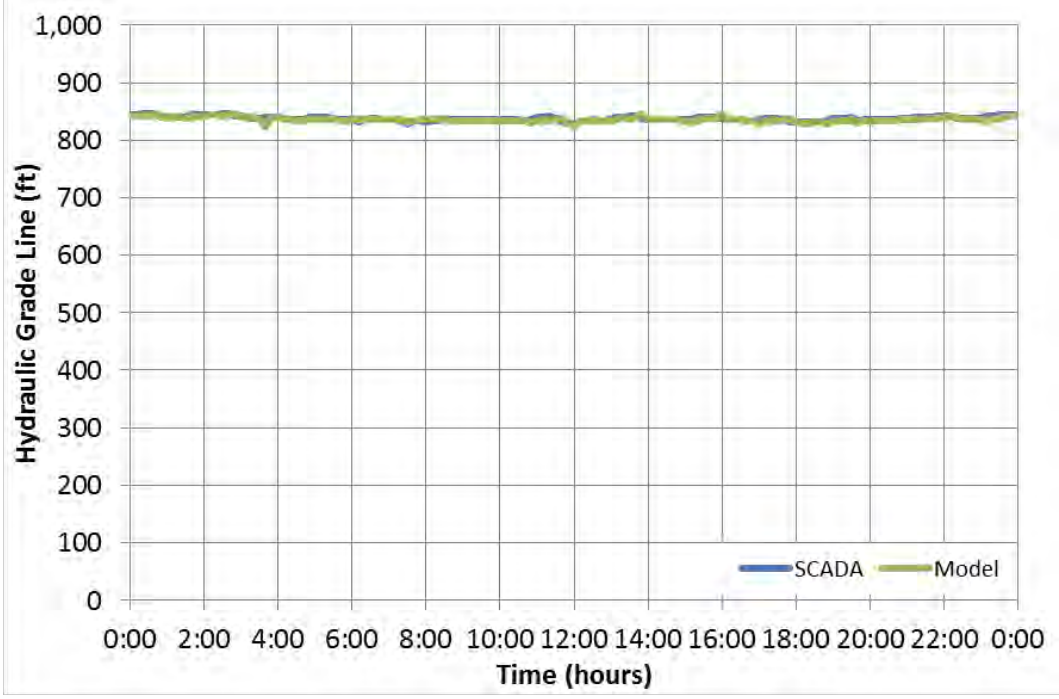


Figure 1-26 Olive Branch BPS Discharge HGL Calibration Verification

Based on the model calibration verification results presented above, the updated Union County hydraulic model has been verified to accurately simulate actual system conditions in the combined 853 West / East pressure zone. This indicates that the model can be confidently used as a planning tool for this system planning update. It is noted that further detailed model calibration activities – including in-situ pump testing, a robust pressure monitoring program throughout the distribution system, and hydrant capacity field tests – could be performed by UCPW in the future to facilitate more detailed distribution-level modeling.

2.0 Capacity Analysis for the New Yadkin River WTP

Union County does not have any measurable water supply resources within the county boundaries. Union County is positioned, however, in relative close proximity to the Catawba River to the west and the Yadkin River to the east. Union County Public Works (UCPW) currently utilizes the Catawba River for the majority of their water supply. Water from the Catawba River is withdrawn, treated, and pumped to Union County from the Catawba River Water Treatment Plant (CRWTP), a joint venture facility equally owned by Union County and Lancaster County Water & Sewer District. The Catawba River Water Treatment Plant (CRWTP) has a current permitted capacity of 36 mgd, with 18 mgd dedicated to Union County.

Water demand within the UCPW water service area are projected to increase by more than 160% through planning year 2050, from a projected maximum day demand of approximately 24 mgd in 2015 (actual observed maximum day: 20.4 mgd) to approximately 63 mgd in 2050. With a demand increase of this magnitude coupled with establishing a more resilient water supply system, UCPW is actively pursuing the utilization of the Yadkin River as a second water supply source for the water system. A new Yadkin River Water Treatment Plant (YRWTP) is planned to be constructed in the northeastern area of Union County. UCPW has already contracted with the Town of Norwood to serve as a partner for a new water supply from Lake Tillery and are currently pursuing a new Yadkin to Rocky River IBT. The Rocky River is a subbasin of the Yadkin River. An IBT certificate is expected to be received in late 2016.

From the extensive work done while creating an Environmental Impact Statement in pursuit of an IBT certificate, the new YRWTP will need a 2050 treatment capacity of 28 mgd, with an initial capacity of 12 mgd followed by two expansions of 8 mgd each. This chapter documents the initial and phased capacity expansions of the new YRWTP and the corresponding phased capacity expansions of the CRWTP to meet system demands and to maintain IBT compliance of the system.

2.1 INTERBASIN TRANSFER LIMITATIONS

The UCPW Water Distribution System delivers water to customers within two river basins: the Catawba River Basin and the Rocky River subbasin of the Yadkin River Basin. Figure 2-1 displays the two basins as well as the extents of the planned future pressure zones through year 2030, which include the expanded 762 Zone and combined 853 West / East Zone. UCPW has a grandfathered 5 mgd Catawba to Rocky River IBT. As presented in the 2011 Comprehensive Master Plan, this Catawba to Rocky River IBT was planned to be expanded to 10 mgd and the facility improvements planned for both the water and wastewater systems were developed to maintain compliance within the anticipated 10 mgd Catawba to Rocky River IBT.

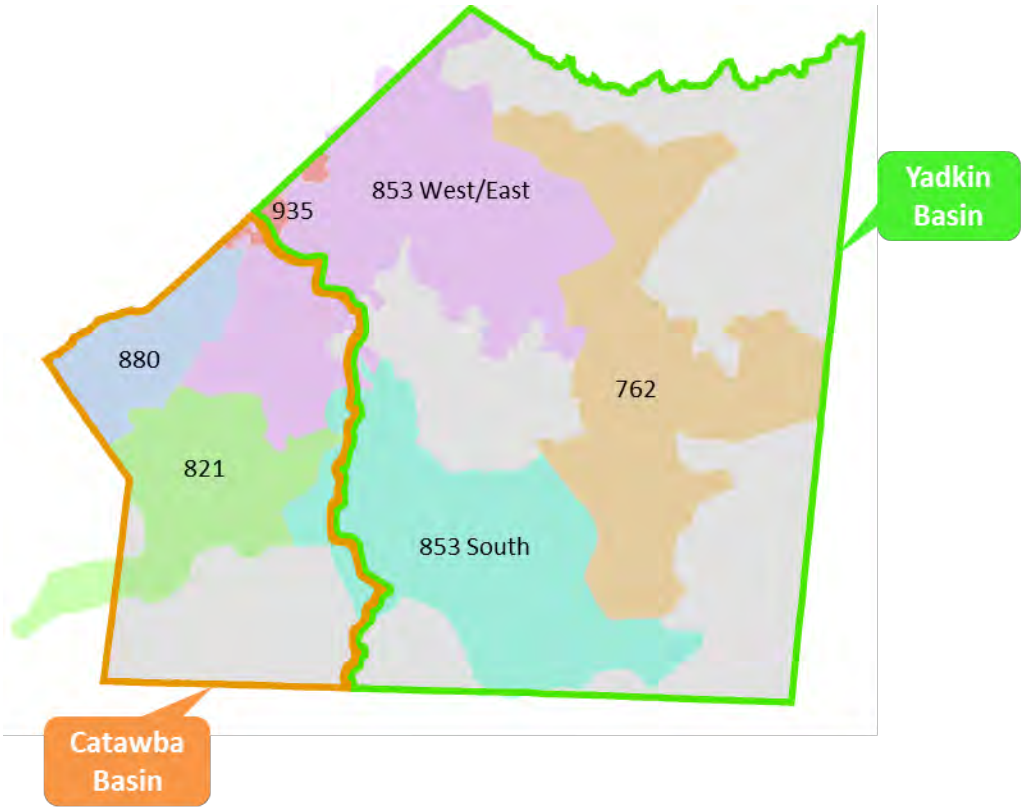


Figure 2-1 River Basins and 2030 Pressure Zones

After completing the 2011 Comprehensive Master Plan and evaluating the likelihood of obtaining an expanded IBT certificate from the Catawba to Rocky River, Union County decided to pursue the Yadkin River for additional capacity. With a new Yadkin River supply and YRWTP, the CRWTP can supply the Catawba Basin customers and the YRWTP can supply the Yadkin Basin customers. The grandfathered 5 mgd Catawba to Rocky River IBT will serve as a buffer to allow some flexibility in system operations between the two sides of the County and could help defer future expansions to the YRWTP.

2.2 CATAWBA AND YADKIN BASIN SUPPLY AND PROJECTED MAXIMUM DAY DEMAND

Water demand projections have been adjusted as described in detail in Chapter 1. As shown in Figure 2-2, County wide maximum day demands are projected to increase to more than 63 mgd by 2050, with the Yadkin Basin demand projected to increase from the current 10 mgd to to approximately 35 mgd and the Catawba Basin demand projected to increase from the current 13 mgd to 28 mgd. In order to meet the projected maximum day demands and maintain IBT compliance, the CRWTP must be expanded in the Catawba Basin and a new YRWTP must be constructed in the Yadkin Basin.

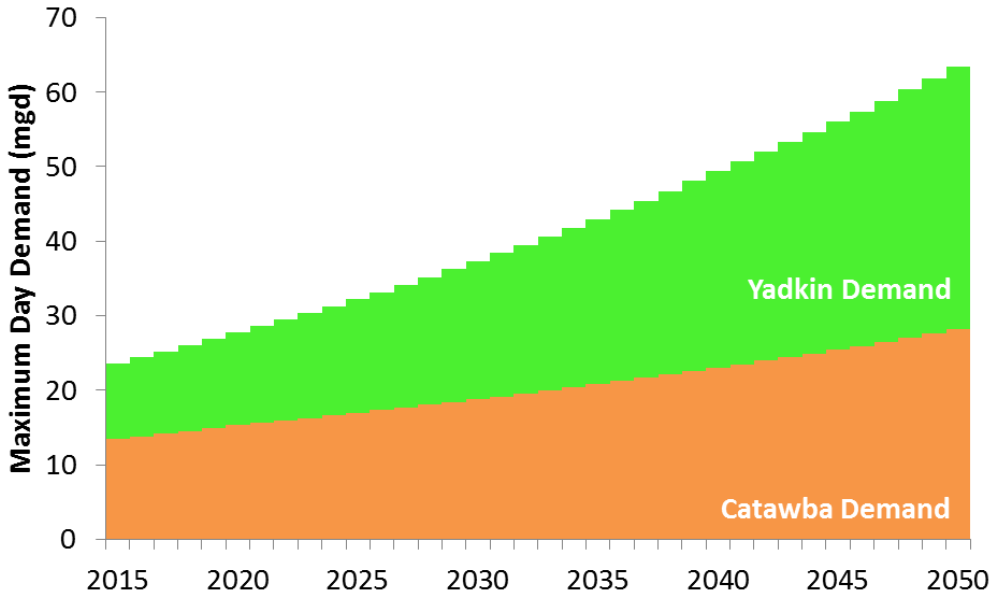


Figure 2-2 Total Projected Maximum Day Demand by Basin

2.2.1 Catawba Basin Supply and Demand

Currently, the CRWTP provides water to the majority of the distribution system. The CRWTP has a permitted capacity of 36 mgd, of which 18 mgd is owned by Union County. Union County has also contracted with their facility partner, Lancaster County Water & Sewer District, for a short-term lease of an additional 3 mgd of WTP capacity. This lease agreement is set to expire at the beginning of 2019.

Figure 2-3 displays the projected Catawba Basin maximum day demand compared to the currently contracted supply from CRWTP. As anticipated, the CRWTP is projected to maintain a surplus of supply through 2027 when only supplying the needs of the Catawba Basin Customers. To meet system demand in the Catawba Basin beyond 2027, an expansion of the CRWTP is recommended.

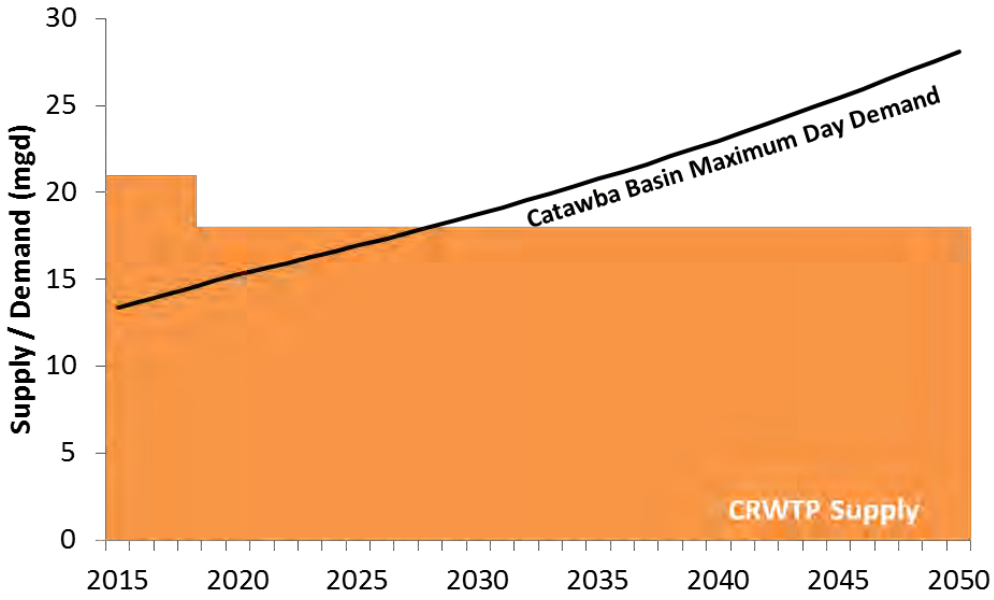


Figure 2-3 Currently Contracted CRWTP Supply and Projected Maximum Day Demand

2.2.2 Yadkin Basin Supply and Demand

Currently, the Yadkin Basin is supplied through a combination of water from the CRWTP and a bulk-sale agreement with Anson County, delivered to Union County by the Highway 74 Booster Pump Station in the 762 Zone. The existing agreement with Anson County is for 4 mgd. Due to hydraulic limitations within the Anson County system, only 3 mgd is typically available to be supplied to the Union County.

Figure 2-4 displays the projected Yadkin Basin maximum day demand compared to the available supply from Yadkin Basin sources. As shown, the Yadkin Basin is currently deficient in available supply by approximately 7 mgd. This deficiency is projected to increase to 16 mgd by 2030 and 32 mgd by 2050. Currently, the Catawba to Rocky River IBT covers this difference by utilizing the capacity at the CRWTP. The YRWTP is intended to replace this supply from the CRWTP.

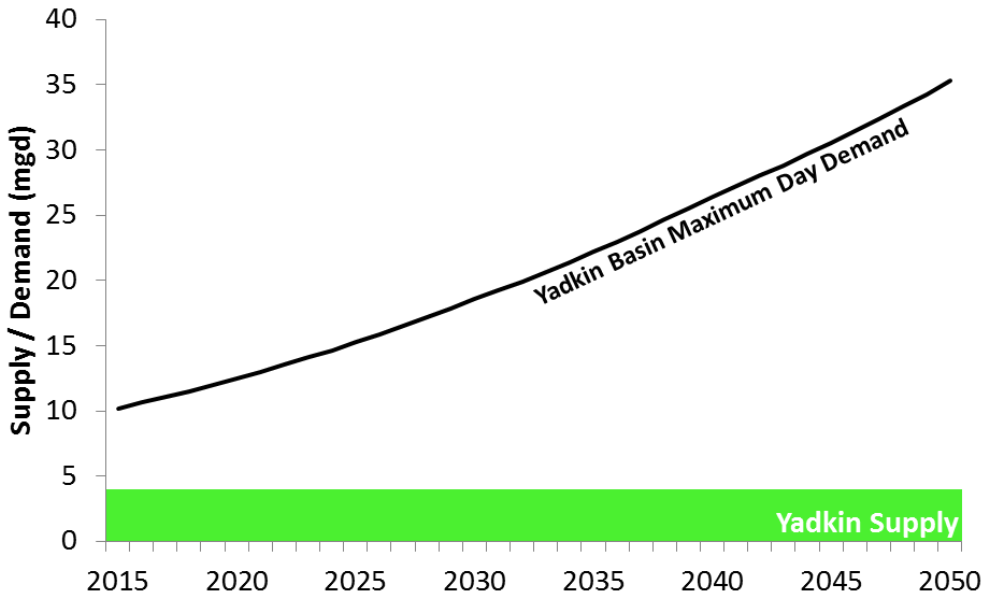


Figure 2-4 Yadkin Basin Supply and Projected Maximum Day Demand

2.3 PROPOSED WATER SUPPLY PROJECTS AND TIMING

As described in the previous section, additional water supply will be required in both the Catawba and Yadkin Basins to meet increasing maximum day system demands as well as to comply with the grandfathered 5 mgd Catawba to Rocky River IBT. With the time estimated to obtain a Yadkin to Rocky River IBT certificate as well as the time required to design, permit, and construct the new infrastructure and YRWTP, the earliest probabilistic completion for these new facilities in 2022. To meet overall system demands, the proposed timeline for water supply projects based on the work done for the Environmental Impact Statement for the Yadkin to Rocky River IBT is summarized below and shown in Figure 2-5.

Catawba Water Supply Projects

- 2018: CRWTP Expansion #1. Increase treatment capacity of CRWTP by 9 mgd to a total of 27 mgd
- 2039: CRWTP Expansion #2. Increase treatment capacity of CRWTP by 9 mgd to a total of 36 mgd

Yadkin Water Supply Projects

- 2022: YRWTP Initial Construction. Construct YRWTP with an initial capacity of 12 mgd
- 2032: YRWTP Expansion #1. Increase treatment capacity of CRWTP by 8 mgd to a total of 20 mgd
- 2044: YRWTP Expansion #2. Increase treatment capacity of CRWTP by 8 mgd to a total of 28 mgd

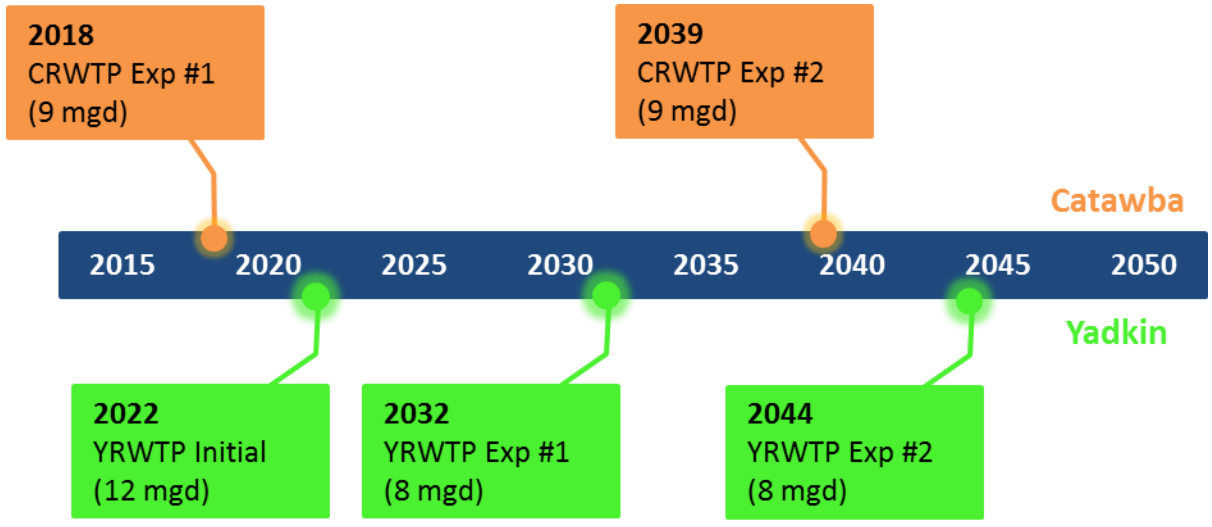


Figure 2-5 Proposed Water Supply Project Timeline

Figure 2-6 displays the ability of the proposed water supply projects to meet projected system-wide maximum day demands through planning year 2050. As shown, a minor near-term capacity deficiency is projected in 2017 until the CRWTP is expanded in 2018. If actual maximum day demands increase as projected, alternatives for addressing this minor near-term capacity deficiency include expanding the capacity of the current lease agreement with Lancaster County Water & Sewer District (pending available CRWTP capacity), interconnections with Charlotte Water (pending resolution of chlorine issues), and/or utilization of existing distribution system interconnections with Charlotte Water during peak day events.

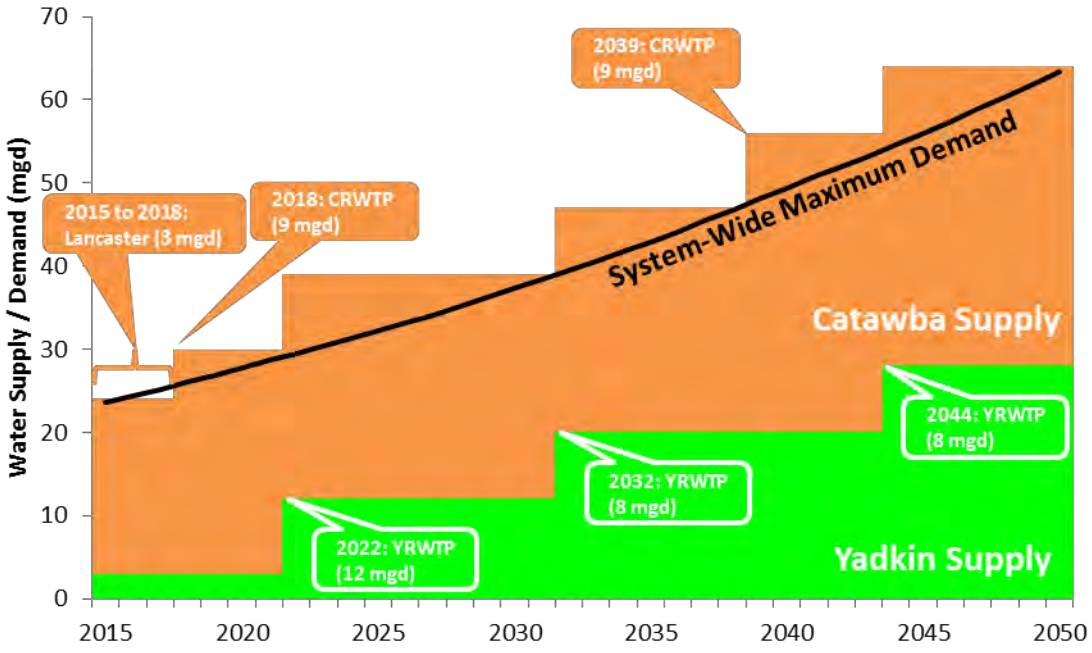


Figure 2-6 Proposed Water Supply Projects and Total Maximum Day Demands

3.0 New Yadkin River WTP Location and Distribution System Capacity Planning Update

As described in Chapter 2, UCPW is actively pursuing an IBT certificate to move water from Lake Tillery on the Yadkin River in Stanly County to Yadkin Basin customers in the Rocky River subbasin. A new Yadkin River Water Treatment Plant (YRWTP) is planned to be constructed in the northeastern area of Union County. UCPW has already contracted with the Town of Norwood to serve as a partner for the new water supply from Lake Tillery. This chapter details the analysis conducted as part of this project to evaluate three potential areas to locate the new YRWTP identified during the Environmental Impact Statement (EIS) for the IBT.

Following the evaluation of the YRWTP locations, a distribution system planning update was completed to:

- Determine water main diameters and approximate alignments to connect the new YRWTP to the existing distribution system
- Evaluate the 853 and 762 Zone boundaries to improve water service pressures and modify as needed
- Determine the recommended location and size of the New 762 Zone Tank
- Update system water supply, pumping, and storage capacity analyses
- Update distribution system modeling and pipeline capacity analyses

These analyses serve as the basis for this distribution system planning update as well as the detailed CIP projects described in Chapter 5.

3.1 LOCATION EVALUATION FOR NEW YADKIN RIVER WTP

During the development of the EIS and the IBT certificate process, alternative areas were identified and evaluated for suitability for the new YRWTP. From this study, three areas in the northeastern portion of Union County were identified as good candidate site areass for the new YRWTP that needed to be evaluated further for impacts to the distribution system UCPW provided B&V with the locations of these three candidate areas for further evaluation.

3.1.1 Potential YRWTP Site Areas

UCPW provided Black & Veatch with three potential areas for the YRWTP in the northeastern portion of Union County. These areas are described below and shown in Figure 3-1 and Figure 3-2.

- **WTP Site Area A**
  Located north of the intersection of Highway 218 and Highway 205 at the northeastern most point of the current water distribution system service area. The site area contains ground elevations between 500 and 530 ft.
- **WTP Site Area B**
  Located off of Haigler Baucom Road near the intersection with Highway 200. The site area contains ground elevations between 550 and 570 ft.

WTP Site Area C
Located south of the intersection of Baucom Tarleton Road and New Salem Road. The site area contains ground elevations between 490 and 530 ft.

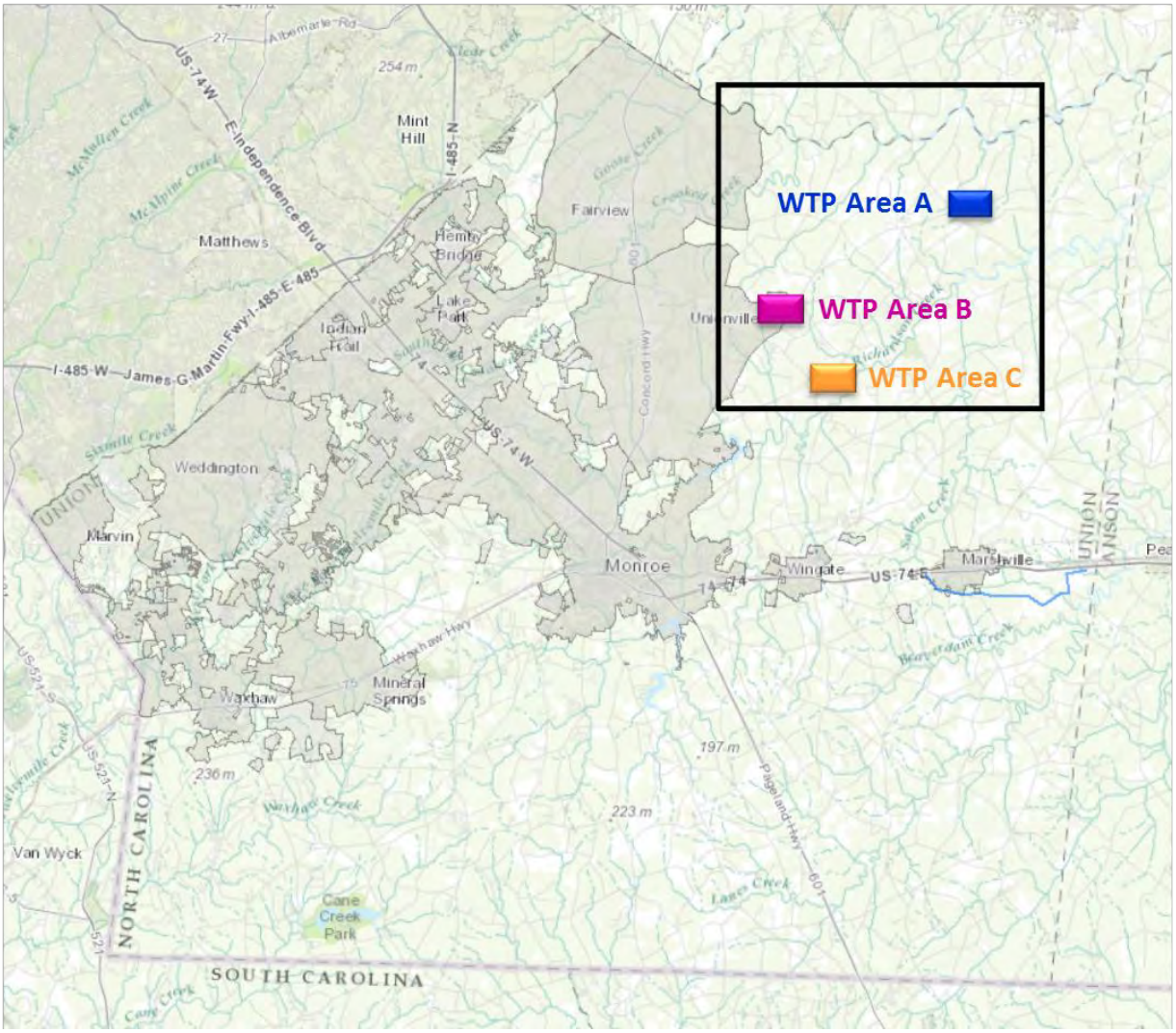


Figure 3-1 Potential YRWTP Areas – Countywide View

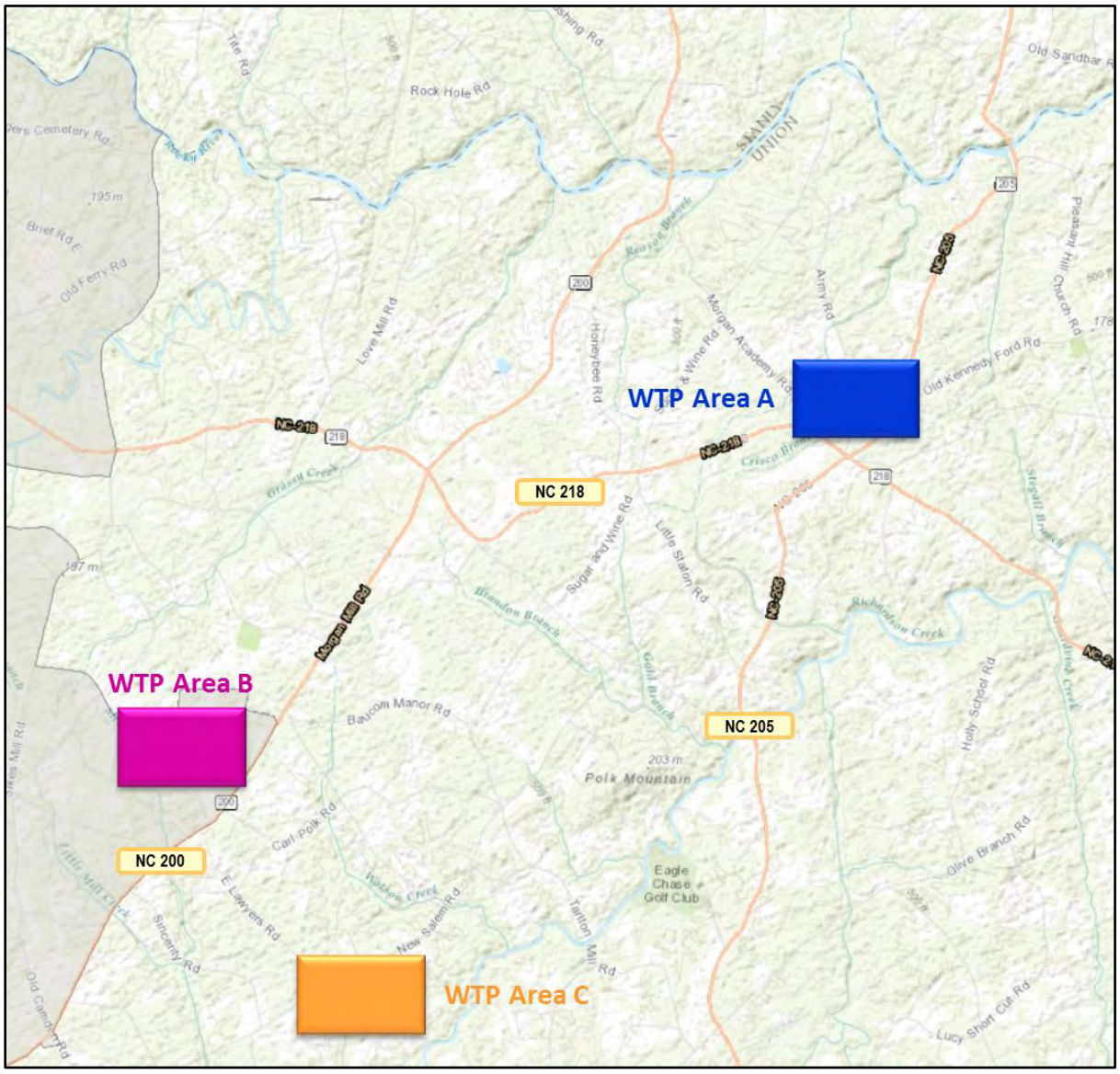


Figure 3-2 Potential YRWTP Areas – Zoomed View

3.1.2 YRWTP Location Evaluation

In order to evaluate the ability of the new YRWTP to supply the Union County water distribution system in the future, it was necessary to determine a general location of the WTP for the purposes of hydraulic modeling. Black & Veatch evaluated the three potential YRWTP site areas to determine the relative costs of each location, including the required construction costs and energy costs of the raw and finished water mains.

3.1.2.1 Raw Water Main Alignments

Water supply to the YRWTP is currently planned to be delivered through a raw water transmission main from a raw water pump station located on Lake Tillery. The two alternative raw water main alignments that were developed as part of the Environmental Impact Statement are shown in Figure 3-3. As presented in the EIS, the shorter alignment, Alignment A, was the preferred alignment of the project team and appears from early review comments to also be the preferred alignment of NCDENR. Alignment A was utilized as the alignment of the raw water transmission main for this study.

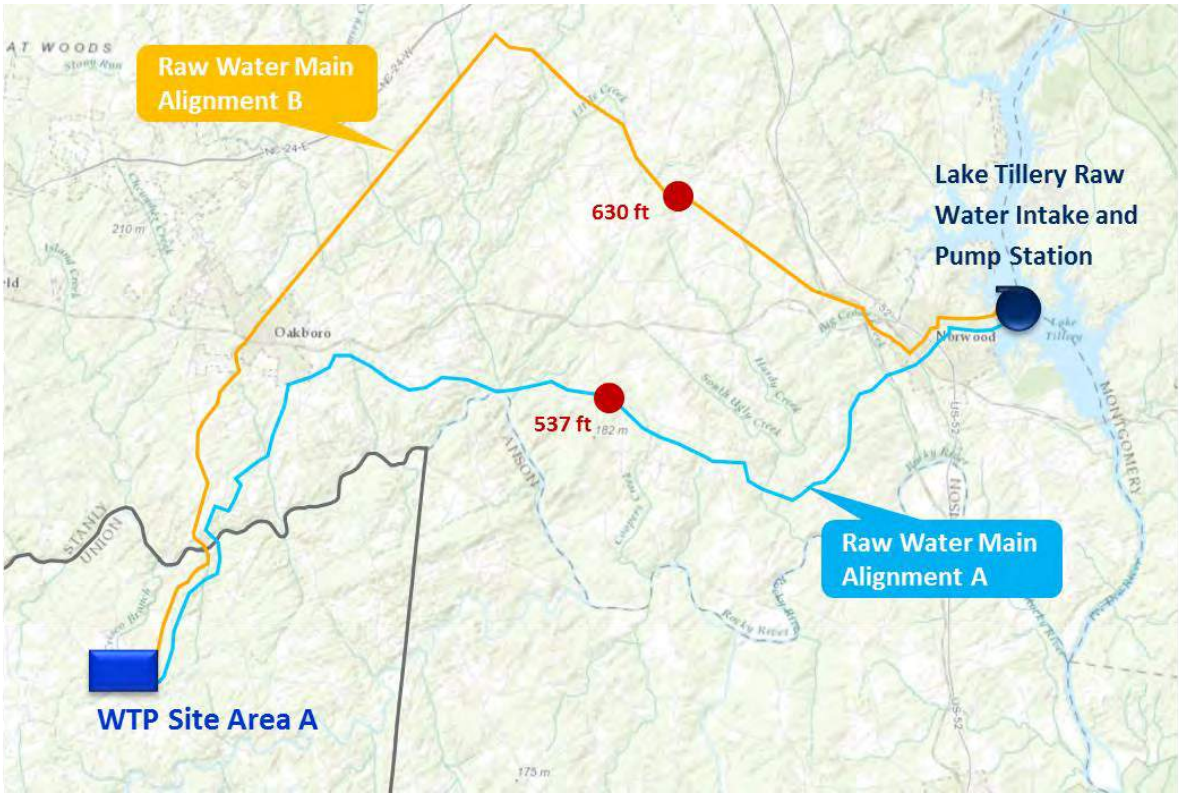


Figure 3-3 Raw Water Main Alignment Alternatives

3.1.2.2 Raw Water Main Lengths

Based on discussions made as part of the EIS, two 36-inch raw water transmission mains (TM) are planned for the ultimate 28 mgd YRWTP. One 36-inch TM will be installed with the first phase of the new YRWTP and the second added in the future. The total length of raw water transmission main required for each of the three potential WTP site areas is summarized in Table 3-1 and shown in Figure 3-4. WTP Site Area A (22.6 miles) will require approximately 7.5 miles less raw water main than WTP Site Areas B and C, as it is located closest to Lake Tillery.

Table 3-1 Approximate Raw Water Main Lengths by YRWTP Site Area

WTP SITE	RAW WATER MAIN LENGTH (MILES)
Site Area A	22.6
Site Area B	29.9
Site Area C	29.5

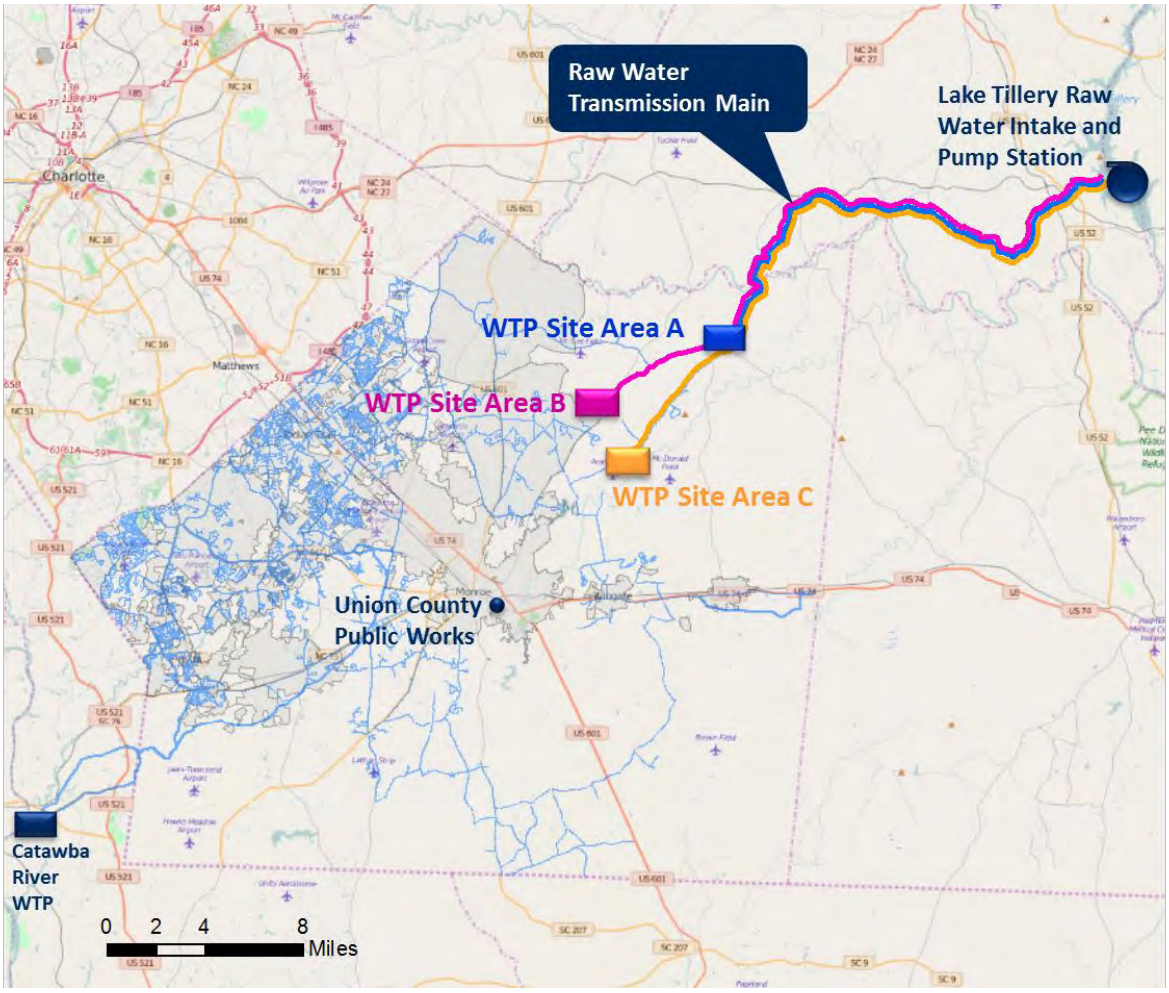


Figure 3-4 Raw Water Main Alignments

3.1.2.3 Finished Water Transmission Main Lengths

The three potential WTP site areas are not located near existing large diameter (16-inch and larger) transmission mains. The largest mains in the vicinity of the alternative WTP site areas are 12-inch, which can only convey approximately 2.5 mgd at a velocity of 5 ft/s. The initial capacity of the YRWTP is 12 mgd, planned to be expanded to 28 mgd in the future. Therefore, to deliver treated water from the WTP to the distribution system, new finished water mains will be required for each of WTP site areas.

The YRWTP is planned to directly serve two pressure zones, the combined 853 West / East Zone and the expanded 762 Zone . Based on hydraulic analysis as well as existing road rights-of-way, finished water transmission main alignments were developed for each WTP site area to deliver water to the two zones. The finished water main lengths are summarized in Table 3-2 and shown in Figure 3-5.

Because Site Area B and Site Area C are located closer to the center of the distribution system, they will require less finished water main (9.4 and 10.9 miles less, respectively) than Site Area A.

Table 3-2 Approximate Finished Water Transmission Main Lengths by YRWTP Site

FINISHED WATER TRANSMISSION MAIN	SITE AREA A (MILES)	SITE AREA B (MILES)	SITE AREA C (MILES)
762 Zone (24-inch)	12.5	10.6	8.1
853 West / East Zone and Cross County Transmission Main[1] (36-inch)	17.3	9.8	10.8
Total	**29.8**	**20.4**	**18.9**

[1]The selected WTP site area will impact the alignment of the 36-inch Cross County Transmission Main. In order to make an accurate length comparison, it was included as part of the 853 West / East Zone finished water mains in this analysis.

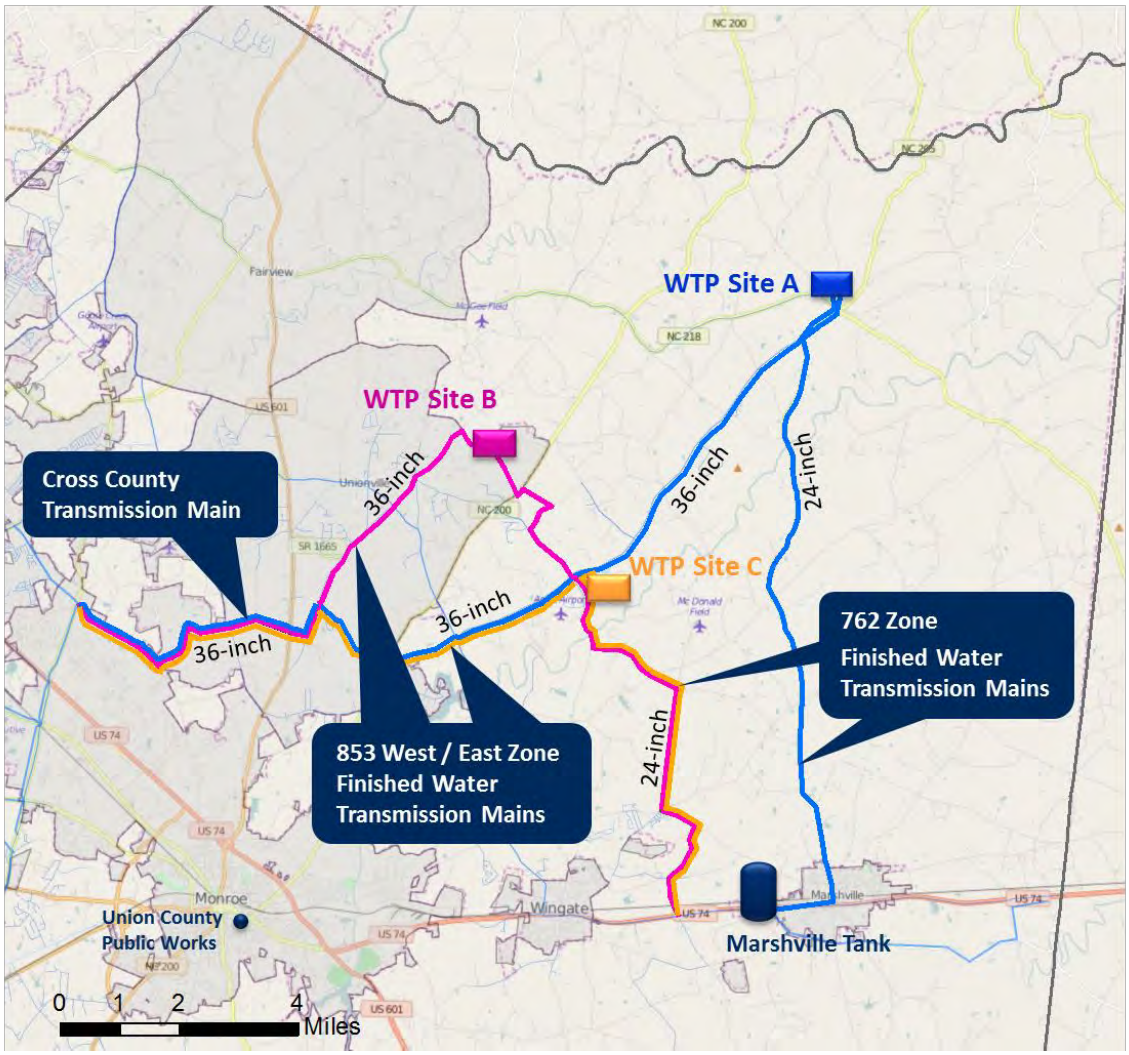


Figure 3-5 Finished Water Transmission Main Alignments

3.1.2.4 Raw Water Pumping Energy

For each of the three WTP Site Areas, the required total dynamic head (TDH) and pumping energy were evaluated for various flow conditions. A hydraulic profile was developed for each raw water main alignment to determine the head conditions along each alignment and the total required TDH at the raw water pump station. An example of the hydraulic profiles which were developed is shown in Figure 3-6.

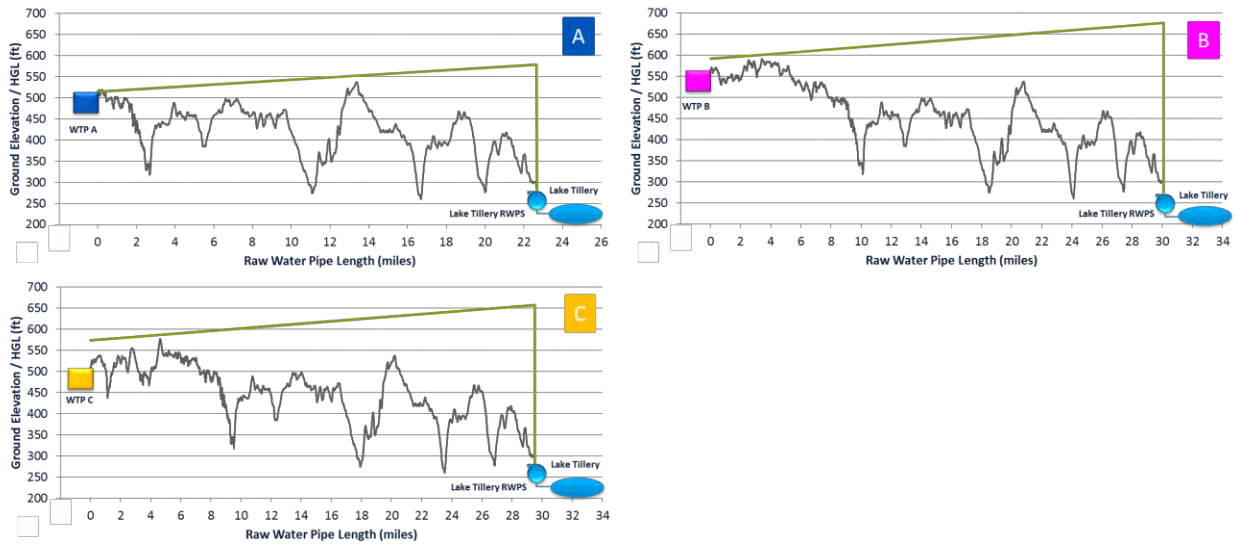


Figure 3-6 Example Raw Water System Hydraulic Profiles

TDH requirements for the Lake Tillery RWPS were analyzed for three flow conditions for each of the three WTP site areas. These flow conditions were selected to understand how the pressures and resultant energy consumption might vary over the life of the system. Flow conditions evaluation included the following:

- 12 mgd raw water flow, single 36-inch raw water main
- 18 mgd raw water flow, single 36-inch raw water main. The YRWTP high-rating concept as discussed in Chapter 4.
- 28 mgd, two parallel 36-inch raw water mains

As shown in Figure 3-7, due to their longer length and additional intermediate high elevation points along their raw water main alignments, Site Areas A and B will require approximately 30% more TDH and energy than Site Area A operating at 12 and 18 mgd with the single 36-inch raw water main. At the 28 mgd capacity with the second 36-inch raw water main in place, however, Site Areas B and C will require approximately 8% and 24% more TDH and energy than Site Area A, respectively.

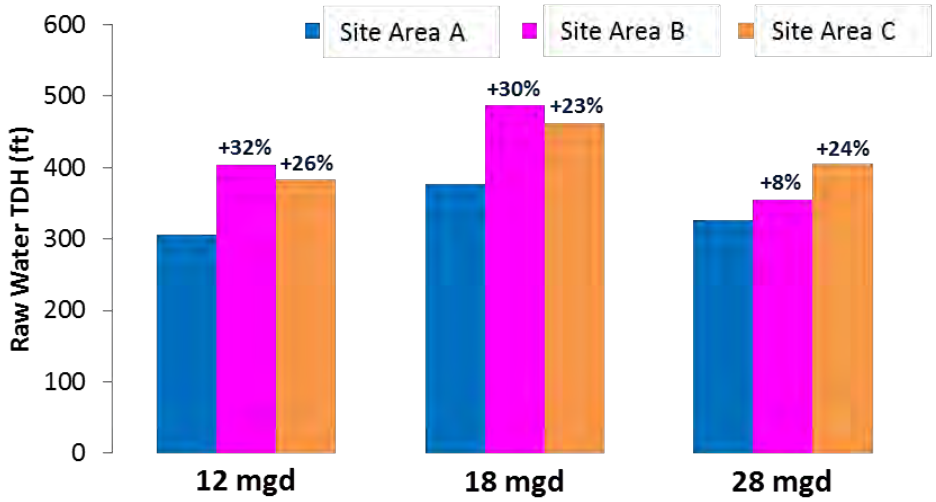


Figure 3-7 Raw Water Pumping Total Dynamic Head Requirements

3.1.2.5 Finished Water High Service Pump Station Energy

WTP Site Area B is located at ground elevations approximately 50 ft higher than Site Areas A and C, resulting in lower TDH requirements for the YRWTP high service pump station which will deliver finished water to the distribution system. Based on an analysis of the ground elevations as well as the proposed finished water transmission mains which will convey water from the YRWTP to the distribution system, WTP Site Area B was calculated to require the least amount of TDH and energy to deliver finished water from the YRWTP to the distribution system – approximately 25% less TDH than Site Areas A and C.

3.1.3 YRWTP Location for Distribution System Modeling

Following the analysis described in the previous section, total present worth costs for each of the three YRWTP site areas for both initial and build-out construction were compared as shown in Figure 3-8. The cost of the Lake Tillery Raw Water Intake, RWPS and the YRWTP were assumed to be the same for the three site areas, with the variable costs limited to the raw water and finished water transmission mains and the 20 year present worth energy costs of the raw and finished water pump stations. Please note that the overall project costs are capital-driven, with less than 6% of the overall costs due to energy.

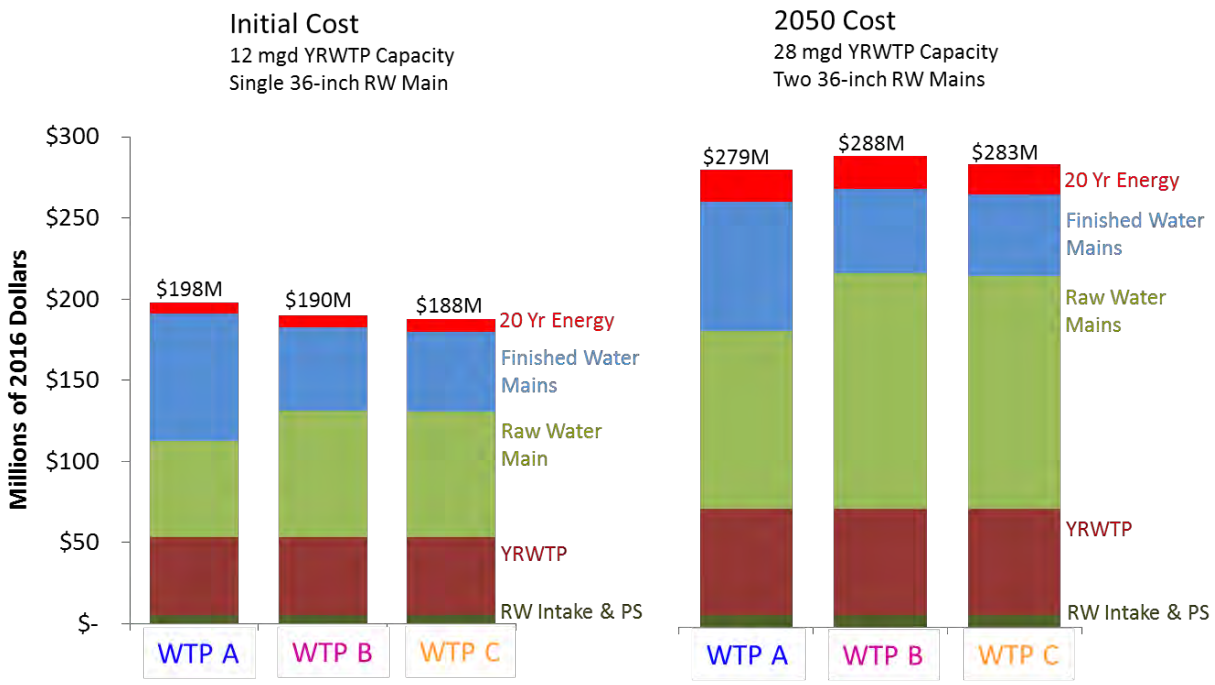


Figure 3-8 Potential YRWTP Sites – Approximate Present Worth Cost Comparison

As shown, the total present worth costs for each of the three WTP site areas are similar, with less than 6% difference between the least expensive and most expensive site areas for both Initial and 2050 constructions, which is within the level of accuracy of the cost estimates. The costs developed for this analysis were developed for relative comparison purposes only and should not be assumed to be accurate for budgetary planning or construction. Costs for planning purposes can be obtained from the CIP in Chapter 5.

Based on the results of the analysis presented above, raw and finished water transmission main capital cost and pumping energy cost are not key differentiators for the site area selection of the YRWTP. Instead, the final YRWTP site area should be selected considering the following criteria:

- Site Area Geometry/Topography
- Reliability of Power to WTP
- Land Acquisition Cost
- Accessibility for Chemical/Fuel Deliveries to WTP
- Accessibility to UCPW Maintenance Staff to WTP
- Beneficial Use by the Public (meeting rooms)
- Proximity to Schools for Tours/Educational Purposes

An initial screening of the three alternative WTP site areas was performed based on these criteria and Site Area A is less desirable for future consideration due to its remote position in the County, making Site Area A less accessible for deliveries, to maintenance staff, and to the public. Site Areas B and C and other site areas in their vicinity remain viable candidates for the future YRWTP. For the purposes of this project, a preferred target area for the location of the YRWTP was identified and is indicated by the dotted blue circle in Figure 3-9. It is currently anticipated that the YRWTP will be located on a site within that area that is selected based on the criteria above. It is noted that while the transmission main hydraulic analysis results and recommendations will be similar for any site within the target area, it was necessary to assume a precise location for the YRWTP in order to conduct the hydraulic modeling for this project. Based on discussions with UCPW, Site Area B was chosen for modeling purpose.

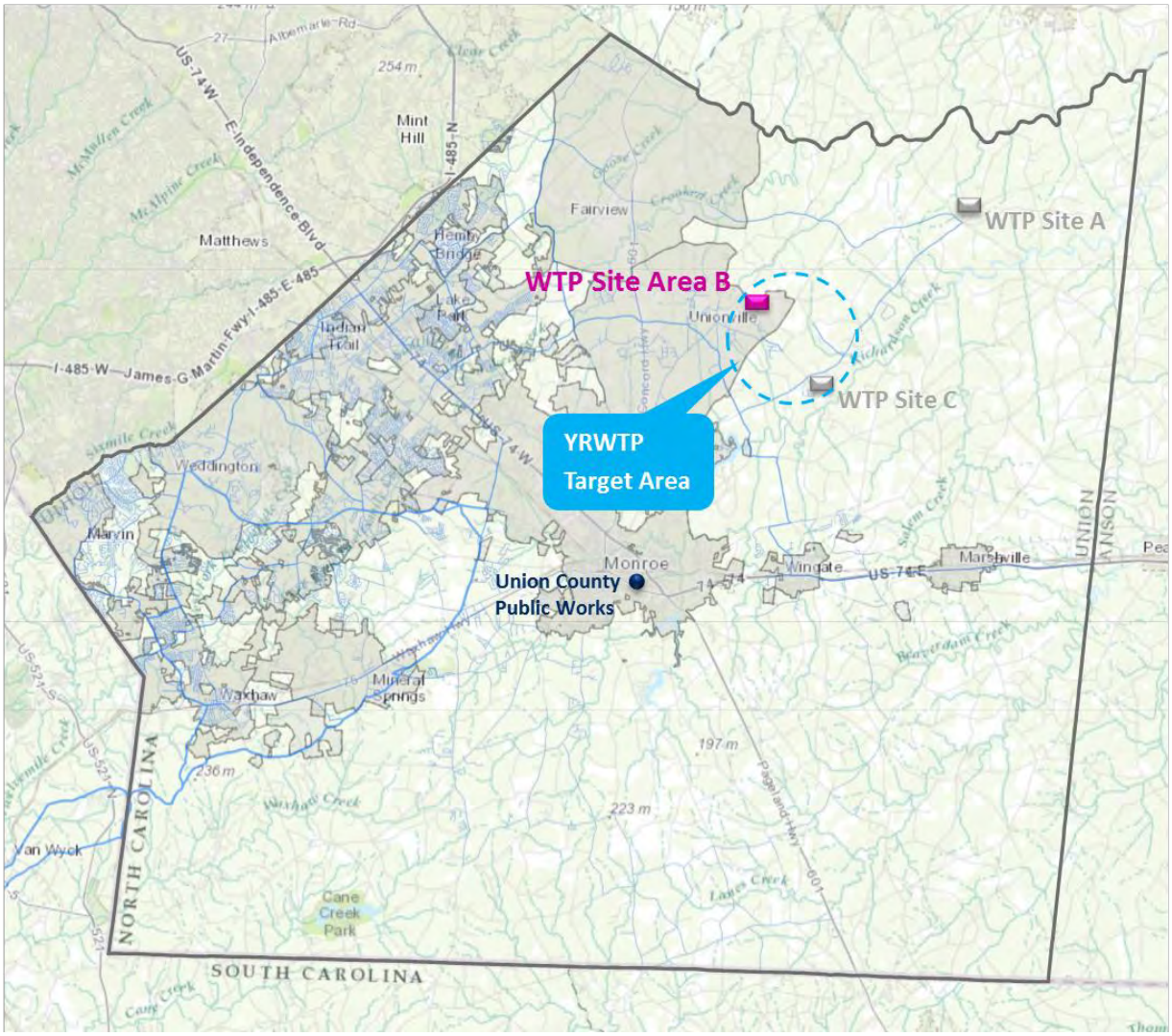


Figure 3-9 YRWTP Target Area and Assumed Site Location

3.2 PRESSURE ZONE MODIFICATIONS AND INFRASTRUCTURE TO INTEGRATE THE NEW YRWTP

A primary goal of the water system planning update was to analyze how to most effectively integrate the new YRWTP into the existing water distribution system, including potential pressure zone boundary modifications, locating storage in the 762 Zone, and new transmission main locations and sizing. The phased improvement solution is shown in Figure 3-10 to Figure 3-13, and the major planning elements for each phase are summarized below. The facility capacity analyses and distribution system capacity analyses which are the basis of the results described below are described in Sections 3.3 and 3.4. Detailed descriptions of individual CIP projects are included in Chapter 5.

- **Existing Conditions - After 880 Zone Online (Figure 3-10):** Under existing system conditions, the 762 and 853 East zones are served by the Highway 74 BPS, which can reliably deliver up to 3 mgd from Anson County. The combined maximum day demand of the 762 and 853 East zones in 2015 was projected to be approximately 3.8 mgd in the demand projections detailed in Chapter 1, which exceeds the supply capacity available from the Highway 74 BPS. To mitigate this supply capacity deficiency, the boundary between the 853 West and East zones should be opened to allow the 853 East Zone to be partially supplied by the Watkins BPS as well. In order to ensure that all 762 Zone and 853 East Zone demands can be met during high demand days, the 853 West / East boundary is recommended to be opened as soon as possible.

- **By 2020 (Figure 3-11):** By 2020 the following system improvements are planned to be completed:

  - *Combine 853 West and East Zone (853W-Z-01)*

    This new zone will be capable of being served both by the Olive Branch BPS (when 762 Zone demands are less than the 3 mgd reliable capacity of the Highway 74 BPS supply from Anson) and by the Watkins BPS.

  - *New 853 West 16-inch and 36-inch Mains (853W-M-01 to 853-M-05)*

    Based on the 2011 Master Plan, 16-inch and 36-inch mains were recommended to be installed to improve transmission capacity from the Watkins BPS. These projects are currently in design and are expected to be complete by 2019.

  - *New 762 Zone Tank (762-T-01)*

    The new tank is planned to be constructed by 2018 and located along the 16-inch transmission main in the 762 Zone.

- **By 2022 (Figure 3-12):** By 2022, the following system improvements are planned to be completed:

  - *Lake Tillery Raw Water Intake and Pump Station (YAD-S-01) and Raw Water Transmission Main (YAD-M-01)*

    The new 28 mgd raw water intake, 12 mgd RWPS, and 36-inch Raw Water Transmission main are planned to be complete by 2022. These system improvements are not shown in Figure 3-10.

  - *New YRWTP and 853 Zone HSPS (YAD-S-02)*

    The new 12 mgd YRWTP and 853 Zone HSPS are planned to be complete by 2022. The YRWTP is proposed to include two high service pump stations, the 853 Zone HSPS and the 762 Zone HSPS.

Without two HSPSs, water supply delivered to the 762 Zone would first need to be pumped to the higher 853 ft hydraulic grade and then reduced through a pressure reducing valve to 762 ft, resulting in an average head loss of 91 ft for all water delivered to the 762 Zone. Constructing two HSPSs will result in significant energy savings throughout the operating life of the YRWTP.

- *New 36-inch 853 Finished Water Transmission Main (FWTM) and Cross County Transmission Main (CCTM) (YAD-M-02)*

  The new main will complete a 36-inch connection between the YRWTP 853 Zone HSPS and the Watkins BPS, allowing for flexible transmission of water supply across the county from either the CRWTP or the YRWTP.

- *Expand 762 Zone (762-Z-01)*

  Following completion of the YRWTP, the 762 Zone is planned to be expanded to include lower elevation areas in the northeastern portion of the distribution system that are currently served by the 853 East Zone. This will reduce high pressures in this part of the system and appropriately shift ground elevations to be served at a more beneficial hydraulic grade line to maintain pressures within the performance criteria.

- *New 762 Zone PRVs (762-V-02 and 762-V-03)*

  Two new PRVs are planned to deliver water from the 853 West / East Zone to the expanded 762 Zone. The PRVs are needed to supplement supply to the 762 Zone when demands exceed the 3 mgd reliable supply capacity of the Highway 74 BPS. These projects will allow the 762 Zone HSPS and 24-inch 762 Zone FWTM projects to be deferred until 2028.

- *Olive Branch BPS (Back-Up Only)*

  Demands in the expanded 762 Zone are projected to meet or exceed the reliable supply capacity of the Highway 74 BPS by 2022. As such, and considering the YRWTP will be in service to directly supply the 853 East Zone, the Olive Branch BPS will no longer be needed to transfer Anson County supply to the 853 East Zone under normal operating conditions. However, the BPS should be maintained to serve as a back-up source of supply for the 853 West / East Zone.

- **By 2028 (Figure 3-13):** By 2028, maximum day demands in the 762 Zone are projected to exceed the rate at which water can reliably be supplied from the Highway 74 BPS and the 762 Zone PRVs (762-V-02 and 762-V-03) to maintain levels in the Marshville and New 762 Zone Tanks. This is primarily due to large head losses in the 16-inch transmission main which will deliver water from the 853 West / East Zone to the 762 Zone. To meet projected system demands, the following system improvements are planned to be completed:

  - *New 762 Zone HSPS and 24-inch 762 FWTM (YAD-M-03)*

    The new 762 Zone HSPS at the YRWTP and 762 FWTM are planned to be complete by approximately 2028. The new main will connect the new 762 Zone HSPS to the existing 16-inch transmission main along Highway 74 in the 762 Zone.

  - *Highway 74 BPS (Back-Up Only)*

    Following construction of the direct connection from the YRWTP to the 762 Zone, the 762 Zone will have sufficient supply without the need to purchase water from Anson County. As such, the Highway 74 BPS will not be needed for normal system supply. However, it is recommended that the Highway 74 BPS be maintained as an emergency back-up.

- *Olive Branch BPS (Retire) (762-P-01)*

  As system demands continue to increase in the 762 Zone, it will be less and less likely that the Olive Branch BPS will ever be needed for normal and even emergency back-up purposes. Therefore, it is planned that the Olive Branch BPS will be retired.

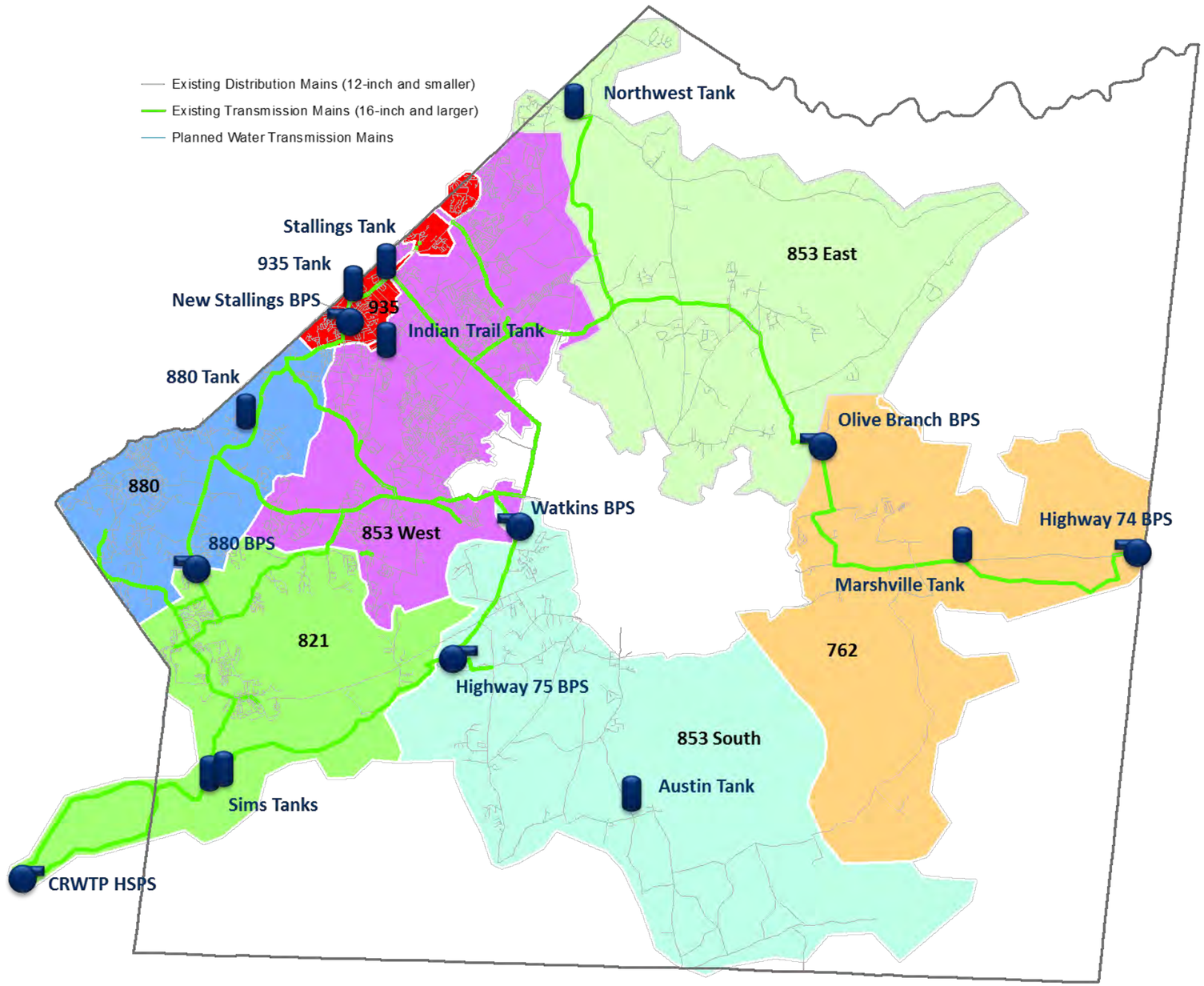


Figure 3-10 Phasing of Pressure Zone Modifications and Major Distribution System Improvements to Integrate the New YRWTP – Existing Conditions (After 880 Zone Online)

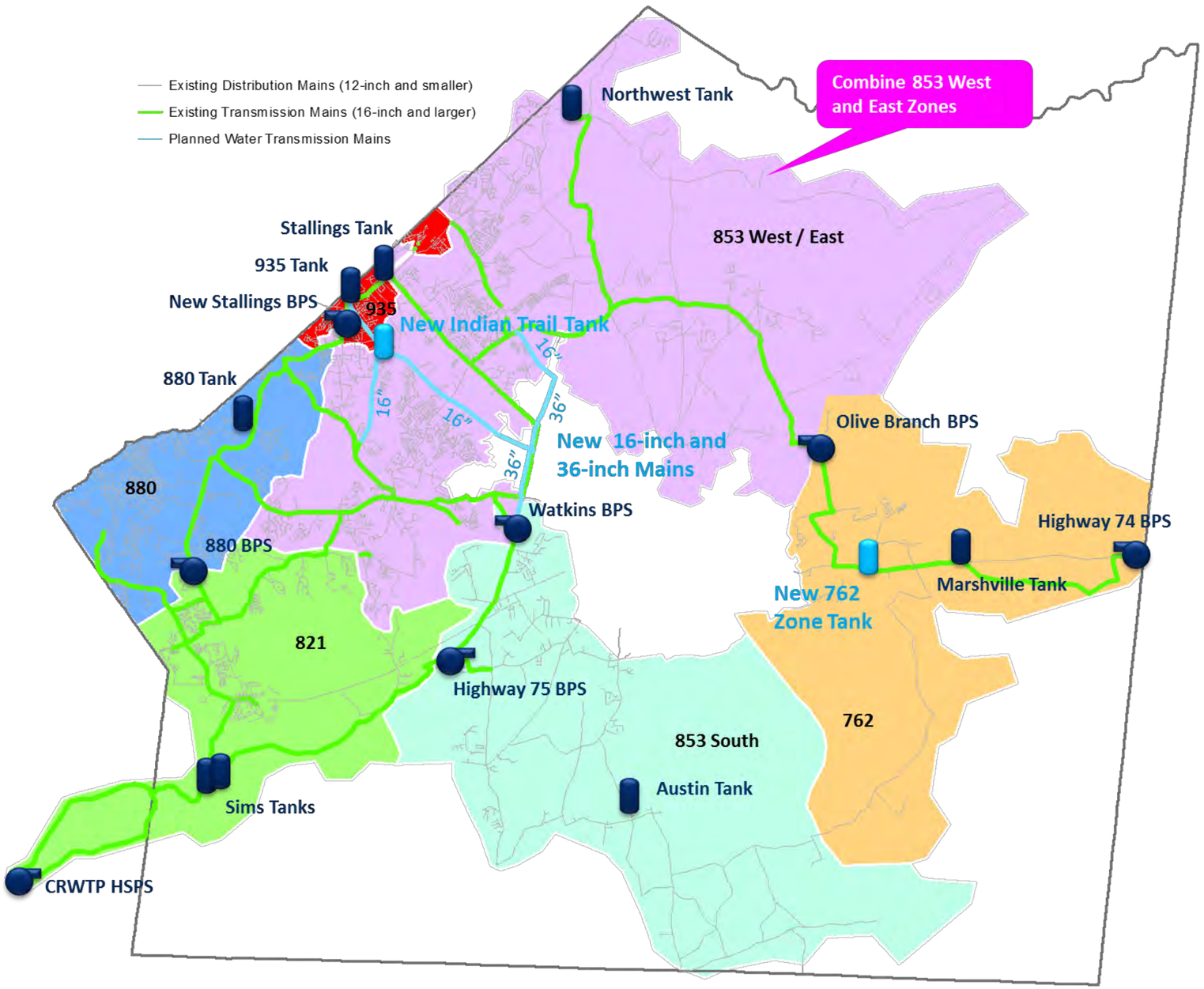


Figure 3-11 Phasing of Pressure Zone Modifications and Major Distribution System Improvements to Integrate the New YRWTP – By 2020

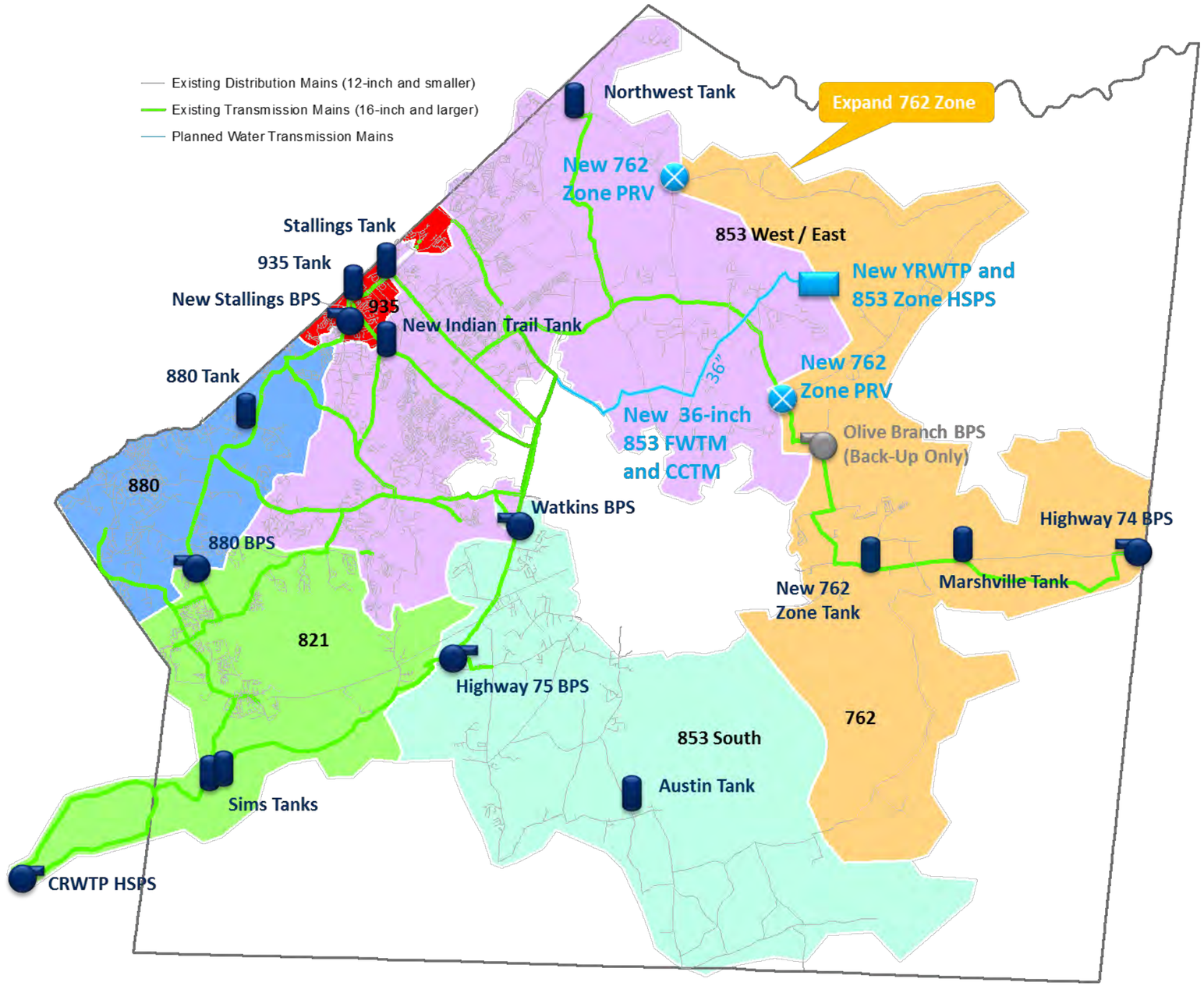


Figure 3-12 Phasing of Pressure Zone Modifications and Major Distribution System Improvements to Integrate the New YRWTP – By 2022

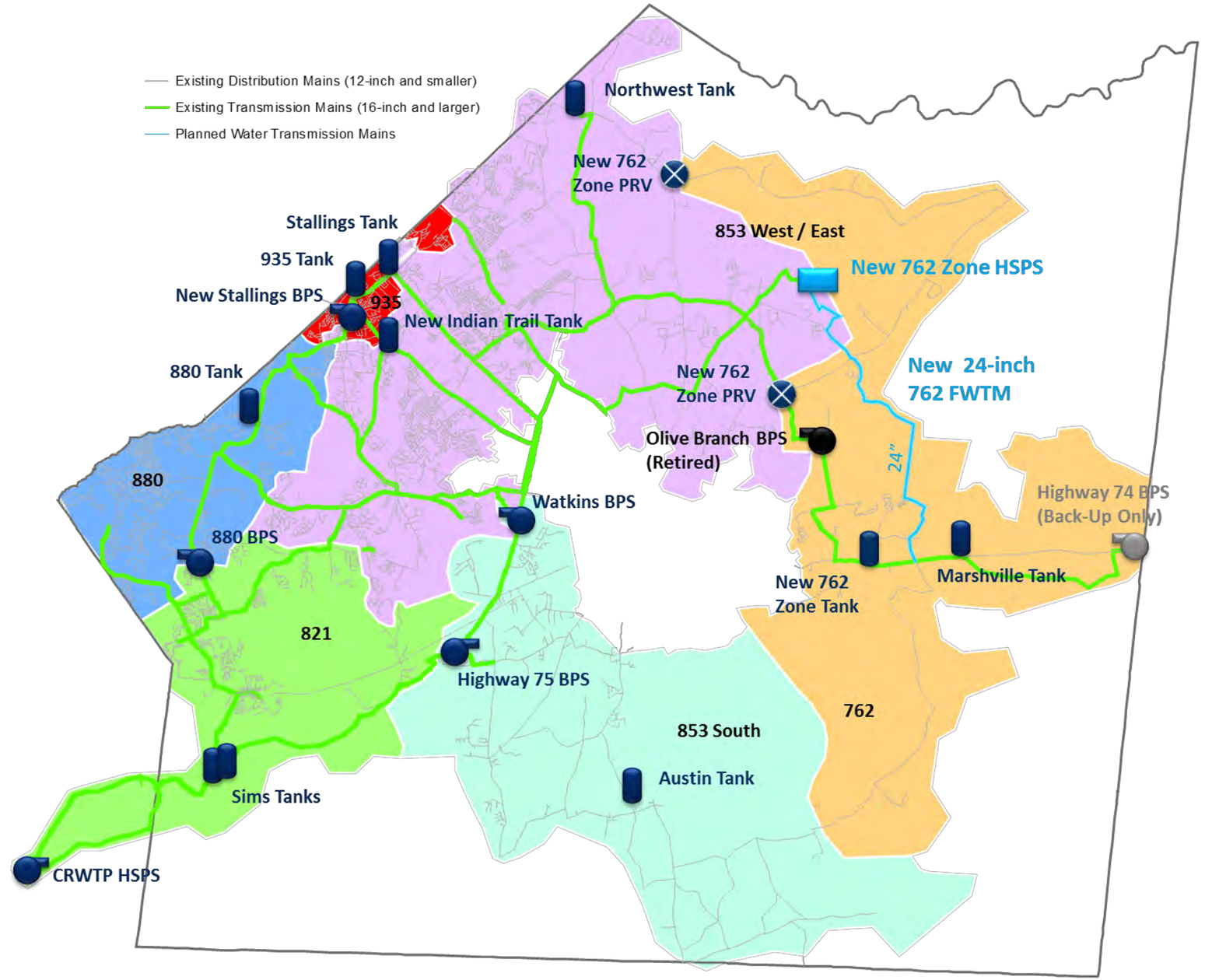


Figure 3-13 Phasing of Pressure Zone Modifications and Major Distribution System Improvements to Integrate the New YRWTP – By 2028

3.3 WATER SUPPLY, PUMPING AND STORAGE CAPACITY ANALYSIS

This section contains a capacity analysis of current water supply, supply and zone transfer pumping and storage facilities for the Union County water distribution system. These capacity analyses are based on the demand projections detailed in Chapter 1 and served as the basis for determining the size and timing of the facility improvement projects in the CIP. Deficiency magnitudes were determined based on the performance criteria developed for the 2011 Master Plan, included in Appendix A.

3.3.1 Water Supply Capacity Analysis

Although a system-wide treated water supply capacity criterion was not defined in the performance criteria as part of the 2011 Master Plan, the analysis of treated water supply capacity adequacy is necessary as the first step to assess the overall adequacy of Union County's water distribution system facilities. Insufficient supply capacity to meet projected maximum day demands must be addressed as a primary component of the improvement approach for the system. This analysis considered treatment capacity to be the factor limiting the quantity of water which can be delivered to the system from a particular plant/location. High service pumping capacity was not considered to be a limiting factor.

The existing Union County water distribution system includes two water supply facilities, the Catawba River Water Treatment Plant (CRWTP) and the supply interconnection with Anson County at the Highway 74 BPS.

- CRWTP (18 mgd): Located in Lancaster County, South Carolina, southwest of Union County. The plant treats surface water from the Catawba River and is capable of treating up to 36 mgd per day – 18 mgd of which is available for supply to Union County.
- Anson County (4 mgd): The bulk supply purchase from Anson County is pumped into the Union County distribution system by the Highway 74 BPS at the eastern edge of Union County. Based on hydraulic limitations within the Anson County system, currently up to 3 mgd is available to be supplied to the Union County system on a consistent basis.
- Lease Agreement with Lancaster: To meet short-term water supply deficiencies, Union County entered into a lease agreement with Lancaster County Water and Sewer District in 2012 to provide an additional 3 mgd of treated water at the CRWTP. This agreement is set to expire at the beginning of 2019.

As shown in Figure 3-14, the current available supply of the CRWTP (including leased capacity from Lancaster) and the Anson supply were predicted to be capable of meeting the 2015 MDD of 23.7 mgd. As demands increase, however, MDD is predicted to exceed available supply in 2016, growing to a deficiency of more than 13 mgd by 2030. As described in Chapter 2, projected supply deficiencies are planned to be met through the planning horizon by a 9 mgd CRWTP expansion in 2018 and the new 12 mgd YRWTP planned to be complete in 2022.

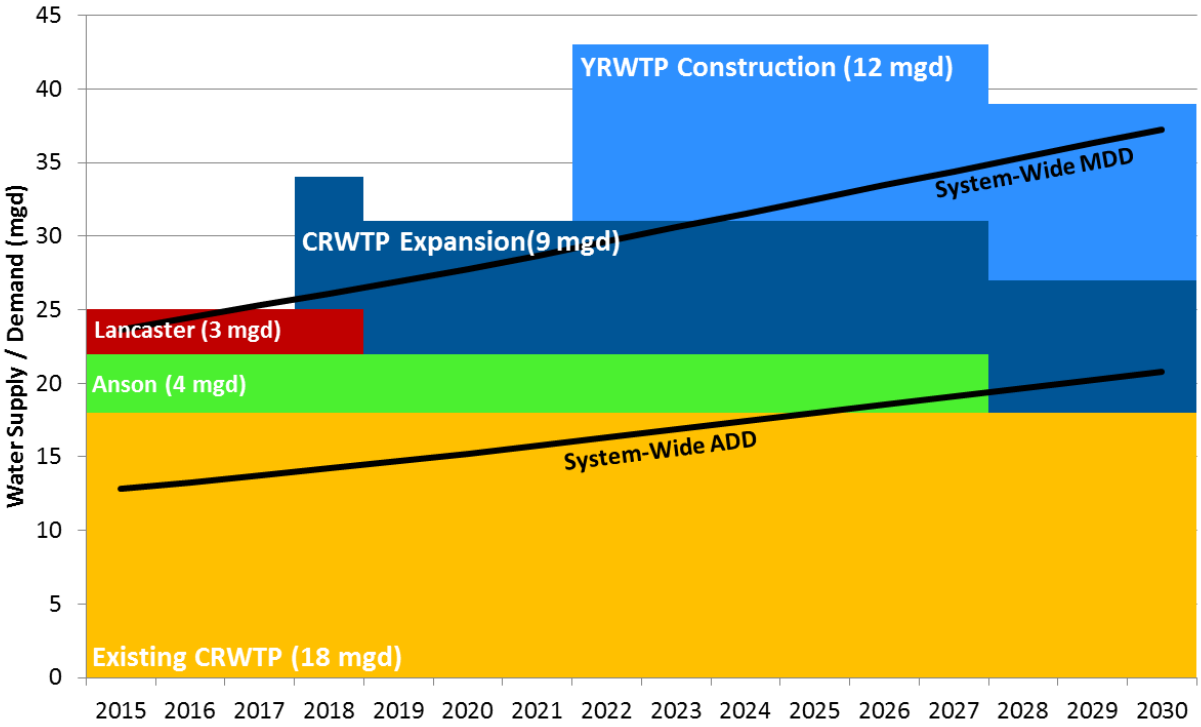


Figure 3-14 Water Supply Capacity Analysis

3.3.2 Supply and Zone Transfer Pumping Capacity Analysis

Although sufficient supply capacity is planned to be constructed to meet system-wide maximum day demands, this does not ensure that each pressure zone will have sufficient supply and zone transfer pumping capacity to meet zone-specific maximum day demands. Based on the performance criteria developed for the 2011 Comprehensive Master Plan, the firm capacity (pump station capacity with the largest pump out of service) must be capable of delivering maximum day demands to the zone(s) supplied by those pumping stations. This section includes a capacity analysis from the perspective of each supply and zone transfer pumping station in the Union County distribution system, including the impacts of the proposed CIP projects detailed in Chapter 5.

3.3.2.1 Calculation of Pump Capacities

For the Supply and Zone Transfer Pumping assessment, actual pump station capacities were used to assess the capacity of water which can be delivered into each pressure zone. It is noted that pump stations with multiple pumps operating in parallel typically don't produce their rated capacities under actual system conditions. Because pump station capacity tests were not conducted as part of this study, the calibrated hydraulic model was utilized to estimate the actual firm pumping capacities at each pump station during maximum day system demand conditions. These estimated capacities (evaluated during the 2011 Comprehensive Master Plan) are presented in Table 3-3 and were utilized as the basis for the capacity analysis.

Table 3-3 Model-Estimated Firm Pump Station Capacities

PUMP STATION	ZONE SUPPLIED	ESTIMATED FIRM CAPACITY (MGD)
CRWTP HSPS	821	28.2
Highway 75 BPS	853 South	1.4
Watkins BPS	853 West / East	18.7[1]
New Stallings BPS	935	1.6
Olive Branch BPS	853 East	2.6[2]
Highway 74 BPS	762	3.0[3]
880 Zone BPS	880	6.4

[1]Based on best-efficiency point of existing pumps. May change based on pump station modifications recommended as part of this project.
[2]Based on manufacturer pump curve rated pump capacity
[3]Capacity limited by Anson County system.

3.3.2.2 System Supply Pump Station Capacity Analysis

The CRWTP High Service Pump Station (HSPS) and the supply interconnection with Anson County at the Highway 74 BPS currently deliver all of the water supply to the distribution system. The total firm capacity of these two pump stations must be capable of meeting the system-wide MDD.

As shown in Figure 3-15, the existing firm capacity of the CRWTP HSPS and Anson supply at the Highway 74 BPS is projected to be capable of meeting the system-wide MDD until approximately 2024. This supply deficiency will be addressed by the new YRWTP, which is planned to provide an additional 12 mgd of firm capacity pumping starting in 2022. With the addition of the YRWTP (YAD-S-02), maximum day demands can be met throughout the planning horizon.

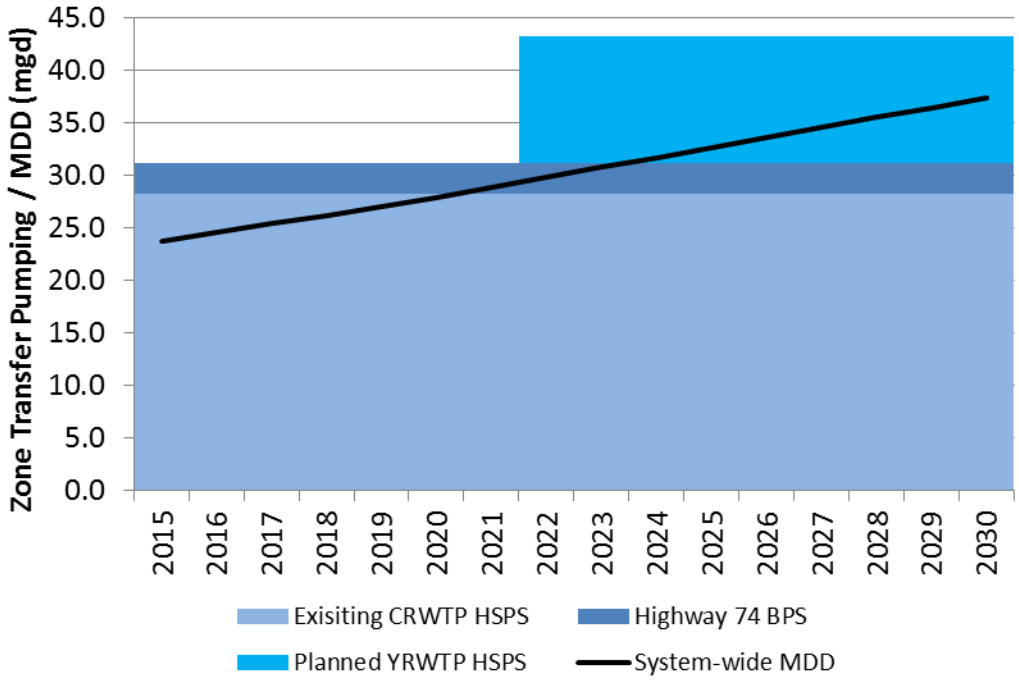


Figure 3-15 System Supply Pumping Capacity Analysis

3.3.2.3 853 West / East, 935 and 762 Zone Transfer Pumping Capacity Analysis

While the CRWTP delivers treated water into the distribution system, the Watkins BPS is required to boost the water from the 821 Zone to the 853 and 935 zones. The firm capacity of the Watkins BPS in tandem with the Anson supply interconnection at the Highway 74 BPS must be capable of meeting the MDD of the 853 West / East, 935 and 762 zones.

As shown in Figure 3-16, the firm capacity (following the pump station modifications detailed in Chapter 5) of the Watkins BPS and Anson supply at the Highway 74 BPS is projected to be capable of meeting the projected MDD until approximately 2025. This deficiency will be addressed by the new YRWTP, which is planned to provide an additional 12 mgd of firm pumping capacity starting in 2022. With the construction of the YRWTP (YAD-S-02), the Watkins BPS is predicted to capable of meeting maximum day demands under normal system operations throughout the planning horizon.

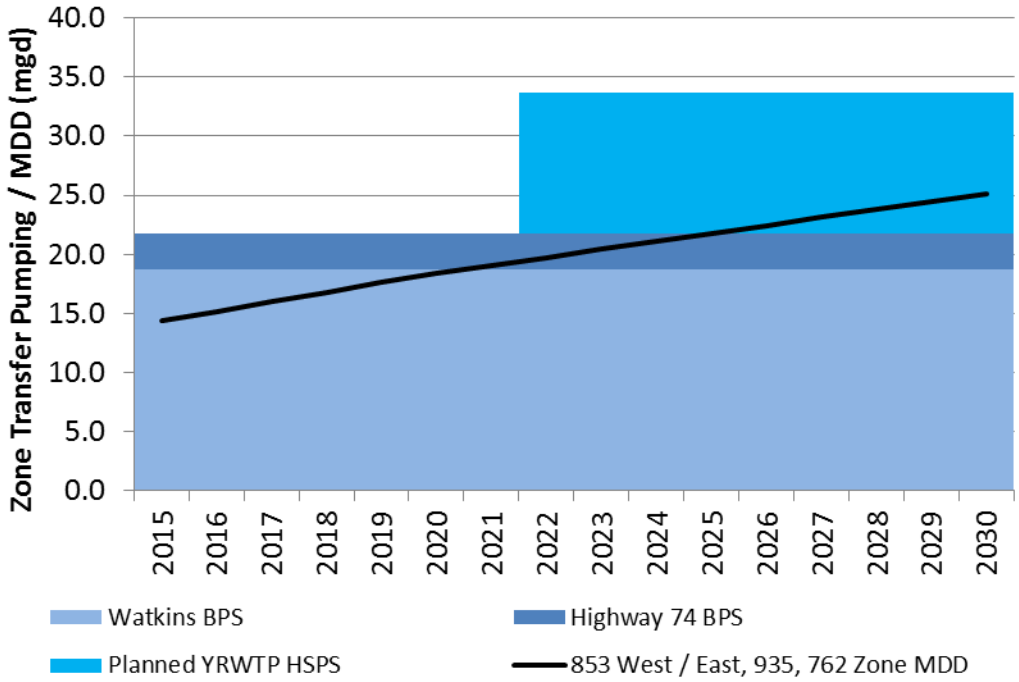


Figure 3-16 853 West / East, 935 and 762 Zone Pumping Capacity Analysis

3.3.2.4 Highway 75 Booster Pump Station Capacity Analysis

The Highway 75 BPS is currently the sole source of supply to the 853 South Zone. The 2011 Comprehensive Master Plan identified a pressure reducing valve (PRV) project (853S-Z-01) to be installed near the Watkins BPS which would allow water from the 853 West / East Zone to be delivered to the 853 South Zone to supplement the Highway 75 BPS as zone demands increase beyond the firm capacity of the Highway 75 BPS. Based on hydraulic modeling analysis, the PRV connection will be capable of delivering approximately 0.5 mgd under current system conditions.

Figure 3-17 displays the firm capacity of the Highway 75 BPS and the projected MDD of the 853 South Zone as determined in the 2011 MP in conjunction with the demand adjustments described in Chapter 1. As shown, under the projected demands the 853 South Zone is predicted to be deficient in supply capacity by 2017, with the new PRV connection near Watkins (853S-V-01) capable of deferring the deficiency until approximately 2022 at which point an improvement project will be required.

Based on discussions with UCPW, system growth in the 853 South Zone has been lower than projected. Due to the observed reduction in system growth, UCPW does not anticipate the 853 South Zone to become deficient in supply until 2025 or later. The solid line in Figure 3-17 displays 853 South Maximum Day Demands assuming the zone experiences no growth. In this case, no improvement projects would be required. UCPW will continue to monitor demands in the 853 South Zone and will initiate an improvement project to address the supply deficiency if/when one is needed. Potential improvement projects to address the pumping capacity deficiency include pump capacity improvements at the Highway 75 BPS (853S-P-01) and construction of the 16-inch 853 South Transmission Main (853S-M-01) identified in the CIP.

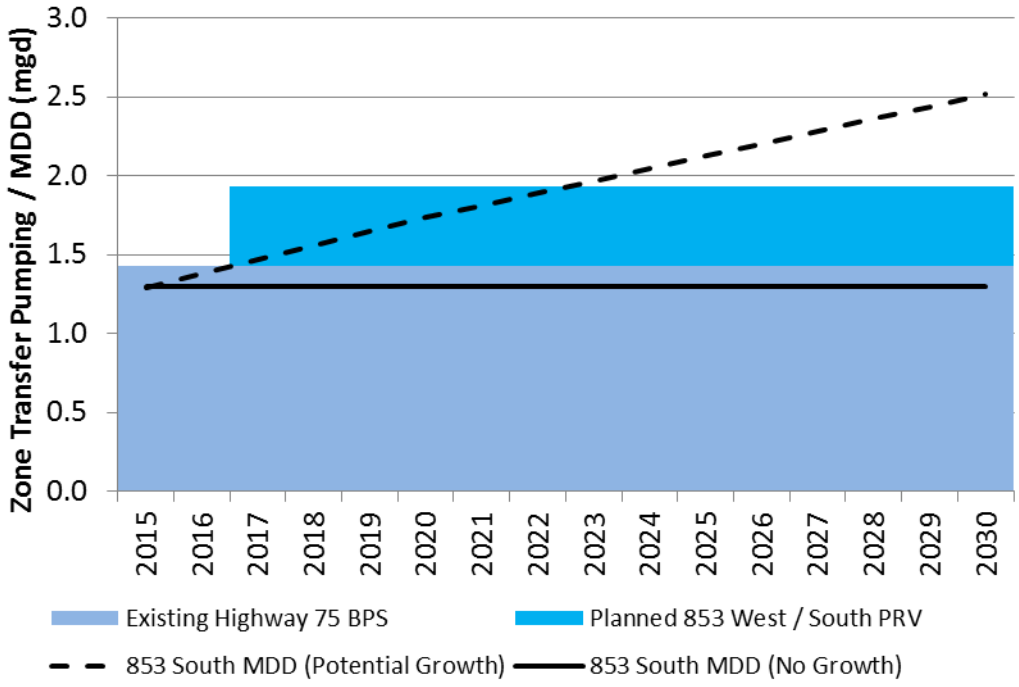


Figure 3-17 Highway 75 BPS Pumping Capacity Analysis

3.3.2.5 880 Zone Booster Pump Station Capacity Analysis

The 880 Zone BPS is the sole source of supply to the 880 Zone. Therefore, the firm capacity of the 880 Zone BPS must be capable of meeting the MDD of the 880 Zone.

As shown in Figure 3-18, the firm capacity of the 880 Zone BPS is predicted to capable of meeting maximum day demands under normal system operations throughout the planning horizon.

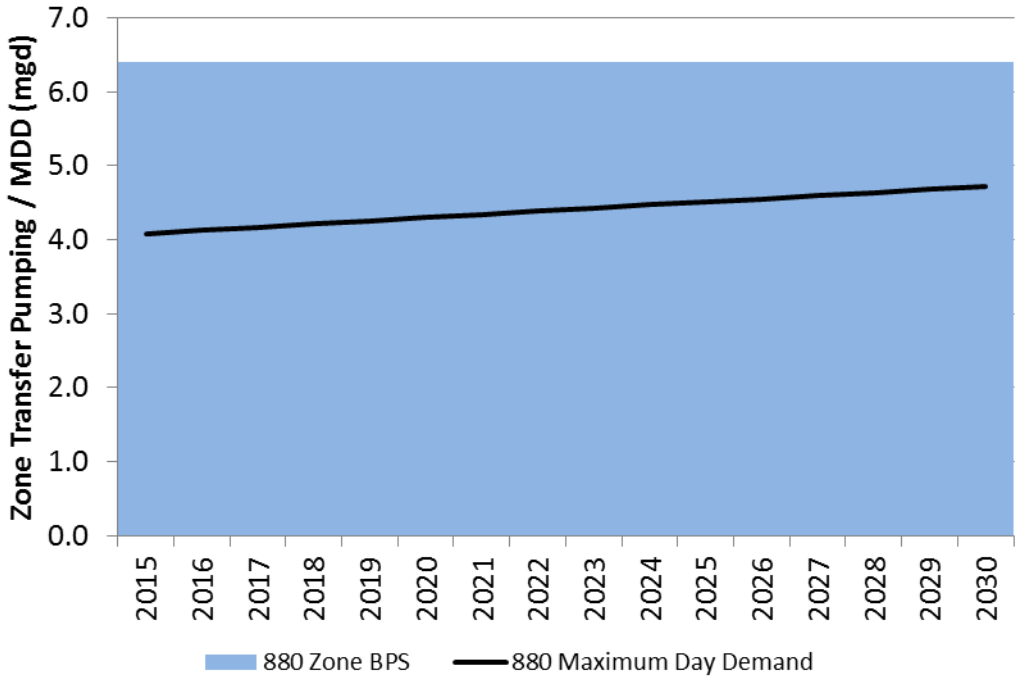


Figure 3-18 880 Zone BPS Pumping Capacity Analysis

3.3.2.6 New Stallings Booster Pump Station Capacity Analysis

The New Stallings BPS is the sole source of supply to the 935 Zone. Therefore, the firm capacity of the New Stallings BPS must be capable of meeting the MDD of the 935 Zone.

As shown in Figure 3-19, the firm capacity of the New Stallings BPS is predicted to capable of meeting maximum day demands in the existing and expanded 935 Zone under normal system operations throughout the planning horizon.

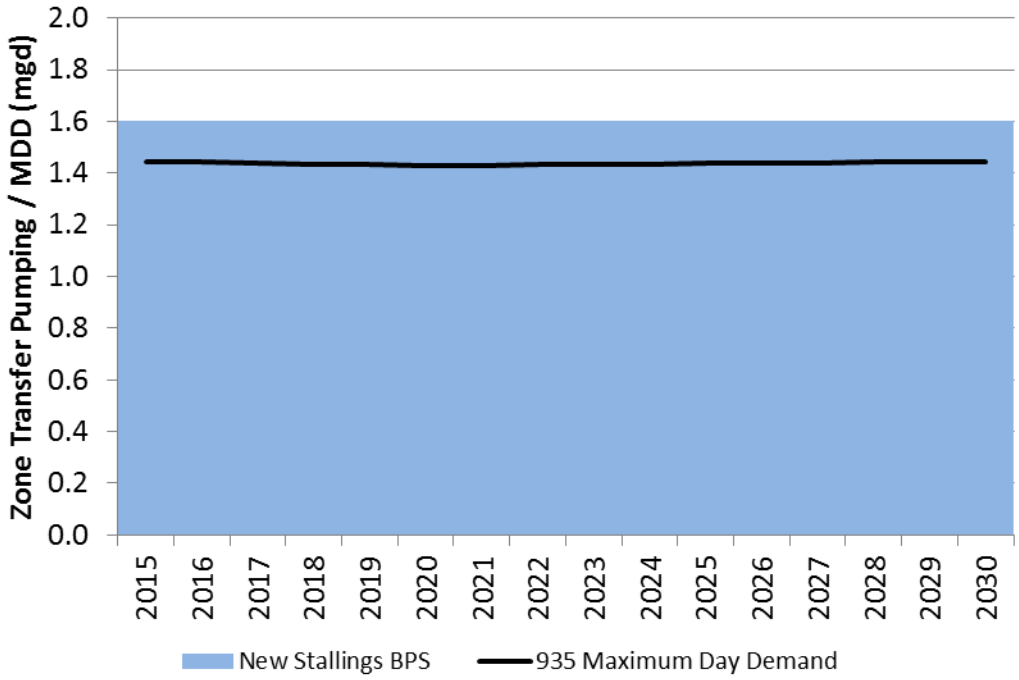


Figure 3-19 New Stalling BPS Pumping Capacity Analysis

3.3.3 Storage Capacity Analysis

Storage facilities in a distribution system serve a number of purposes, including demand/flow equalization, fire reserve, and emergency reserve. Without storage facilities, the supply, treatment, pumping, and transmission facilities would have to be sized to meet instantaneous peak demands, which would be both impractical and uneconomical. By constructing appropriately sized storage tanks at strategic locations throughout the system, supply and production facilities are able to operate at relatively uniform rates over the course of a day, thereby optimizing their operation and minimizing their cost. An assessment was completed to determine the storage volumes which will be needed for each pressure zone. This section presents a storage capacity analysis for each pressure zone of the Union County distribution system and includes the impacts of the proposed CIP projects detailed in Chapter 5.

3.3.3.1 Storage Required

The required storage is based on the performance criteria developed for the 2011 Master Plan:

- **Equalization Storage Required:** (Peak Hour Demand – Maximum Day) Demand for 6 hours, delivered at a static pressure of 40 psi or greater.
- **Fire Flow Storage Required:** Maximum Fire Flow Rate x Associated Fire Flow Duration, delivered at a pressure of 20 psi or greater.
  - Based on the 2011 Comprehensive Master Plan, each zone was found to include at least one customer which requires the maximum fire flow rate of 3,500 gpm for a duration of three hours. Therefore, the Total Fire Flow Storage Required was calculated to be 0.63 MG for all pressure zones.
- **Emergency Storage Required:** ½ Average Day Demand, delivered at a static pressure of 20 psi or greater.
- **Total Storage Required:** While maintaining a static pressure of 20 psi or greater, the larger of:

  Equalization Storage + Fire Flow Storage

  OR

  Equalization + Emergency Storage

3.3.3.2 Storage Available

Based on the 2011 Master Plan, the storage available for equalization, fire and emergency was calculated based on the highest elevation customer in each pressure zone. Available storage was recalculated for this project assuming that the 880 Zone boundary was active (with the 880 Zone Tank in service) and 853 West / East Zone combined. The available zone-specific storage utilized for this analysis is summarized in Table 3-4. As shown, approximately 50% of the total available storage capacity in the Union County distribution system can be delivered to customers at a minimum static pressure of 40 psi (for equalization) and 100% can be delivered at a minimum static pressure of 20 psi (for total emergency).

Table 3-4 Available Storage for Equalization, Fire and Emergency by Pressure Zone

PRESSURE ZONE	STORAGE FACILITIES	TOTAL CAPACITY (MG)	EFFECTIVE STORAGE VOLUME FOR EQUALIZATION[1] (MG)	EFFECTIVE STORAGE VOLUME FOR TOTAL EMERGENCY[2] (MG)
821[3]	Sims Tanks 1 & 2	6.0	1.0	6.0
853 South	Austin Tank	0.3	0.1	0.3
853 West / East	Indian Trail, Stallings, Northwest Tanks	2.2	1.9	2.2
935	935 Zone Tank	0.5	0.5	0.5
762	Marshville Tank	1.0	1.0	1.0
880	880 Zone Tank[4]	1.5	1.2	1.5
Totals		**11.5**	**5.7**	**11.5**

[1]Storage volume available to deliver a static pressure of 40 psi to the highest elevation customer in the pressure zone served.
[2]Storage volume available to deliver a static pressure of 20 psi to the highest elevation customer in the pressure zone served.
[3]Individual customer service line booster pumps recommended as part of 2011 Master Plan assumed installed.
[4]Not yet constructed and in service at the time of this report.

3.3.3.3 821 Zone Storage Capacity Analysis

The 821 Zone contains customers at high ground elevations (as high as 755 ft) in the vicinity of the Sims Tanks. Based on a static pressure evaluation with the Sims Tank at their overflow of 821 ft, the maximum customer elevation which can be delivered water at the performance criteria level of 40 psi is 728 ft. In order to mitigate this deficiency, individual service line booster stations were recommended in the 2011 Comprehensive Master Plan for all customers in the 821 Zone located at elevations of 720 ft or greater. This storage deficiency analysis assumed that the maximum customer elevation the Sims Tanks would need to serve by gravity was 720 ft.

Figure 3-20 displays the 821 Zone Storage Capacity Analysis between 2015 and 2030. Available equalization storage in the Sims Tanks is shown in green, with available fire flow and emergency storage shown in red. The red and green bars sum to the total 6.0 MG volume of the Sims Tanks. The solid black line displays the Equalization Storage Required by year, the dashed black line displays Equalization + Fire Flow Storage Required by year and the dotted black line displays the Equalization + Emergency Storage Required by year. As shown, assuming that all customers located at elevations above 720 ft are equipped with individual service line booster pumps as discussed above, the 821 Zone is predicted to have sufficient Equalization and Total Emergency Storage to meet required storage through the planning horizon.

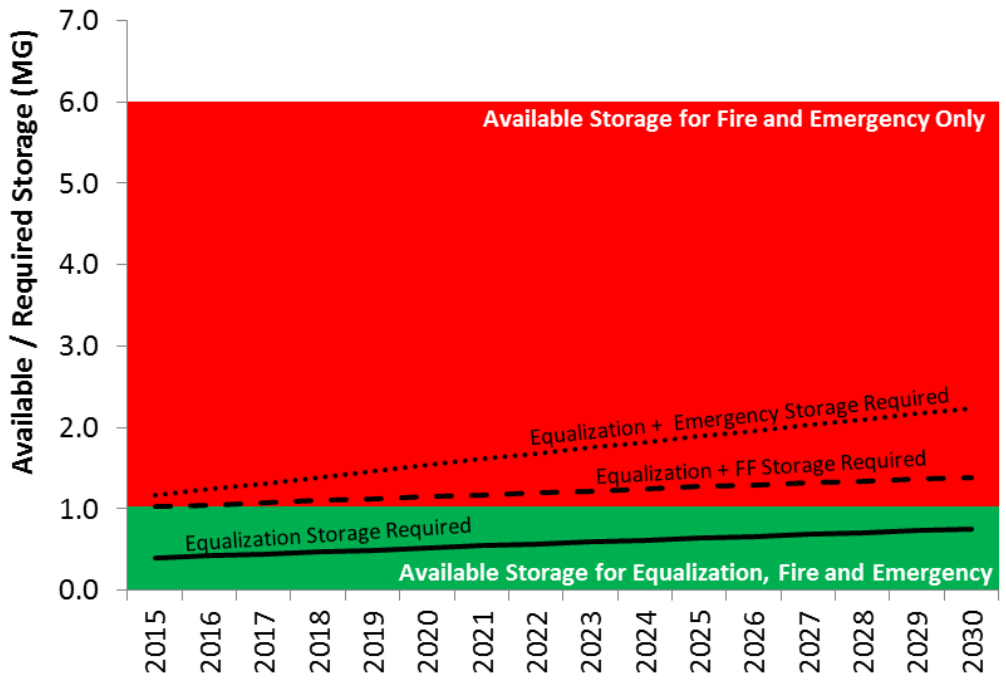


Figure 3-20 821 Zone Storage Capacity Analysis

3.3.3.4 853 South Zone Storage Capacity Analysis

The 853 South Zone contains one elevated storage tank – the 0.3 MG Austin Tank – of which approximately 0.1 MG is available for Equalization Storage and 0.3 MG is available for Emergency Storage.

Figure 3-21 displays the 853 South Zone Storage Capacity Analysis between 2015 and 2030. As shown, the Austin Tank is currently deficient in Equalization, Equalization + Fire and Equalization + Emergency Storage, with the magnitude of the deficiency expected to increase as demands in the 853 South Zone increase throughout the planning horizon. In order to mitigate this deficiency, a storage improvement project (0.75 MG 853 South Zone Tank, 853S-T-01) is recommended.

Although the storage improvement is recommended to be completed as soon as possible, due to the previously discussed uncertainty with system growth in the 853 South Zone, the project was deferred to between 2026 and 2030. UCPW will continue to monitor actual demands in the 853 South Zone and adjust the timing of this improvement project as needed.

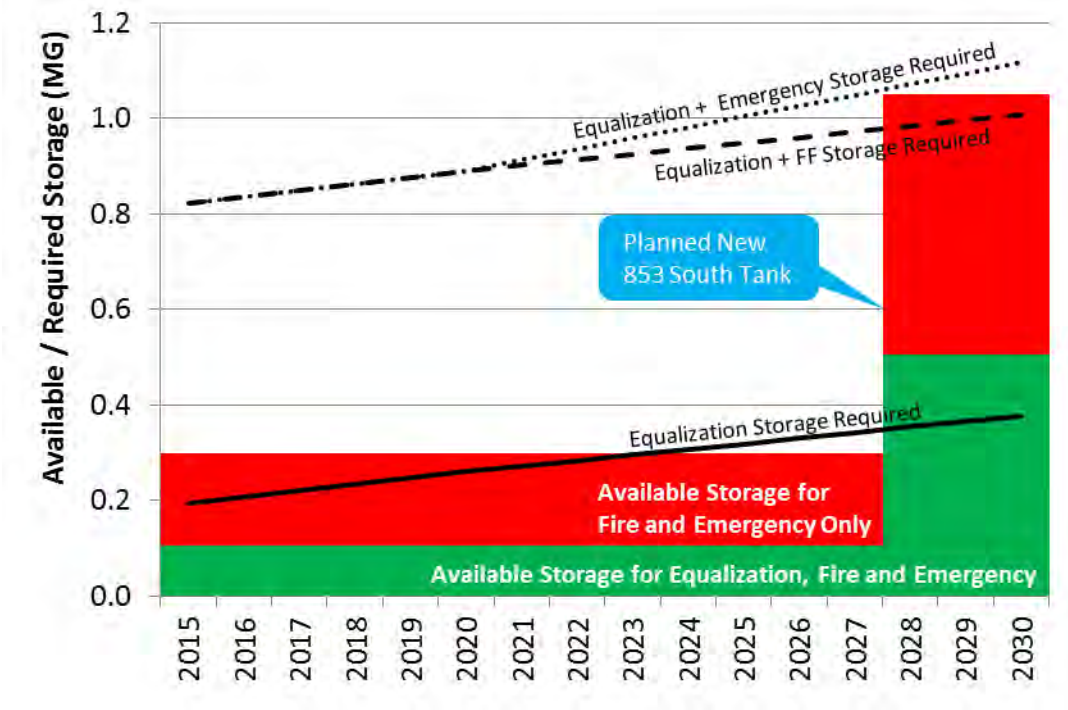


Figure 3-21 853 South Zone Storage Capacity Analysis

3.3.3.5 853 West / East Zone Storage Capacity Analysis

The combined 853 West / East Zone will contain three elevated storage tanks – the 0.2 MG Indian Trail Tank, 1.0 MG Stallings Tank and 1.0 MG Northwest Tank – of which approximately 1.9 MG is available for Equalization Storage and 2.2 MG is available for Emergency Storage.

Figure 3-22 displays the 853 West / East Zone Storage Capacity Analysis between 2015 and 2030. As shown, the 853 West / East Zone is predicted to be deficient in Equalization Storage by approximately 2020, at which point a new 2.0 MG Indian Trail Tank (853W-T-01) is planned to be completed. With the new Indian Trail Tank, the 853 West / East Zone is predicted to have sufficient Equalization and Equalization + Fire Flow Storage throughout the planning horizon. The 853 West / East Zone is not predicted to meet the criteria for Equalization + Emergency Storage, however, based on discussions with UCPW, this criteria will not be applied to this zone. Instead, it is assumed that emergency supply needs will be met by the Watkins BPS and/or the new YRWTP 853 Zone HSPS, and from the 880 Zone Tank via the 880/853 zone boundary PRVs. Emergency supply could also potentially be provided from Charlotte Water via existing interconnections with Charlotte Water's 960 Zone.

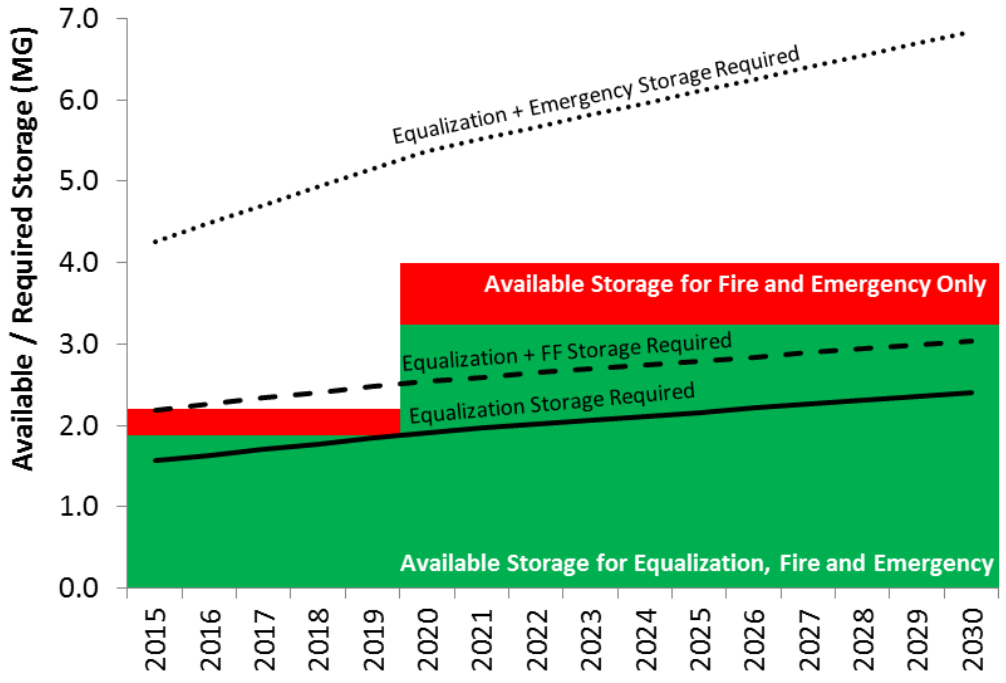


Figure 3-22 853 West / East Zone Storage Capacity Analysis

3.3.3.6 935 Zone Storage Capacity Analysis

The 935 Zone contains one elevated storage tank – the 0.5 MG 935 Zone Tank – of which all 0.5 MG is available for both Equalization Storage and Emergency Storage.

Figure 3-23 displays the 935 Zone Storage Capacity Analysis between 2015 and 2030. As shown, the 935 Zone will have sufficient storage to meet required Equalization Storage through the planning horizon. Due to the Fire Storage requirement of 0.63 MG, the 935 Zone is currently predicted to be deficient in required Equalization + Fire Flow Storage. Based on discussions with UCPW, a new 935 Zone Tank to address the deficiency is planned to be constructed by approximately 2031.

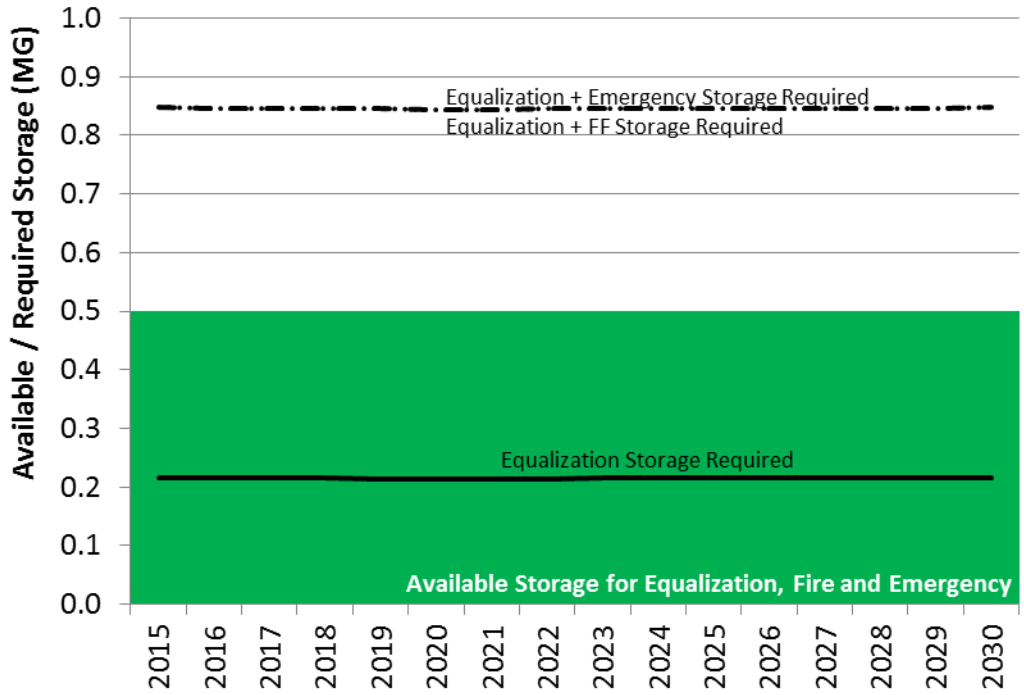


Figure 3-23 935 Zone Storage Capacity Analysis

3.3.3.7 762 Zone Storage Capacity Analysis

The 762 Zone contains one elevated storage tank – the 1.0 MG Marshville Tank – of which all 1.0 MG is available for both Equalization Storage and Emergency Storage.

Figure 3-24 displays the 762 Zone Storage Capacity Analysis between 2015 and 2030. As shown, the 762 Zone will have sufficient storage to meet required Equalization Storage through the planning horizon. Additionally, the existing Marshville Tank is in need of rehab and must be temporarily taken out of service in the near future. In order to do so, a storage improvement project (New 1.0 MG 762 Zone Tank, 762-T-01) is recommended to both allow for the Marshville Tank rehab as well as increase available Emergency Storage. With the new 762 Zone Tank in place, the 762 Zone is predicted to have sufficient Equalization + Fire Flow Storage throughout the planning horizon, however, is predicted to be deficient in Equalization + Emergency Storage in 2024. Based on discussions with UCPW, this storage criteria will not be applied to this zone. Instead, it is assumed that emergency supply needs will be met by the new YRWTP 762 Zone HSPS and from the 853 West / East Zone tanks via the new 853/762 zone boundary PRVs. Emergency supply could also potentially be provided from Anson County via the Highway 74 BPS.

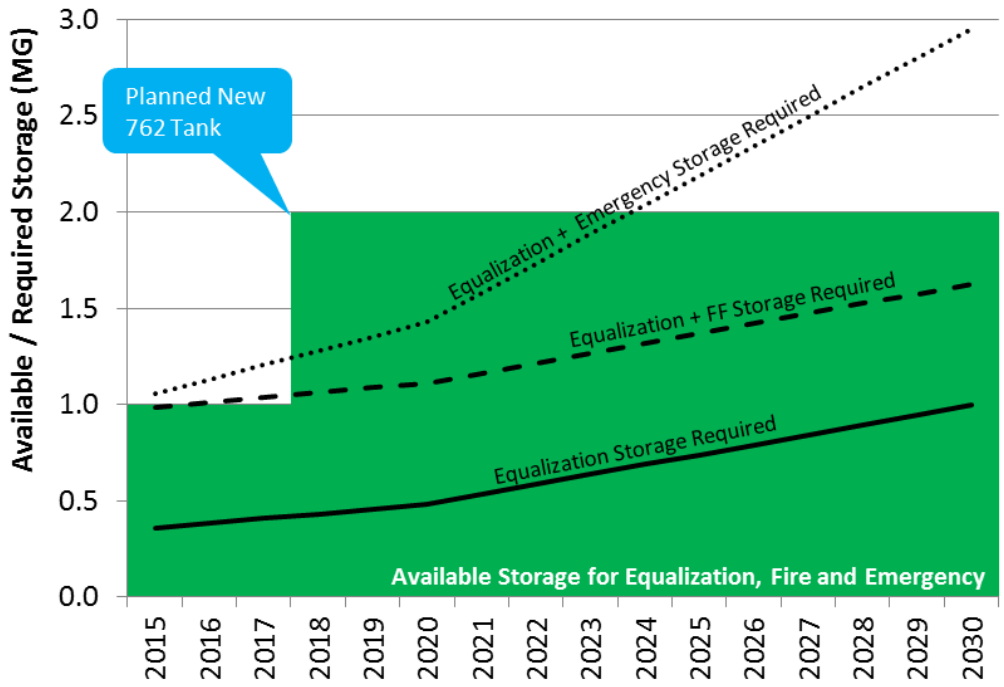


Figure 3-24 762 Zone Storage Capacity Analysis

3.3.3.8 880 Zone Storage Capacity Analysis

The 880 Zone will contain one elevated storage tank – the 1.5 MG 880 Zone Tank – of which approximately 1.2 MG will be available for Equalization Storage and 1.5 MG will be available for Emergency Storage.

Figure 3-25 displays the 880 Zone Storage Capacity Analysis between 2015 and 2030. As shown, the 880 Zone will have sufficient storage to meet required Equalization and Equalization + Fire Flow Storage through the planning horizon. The 880 Zone is not predicted to have sufficient storage to meet Equalization + Emergency Storage Requirements, however, based on discussions with UCPW, this storage criteria will not be applied to this zone. Instead, it is assumed that emergency supply needs will be met by the 880 Zone BPS and from the 853 West / East Zone tanks via the new 880/853 zone boundary check valves. Emergency supply could also potentially be provided from Charlotte Water via existing interconnections with Charlotte Water's 882 Zone.

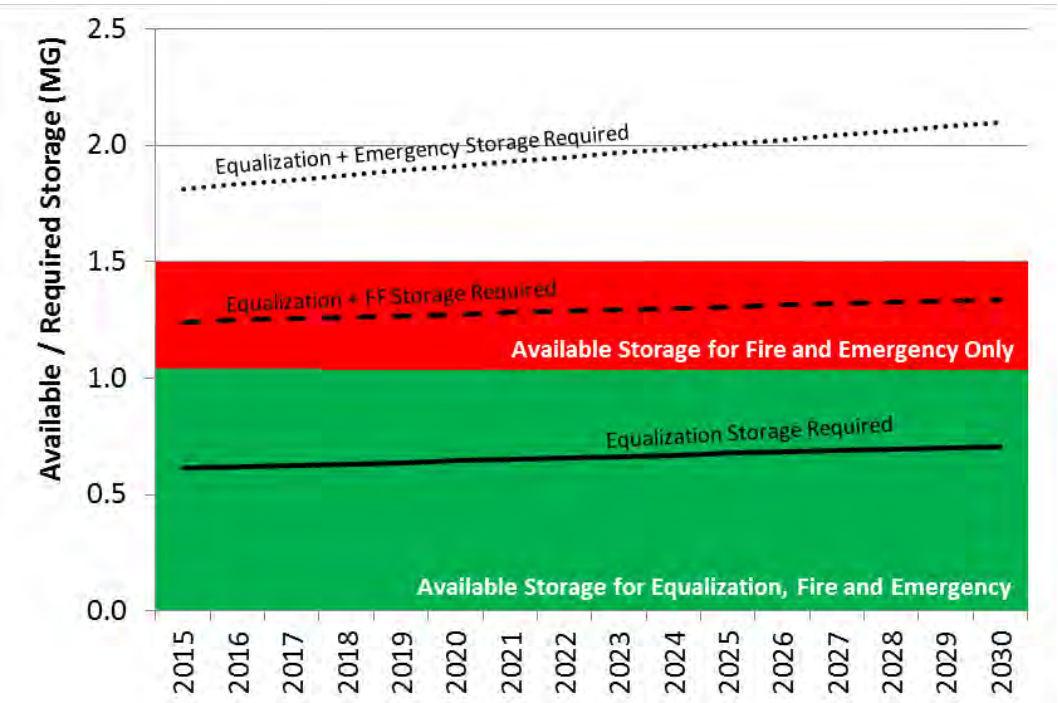


Figure 3-25 880 Zone Storage Capacity Analysis

3.4 DISTRIBUTION SYSTEM MODELING AND CAPACITY ANALYSES

Following the water supply, pumping, and storage capacity analyses detailed in Section 3.3, the hydraulic model was utilized to analyze the distribution system under projected 2020, 2022 and 2030 system demand conditions. Through these analyses, it was possible to identify distribution system deficiencies and evaluate potential system improvements. Utilizing iterative analyses, deficiencies were examined and, if needed, improvement projects were identified which improved available flows and/or pressures to substantially meet the performance criteria throughout the distribution system. This section describes the set-up of the hydraulic model, the model scenarios evaluated, as well as the final model results which include the CIP projects detailed in Chapter 5.

3.4.1 Hydraulic Model Set-Up

Based on the analysis described in Section 3.1, the YRWTP and associated finished water transmission mains were added to the hydraulic model as shown in Figure 3-26.

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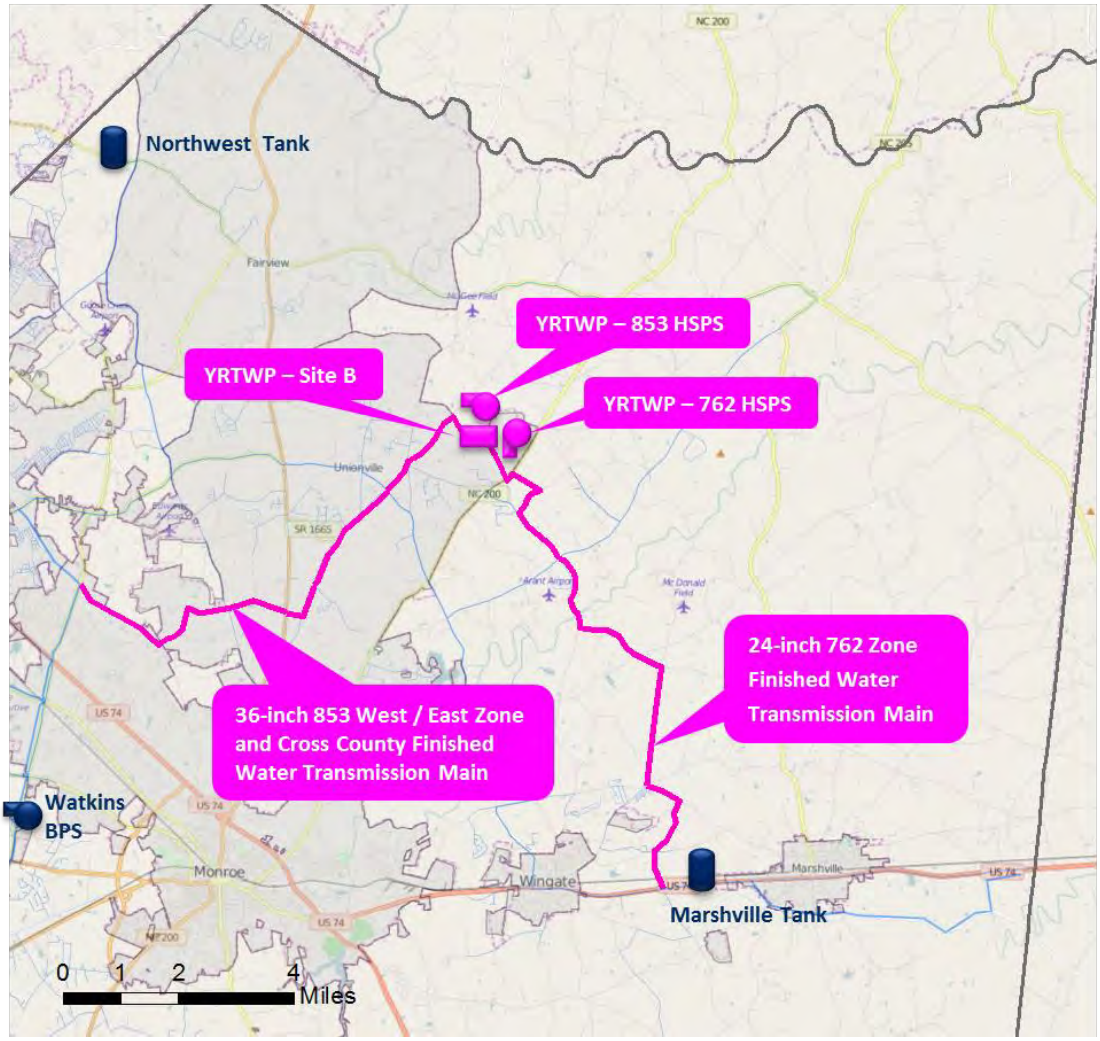

Figure 3-26 YRWTP Facilities and Infrastructure Added to Hydraulic Model

3.4.1.1 Modeled YRWTP

The new YRWTP was added to the model at Site Area B as two fixed grade nodes to represent the two planned HSPSs as shown in Figure 3-26.

- **YRWTP – 853 Zone HSPS:** Fixed grade node representing the 853 West / East Zone HSPS at the new YRWTP.
- **YRWTP – 762 Zone HSPS:** Fixed grade node representing the 762 HSPS at the new YRWTP.

3.4.1.2 Modeled Finished Water Mains

Finished water mains were added to the model following existing roads and right-of-ways to minimize pipe length as shown in Figure 3-26. The exact routing of these mains can be changed during final route selection as these projects move into design. Transmission main diameters were determined based on the hydraulic modeling conducted in subsequent sections.

- **762 Zone FWTM:** Approximately 10.6 miles of 24-inch main connecting the YRWTP 762 Zone HSPS to the 16-inch transmission main along Highway 74 in the 762 Zone.
- **853 West / East Zone FWTM and CCTM:** Approximately 9.8 miles of 36-inch main connecting the YRWTP 853 Zone HSPS to the planned 36-inch main near the discharge of the Watkins BPS. This new 36-inch main will allow the initial supply capacity of the YRWTP to be delivered to the 853 West / East Zone as well as provide a major artery across the Union County system to allow for water supply redundancy and resiliency in the future.

3.4.2 Hydraulic Model Scenario Development

The following model scenarios were developed in the hydraulic model to facilitate system analysis as part of this master plan. All scenarios were simulated as 24 hour extended period simulations (EPS) to allow analysis of system operations and performance over time as tank levels and pump status change in response to system demand variations.

3.4.2.1 Normal System Operation Model Scenarios

Three model scenarios were developed to analyze the system under normal operating conditions and allow for the refinement of system planning decisions and CIP project phasing for the master plan. The scenarios are summarized below and their results are presented in Section 3.4.3.

- **2020 MDD EPS:**
  - System Demand: 27.9 mgd (Demand Alternative *2020 ADD – IBT Adjusted (15.2 mgd)* scaled to MDD using a Unit Demand Adjustment of 1.7.
  - Active Topology: *2020 Base.* Includes all master plan projects proposed to be active in 2020.
  - Purpose: Simulate the UC system under 2020 MDD to identify performance issues and phase master plan projects prior to the completion of the YRWTP.

- **2022 MDD EPS:**
  - System Demand: 29.6 mgd (Demand Alternative *2022 ADD – IBT Adjusted (16.2 mgd)* scaled to MDD using a Unit Demand Adjustment of 1.7.
  - Active Topology: *2022 Base.* Includes the new YRWTP, 36-inch 853 FWTM and CCTM, expanded 762 Zone and all other master plan projects proposed to be active in 2022.
  - Purpose: Simulate the UC system under 2022 MDD, which is the Initial Capacity Year of the YRWTP. Identify performance issues and phase master plan projects.

- **2030 MDD EPS:**
  - System Demand: 37.4 mgd (Demand Alternative *2030 ADD – IBT Adjusted (20.8 mgd)* scaled to MDD using a Unit Demand Adjustment of 1.7.
  - Active Topology: *2030 Base.* Includes the new YRWTP, 36-inch 853 FWTM and CCTM, New 24-inch 762 FWTM and all other master plan projects proposed to be active in 2030.
  - Purpose: Simulate the UC system under 2030 MDD to identify performance issues and phase master plan projects following the construction of the YRWTP.

3.4.2.2 Emergency System Operation Model Scenarios

Four model scenarios were developed to analyze the system under emergency operating conditions during which one of the WTP Supplies is temporarily lost in the future. The scenarios are summarized below and their results are presented in Chapter 4.

- **2022 – Complete Loss of the Yadkin River Supply**
  - System Demand: 29.6 mgd (Demand Alternative *2022 ADD – IBT Adjusted (16.2 mgd)* scaled to MDD using a Unit Demand Adjustment of 1.7.
  - Active Topology: *2022 CRWTP Supply.* Includes the 36-inch 853 FWTM and CCTM, expanded 762 Zone and all other master plan projects proposed to be active in 2022. YRWTP not active. Highway 74 BPS not active.
  - Purpose: Evaluate the ability of the CRWTP and distribution system to deliver MDD to customers following an emergency outage of the Yadkin River Supply in 2022.

- **Planning Year 2030 – Complete Loss of the Yadkin River Supply**
  - System Demand: 37.4 mgd (Demand Alternative *2030 ADD – IBT Adjusted (20.8 mgd)* scaled to MDD using a Unit Demand Adjustment of 1.7.
  - Active Topology: *2030 CRWTP Supply.* Includes the 36-inch 853 FWTM and CCTM, New 24-inch 762 FWTM and all other master plan projects proposed to be active in 2030. YRWTP not active. Highway 74 BPS not active.
  - Purpose: Evaluate the ability of the CRWTP and distribution system to deliver MDD to customers following an emergency outage of the Yadkin River Supply in 2030.

- **Initial Capacity Year (2022) – Complete Loss of the Catawba River SUpply**
  - System Demand: 12 mgd (Demand Alternative *2022 ADD – IBT Adjusted (16.2 mgd)* scaled to 12 mgd using a Unit Demand Adjustment of 0.74. For this scenario, it was assumed that the system demand would be limited to the supply capacity of the YRWTP.
  - Active Topology: *2022 YRWTP Supply.* Includes the YRWTP, 36-inch 853 FWTM and CCTM, expanded 762 Zone and all other master plan projects proposed to be active in 2022. CRWTP not active.
  - Purpose: Evaluate the ability of the YRWTP and distribution system to deliver the 12 mgd initial capacity to customers following an emergency outage of the Catawba River Supply in 2022.

- **Planning Year 2030 – Complete Loss of the Catawba River Supply**
  - System Demand: 20.8 mgd (Demand Alternative *2030 ADD – IBT Adjusted (20.8 mgd)*
  - Active Topology: *2030 YRWTP Supply.* Includes the YRWTP, 36-inch 853 FWTM and CCTM, New 24-inch 762 FWTM and all other master plan projects proposed to be active in 2030. Highway 74 BPS active.
  - Purpose: Evaluate the ability of the YRWTP, Highway 74 BPS (Anson County supply) and the distribution system to deliver ADD to customers following an emergency outage of the Catawba River Supply in 2030.

3.4.3 Hydraulic Modeling Results

The system modeling and improvement analysis was an iterative process which incorporated the YRWTP siting and the supply, zone transfer and storage capacity analyses detailed in Section 3.3. The hydraulic model was used to phase CIP improvement projects, identify system deficiencies and validate that the Union County water distribution system will be capable of providing customers with the desired level of service (based on the 2011 Performance Criteria) throughout the planning horizon.

The results presented in this section include an overview figure of the system for each model scenario, including average pump station and PRV flows for the 24 hour period and tank level graphs which display the diurnal level variations of each tank. The y-axis of each tank level graph is equal to the actual head range of the tank, in feet. In other words, a tank is full if the level is shown at the top of the y-axis and empty if shown at the bottom.

For the model scenarios detailed below, the key indicators that the system is designed well and capable of meeting the performance criteria are:

- Pump station flows do not exceed firm capacity.
- Storage tanks remain at least half full. The Union County distribution is configured such that system customers will receive adequate service pressures when the storage tanks in each zone are at least half full. Localized low and high pressure exceptions are described in Section 3.4.3.4.
- Storage tanks float at similar water surface elevations. This indicates that there is good hydraulic capacity within the pipeline network between storage tanks.
- Storage tank levels end the 24 hour simulation near the same level that they started. This indicates that the system is capable of refilling tanks over the course of the day and the tanks will not eventually empty during consecutive maximum days.

3.4.3.1 2020 MDD EPS

The 2020 MDD EPS model scenario represents the distribution system under 2020 Maximum Day Demands of 27.9 mgd and includes all CIP projects identified in Chapter 5 planned to be complete by 2020, including the 853 West Transmission Improvement Mains (853W-M-01 to 853W-M-05), the new 1.5 MG Indian Trail Tank (853W-T-01) and the 853 West / South PRV at the Watkins BPS (853S-V-01).

Figure 3-27 displays the model results of the 2020 MDD EPS scenario, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place, maximum day demands can be delivered throughout the distribution system with tank levels remaining at least half full with the following observations, exceptions and notes:

- **Northwest Tank Level**

  Due to transmission capacity limitations in the combined 853 West / East Zone, the Northwest Tank is predicted to float approximately 10 to 15 ft lower than the Stallings and New Indian Trail Tanks under 2020 MDD. It is noted that in order to keep the Northwest Tank more than half full, the Watkins BPS must keep the Stallings and New Indian Tank levels near overflow throughout the day. This system operating condition will not be as pronounced under lower demand conditions and will be eliminated following the construction of the 36-inch 853 FWTM and CCTM in 2022.

- **762 Zone Demand Exceeds Supply**

  The 762 Zone 2020 MDD is projected to be 3.2 mgd, which exceeds the reliable available supply capacity of 3 mgd from Anson County at the Highway 74 BPS. As shown in the model simulation, the Marshville and New 762 Zone Tanks end the 24 hour period lower than they started to meet the supply shortfall of 0.2 mgd. It is noted that if the system experiences consecutive MDDs which cannot be supplied by the Highway 74 BPS alone, a boundary valve on the 16-inch main at the Olive Branch BPS could be partially opened to supplement 762 Zone supply.

- **New 762 Zone Tank Level**

  Under 2020 conditions, the 762 Zone will be supplied by the Highway 74 BPS only. Due to head loss along the 16-inch transmission main, the New 762 Zone Tank will float approximately 15 ft lower than the Marshville Tank under MDD conditions. This issue will not be as pronounced under lower demand conditions and will be minimized following the expansion of the 762 Zone and associated supply PRVs (762-V-02 and 762-V-03) in 2022.

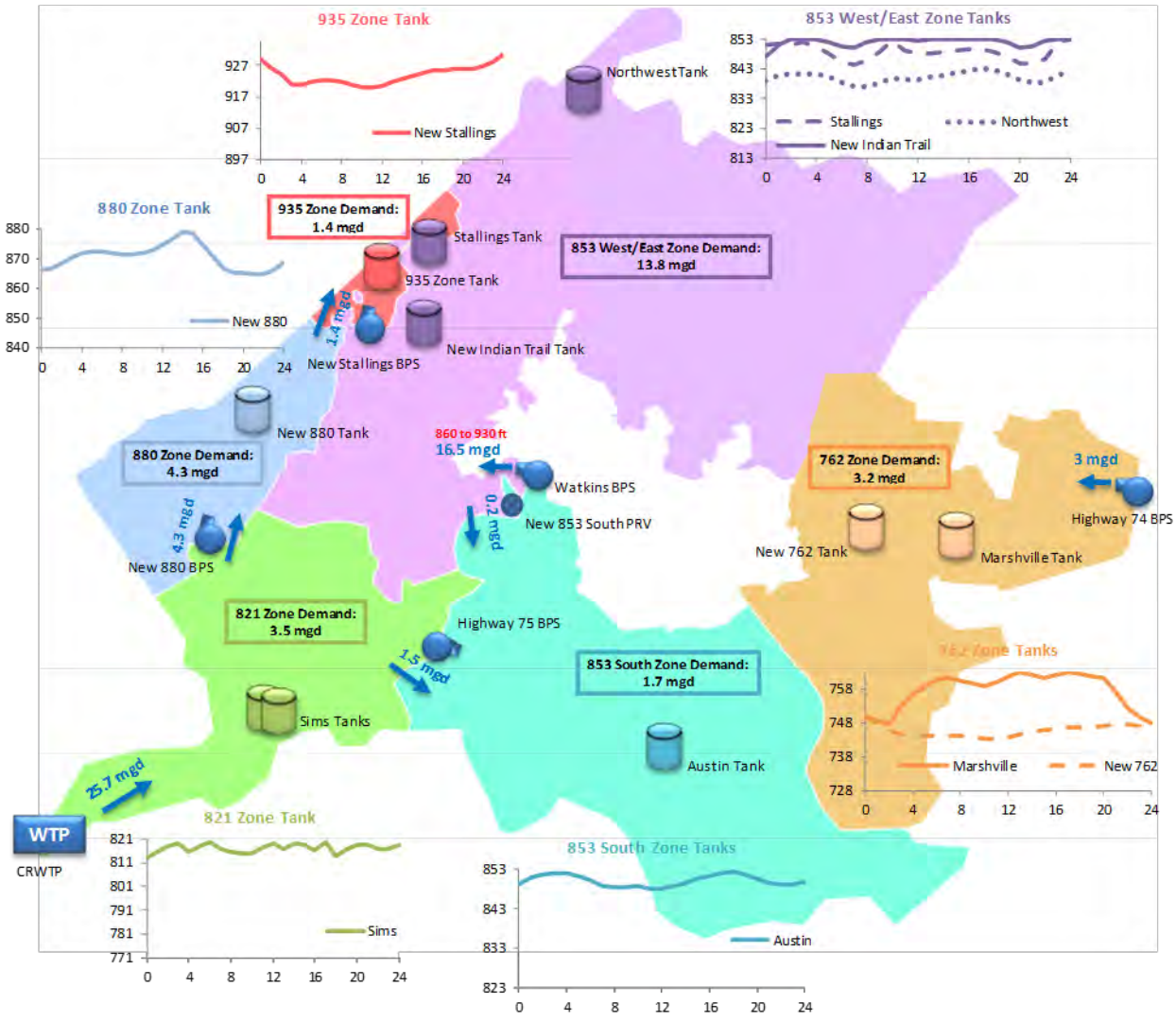

Figure 3-27 2020 MDD Hydraulic Model Results

3.4.3.2 2022 (Initial Capacity Year) MDD EPS

The 2022 MDD EPS model scenario represents the distribution system under 2022 Maximum Day Demands of 29.6 mgd and includes all CIP projects identified in Chapter 5 planned to be complete by 2022, including expansion of the 762 Zone, the new 12 mgd Yadkin River WTP (YAD-S-02), 36-inch 853 FWTM and CCTM (YAD-M-02) and the 853 / 762 PRVs (762-V-02 and 762-V-03).

Figure 3-28 displays the model results of the 2022 MDD EPS scenario, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place, maximum day demands can be delivered throughout the distribution system with tank levels remaining at least half full with the following observations, exceptions and notes:

- **Northwest Tank**

  Following the addition of the YRWTP, the issue observed in the 2020 MDD EPS scenario of the Northwest Tank floating at a significantly lower water surface elevation than the New Indian Trail and Stallings Tanks is predicted to be eliminated.

- **762 Zone Supply**

  Following the addition of the two new 762 Zone PRVs (762-V-02 and 762-V-03), the 762 Zone will be supplied from both the PRVs and the Highway 74 BPS. It is noted that although there is sufficient supply in the 853 West / East Zone (via the Watkins BPS) to supply all of the expanded 762 Zone demand, high head losses in the existing 16-inch 762 Zone transmission main were predicted to significantly limit the volume of water which can be delivered through the 762 PRVs. As such, the Highway 74 BPS will continue to be needed under normal operating conditions until the new 762 FWTM is constructed.

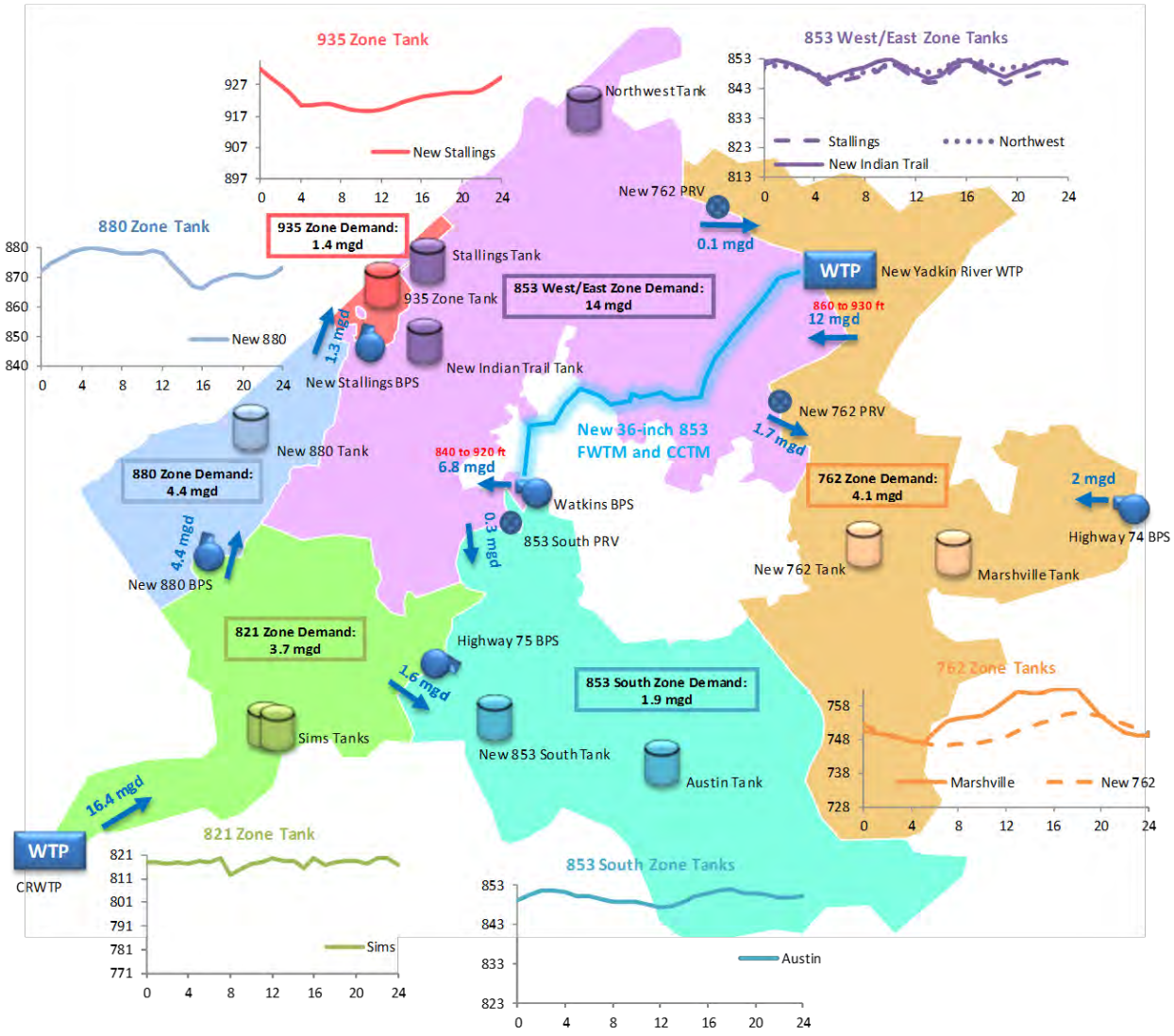

Figure 3-28 2022 (Initial Capacity Year) MDD EPS Hydraulic Model Results

3.4.3.3 2030 MDD EPS

The 2030 MDD EPS model scenario represents the distribution system under 2030 Maximum Day Demands of 37.4 mgd and includes all CIP projects identified in Chapter 5 planned to be complete by 2030, including the New 853 South Zone Tank (853S-T-01), 16-inch 853 South Transmission Main (853S-M-01) and the 24-inch 762 FWTM (YAD-M-03).

Figure 3-29 displays the model results of the 2030 MDD EPS scenario, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place, maximum day demands can be delivered throughout the distribution system with tank levels remaining at least half full with the following observations and notes:

- **762 Zone Supply**

  Following completion of the 762 Zone HSPS and 24-inch 762 FWTM, the 762 Zone will have sufficient supply capacity such that the Anson County supply via the Highway 74 BPS will not be needed during normal operating conditions. The Highway 74 BPS and a limited water supply agreement with Anson County should, however, be maintained as an emergency supply back-up.

- **853 / 762 YRWTP Supply Split**

  In 2030, the YRWTP will be the only supply for the 762 Zone under normal operating conditions. As such, for this model simulation the 12 mgd available supply from the YRWTP was divided between 762 and 853 by assuming that 100% of 762 Zone MDD (6.65 mgd) was met by the YRWTP and the balance (5.35 mgd) delivered to the 853 West / East Zone.

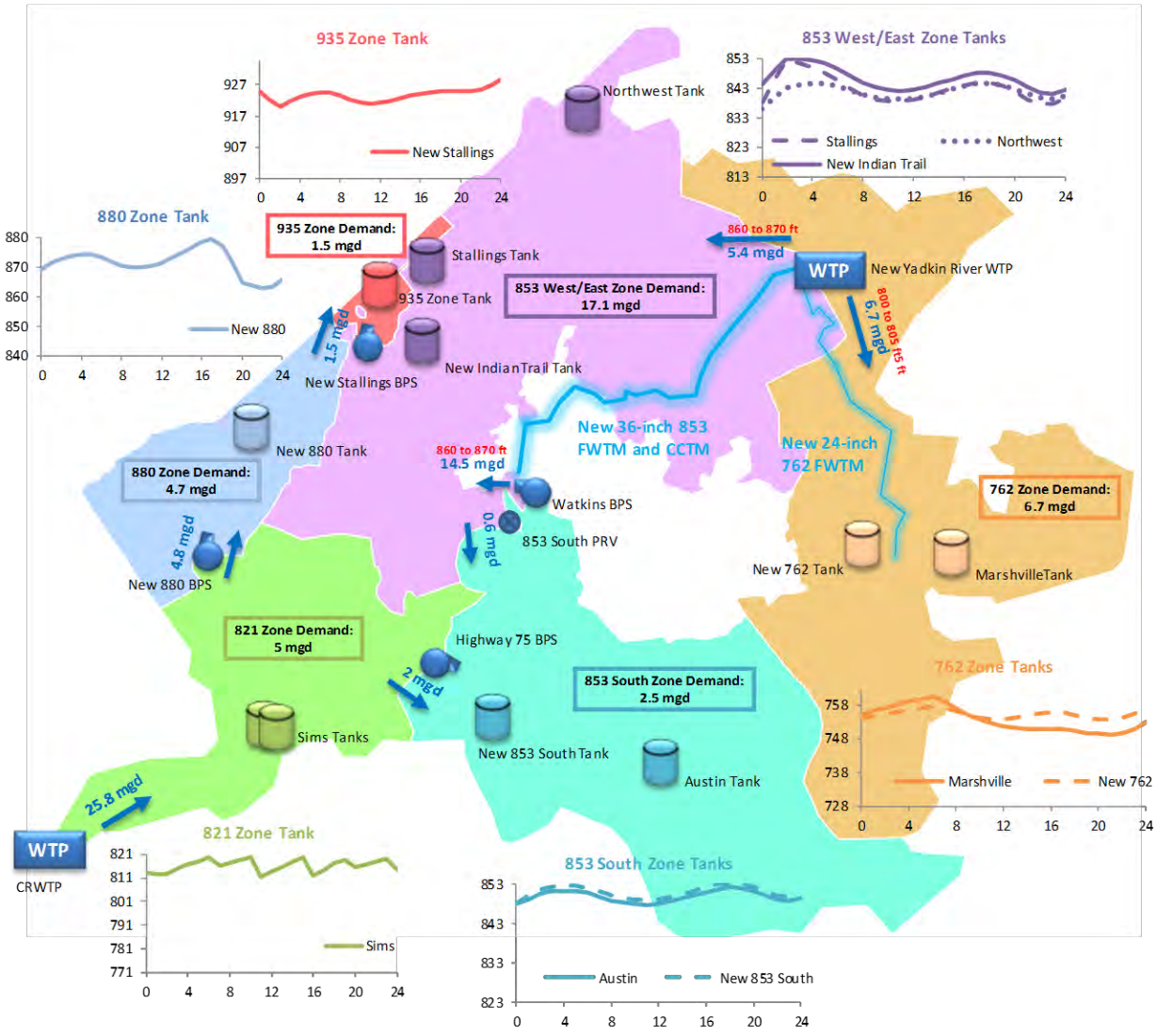

Figure 3-29 2030 MDD EPS Hydraulic Model Results

3.4.3.4 Localized System Deficiencies Addressed by CIP Projects

The hydraulic modeling analyses detailed in the previous section indicate that the planned distribution system is predicted to deliver water service which meets or exceeds the 2011 Master Plan performance criteria for the majority of the distribution system. However, there were a few areas predicted to experience low or high pressures due to localized issues. This section details the locations of the localized low and high pressures as well as CIP projects recommended to mitigate the deficiencies.

3.4.3.4.1 Low Pressures (Less than 40 psi)

Based on the results of the hydraulic modeling, the three areas shown in Figure 3-30 were predicted to experience pressures below the minimum pressure performance criteria of 40 psi under normal operating conditions. These areas were studied and improvement projects recommended as described below. Based on discussions with UCPW, addressing low pressures are a high priority which should be addressed between 2015 and 2020.

- **Low Pressure Area 1**

  There are currently customers supplied from the dedicated 16-inch 853 West Zone transmission main within the 935 Zone. These customers are currently served at the 853 West hydraulic grade line though their high elevations would more appropriately be served by the 935 Zone. Based on discussions with UCPW, a 935 Zone Service Study (935-Z-01) has been proposed to evaluate and optimize the 935 Zone boundary and from which zone some customers are supplied.

- **Low Pressure Area 2**

  There are currently customers located on a long, dead-end 8-inch in the southern portion of the 853 West / East Zone which are predicted to experience low pressures under peak hour demand conditions. A 2,000 ft, 8-inch improvement project (853W-M-06) has been proposed to provide a loop and decrease headloss and is predicted to eliminate low pressures in this area.

- **Low Pressure Area 3**

  There are currently customers located on a long, dead-end 8-inch in the 762 Zone which are predicted to experience low pressures under peak hour demand conditions. These low pressures will be eliminated when the 24-inch 762 FWTM is completed by 2028, however, based on discussions with UCPW this deficiency should be addressed sooner. Therefore, a 1,500 ft, 8-inch improvement project (762-M-01) has been proposed to provide a loop and decrease headloss and is predicted to eliminate low pressures in this area.

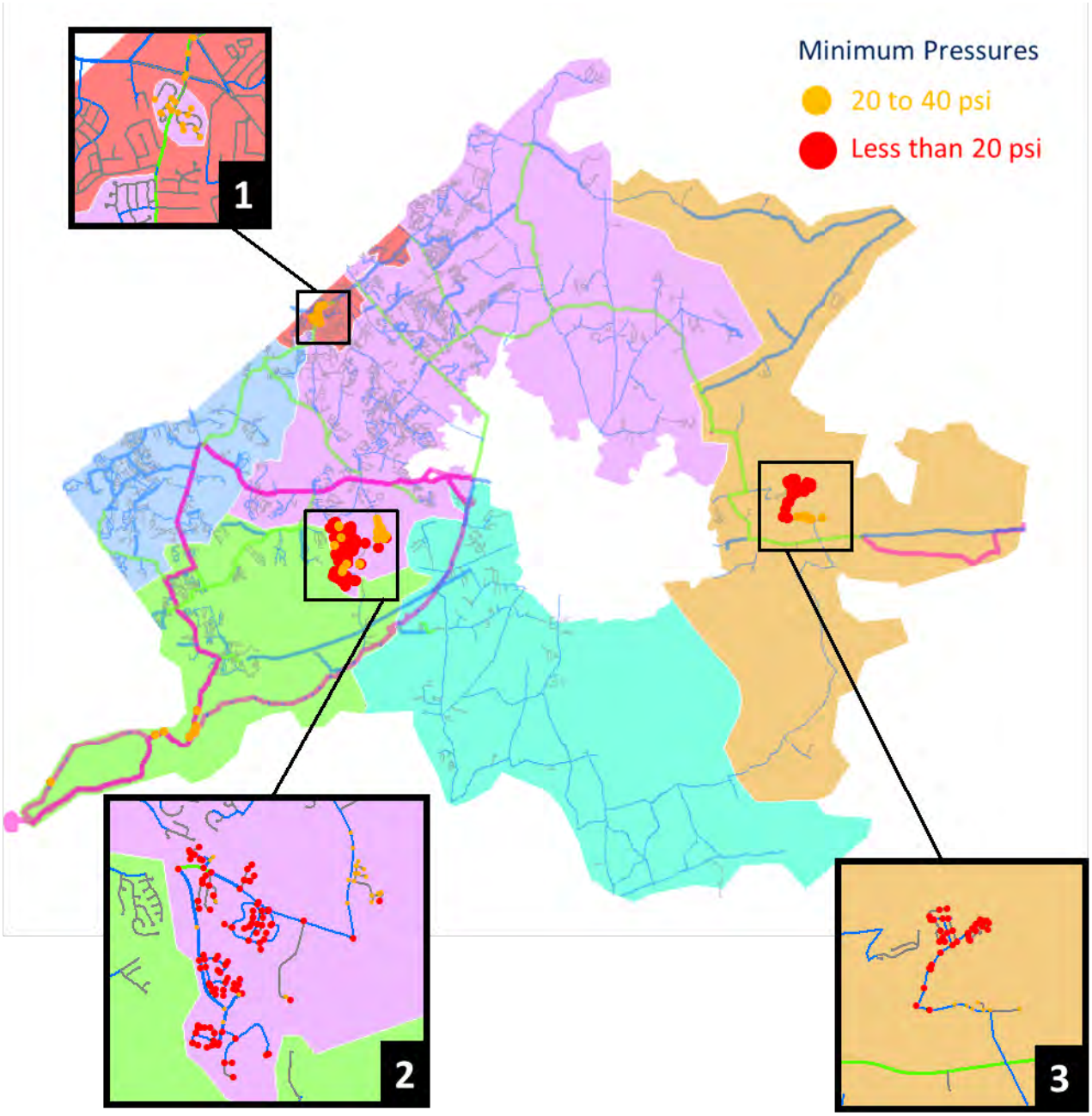

Figure 3-30 Localized Low Pressure Areas

3.4.3.4.2 High Pressures (Greater than 150 psi)

Based on the results of the hydraulic modeling, the two areas shown in Figure 3-31 were predicted to experience pressures above the maximum pressure performance criteria of 150 psi under normal operating conditions. These areas were studied and improvement projects recommended as described below. Based on discussions with UCPW, addressing high pressures are of a lower priority than addressing low pressures and therefore should be addressed between 2020 and 2030.

- **High Pressure Area 1**

  There are currently customers located at the eastern portion of the future 853 West / East Zone which are located at low elevations relative to the nominal hydraulic grade line in the zone, leading to high pressures above 150 psi. Following construction of the 762 FWTM, these customers are planned to be shifted to the 762 Zone to eliminate the high pressures (762-Z-02).

- **High Pressure Area 2**

  There are currently customers in the southeastern portion of the future 853 West / East Zone which are located at low elevations relative to the nominal hydraulic grade line in the zone, leading to high pressures above 150 psi. In order to mitigate high pressures in this area, a small reduced pressure zone fed by two PRVs has been proposed (853W-Z-02).

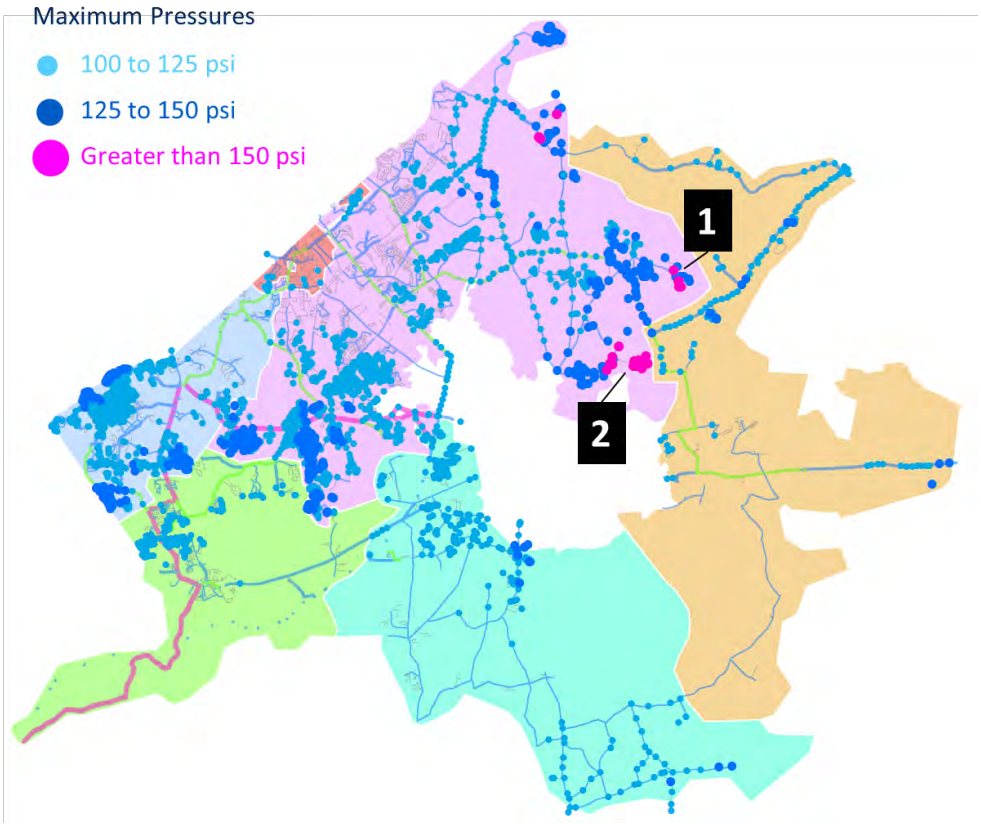

Figure 3-31 Localized High Pressure Areas

3.4.3.4.3 Fire Flows

The 2011 Master Plan recommended a 47,000 ft 12-inch main project in the 762 Zone (762-M-02) for the sole purpose of improving fire flows to the extreme southern portion of the 762 Zone. Based on discussions with UCPW, this project should be deferred in order to conserve capital for more critical water supply projects required in the next 10 years.

4.0 System Redundancy Planning

The availability of water supply can be affected by a number of potential emergencies such as an exceptional drought that affects an entire river basin or a chemical spill/contamination which could compromise a water source for an extended period of time. In the case of the Catawba River, a reduction of the available supply or a complete loss of the river could be catastrophic for the region as nearby communities including Charlotte also depend on the Catawba River for supply. Other localized emergencies could impact the Union County supply such as the loss of the Catawba River Water Treatment Plant (CRWTP) or a raw or finished water transmission main failure.

Following construction of the Yadkin River Water Treatment Plant (YRWTP), which is planned for 2022, the Union County water distribution system will have two significant and separate sources of supply. The CRWTP will provide water supply from the Catawba River and the YRWTP will provide supply from the Yadkin River. With the completion of the 853 Finished Water Transmission Main and Cross County Transmission Main (FWTM and CCTM) (YAD-M-02), Union County will have the capability to supply water from either source to customers throughout the distribution system. This supply flexibility will allow the system to provide water service to customers even under emergency conditions such as the loss of either the Catawba River Supply or Yadkin River Supply, providing Union County with a higher level of resiliency and redundancy.

A component of this water system planning update was to use the hydraulic model to evaluate the ability of the improved distribution system to supply customers under emergency conditions. This Chapter presents the results of the hydraulic modeling analyses under the following emergency conditions:

- **2022 – Complete Loss of the Yadkin River Supply**
  Maximum day demands, 100% of supply provided by the CRWTP
- **Planning Year 2030 – Complete Loss of the Yadkin River Supply**
  Maximum day demands, 100% of supply provided by the CRWTP
- **Initial Capacity Year (2022) – Complete Loss of the Catawba River Supply**
  12 mgd demand, 100% of supply provided by the YRWTP
- **Planning Year 2030 – Complete Loss of the Catawba River Supply**
  Average day demands, 100% of supply provided by the YRWTP and Anson County via the Highway 74 BPS

In a workshop setting with Union County Public Works (UCPW) staff, the reasonable level of service (or capacity) during catastrophic water supply events was discussed and it was decided that the performance goal for the system was to meet average day demands under emergency conditions throughout the planning horizon.

4.1 UNION COUNTY WATER SUPPLY UNDER EMERGENCY CONDITIONS

Union County's available water supply sources under normal operating conditions are described in Chapter 3 and include the CRWTP, YRWTP (beginning in 2022), Anson County (via Highway 74 BPS) and a short-term lease agreement with Lancaster County Water & Sewer District from the CRWTP. The following additional sources of supply are planned to be available under emergency conditions:

- **High-Rated YRWTP**

  The YRWTP is planned to be operational in 2022 with an initial permitted capacity of 12 mgd. The first planned expansion of 8 mgd is not planned until 2032. It is anticipated that Union County will desire the flexibility to treat and deliver more than the initial 12 mgd capacity of the YRWTP prior to 2032. This can be accomplished through an interim high-rating of the treatment plant. The new YRWTP should be designed with a minimum of 50% hydraulic condition surplus. This hydraulic condition provides numerous process and operational benefits to the operating treatment facilities, but also offers short-term ability to operate the facilities at a 50% increase in capacity. During a catastrophic water supply emergency, it was assumed that the initial year YRWTP could be high-rated to an 18 mgd capacity.

- **Emergency Interconnection(s) with Charlotte Water**

  The Union County and Charlotte Water (CW) distribution systems are adjacent, with several locations that connect along 8 and 12-inch pipelines (though the systems are isolated by closed valves). UCPW and CW are currently in discussions about future beneficial sharing of distribution system water during emergency and planned system conditions. For the purposes of this analysis, an emergency capacity of 4 mgd was assumed to be available from CW beginning in 2019. The capacity and timeline for potential serviceable interconnection(s) must be studied further, defined contractually, and equipped as needed with metering and other temporary facilities implemented. One of the more challenging issues to address when implementing the interconnections is the blending of free chlorine water from the CW system with chloramine water in the UC system.

- **Anson County Emergency Back-Up**

  Following the construction of the YRWTP 762 HSPS and 24-inch FWTM (YAD-M-03) in 2028, the 762 Zone will have sufficient supply and transmission capacity to be served under normal operating conditions without utilization of the existing Anson Supply at the Highway 74 BPS. After 2028, the Anson Supply should be maintained as an emergency back-up supply.

4.1.1 Total Emergency Water Supply Available

Figure 4-1 displays the total emergency water supply available from all sources, including the existing and planned capacity of the CRWTP, the planned capacities of the YRWTP, the existing lease agreement with Lancaster (until the beginning of 2019), the existing Anson Supply (converting to emergency back-up in 2028), the planned CW emergency interconnects (assumed to be available by 2019) and an assumed 50% high-rating of the YRWTP. Although the scope of this project was limited to 2030, available supply capacities were analyzed between 2015 and 2050 to ensure that the macro infrastructure decisions were consistent with the long-range sustainability of the Union County system beyond the planning horizon.

As shown in Figure 4-1, following the completion of the initial capacity of the YRWTP in 2022, the total available emergency supply is predicted to exceed system-wide average day demands by 30 mgd or more through 2050.

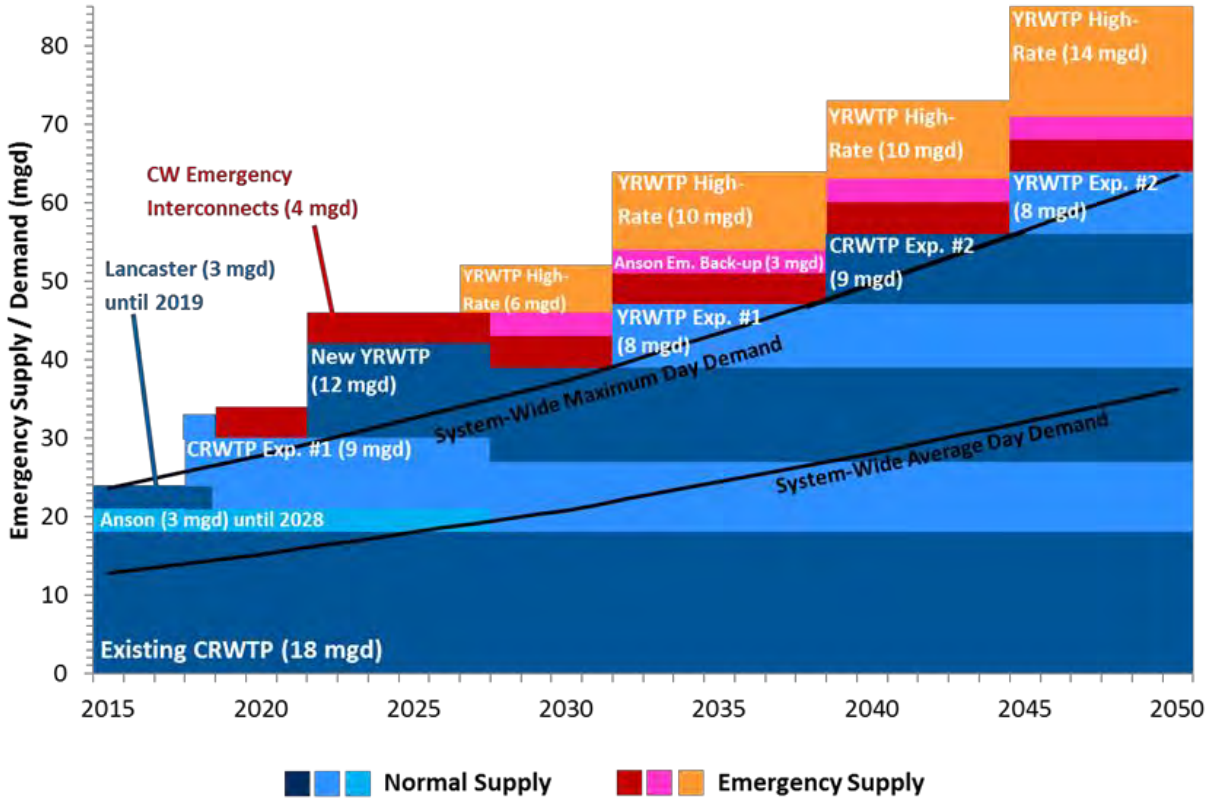

Figure 4-1 Total Emergency Water Supply Available

4.1.2 Emergency Water Supply Available with the YRWTP Offline

Figure 4-2 displays the total emergency supply available with the YRWTP offline, assuming a loss of the Yadkin River or complete failure of the YRWTP. Without the YRWTP, the available emergency water supply will include the existing and planned capacities of the CRWTP, the existing lease agreement with Lancaster (until 2018), the existing Anson Supply (converting to emergency back-up in 2028) and the planned CW emergency interconnects (assumed to be available by 2019).

As shown in Figure 4-2, the Union County distribution system emergency supply with the YRWTP offline is predicted to exceed average day demands through 2050. It is noted that in the event of widespread contamination of the Yadkin River, the Anson Emergency Back-up supply would also possibly not be available. Based on the surplus shown, average day demands are still predicted to be available without the YRWTP and Anson Supply through 2050.

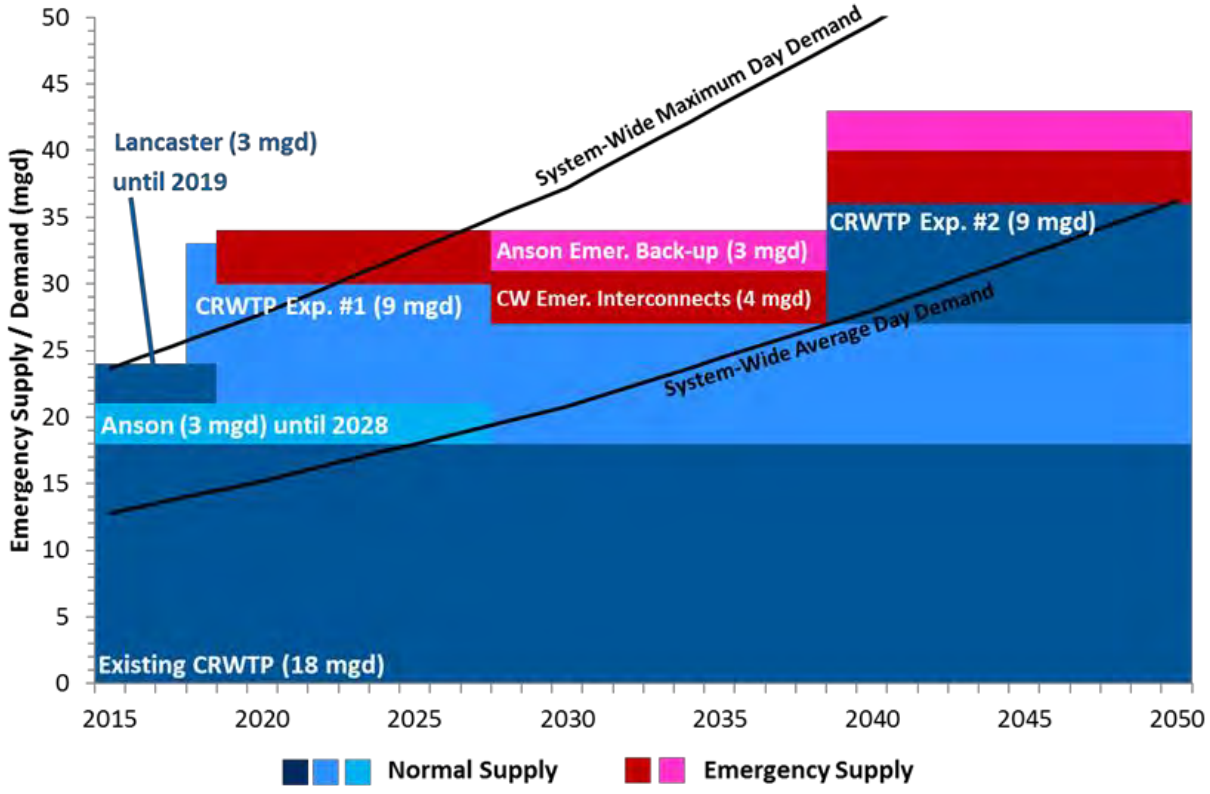

Figure 4-2 Emergency Supply Available with the YRWTP Offline

4.1.3 Emergency Supply Available with the CRWTP Offline

Figure 4-3 displays the total emergency supply available with the CRWTP offline, assuming a total loss of the Catawba River or a failure of the CRWTP. Without the CRWTP, the available emergency water supply will include the planned capacities of the YRWTP, the existing Anson Supply (converting to emergency back-up in 2028), planned CW emergency interconnects (assumed to be available by 2019) and an assumed 50% high-rating of the YRWTP.

As shown in Figure 4-3, the Union County distribution system will not be capable of supplying average day demands without the CRWTP until the YRWTP is completed in 2022. Following the construction of the YRWTP, the available emergency supply with the CRWTP offline is predicted to exceed average day demands through 2050. In order to meet increasing average day demands without the CRWTP, the YRWTP is predicted to be required to be high-rated from 12 mgd to 18 mgd by 2027. The YRWTP was assumed to be capable of continuing to be high-rated at 50% of total capacity following each of the two planned expansions (in 2032 and 2044). It is noted that in the event of widespread contamination of the Catawba River, the CW Emergency Interconnects may also not be available. Based on the surplus shown, average day demands are still predicted to be able available without the CRWTP and CW Interconnects following the initial YRWTP high-rate through 2050. The planned sources of supply will not be able to meet maximum day demands without the CRWTP.

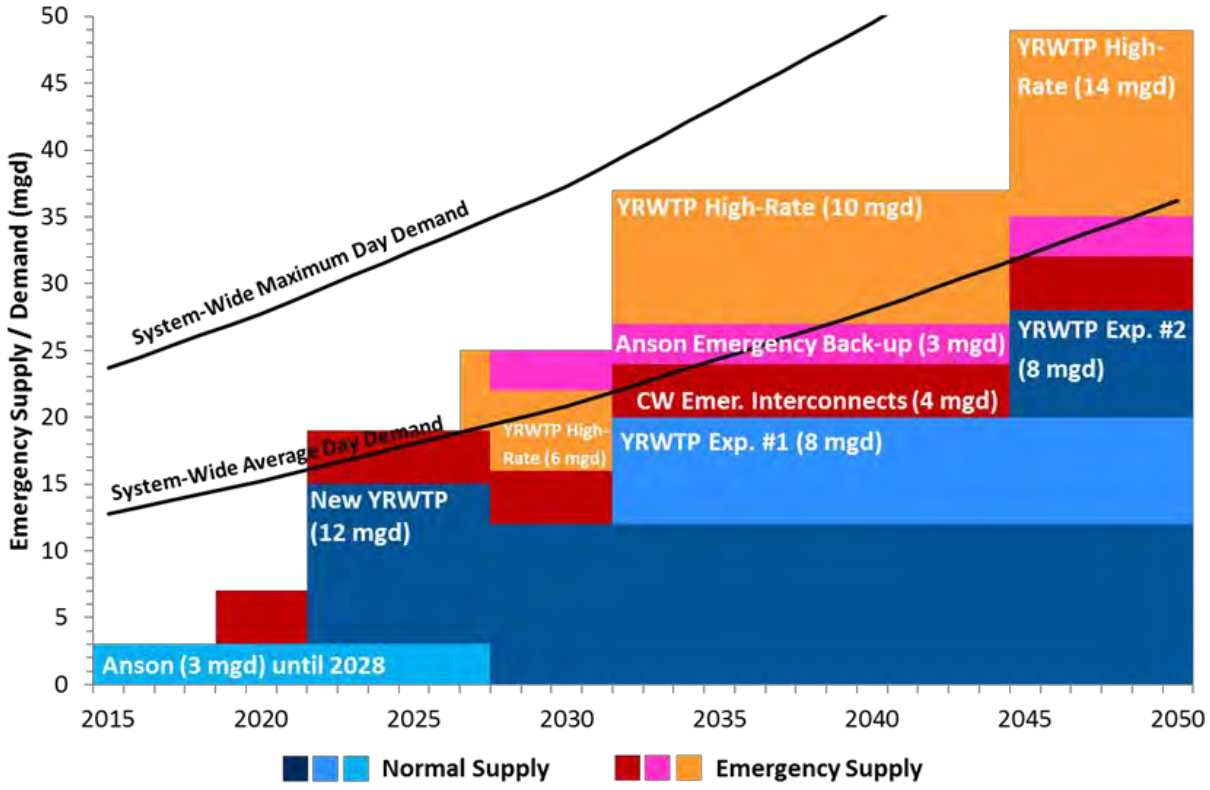

Figure 4-3 Emergency Supply Available with CRWTP Offline

4.2 EMERGENCY SUPPLY ANALYSES HYDRAULIC MODELING RESULTS

As described in Chapter 3, four model scenarios were developed to analyze the system under emergency supply conditions and to develop an understanding of the improved distribution system's ability to provide water service to customers under catastrophic water supply scenarios (loss of Yadkin Supply or loss of Catawba Supply) during the initial capacity year of the YRWTP (2022) and the end of the planning horizon (2030). The results of these scenarios are presented in this section.

4.2.1 Emergency Supply Modeling with No Yadkin River Supply

In order to validate the ability of the planned distribution system infrastructure to deliver emergency water supply from the CRWTP with the Yadkin River Supply offline, an evaluation was completed using the hydraulic model under both 2022 and 2030 maximum day demand conditions.

4.2.1.1 2022 Maximum Day Demand, Complete Loss of the Yadkin River Supply

The 2022 MDD EPS model scenario with all Yadkin River Supply facilities (YRWTP and Anson County) offline represents the distribution system under 2022 Maximum Day Demands of 29.6 mgd and includes all CIP projects identified in Chapter 5 planned to be complete by 2022, including expansion of the 762 Zone, the 36-inch 853 FWTM and CCTM (YAD-M-02) and the 853 / 762 PRVs (762-V-01 and 762-V-02).

Figure 4-4 displays the results of the model simulation, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place and supply from only the CRWTP, maximum day demands could be delivered throughout the distribution system with tank levels remaining at least half full with the following observations, exceptions and notes:

- **CRWTP Available Supply**

  The projected MDD of the distribution system in 2022 is 29.7 mgd, which exceeds the planned 27 mgd capacity of the CRWTP. Without the YRWTP, Anson Supply from the Highway 74 BPS or emergency interconnects from CW, the system will be supply capacity limited in 2022. For hydraulic analysis purposes, the available supply at the CRWTP was assumed to be capable of delivering 2022 MDD in order to focus the assessment on the ability of the distribution system infrastructure (transmission mains and zone transfer pumping) to convey the supply from the CRWTP through the system.

- **Watkins BPS Available Capacity**

  Following the Watkins BPS Pump Modification Project (853W-P-01) planned to be complete in 2019, the Watkins BPS firm capacity is predicted to be approximately 18.7 mgd. In order to deliver the required flow under 2022 MDD emergency conditions, it is possible that all pumps (total capacity) at the Watkins BPS will be required.

853 South Zone

Based on discussions with UCPW, growth in the 853 South Zone has been low in recent years and is not currently anticipated to increase notably in the near future. The results of the 2022 MDD model simulation are based on the original demand projects for the 853 South Zone and do not assume flat growth as currently anticipated by UCPW. Therefore, the model results display a deficiency in the system's ability to maintain adequate water levels in the Austin Tank. This is due to a transmission capacity deficiency between the New 853 West / South PRV and the Austin Tank because UCPW has decided to defer construction of the 16-inch 853 South Transmission Main (853S-M-01) until demands in the 853 South Zone are observed to be increasing. Without this new main in place, high head losses in the existing 8-inch mains in the 853 South Zone will limit the ability to maintain water levels in the Austin Tank under emergency conditions.

UCPW should continue to monitor demands in the 853 South Zone and initiate system improvement projects to address the supply deficiency when one is needed. As discussed with UCPW, potential improvement projects to address the supply deficiency include pump capacity improvements at the Highway 75 BPS or construction of the 16-inch 853 South Transmission Main (853S-M-01).

762 Zone

Although there is sufficient supply in the 853 West / East Zone (via the Watkins BPS) to supply all of the expanded 762 Zone demand, high head losses in the existing 16-inch 762 Zone transmission main are predicted to significantly limit the amount of water which can be delivered through the 762 PRVs under emergency conditions. It is noted that adequate emergency supply can be provided to the 762 Zone by either raising the HGL set point of the 762 Zone PRVs above 762 ft or by utilizing the Anson Supply from the Highway 74 BPS if it is operational and Anson County's water supply is not affected by the emergency situation at the YRWTP.

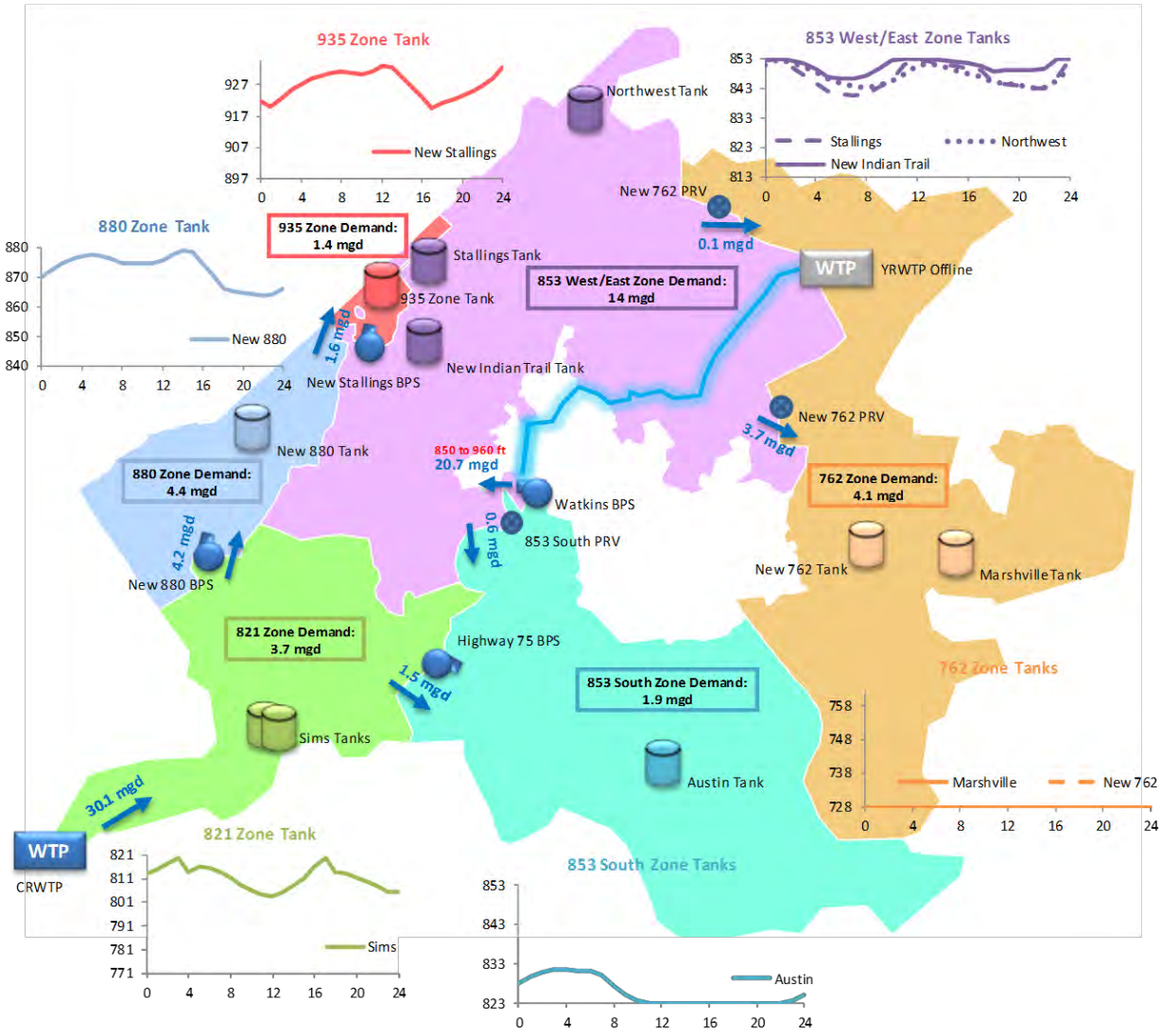

Figure 4-4 2022 MDD – Complete Loss of the Yadkin River Supply

4.2.1.2 2030 Maximum Day Demand, Complete Loss of the Yadkin River Supply

The 2030 MDD EPS model scenario with all Yadkin River Supply facilities (YRWTP and Anson County) offline represents the distribution system under 2030 Maximum Day Demands of 37.4 mgd and includes all CIP projects identified in Chapter 5 planned to be complete by 2030, including the New 853 South Zone Tank (853S-T-01), 16-inch 853 South Transmission Main (853S-M-01) and the 24-inch 762 FWTM (YAD-M-03).

Figure 4-5 displays the results of the model simulation, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place and supply from only the CRWTP, maximum day demands could be delivered throughout the distribution system with tank levels remaining at least half full with the following observations, exceptions and notes:

- **CRWTP Available Supply**

  The projected MDD of the distribution system in 2030 is 37.4 mgd, which exceeds the planned 27 mgd capacity of the CRWTP. Without the YRWTP, Anson Supply from the Highway 74 BPS or emergency interconnects from CW, the system will be supply capacity limited to meet maximum day demands. For hydraulic analysis purposes, the available supply at the CRWTP was assumed to be capable of delivering MDD in order to focus the assessment on the ability of the distribution infrastructure (transmission mains and zone transfer pumping) to convey the supply from the CRWTP through the system.

- **Watkins BPS Available Capacity**

  Following the Watkins BPS Pump Modification Project (853W-P-01) planned to be complete in 2019, the Watkins BPS firm capacity is predicted to be approximately 18.7 mgd. In order to deliver the required flow under 2030 MDD emergency conditions, it is possible that all pumps (total capacity) at the Watkins BPS will be required.

- **762 Zone**

  Although there is sufficient supply in the 853 West / East Zone (via the Watkins BPS) to serve all of the expanded 762 Zone demand, high head losses in the existing 16-inch and 12-inch 762 Zone transmission mains are predicted to limit the amount of water which can be delivered through the 762 PRVs under emergency conditions. It is noted that adequate emergency supply can be provided to the 762 Zone by either raising the HGL set point of the 762 Zone PRVs above 762 ft or by utilizing the Anson Supply from the Highway 74 BPS if it is operational and Anson County's supply is not affected by the emergency situation at the YRWTP.

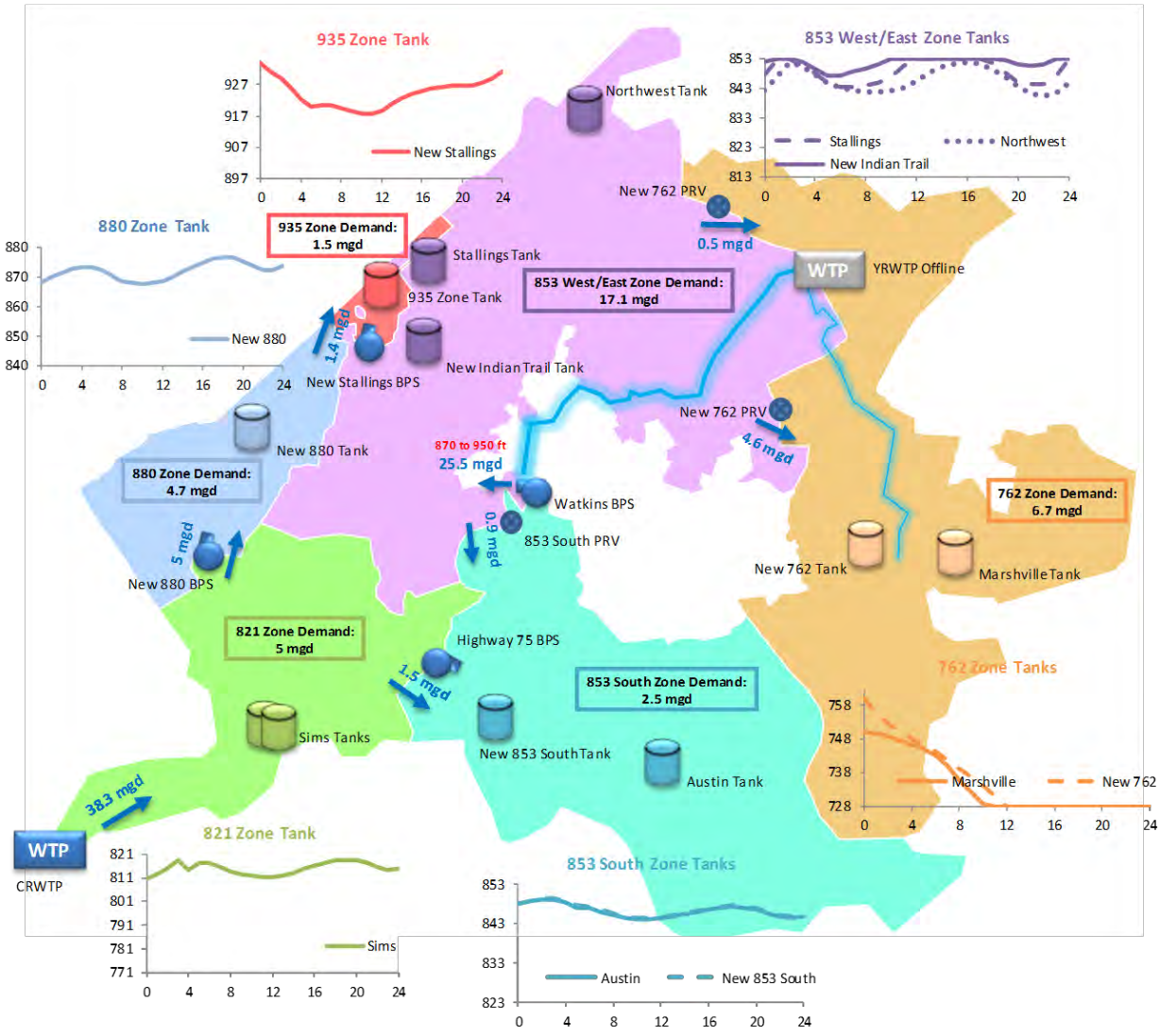

Figure 4-5 2030 MDD – Complete Loss of the Yadkin River Supply

4.2.2 Emergency Supply Modeling with No Catawba River Supply

In order to validate the ability of the planned distribution system to deliver emergency water supply from the CRWTP with the Yadkin River Supply offline, an evaluation was completed using the hydraulic model under both 2022 and 2030 conditions.

4.2.2.1 2022 (Initial Capacity Year) 12 mgd Demand, Complete Loss of the Catawba River Supply

The initial capacity of the YRWTP is 12 mgd, which is less than the projected average day demand of 16.4 mgd in 2022. Because the YRWTP will not be capable of supplying the desired emergency performance goal of meeting average day demand in 2022, the focus of the modeling analysis was to confirm that the total initial capacity of the YRWTP could be delivered to the distribution system with the CRWTP offline. Therefore, system demands were scaled down to 12 mgd for system analysis purposes.

The 2022 MDD EPS model scenario with all Catawba River Supply facilities (CRWTP, CW Interconnects) offline represents the distribution system under 2022 12 mgd demands and includes all CIP projects identified in Chapter 5 planned to be complete by 2022, including the YRWTP, expansion of the 762 Zone, the 36-inch 853 FWTM and CCTM (YAD-M-02), the 853 / 821 Emergency PRV (821-V-01) and the 853 / 762 PRVs (762-V-01 and 762-V-02).

Figure 4-6 displays the results of the model simulation, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place and supply from only the YRWTP, the 12 mgd system demand could be delivered throughout the distribution system with tank levels remaining at least half full with the following observations, exceptions and notes:

- **YRWTP Available Supply**

  As discussed above, in 2022 the YRWTP will be able to supply only 12 mgd (approximately 75% of the 2022 ADD of 16.4 mgd). In order to meet ADD in 2022 without the CRWTP, the 3 mgd Anson Supply from the Highway 74 BPS and the emergency interconnects with CW are predicted to be required.

- **762 Zone**

  Although there is sufficient supply in the 853 West / East Zone (via the YRWTP and 853 HSPS) to serve all of the expanded 762 Zone demand, high head losses in the existing 16-inch 762 Zone transmission mains were predicted to limit the hydraulic grade line under emergency conditions, resulting in the 762 Zone tanks remaining less than half full. It is noted that adequate emergency supply can be provided to the 762 Zone by either raising the HGL set point of the 762 Zone PRVs above 762 ft or by utilizing the Anson Supply from the Highway 74 BPS.

- **821 Zone**

  With the CRWTP offline, available supply must be conveyed from the YRWTP through the planned 36-inch 853 FWTM and CCTM (YAD-M-02). In order to transfer supply to the western zones (821 and 880), an emergency PRV (821-V-01) is required to be installed at the Watkins BPS to reduce the HGL in the CCTM from the 853 Zone hydraulic grade to the 821 Zone hydraulic grade.

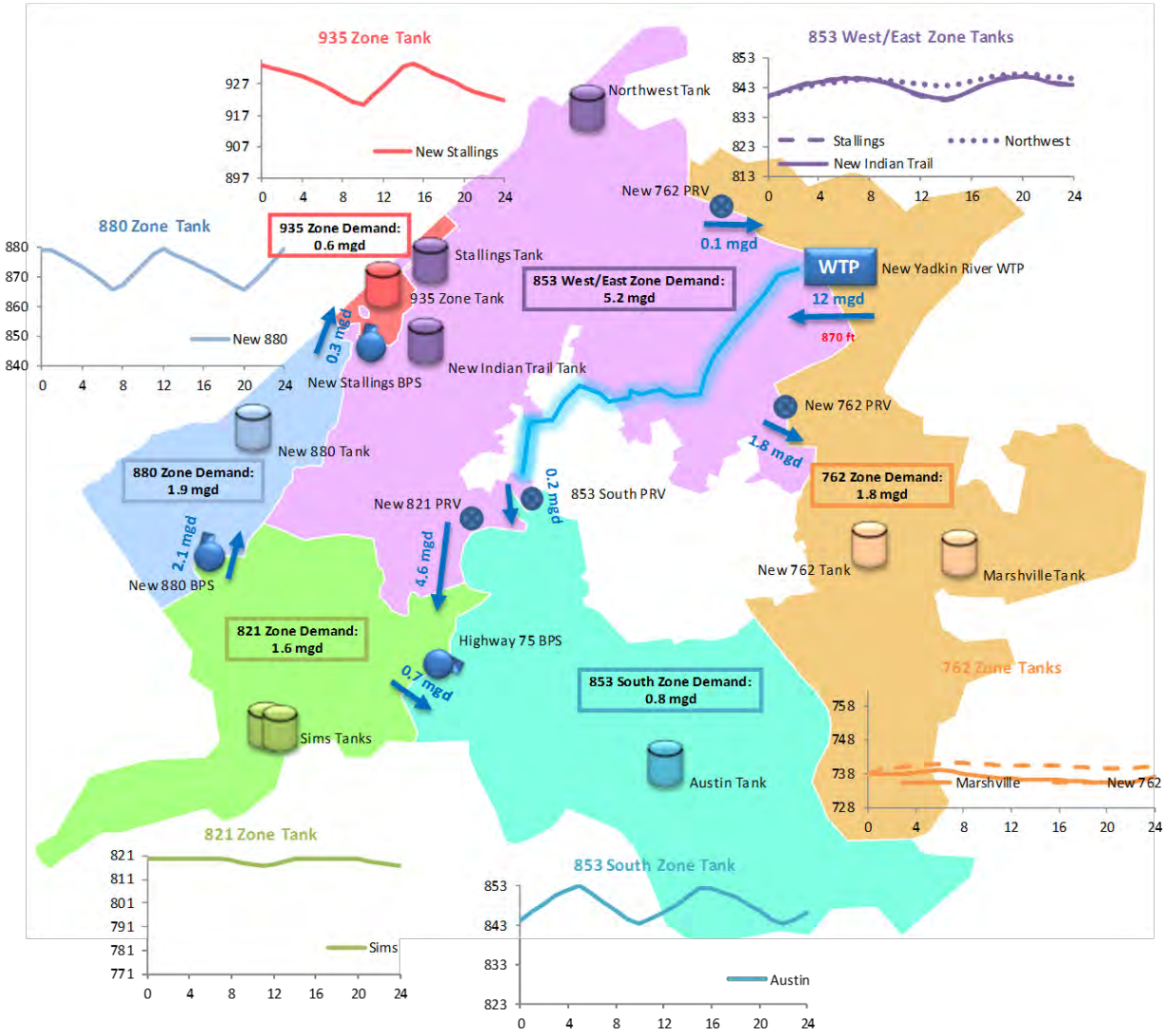

Figure 4-6 2022 (Initial Capacity Year) 12 mgd – Complete Loss of the Catawba River Supply

4.2.2.2 2030 Average Day Demand, Complete Loss of the Catawba River Supply

The initial capacity of the YRWTP is 12 mgd, which is less than the projected average day demand of 20.8 mgd in 2030. As described in Section 4.1, in order to increase available supply capacity the YRWTP is planned to be high-rated by 50% to a treatment capacity of 18 mgd by 2027. Because the YRWTP will not be capable of supplying the desired emergency performance goal of meeting average day demand in 2030, the Anson Supply from the Highway 74 BPS was also assumed to be in service, bringing the total available emergency supply of the Yadkin River Supply facilities to 21 mgd in 2030.

The 2030 ADD EPS model scenario with all Catawba River Supply facilities (CRWTP, CW Interconnects) offline represents the distribution system under 2030 ADD mgd demands of 20.8 mgd and includes all CIP projects identified in Chapter 5 planned to be complete by 2022, including the YRWTP, expansion of the 762 Zone, the 36-inch 853 FWTM and CCTM (YAD-M-02), the 853 / 821 Emergency PRV (821-V-01) and the 853 / 762 PRVs (762-V-01 and 762-V-02).

Figure 4-7 displays the results of the model simulation, including all zone transfer flows at pump stations and PRVs as well as tank level variations throughout the 24 hour simulation. As shown, with the proposed CIP projects in place and supply from only the YRWTP and Highway 74 BPS, 2030 average day demands could be delivered throughout the distribution system with tank levels remaining at least half full with the following observations, exceptions and notes:

- **YRWTP Available Supply**

  Even at a high-rated capacity of 18 mgd, the YRWTP will not be capable of meeting average day demands without supplemental supply from Anson County via the Highway 74 BPS (or emergency interconnects with CW). For this analysis, the Anson Supply was assumed to deliver 3 mgd with the balance of required supply (approximately 18 mgd) delivered by the high-rated YRWTP into the 853 West / East Zone.

- **762 Zone**

  Although there is sufficient supply predicted in the 853 West / East Zone (via the YRWTP and 853 HSPS) to serve all of the 762 Zone demand not met by the Anson Supply from the Highway 74 BPS, high head losses in the existing 12-inch and 16-inch 762 Zone transmission mains were predicted to limit the hydraulic grade line under emergency conditions, resulting in the New 762 Zone tank remaining less than half full. It is noted that adequate emergency supply can be provided to the 762 Zone by raising the HGL set point of the 762 Zone PRVs above 762 ft.

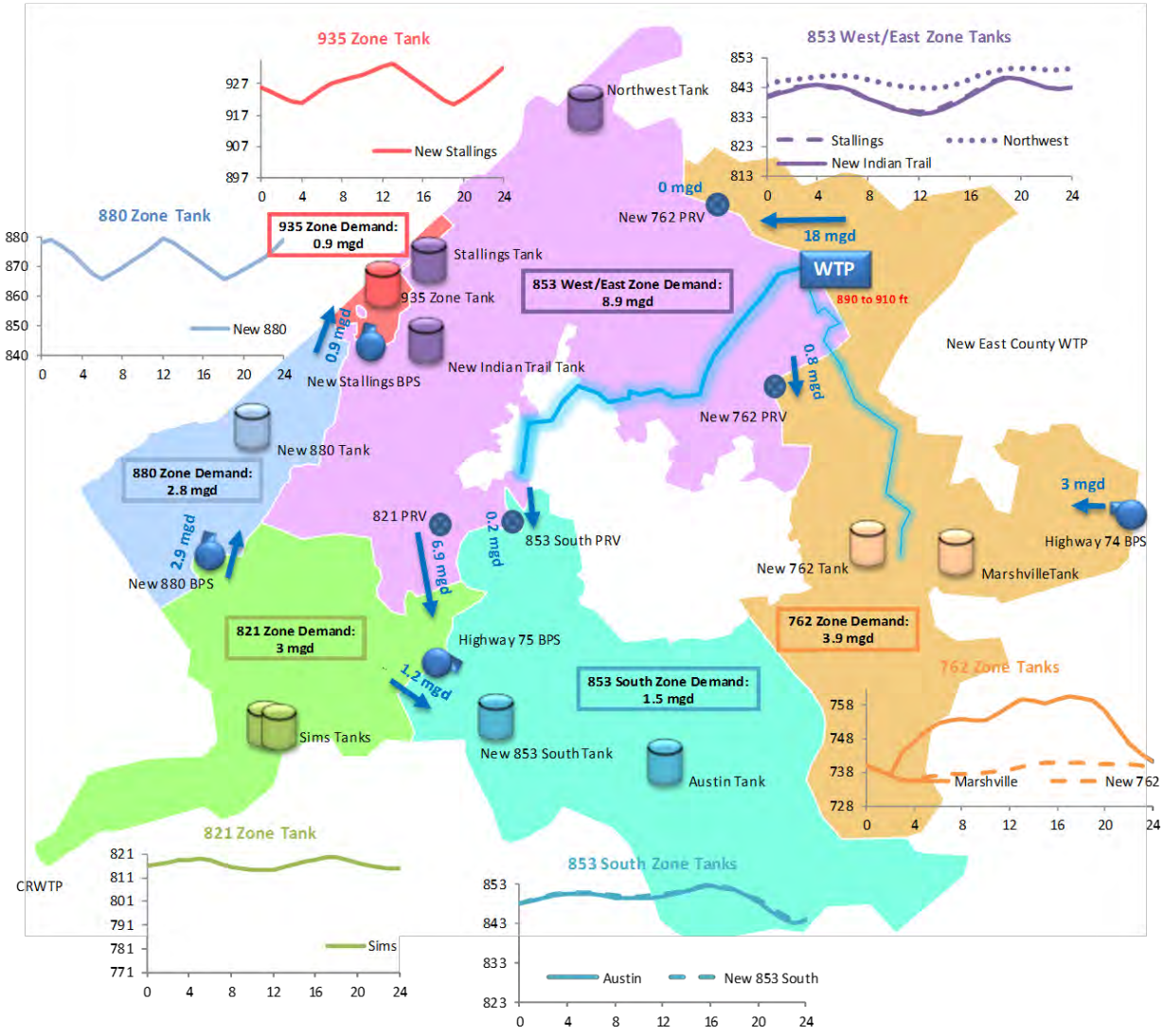

Figure 4-7 2030 ADD – Complete Loss of the Catawba River Supply

4.3 CONCLUSIONS AND RECOMMENDATIONS

The system redundancy analysis provided an understanding of how the improved Union County distribution system can be expected to operate during catastrophic emergency scenarios in the future. The analysis served to validate the planned CIP projects, including the 36-inch 853 West FWTM and CCTM (YAD-M-02). The system redundancy analysis reinforced the importance of this project from a vulnerability, redundancy and resiliency standpoint. The new main is critical to provide water supply source flexibility between the Yadkin River and Catawba River in the future.

With the planned system improvements detailed in the CIP (Chapter 5) in place, the Union County distribution system is predicted to be capable of effectively delivering supply to customers from either the Catawba River or Yadkin River under emergency system conditions through the planning horizon, as described in the preceding sections. In order to maximize supply source redundancy, UC should maintain their water supply agreement with Anson County, work with CW to determine the availability of emergency supply from the CW system, and make preparations during the design of the new YRWTP for future high rating.

5.0 Capital Improvement Plan

5.1 INTRODUCTION

The purpose of this chapter is to document:

- Opinions of probable planning level cost for each project
- Capital Improvement Plan (CIP) Summary Project schedule and CIP cash flow assumptions

Improvements to the water system have been broken into the following categories: water supply, water mains, storage, pump station, and valve projects. All of the improvement projects have been placed into the following three planning periods:

- Critical Projects: 2016 - 2020
- 2021 – 2025: Projects to be completed by 2025
- 2026 – 2030: Projects to be completed by 2030

The goal of this chapter is to describe procedure for creating the projects, completing the cost opinions, and prioritizing the projects into planning years. Each individual project is described in the CIP documentation contained in the Appendices. The CIP Table and Maps are included in Appendix B and the detailed project descriptions are included in Appendix C.

5.2 SUMMARY OF PROJECTS

The water CIP developed includes projects ranging from major water treatment plants to small projects such as pressure zone boundary adjustments. Inspection, rehabilitation and replacement activities are planned in every budget year to represent ongoing asset management efforts. The project cost opinions and scheduling are discussed in the following sections. Detailed descriptions for 10 of the CIP projects are included in Appendix C.

The Project IDs are designated by River Basin for supply projects or by Zone for distribution system projects. The two river basins used for water supply in Union County are:

- The Catawba River Basin (CAT)
- The Yadkin River Basin (YAD)

For distribution system projects, IDs are identified by pressure zone:

- 762 Zone (762)
- 935 Zone (935)
- 821 East Zone (821)
- 853 East Zone (853E)
- 853 West Zone (853W)
- 853 South Zone (853S)
- 880 Zone (880)

The 6 project categories are:

- M – Water Main Projects
- S – Supply Projects
- T – Storage Tank Projects
- P – Booster Pump Station Projects
- V – Valve Projects
- Z – Zone Adjustment

The third section of the Project ID is a number designating the individual project. The Project ID is used to distinguish between the projects in the CIP Table, CIP Map, and the project descriptions.

5.3 PROJECT COSTS

Planning level opinions of probable cost were developed for each CIP project. Unit costs were developed based on information from recent bid tabs in North Carolina and surrounding states, vendor information, other Master Plan costs, and Black & Veatch experience with recent similar projects. The unit costs vary based on pipe diameter.

5.3.1 Construction Costs

Water mains were assumed to be made of ductile iron pipe. Bid Tabs were collected for similar projects in the Southeast and the recommended planning costs were heavily influenced by the more recent tabulations (since April 2015). Older bid tabs from nearby utilities were escalated to December 2015 dollars for use as comparison. The water pipe unit costs used to develop the planning level cost opinions for this project are listed in Table 5-1.

Table 5-1 Water Pipe Unit Costs

DIAMETER (IN)	UNIT COST ($/ LF)
6	90
8	112
12	120
16	160
18	198
20	220
24	264
30	330
36	432
42	525
48	624
54	756

Construction Costs for treatment facilities, storage tanks, pump stations, and other non-linear projects were developed for each individual project. The scope included in the cost estimate is described in the project description.

Estimated project costs for the Yadkin Water Supply program were completed as part of the Environmental Impact Study (EIS). The project costs for the Lake Tillery Raw Water Intake and Pump Station, Yadkin River WTP, and Raw Water Transmission Main from the EIS were used in the CIP table. In general, the costs for the intake/pump station and treatment plant from the EIS were similar to the initial costs developed by B&V for these facilities. The costs for the raw water transmission main from the EIS is lower than the costs developed by B&V with recognition that the length and terrane of this transmission main could offer savings relative to other distribution system mains. The finished water main costs were all developed using the unit costs from Table 5-1.

5.3.2 Construction Scope Contingency

The construction cost contingency provides a buffer to the planning level cost to account for items not included in the preliminary project planning process, as well as variability in the unit costs. The construction contingency was assumed to be equal to 20% of the construction cost for each project.

Construction Contingency = 20% (of Construction Cost)

5.3.3 Engineering Planning/Design Costs

Project engineering costs include siting and permitting, detailed project planning and design, bidding, and construction phase services. The engineering costs for above ground projects, such as treatment or pump stations, were assessed at 20% of the construction costs including the construction contingency. Engineering costs for linear projects were assessed at 15% of the total construction and contingency costs.

Engineering cost = 15% to 20% (of Construction Cost + Construction Contingency)

5.3.4 Easements

New easement acquisition was assumed to for the new Yadkin River raw water transmission main. The cost of the easement assumes a width of 60 feet. The county is expected to pay 50% of the tax value of the land. Based on information from the Stanly county tax assessor's office, $10,000 per acre was used for the land tax value for the easement cost calculations.

5.3.5 Total Costs

The total cost of each project was calculated by adding the engineering, construction, construction contingency and easement costs together. The CIP Table in Appendix B shows the estimated cost breakdown for each improvement project in 2016 dollars.

5.4 SCHEDULE AND COST LOADING

The CIP Table was developed to facilitate scheduling and cash flow analyses of the planned improvements. The table distributes the estimated easement, engineering planning and design, construction and contingency costs for each project into fiscal years.

5.4.1 Planning/Design and Construction Durations

Durations were assumed for planning and construction based on project type and scope and typical design-bid-construction delivery methods. The project durations are shown in Table 5-2. Project durations are used to estimate the length of each project for cash flow purposes.

Table 5-2 Project Durations

PROJECT TYPE	PLANNING TIME (YRS)	CONSTRUCTION TIME (YRS)
Pipeline (> 50,000 ft):	2	3
Pipeline (10,000 to 50,000 ft):	1-2	2
Pipeline (< 10,000 ft):	1	1-2
New Water Treatment Plant	2	3
Water Treatment Plant Expansion	2	2
Pump Station Improvements	1	1-2
New Storage Tank	1-2	1-2
*Some project durations were adjusted up or down based on the scope of the project		

5.4.2 Cost Allocation/Schedule

The capacity driven improvements were prioritized based on risk and necessity. Each project was assigned to a planning period based on the prioritization efforts. The CIP Table shows which projects are scheduled for each fiscal year in the 15 year planning period. A “P” is used to designate a planning/design year and a “C” to designate a construction year. The number of P’s and C’s correspond to the project duration. The total project cost was allocated to each fiscal year based on the planning and construction schedule.

During the planning years, UC is expected to encumber the total easement cost and 60% of the engineering planning and design costs. The remainder of the engineering cost is expected to be used for construction services during the construction period. The construction costs, the construction contingency, and the construction services portion of the engineering costs are encumbered at the outset of the construction period. Project cash flows were developed by spreading planning and design cost across the planning years and the construction cost across the construction years.

The prioritized CIP cash flow is shown in Figure 5-1. The total cost of all the water projects in the 15 year CIP is approximately at $404 million (2016 dollars). Approximately $259 million of project capital needs occur between 2016 and 2021. Costs are lower in later years after the capacity upgrades at the CRWTP and the new YRWTP are completed. It is expected that long term project phasing and cost will continue to be updated through future capacity study updates.

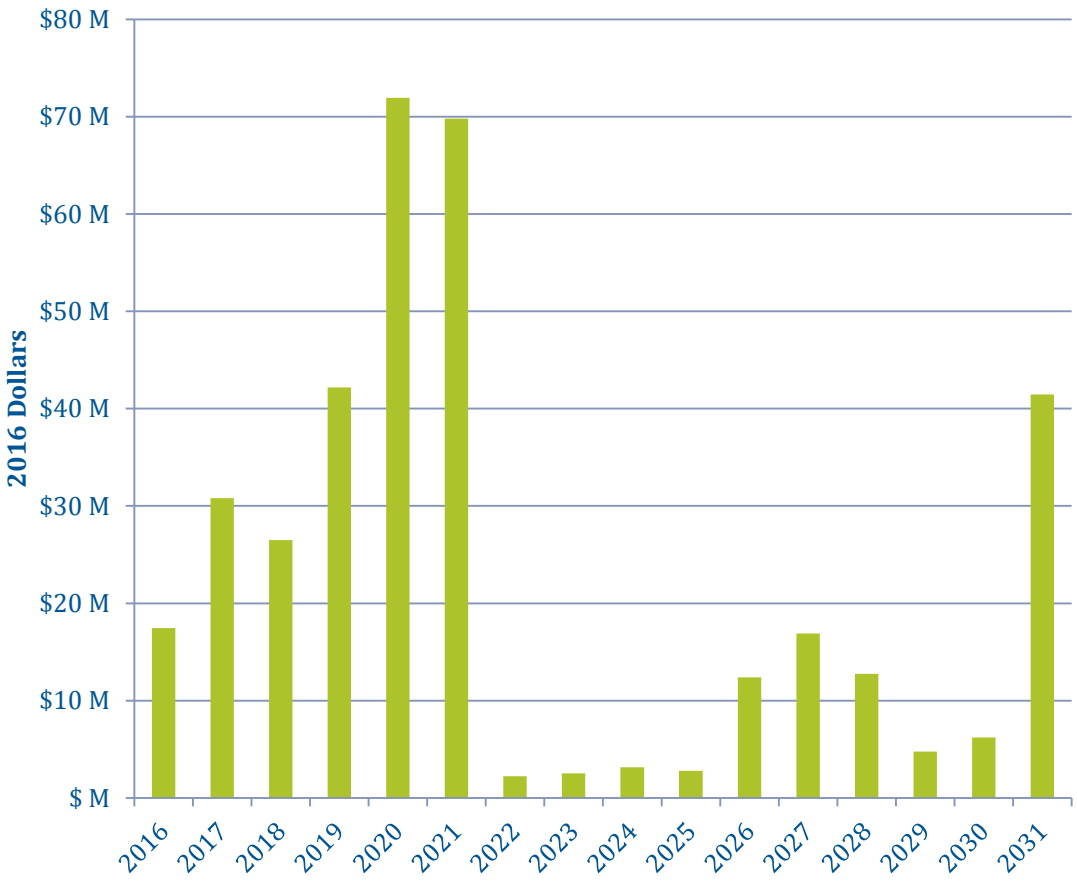

Figure 5-1 Prioritized Cash Flow

Figure 5-2 shows the same cash flow broken out by project type. The water treatment and raw water transmission projects cash flows are heavily front-loaded. After the initial capital costs of the two treatment plants, the cash flow is predominately made up of asset management driven costs relating to inspection, SSES, and R&R work in the distribution system.

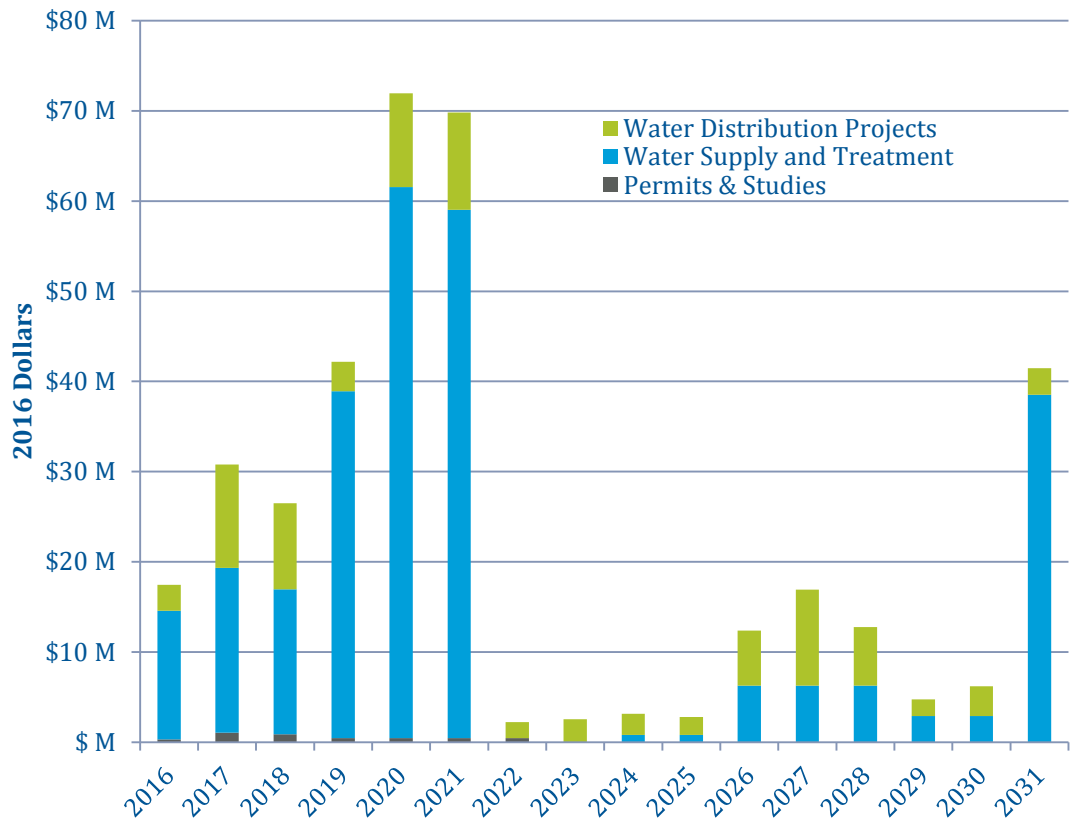

Figure 5-2 Cash Flow by Project Type

Appendix A: 2011 Master Plan Water Performance Criteria

The following includes the water performance criteria developed during the 2011 Master Plan and was established as the basis for comparing the existing system and developing the future system characteristics with appropriate Union county, regulatory agency, and water industry goals, standards, and guidelines. A secondary objective was to provide a set of guidelines to assist in the prioritizing of projects developed within the CIP.

The water performance criteria were drawn from regulatory requirements (e.g. NCDENR), best management practices (e.g. AWWA, WEF), previous experience, and a thorough compilation and review of accepted industry standards (e.g. ISO, AWWA, 10- States Standards, GAAP) and performance benchmarks.

The following performance parameters were recommended for Union County's water distribution system:

PARAMETER	CRITERIA/DESCRIPTION	SERVICE GOALS	MINIMUM ACCEPTABLE PERFORMANCE	COMMENTS
Fire Flow	Minimum Flow	1,000 gpm	500 gpm	The minimum flow is the minimum fire flow required; typically in residential areas
	Maximum Flow	3,500gpm	3,500 gpm	The maximum flow is the maximum fire flow to be provided by the system; typically in heavy commercial and industrial areas
	Minimum Residual Pressure	20 psi	20 psi	Insufficient residual pressure indicates need for greater pipe capacity
Pressure	Minimum Pressure - Normal Conditions	>40 psi under peak hour demand	> 30 psi under peak hour demand	Pressure reference point – "at the curb"
	Minimum Pressure - Fire Flow Conditions	> 20 psi under fire flow conditions	> 20 psi under fire flow conditions	
	Maximum Pressure – Normal Conditions	<150 psi	< 200 psi	

PARAMETER	CRITERIA/DESCRIPTION	SERVICE GOALS	MINIMUM ACCEPTABLE PERFORMANCE	COMMENTS
Storage Volume	Equalization Volume	MDD x Equalization Rate where the rate is (Peak Hour Demand - Maximum Day Demand) x 6 hours		Calculated for each pressure zone
	Fire Reserve	3,500 gpm for 3 hours		Assuming that at least one location in each pressure zone requires a fire flow of 3,500 gpm
	Emergency Reserve	1/2 ADD		Calculated for each pressure zone; Can be transferred from adjacent pressure zones if by gravity or adequate pumping capacity if available under back-up power; Should be available at a minimum zone pressure of 20 psi
	Total	Equalization Volume + (larger of Fire Reserve OR Emergency Reserve)	Equalization Volume + Fire Reserve	Storage volumes must be available to the system to maintain adequate system pressures
Pipeline Hydraulic Analysis	Maximum Velocity	< 5 ft/sec peak hour demand	N/A	
	Maximum Head loss (HL) per 1,000 Feet	< 5 ft peak hour demand	N/A	This parameter is used to identify pipes that may be contributing to pressure and/or flow deficiencies.
Pump Station Sizing	Zone Transfer Stations	Firm Capacity > MDD of zone(s) supplied	Total Capacity > MDD of zone(s) supplied	Firm Capacity is equal to Total capacity minimum the single larges
	Pumped Storage Facilities (WTP Clearwell)	Firm capacity > MDD of zone(s) supplied		Firm pump capacity in excess of MDD can be considered available for delivering available clearwell storage to help meet distribution system storage requirements

Notes:

ADD = Average Day Demand

MD = Maximum Day

MDD = Maximum Day Demand

MH = Maximum Hour

Appendix B: CIP Table and Map

The attached table summarizes the CIP Project costs and schedule. The scheduling tool was used to develop the cash flow presented in the Water System Planning Update report. The attached large scale project map shows the relative locations and timing of the CIP projects.

Union County Public Works - Water System Planning Update
CIP Projects: 2016-2030

				Costs					Project Drivers			
ID	Project	Description	Source	Land Acquisition	Construction (Including 20% Contingency)	Eng %	Engineering	Total	Expansion for Growth (%)	Non-Growth (%)	Expansion for Growth ($)	Non-Growth ($)
Permitting and Studies												
x	Yadkin/Rocky River IBT Permitting	28 MGD IBT from Yadkin River	2016 Update/EIS		$ -		$ 1,000,000	$ 1,000,000	100%	0%	$1,000,000	$0
935-Z-01	935 Zone Service Study		2016 Update		$ -		$ 50,000	$ 50,000		100%	$0	$50,000
x	CLT Water Interconnect Study	Investigate possible supply to/from CLT Water via existing interconnects located along the Union/Mecklenburg County Line	2016 Update	$ -	$ -		$ 75,000	$ 75,000		100%	$0	$75,000
x	Water & Wastewater System SCADA Master Plan		2016 Update		$ -		$ 250,000	$ 250,000		100%	$0	$250,000
x	Water & Wastewater System SCADA Improvements		2016 Update		$ 2,400,000	15%	$ 360,000	$ 2,760,000		100%	$0	$2,760,000
		Subtotal			**$ 2,400,000**		**$ 1,700,000**	**$ 4,135,000**			**$ 1,000,000**	**$ 3,135,000**
Water Supply & Treatment												
Catawba Basin												
x	CRWSP Reservoir Expansion	New 1 BG RW Reservoir at CRWTP	2016 Update		$ 21,000,000	6%	$ 1,500,000	$ 22,500,000		100%	$0	$22,500,000
x	CRWSP Intake and PS Expansion	New parallel Intake and PS	2016 Update		$ 4,100,000	6%	$ 250,000	$ 4,350,000		100%	$0	$4,350,000
CAT-S-02	CRWSP WTP Expansion	9 MGD Expansion of CRWTP (UC Catawba Total = 27 MGD)	2016 Update		$ 14,400,000	20%	$ 2,900,000	$ 17,300,000	100%		$17,300,000	$0
Yadkin Basin											$0	
YAD-S-01	Lake Tillery RW Intake and PS	28 MGD Intake and PS with 12 MGD Pumps [Cost Estimates from EIS]	2016 Update/EIS	$ -	$ 4,700,000		$ 800,000	$ 5,500,000	100%		$5,500,000	$0
YAD-M-01	YRWTP Raw Water Transmission Main	158,000 lf (approx. 30 Miles) of 36-inch [Cost Estimates from EIS]	2016 Update/EIS	$ 1,800,000	$ 64,900,000		$ 11,460,000	$ 78,160,000	100%		$78,160,000	$0
YAD-S-02	Yadkin River WTP (YRWTP)	12 mgd WTP Readily expandable to 28 MGD [Cost Estimates from EIS]	2016 Update/EIS	$ 700,000	$ 40,000,000		$ 7,100,000	$ 47,800,000	100%		$47,800,000	$0
YAD-M-02	Cross County Transmission Main	52,000 lf of 36-inch	2016 Update		$ 27,000,000	15%	$ 4,100,000	$ 31,100,000	100%		$31,100,000	$0
YAD-M-03	762 YRWTP Transmission Main	56,000 lf of 24-inch	2016 Update		$ 17,700,000	15%	$ 2,700,000	$ 20,400,000	100%		$20,400,000	$0
YAD-S-03	Lake Tillery PS Expansion	8 MGD PS Expansion	2016 Update	$ -	$ 1,800,000	20%	$ 300,000	$ 2,100,000	100%		$2,100,000	$0
YAD-S-04	Yadkin River WTP (YRWTP) Expansion to 20 MGD	8 MGD Expansion	2016 Update	$ -	$ 14,400,000	20%	$ 2,400,000	$ 16,800,000	100%		$16,800,000	$0
YAD-M-04	YRWTP Raw Water Transmission Main Parallel	158,000 lf (approx. 30 Miles) of parallel 36-inch	2016 Update	$ -	$ 58,400,000	15%	$ 7,300,000	$ 65,700,000	100%		$65,700,000	$0
Water Supply & Treatment Subtotal		**Subtotal**			**$ 268,400,000**		**$ 40,810,000**	**$ 311,710,000**			**$ 284,860,000**	**$ 26,850,000**
762 Zone												
762-V-01	853 South / 762 PRV	PRV to Supply 762 Zone - Emergency	2011 Master Plan		$ 90,000	15%	$ 14,000	$ 104,000		100%	$0	$104,000
762-T-01	762 Zone Tank (Wingate Tank)	1.0 MG Elevated Storage	2016 Update	$ 400,000	$ 2,400,000	15%	$ 360,000	$ 3,160,000	50%	50%	$1,580,000	$1,580,000
x	Marshville Tank Rehab	Rehab	2011 Master Plan		$ 370,000	15%	$ 56,000	$ 426,000		100%	$0	$426,000
762-M-01	762 Zone Main - Low Pressure	1,500 lf of 6-inch; To address low pressure	2016 Update		$ 160,000	15%	$ 24,000	$ 184,000	0%	100%	$0	$184,000
762-Z-01	Expand 762 Zone	Shift 762 Zone boundary to include high pressure customers currently served by the 853 East Zone	2016 Update		$ -	0%	$ -	$ -	0%	100%	$0	$0
762-V-02/03	853 East / 762 PRVs	Two (2) PRVs to Expand 762 Zone	2016 Update		$ 170,000	15%	$ 26,000	$ 196,000	0%	100%	$0	$196,000
762-M-02	762 Zone Main	47,000 lf of 12-inch Main - Fire Flow	2011 Master Plan		$ 6,800,000	15%	$ 1,000,000	$ 7,800,000		100%	$0	$7,800,000
762-P-01	Retire Olive Branch BPS	By 2022, Olive Branch becomes a backup only facility. Beyond 2027, the station can be retired.	2016 Update		$ -	0%	$ -	$ -		100%	$0	$0
762-Z-02	Expand 762 Zone	Shift 762 Zone boundary to include high pressure customers currently served by the 853 East Zone	2016 Update		$ -	0%	$ -	$ -	0%	100%	$0	$0
821 East Zone												
821-V-01	853 West / 821 PRV	PRV to deliver emergency supply from the YRWTP to the 821 and 880 Zones; Constructed with the Cross County Transmission Main	2016 Update		$ 90,000	15%	$ 14,000	$ 104,000		100%	$0	$104,000
853 West Zone												
853W-M-01	853 West Zone Transmission Main Construction Phase	22,000 lf of 36-inch Main	2016 Update	$ 50,000	$ 11,400,000	6%	$ 680,000	$ 12,130,000	75%	25%	$9,097,500	$3,032,500
853W-M-02	853 West Zone Transmission Main Construction Phase	9,000 lf of 16-inch Main	2016 Update		$ 1,700,000	6%	$ 100,000	$ 1,800,000	25%	75%	$450,000	$1,350,000
853W-M-03	853 West Zone Transmission Main	27,000 lf of 16-inch Main	2016 Update		$ 5,200,000	15%	$ 780,000	$ 5,980,000	25%	75%	$1,495,000	$4,485,000
853W-M-04	853 West Zone Transmission Main	17,000 lf of 16-inch Main	2016 Update		$ 3,300,000	15%	$ 500,000	$ 3,800,000	25%	75%	$950,000	$2,850,000
853W-M-05	853 West Zone Transmission Main	9,000 lf of 16-inch Main	2016 Update		$ 1,700,000	15%	$ 260,000	$ 1,960,000	25%	75%	$490,000	$1,470,000
853W-M-06	853 West Distribution Main	2,000 lf of 8-inch Main	2016 Update		$ 270,000	15%	$ 41,000	$ 311,000	0%	100%	$0	$311,000
853W-Z-01	Eliminate 853 West / East Pressure Zone Boundary	Open zone boundary valves	2016 Update		$ -	15%	$ -	$ -	0%	100%	$0	$0
853W-P-01	Watkins BPS Pump Modifications	Modify Pumps (New Impellers)	2016 Update		$ 310,000	15%	$ 47,000	$ 357,000	25%	75%	$89,250	$267,750
853W-T-01	New Indian Trail Tank	2.0 MG Elevated Storage - Replacement	2016 Update	$ 400,000	$ 5,400,000	15%	$ 810,000	$ 6,610,000	25%	75%	$1,652,500	$4,957,500
853W-Z-02	Reduced Zone	Install two new PRVs to create small reduced zone to address high pressures	2016 Update		$ 170,000	20%	$ 34,000	$ 204,000	25%	75%	$51,000	$153,000
853 South Zone												
853S-V-01	853 West/South PRV	PRV to Supply 853 South Zone; Complete with 853W projects	2011 Master Plan		$ 90,000	15%	$ 14,000	$ 104,000	75%	25%	$78,000	$26,000
853S-P-01	Hwy 75 Booster Pump Station Capacity Improvements	Triggered by Growth in 853 South Zone	2016 Update	$ -	$ 800,000	20%	$ 160,000	$ 960,000	100%		$960,000	$0
853S-M-01	853 South Zone Transmission Main	38,000 lf of 16-inch Main; Driven by growth in the 853S Zone	2016 Update		$ 7,300,000	15%	$ 1,100,000	$ 8,400,000	25%	75%	$2,100,000	$6,300,000
853S-T-01	853 South Zone Tank	0.75 MG Elevated Storage - New (Assume no land acquisition); Driven by growth in the 853S Zone	2016 Update	$ -	$ 1,800,000	15%	$ 270,000	$ 2,070,000	25%	75%	$517,500	$1,552,500
880 Zone												
880-P-02	Waxhaw-Marvin BPS Demolition	Retire and Demolish; Complete with 853W projects	2016 Update		$ 240,000	15%	$ 36,000	$ 276,000	0%	100%	$0	$276,000
935 Zone												
935-T-01	New Stallings Tank	1.0 MG Elevated Storage - Replacement (Assume no land acquisition)	2016 Update	$ -	$ 2,400,000	15%	$ 300,000	$ 2,700,000	50%	50%	$1,350,000	$1,350,000
Water Annual Programs												
x	Miscellaneous Water Line Replacements	Prior CIP	2011 Master Plan		$ 8,400,000	15%	$ 1,000,000	$ 9,400,000		100%	$0	$9,400,000
x	Storage Tank Rehabilitations	Rehab Improvements to Existing Elevated Storage Tanks	2011 Master Plan		$ 1,600,000	15%	$ 200,000	$ 1,800,000		100%	$0	$1,800,000
x	Short Water Line Extensions	Prior CIP	2011 Master Plan		$ 8,400,000	15%	$ 1,000,000	$ 9,400,000		100%	$0	$9,400,000
x	R&R Program	Placeholder	2011 Master Plan		$ 6,000,000	15%	$ 2,000,000	$ 8,000,000		100%	$0	$8,000,000
		Subtotal		**$ 850,000**	**$ 76,560,000**		**$ 10,800,000**	**$ 88,236,000**			**$ 20,860,750**	**$ 67,375,250**
		Water CIP Grand Totals (15 Years)		**$ 3,350,000**	**$ 347,360,000**		**$ 65,871,000**	**$ 404,081,000**			**$ 306,720,750**	**$ 97,360,250**

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		Cash Flow Controls						Planning and Construction Year Scheduling															
ID	Project	% Eng in "P" Years	Planning Year Cost	Construction Year Cost	Start Year	No. of Planning Yrs	No. of Construction Yrs	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Permitting and Studies																							
x	Yadkin/Rocky River IBT Permitting	100%	$ 1,000,000	$ -	2017	1			P														
935-Z-01	935 Zone Service Study	100%	$ 50,000	$ -	2016	1		P															
x	CLT Water Interconnect Study	100%	$ 75,000	$ -	2017	1	0		P														
x	Water & Wastewater System SCADA Master Plan	100%	$ 250,000	$ -	2016	1		P															
x	Water & Wastewater System SCADA Improvements		$ 900,000	$ 1,860,000	2018	1	4			P	C	C	C	C									
Water Supply & Treatment																							
Catawba Basin																							
x	CRWSP Reservoir Expansion	0%	$ -	$ 22,500,000	2016	0	2	C	C														
x	CRWSP Intake and PS Expansion	0%	$ -	$ 4,350,000	2016	0	2	C	C														
CAT-S-02	CRWSP WTP Expansion	60%	$ 1,740,000	$ 15,560,000	2016	2	2	P	P	C	C												
Yadkin Basin																							
YAD-S-01	Lake Tillery RW Intake and PS	60%	$ 480,000	$ 5,020,000	2017	2	2		P	P	C	C											
YAD-M-01	YRWTP Raw Water Transmission Main	60%	$ 8,676,000	$ 69,484,000	2018	2	2			P	P	C	C										
YAD-S-02	Yadkin River WTP (YRWTP)	60%	$ 4,960,000	$ 42,840,000	2017	2	3		P	P	C	C	C										
YAD-M-02	Cross County Transmission Main	60%	$ 2,460,000	$ 28,640,000	2017	2	3		P	P	C	C	C										
YAD-M-03	762 YRWTP Transmission Main	60%	$ 1,620,000	$ 18,780,000	2024	2	3									P	P	C	C	C			
YAD-S-03	Lake Tillery PS Expansion	60%	$ 180,000	$ 1,920,000	2031	1	1																P
YAD-S-04	Yadkin River WTP (YRWTP) Expansion to 20 MGD	60%	$ 1,440,000	$ 15,360,000	2029	2	2														P	P	C
YAD-M-04	YRWTP Raw Water Transmission Main Parallel	60%	$ 4,380,000	$ 61,320,000	2029	2	2														P	P	C
Water Supply & Treatment Subtotal																							
762 Zone																							
762-V-01	853 South / 762 PRV	0%	$ -	$ 104,000	2017	0	1		C														
762-T-01	762 Zone Tank (Wingate Tank)	60%	$ 616,000	$ 2,544,000	2016	1	1	P	C														
x	Marshville Tank Rehab	0%	$ -	$ 426,000	2018	0	1			C													
762-M-01	762 Zone Main - Low Pressure	0%	$ -	$ 184,000	2017	0	1		C														
762-Z-01	Expand 762 Zone	0%	$ -	$ -	2021	0	1						C										
762-V-02/03	853 East / 762 PRVs	0%	$ -	$ 196,000	2021	0	1						C										
762-M-02	762 Zone Main	60%	$ 600,000	$ 7,200,000	2024	2	2									P	P	C	C				
762-P-01	Retire Olive Branch BPS	0%	$ -	$ -	2028	0	1													C			
762-Z-02	Expand 762 Zone	0%	$ -	$ -	2026	0	1											C					
821 East Zone																							
821-V-01	853 West / 821 PRV	0%	$ -	$ 104,000	2021	0	1						C										
853 West Zone																							
853W-M-01	853 West Zone Transmission Main Construction Phase	0%	$ 50,000	$ 12,080,000	2016	1	2	P	C	C													
853W-M-02	853 West Zone Transmission Main Construction Phase	0%	$ -	$ 1,800,000	2016	1	2	P	C	C													
853W-M-03	853 West Zone Transmission Main	60%	$ 468,000	$ 5,512,000	2019	1	2				P	C	C										
853W-M-04	853 West Zone Transmission Main	60%	$ 300,000	$ 3,500,000	2019	1	2				P	C	C										
853W-M-05	853 West Zone Transmission Main	60%	$ 156,000	$ 1,804,000	2019	1	2				P	C	C										
853W-M-06	853 West Distribution Main	60%	$ 24,600	$ 286,400	2019	1	1				P	C											
853W-Z-01	Eliminate 853 West / East Pressure Zone Boundary	60%	$ -	$ -	2019	1	1				P	C											
853W-P-01	Watkins BPS Pump Modifications	60%	$ 28,200	$ 328,800	2019	1	2				P	C	C										
853W-T-01	New Indian Trail Tank	60%	$ 886,000	$ 5,724,000	2019	1	2				P	C	C										
853W-Z-02	Reduced Zone	60%	$ 20,400	$ 183,600	2026	1	1											P	C				
853 South Zone																							
853S-V-01	853 West/South PRV	0%	$ -	$ 104,000	2016	0	1	C															
853S-P-01	Hwy 75 Booster Pump Station Capacity Improvements	60%	$ 96,000	$ 864,000	2022	1	1							P	C								
853S-M-01	853 South Zone Transmission Main	60%	$ 660,000	$ 7,740,000	2026	1	2											P	C	C			
853S-T-01	853 South Zone Tank	60%	$ 162,000	$ 1,908,000	2026	1	2											P	C	C			
880 Zone																							
880-P-02	Waxhaw-Marvin BPS Demolition	60%	$ 21,600	$ 254,400	2017	1	2		P	C	C												
935 Zone																							
935-T-01	New Stallings Tank	60%	$ 180,000	$ 2,520,000	2029	1	2														P	C	C
Water Annual Programs																							
x	Miscellaneous Water Line Replacements	0%	$ -	$ 9,400,000	2016	0	16	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
x	Storage Tank Rehabilitations	0%	$ -	$ 1,800,000	Manual	0	5			C			C			C			C			C	
x	Short Water Line Extensions	0%	$ -	$ 9,400,000	2016	0	16	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
x	R&R Program	0%	$ -	$ 8,000,000	2016	0	16	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

Union County Public Works - Water System Planning Update
CIP Projects: 2016-2030

ID	Project	Fiscal Year Cash Flow 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Permitting and Studies																		
x	Yadkin/Rocky River IBT Permitting		$ 1,000,000															$ 1,000,000
935-Z-01	935 Zone Service Study	$ 50,000																$ 50,000
x	CLT Water Interconnect Study		$ 75,000															$ 75,000
x	Water & Wastewater System SCADA Master Plan	$ 250,000																$ 250,000
x	Water & Wastewater System SCADA Improvements			$ 900,000	$ 465,000	$ 465,000	$ 465,000	$ 465,000										$ 2,760,000
		$ 300,000	**$ 1,075,000**	**$ 900,000**	**$ 465,000**	**$ 465,000**	**$ 465,000**	**$ 465,000**										**$ 4,135,000**
Water Supply & Treatment																		
Catawba Basin																		
x	CRWSP Reservoir Expansion	$ 11,250,000	$ 11,250,000															$ 22,500,000
x	CRWSP Intake and PS Expansion	$ 2,175,000	$ 2,175,000															$ 4,350,000
CAT-S-02	CRWSP WTP Expansion	$ 870,000	$ 870,000	$ 7,780,000	$ 7,780,000													$ 17,300,000
Yadkin Basin																		
YAD-S-01	Lake Tillery RW Intake and PS		$ 240,000	$ 240,000	$ 2,510,000	$ 2,510,000												$ 5,500,000
YAD-M-01	YRWTP Raw Water Transmission Main			$ 4,338,000	$ 4,338,000	$ 34,742,000	$ 34,742,000											$ 78,160,000
YAD-S-02	Yadkin River WTP (YRWTP)		$ 2,480,000	$ 2,480,000	$ 14,280,000	$ 14,280,000	$ 14,280,000											$ 47,800,000
YAD-M-02	Cross County Transmission Main		$ 1,230,000	$ 1,230,000	$ 9,546,667	$ 9,546,667	$ 9,546,667											$ 31,100,000
YAD-M-03	762 YRWTP Transmission Main									$ 810,000	$ 810,000	$ 6,260,000	$ 6,260,000	$ 6,260,000				$ 20,400,000
YAD-S-03	Lake Tillery PS Expansion																$ 180,000	$ 180,000
YAD-S-04	Yadkin River WTP (YRWTP) Expansion to 20 MGD														$ 720,000	$ 720,000	$ 7,680,000	$ 9,120,000
YAD-M-04	YRWTP Raw Water Transmission Main Parallel														$ 2,190,000	$ 2,190,000	$ 30,660,000	$ 35,040,000
Water Supply & Treatment Subtotal		**$ 14,295,000**	**$ 18,245,000**	**$ 16,068,000**	**$ 38,454,667**	**$ 61,078,667**	**$ 58,568,667**			**$ 810,000**	**$ 810,000**	**$ 6,260,000**	**$ 6,260,000**	**$ 6,260,000**	**$ 2,910,000**	**$ 2,910,000**	**$ 38,520,000**	**$ 271,450,000**
762 Zone																		
762-V-01	853 South / 762 PRV		$ 104,000															$ 104,000
762-T-01	762 Zone Tank (Wingate Tank)	$ 616,000	$ 2,544,000															$ 3,160,000
x	Marshville Tank Rehab			$ 426,000														$ 426,000
762-M-01	762 Zone Main - Low Pressure		$ 184,000															$ 184,000
762-Z-01	Expand 762 Zone																	$ -
762-V-02/03	853 East / 762 PRVs						$ 196,000											$ 196,000
762-M-02	762 Zone Main									$ 300,000	$ 300,000	$ 3,600,000	$ 3,600,000					$ 7,800,000
762-P-01	Retire Olive Branch BPS																	$ -
762-Z-02	Expand 762 Zone																	$ -
821 East Zone																		
821-V-01	853 West / 821 PRV						$ 104,000											$ 104,000
853 West Zone																		
853W-M-01	853 West Zone Transmission Main Construction Phase	$ 50,000	$ 6,040,000	$ 6,040,000														$ 12,130,000
853W-M-02	853 West Zone Transmission Main Construction Phase		$ 900,000	$ 900,000														$ 1,800,000
853W-M-03	853 West Zone Transmission Main				$ 468,000	$ 2,756,000	$ 2,756,000											$ 5,980,000
853W-M-04	853 West Zone Transmission Main				$ 300,000	$ 1,750,000	$ 1,750,000											$ 3,800,000
853W-M-05	853 West Zone Transmission Main				$ 156,000	$ 902,000	$ 902,000											$ 1,960,000
853W-M-06	853 West Distribution Main				$ 24,600	$ 286,400												$ 311,000
853W-Z-01	Eliminate 853 West / East Pressure Zone Boundary																	$ -
853W-P-01	Watkins BPS Pump Modifications				$ 28,200	$ 164,400	$ 164,400											$ 357,000
853W-T-01	New Indian Trail Tank	$ 400,000			$ 486,000	$ 2,862,000	$ 2,862,000											$ 6,610,000
853W-Z-02	Reduced Zone											$ 20,400	$ 183,600					$ 204,000
853 South Zone																		
853S-V-01	853 West/South PRV	$ 104,000																$ 104,000
853S-P-01	Hwy 75 Booster Pump Station Capacity Improvements							$ 96,000	$ 864,000									$ 960,000
853S-M-01	853 South Zone Transmission Main											$ 660,000	$ 3,870,000	$ 3,870,000				$ 8,400,000
853S-T-01	853 South Zone Tank											$ 162,000	$ 954,000	$ 954,000				$ 2,070,000
880 Zone																		
880-P-02	Waxhaw-Marvin BPS Demolition		$ 21,600	$ 127,200	$ 127,200													$ 276,000
935 Zone																		
935-T-01	New Stallings Tank														$ 180,000	$ 1,260,000	$ 1,260,000	$ 2,700,000
Water Annual Programs																		
x	Miscellaneous Water Line Replacements	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 9,400,000
x	Storage Tank Rehabilitations			$ 360,000			$ 360,000			$ 360,000			$ 360,000			$ 360,000		$ 1,800,000
x	Short Water Line Extensions	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 587,500	$ 9,400,000
x	R&R Program	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 8,000,000
		$ 2,845,000	**$ 11,468,600**	**$ 9,528,200**	**$ 3,265,000**	**$ 10,395,800**	**$ 10,769,400**	**$ 1,771,000**	**$ 2,539,000**	**$ 2,335,000**	**$ 1,975,000**	**$ 6,117,400**	**$ 10,642,600**	**$ 6,499,000**	**$ 1,855,000**	**$ 3,295,000**	**$ 2,935,000**	**$ 88,236,000**
		$ 17,440,000	**$ 30,788,600**	**$ 26,496,200**	**$ 42,184,667**	**$ 71,939,467**	**$ 69,803,067**	**$ 2,236,000**	**$ 2,539,000**	**$ 3,145,000**	**$ 2,785,000**	**$ 12,377,400**	**$ 16,902,600**	**$ 12,759,000**	**$ 4,765,000**	**$ 6,205,000**	**$ 41,455,000**	**$ 363,821,000**

Union County Public Works - Water System Planning Update
CIP Projects: 2016-2030

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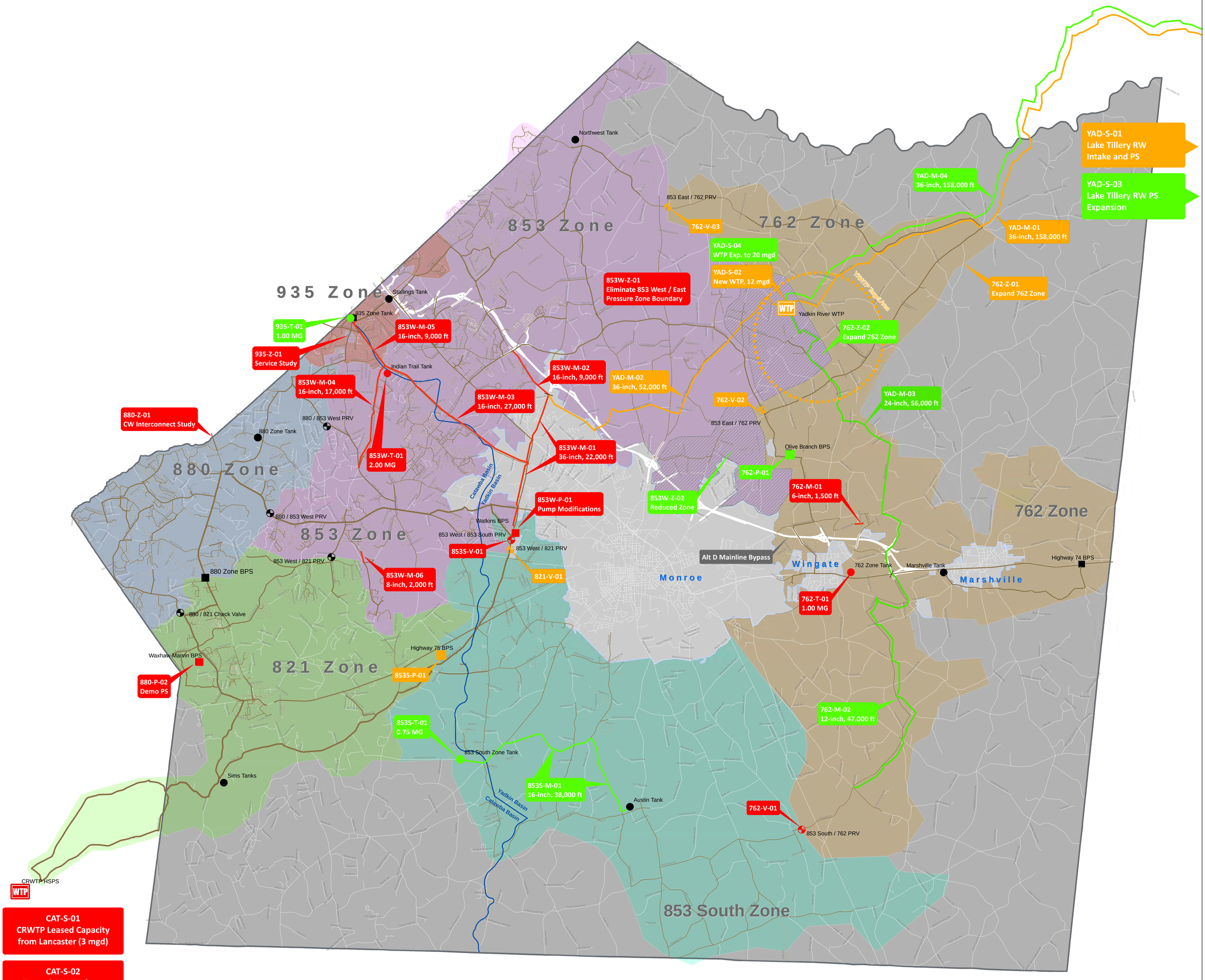
Encumbrance

ID	Project	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Permitting and Studies																	
x	Yadkin/Rocky River IBT Permitting		$1,000,000														
935-Z-01	935 Zone Service Study	$50,000															
x	CLT Water Interconnect Study		$75,000														
x	Water & Wastewater System SCADA Master Plan	$250,000															
x	Water & Wastewater System SCADA Improvements				$2,760,000												
Water Supply & Treatment																	
Catawba Basin																	
x	CRWSP Reservoir Expansion	$22,500,000															
x	CRWSP Intake and PS Expansion	$4,350,000															
CAT-S-02	CRWSP WTP Expansion	$1,740,000		$15,560,000													
Yadkin Basin																	
YAD-S-01	Lake Tillery RW Intake and PS		$480,000		$5,020,000												
YAD-M-01	YRWTP Raw Water Transmission Main			$8,676,000		$69,484,000											
YAD-S-02	Yadkin River WTP (YRWTP)		$4,960,000		$42,840,000												
YAD-M-02	Cross County Transmission Main		$2,460,000		$28,640,000												
YAD-M-03	762 YRWTP Transmission Main									$1,620,000		$18,780,000					
YAD-S-03	Lake Tillery PS Expansion																$180,000
YAD-S-04	Yadkin River WTP (YRWTP) Expansion to 20 MGD														$1,440,000		$15,360,000
YAD-M-04	YRWTP Raw Water Transmission Main Parallel														$4,380,000		$61,320,000
Water Supply & Treatment Subtotal																	
762 Zone																	
762-V-01	853 South / 762 PRV		$104,000														
762-T-01	762 Zone Tank (Wingate Tank)	$616,000	$2,544,000														
x	Marshville Tank Rehab			$426,000													
762-M-01	762 Zone Main - Low Pressure		$184,000														
762-Z-01	Expand 762 Zone																
762-V-02/03	853 East / 762 PRVs						$196,000										
762-M-02	762 Zone Main									$600,000		$7,200,000					
762-P-01	Retire Olive Branch BPS																
762-Z-02	Expand 762 Zone																
821 East Zone																	
821-V-01	853 West / 821 PRV						$104,000										
853 West Zone																	
853W-M-01	853 West Zone Transmission Main Construction Phase	$50,000	$12,080,000														
853W-M-02	853 West Zone Transmission Main Construction Phase		$1,800,000														
853W-M-03	853 West Zone Transmission Main				$468,000	$5,512,000											
853W-M-04	853 West Zone Transmission Main				$300,000	$3,500,000											
853W-M-05	853 West Zone Transmission Main				$156,000	$1,804,000											
853W-M-06	853 West Distribution Main				$24,600	$286,400											
853W-Z-01	Eliminate 853 West / East Pressure Zone Boundary																
853W-P-01	Watkins BPS Pump Modifications				$28,200	$328,800											
853W-T-01	New Indian Trail Tank	$400,000			$486,000	$5,724,000											
853W-Z-02	Reduced Zone											$20,400	$183,600				
853 South Zone																	
853S-V-01	853 West/South PRV	$104,000															
853S-P-01	Hwy 75 Booster Pump Station Capacity Improvements							$96,000	$864,000								
853S-M-01	853 South Zone Transmission Main											$660,000	$7,740,000				
853S-T-01	853 South Zone Tank											$162,000	$1,908,000				
880 Zone																	
880-P-02	Waxhaw-Marvin BPS Demolition		$21,600	$254,400													
935 Zone																	
935-T-01	New Stallings Tank														$180,000	$2,520,000	
Water Annual Programs																	
x	Miscellaneous Water Line Replacements	$9,400,000															
x	Storage Tank Rehabilitations			$1,800,000													
x	Short Water Line Extensions	$9,400,000															
x	R&R Program	$8,000,000															
		$ 56,860,000	**$ 25,708,600**	**$ 26,716,400**	**$ 80,722,800**	**$ 86,639,200**	**$ 300,000**	**$ 96,000**	**$ 864,000**	**$ 2,220,000**	**$ -**	**$ 26,822,400**	**$ 9,831,600**	**$ -**	**$ 6,000,000**	**$ 2,520,000**	**$ 76,860,000**



Water System Planning Update

Water System Improvement Projects: 2016 to 2030

- Tank - Existing
- Tank - CIP 2016 to 2020
- Tank - CIP 2021 to 2025
- Tank - CIP 2026 to 2030
- Pump Station - Existing
- Pump Station - CIP 2021 to 2025
- Pump Station - CIP 2026 to 2030
- Valve - CIP 2016 to 2020
- Valve - CIP 2021 to 2025
- Valve - CIP 2026 to 2030
- Main - Existing
- Main - CIP 2016 to 2020
- Main - CIP 2021 to 2025
- Main - CIP 2026 to 2030

0 0.5 1 2 3 Miles

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APPENDIX C: Detailed Project Descriptions

The Union County water system CIP Projects were classified by river basin or by pressure zone, then by category. The basin/zone and category are indicated in the Project ID.

The Project IDs are designated by River Basin for supply and treatment projects or by Zone for distribution system projects. The two river basins used for water supply and treatment are:

- The Catawba River Basin (CAT)
- The Yadkin River Basin (YAD)

The distribution system Pressure Zones are:

- 762 Zone (762)
- 821 Zone (821)
- 853 East Zone (853E)
- 853 West Zone (853W)
- 853 South Zone (853S)
- 880 Zone (880)
- 935 Zone (935)

The 5 project categories are:

- M – Water Main Projects
- S – Supply and Treatment Projects
- T – Storage Tank Projects
- P – Booster Pump Station Projects
- V – Valve Projects

The project descriptions include the project scope as well as a description of the drivers and benefits of each project. The encumbrance costs and phasing are also summarized for each project.

YAD-S-01: LAKE TILLERY RAW WATER INTAKE AND PUMP STATION

Project Start Year: 2017

Scope: This project consists of two primary components: a new raw water intake on Lake Tillery and a raw water pump station (RWPS) located near Norwood, NC. The intake and RWPS will deliver raw water through the planned 36-inch raw water transmission main (YAD-M-01) to the planned YRWTP (YAD-S-02) and will be expandable to the planned YRWTP 2050 capacity of 28 mgd.

Primary Drivers: Growth, IBT Limit, Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- As UC water demands increase in the future, additional water supply will be required. In order to increase supply while meeting the IBT limits discussed in Chapter 2, a source of supply must be developed in the Yadkin Basin. This raw water intake and RWPS will provide Yadkin Basin raw water to the new YRWTP.
- The raw water supply provided by this project will diversify Union County's water supply to have sources in both the Yadkin and Catawba Basins and provide reliability, resiliency and redundancy to deliver water to the entire UC water distribution system (up to the capacity of the YRWTP) if there is a planned outage or an emergency which renders the Catawba Supply and/or CRWTP unavailable.
- Although the initial capacity of the YRWTP is planned to be 12 mgd, the intake and RWPS should be sized to deliver raw water to the YRWTP at 18 mgd capacity to allow the future high-rating of the YRWTP. This capacity will enhance the ability of the YRWTP to provide water supply to UC water customers under emergency conditions. The intake and RWPS should be designed to be expandable to the planned 2050 YRWTP capacity of 28 mgd.
- As defined in the Norwood Agreement, the new intake and pump station should be sized for an additional 2 mgd capacity for Norwood. A separate hydraulic system within the RWPS will be provided to deliver flow to the Norwood WTP.

Estimated Cost (2015 Dollars): $5,500,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2017	FY 2018	FY 2019	FY 2020	TOTAL
Construction			$4,700,000		**$4,700,000**
Design and Engineering	$480,000		$320,000		**$800,000**
Land Acquisition					**$0**
TOTAL	**$480,000**	**$0**	**$5,020,000**	**$0**	**$5,500,000**

YAD-M-01: YADKIN RIVER WTP RAW WATER TRANSMISSION MAIN

Project Start Year: 2017

Scope: Approximately 158,000 LF (30 miles) of 36-inch raw water transmission main (RWTM) is planned to connect the new Lake Tillery Raw Water Intake and RWPS (YAD-S-01) to the new YRWTP (YAD-S-02). The final sites for the Lake Tillery Raw Water Intake and RWPS and new YRWTP have not been determined at the time of this report. Additionally, an alignment study should be completed as part of the design of this project to determine the optimal pipeline alignment. The Yadkin River WTP RWTM is currently expected to leave the RWPS and continue to the west along Whitley Street and Whitley Road, continuing along Mount Zion Church Road, Hardy Road, Plank Road, NC-138, Rocky River Road, NC-205, NC-218, Haigler Gin Road and Morgan Mill Road and terminate at the YRWTP.

Primary Drivers: Growth, IBT Limit, Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- As UC water demands increase in the future, additional water supply will be required. In order to increase supply while meeting the IBT limits discussed in Chapter 2, a source of supply must be developed in the Yadkin Basin. The RWTM will convey raw water from the Lake Tillery Raw Water Intake and RWPS to the new YRWTP.
- The raw water supply provided by this project will diversify UC's available water supply to both the Yadkin and Catawba Basins and provide reliability, resiliency and redundancy to deliver water to the entire UC water distribution system (up to the capacity of the YRWTP) if there is a planned outage or an emergency which renders the Catawba Supply and/or CRWTP unavailable.
- Although the initial capacity of the YRWTP is planned to be 12 mgd, the RWTM should be sized to deliver raw water to the YRWTP at 18 mgd capacity to allow the future high-rating of the YRWTP. This capacity will enhance the ability of the YRWTP to provide water supply to UC water customers under emergency conditions. A second RWTM is planned to be constructed in the future to provide raw water supply in excess of 18 mgd.

Estimated Cost (2015 Dollars): $78,160,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2018	FY 2019	FY 2020	FY 2021	TOTAL
Construction			$64,900,000		**$64,900,000**
Design and Engineering	$6,876,000		$4,584,000		**$11,460,000**
Land Acquisition	$1,800,000				**$1,800,000**
TOTAL	**$8,676,000**	**$0**	**$69,484,000**	**$0**	**$78,160,000**

YAD-S-02: YADKIN RIVER WATER TREATMENT PLANT

Project Start Year: 2017

Scope: The new YRWTP is planned to be constructed in the northeastern area of Union County, shown as a dotted circle target area on the CIP Map in Appendix B. The YRWTP is planned to be constructed at an initial capacity of 12 mgd, with the ability to be high-rated to 18 mgd and expandable to the planned 2050 YRWTP capacity of 28 mgd.

The YRWTP will receive raw water from the 36-inch YRWTP RWTM (YAD-M-01), which will be stored in the approximately 75 MG of on-site raw water storage at the YRWTP.

In order to deliver finished water most efficiently to the distribution system, two sets of high service pumps will be provided in the high service station at the YRWTP and will pump directly to the 853 Zone and the 762 Zone. The 853 Zone pumps (required at YRWTP start-up) will deliver finished water to the 36-inch Cross County Transmission Main (CCTM) (YAD-M-02). Following construction of the 24-inch 762 Zone YRWTP Transmission Main (YAD-M-03) in approximately 2028, the 762 pumps at the YRWTP will deliver water directly to the 762 Zone.

The 853 Zone HS Pumps and 762 Zone HS Pumps are planned to be constructed in a single building as part of the initial YRWTP construction. At YRWTP start-up in 2022, only the 853 Zone HSPS will be required. The 762 Zone HSPS will be installed following construction of the 24-inch 762 Zone YRWTP Transmission Main in 2028.

Primary Drivers: Growth, IBT Limit, Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- As UC water demands increase in the future, additional water supply will be required. In order to increase supply while meeting the IBT limits discussed in Chapter 2, a source of supply must be developed in the Yadkin Basin. The YRWTP will treat raw water delivered by from Lake Tillery Raw Water Intake and RWPS (YAD-S-01) and the YRWTP RWTM (YAD-M-01) and deliver finished water to the UC water distribution system.
- The finished water delivered by this project will diversify UC's available water supply to both the Yadkin and Catawba Basins and provide reliability, resiliency and redundancy to deliver water to the entire UC water distribution system (up to the capacity of the YRWTP) if there is a planned outage or an emergency which renders the Catawba Supply and/or CRWTP unavailable.
- Although the initial size of the YRWTP is planned to be 12 mgd, all raw water and finished water infrastructure will be sized to be capable of operating at the YRWTP high-rated capacity of 18 mgd. This additional capacity will enhance the ability of the YRWTP to provide water supply to UC water customers under emergency conditions.
- The 75 MG of raw water storage will provide flow equalization capacity and supply reliability in the event of a temporary interruption of raw water supply, allowing the YRWTP to continue to treat and deliver finished water until the raw water supply resumes.

- The two sets of high service pumps will enable UC to realize pumping energy savings for all water delivered to the 762 Zone. Prior to the construction of the 762 Zone HSPS and 762 Zone YRWTP FWTM, all finished water will be delivered to the distribution system by the 853 HSPS via the 36-inch CCTM. Under this configuration, water delivered to the 762 Zone must be first be pumped to the 853 Zone hydraulic grade line (HGL) before being reduced to the 762 Zone HGL, resulting in a loss of energy efficiency. Following completion of the 762 Zone YRWTP Transmission Main, water from the YRWTP will be delivered directly to the 762 Zone, resulting in significant energy savings throughout the operating life of the YRWTP.

Estimated Cost (2015 Dollars): $47,800,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	TOTAL
Construction			$40,000,000			**$40,000,000**
Design and Engineering	$4,260,000		$2,840,000			**$7,100,000**
Land Acquisition	$700,000					**$700,000**
TOTAL	**$4,960,000**	**$0**	**$42,840,000**	**$0**	**$0**	**$47,800,000**

YAD-M-02: CROSS COUNTY TRANSMISSION MAIN

Project Start Year: 2017

Scope: Approximately 52,000 LF (10 miles) of 36-inch water main is planned to connect the new Yadkin River WTP to the new 36-inch and 16-inch 853 West Zone transmission mains (853W-M-01 to 853W-M-05). The final site for the new YRWTP has not been determined at the time of this report and an alignment study should be completed as part of the design of this project to determine the optimal pipeline route. The route of the Cross County Transmission Main is currently expected to leave the YRWTP and travel south on Sikes Mill Rd. The main will then turn west to follow Roanoke Church Road to Secrest Shortcut Road, where the main will cross under the future Monroe Bypass (a casing will be installed under the bypass during construction). The main will follow Secrest Shortcut Road northwest to the intersection with Rocky River Road, where it will connect to the new 36-inch 853 West Zone transmission main project (853W-M-01).

Primary Drivers: Growth, IBT Limit, Reliability, Resiliency and Redundancy

Project Objective and Benefits: Upon completion of the new YRWTP, the initial 12 mgd capacity water treatment plant will increase available water supply in the eastern part of the county. The new Cross County Transmission Main will provide a strong hydraulic connection between the eastern and western portions of the distribution system and will:

- Enable the new YRWTP to deliver water throughout the distribution system
- Improve operation of the Northwest Tank (which currently operates 10 to 15 feet lower than the Indian Trail and Stallings Tanks) by decreasing head loss across the 853 West / East Zone
- Provide additional transmission capacity and redundancy to the existing 16-inch east-west transmission main in the 853 West / East Zone
- Enable all Union County water customers to be served by water supplied from either the Catawba River only or the Yadkin River only during emergency supply scenarios, enhancing system reliability, redundancy and resiliency

Estimated Cost (2015 Dollars): $31,100,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	TOTAL
Construction			$27,000,000			**$27,000,000**
Design and Engineering	$2,460,000		$1,640,000			**$4,100,000**
Land Acquisition	$0					**$0**
TOTAL	**$2,460,000**	**$0**	**$28,640,000**	**$0**	**$0**	**$31,100,000**

YAD-M-03: 762 ZONE YRWTP TRANSMISSION MAIN

Project Start Year: 2024

Scope: Approximately 56,000 LF (10.5 miles) of 24-inch transmission main is planned to connect the 762 Zone High Service Pump Station at the new YRWTP (YAD-S-02) to the existing 16-inch transmission main in the 762 Zone, delivering finished water from the YRWTP to the 762 Zone. The final site for the new YRWTP has not been determined at the time of this report and an alignment study should be completed as part of the design of this project to determine the optimal pipeline route. The 762 Zone YRWTP Transmission Main is planned to leave the YRWTP and continue south towards Marshville along Lawyers Road, Mills Harris Road and Forest Hills School Road, terminating at the existing 762 Zone 16-inch transmission main at Highway 74.

Primary Drivers: Growth, Energy Efficiency, Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- The transmission main project will provide a direct supply point from the new YRWTP to the existing and expanded 762 Zone
- As demands in the 762 Zone increase, the existing 16-inch transmission main (in conjunction with 3 mgd reliable supply capacity from Anson County at the Highway 74 BPS) will not be capable of adequately serving the 762 Zone during high demand periods. This new main will improve transmission capacity to the 762 Zone, allow the Marshville Tank and New 762 Zone Tank (762-T-01) to operate effectively and reduce Union County's reliance on the Highway 74 BPS during normal system demand conditions.
- Prior to construction of the 762 Zone YRWTP Transmission Main, water delivered to the 762 Zone from the YRWTP will need to be pumped to the 853 Zone HGL first and then reduced down to the 762 Zone HGL via a PRV. Following construction of this project, water will be pumped directly to the 762 Zone, resulting in increased energy efficiency.

Estimated Cost (2015 Dollars): $20,400,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	TOTAL
Construction			$17,700,000			**$17,700,000**
Design and Engineering	$1,620,000		$1,080,000			**$2,700,000**
Land Acquisition	$0					**$0**
TOTAL	**$1,620,000**	**$0**	**$18,780,000**	**$0**	**$0**	**$20,400,000**

762-T-01: NEW 762 ZONE TANK

Project Start Year: 2016

Scope: A new 1.0 MG elevated storage tank (overflow elevation: 762 ft) is planned to be constructed along the existing 16-inch transmission main in Highway 74 in the 762 Zone.

Primary Drivers: Growth, System Operations, Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- As described in the Storage Capacity Analysis in Chapter 3, the 762 Zone is currently deficient in Equalization + Emergency Storage Capacity. This deficiency is predicted to continue and worsen in the future. The New 762 Zone Tank will address this deficiency and is predicted to provide the 762 Zone with adequate Equalization and Equalization + Fire Flow Storage throughout the planning horizon.
- The Marshville Tank is currently the only storage facility in the 762 Zone. As such, it has not been removed from service for cleaning, painting and other maintenance. The New 762 Zone Tank will provide not only provide additional storage capacity, but also storage redundancy to allow the Marshville Tank to be serviced without significant system operational challenges.

Estimated Cost (2015 Dollars): $3.3M

Project Encumbrance Schedule:

PROJECT PHASE	FY 2016	FY 2017	TOTAL
Construction		$2,400,000	**$2,400,000**
Design and Engineering	$216,000	$144,000	**$360,000**
Land Acquisition	$400,000		**$400,000**
TOTAL	**$616,000**	**$2,544,000**	**$3,160,000**

762-M-01: 762 ZONE MAIN – LOW PRESSURE

Project Start Year: 2017

Scope: Approximately 1,000 LF of 6-inch distribution main is planned to be constructed to form a loop between two existing dead-end mains at Windsong Way and Wade Rorie Road in the 762 Zone.

Primary Drivers: Low Pressures, Low Fire Flow, Water Quality

Project Objective and Benefits:

- Complete a pipeline loop which will decrease headloss during high system demand periods and increase pressures and available fire flows in this area of the distribution system.
- Eliminating two dead-end mains will also service to reduce water age and improve water quality conditions.

Estimated Cost (2015 Dollars): $184,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2017	TOTAL
Construction	$160,000	**$160,000**
Design and Engineering	$24,000	**$24,000**
Land Acquisition	$0	**$0**
TOTAL	**$184,000**	**$184,000**

821-V-01: 853 WEST / 821 ZONE PRV

Project Start Year: 2021

Scope: A new Pressure Reducing Valve (PRV) located at the Watkins BPS which will deliver water from the 36-inch transmission main on the discharge of the Watkins BPS to the 42-inch transmission main on the suction side of the Watkins BPS during emergency supply conditions when the CRWTP is out-of-service and 880, 853 South, and/or 821 Zones must be supplied from the YRWTP. This new PRV will reduce pressures from the 853 Zone HGL to the 821 Zone HGL. Required sizing and operation of this PRV should be finalized during detailed design.

Primary Drivers: Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- This project will allow water to be delivered from the YRWTP to the 821, 853 South and 880 Zones during emergency conditions when water supply from the Catawba Basin is unavailable. Following completion of the YRWTP (YAD-S-02) and Cross County Transmission Main (YAD-M-02), the UC water distribution will be capable of being served entirely by the YRWTP under emergency conditions (up to the capacity of the YRWTP). In order to supply water to the 821, 853 South and 880 Zones, water delivered by the YRWTP (at a nominal HGL of 853 ft) must be reduced to the HGL of the 821 Zone by this PRV.
- By locating this PRV along the existing zone boundary at the Watkins BPS, flexibility will be maintained to transfer large volumes of water across the county in either direction, via the 36-inch CCWTM (YAD-M-02).

Estimated Cost (2015 Dollars): $104,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2017	TOTAL
Construction	$90,000	**$90,000**
Design and Engineering	$14,000	**$14,000**
Land Acquisition	$0	**$0**
TOTAL	**$104,000**	**$104,000**

853W-T-01: NEW INDIAN TRAIL TANK

Project Start Year: 2016

Scope: A new 2.0 MG elevated storage tank (overflow elevation: 853 ft) is planned to be constructed in the current 853 West Zone. The new elevated storage tank is planned to be located at a site along the new 16-inch main (853-M-04) in Waxhaw Indian Trail Road and will not only replace the existing 0.3 MG Indian Trail Tank, but will also increase storage total storage capacity in the zone.

Primary Drivers: Growth, System Operations, Reliability, Resiliency and Redundancy

Project Objective and Benefits:

- As described in the Storage Capacity Analysis in Chapter 3, the planned combined 853 West / East Zone is currently projected to be deficient in Equalization + Fire Flow Storage Capacity, with that deficit projected to grow to 1.8 MG by 2030. The new 2.0 MG Indian Trail Tank will address this deficiency and is predicted to provide the 853 West / East Zone with adequate Equalization and Equalization + Fire Flow Storage throughout the planning horizon.
- The project will also serve to improve water service reliability in the zone by adding another storage tank which is significantly greater in capacity than the existing Indian Trail Tank that will be replaced.

Estimated Cost (2015 Dollars): $6,610,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	TOTAL
Construction					$5,400,000		**$5,400,000**
Design and Engineering				$486,000	$324,000		**$810,000**
Land Acquisition	$400,000						**$400,000**
TOTAL	**$400,000**			**$486,000**	**$5,724,000**		**$6,610,000**

853S-P-01: HIGHWAY 75 BOOSTER PUMP STATION CAPACITY IMPROVEMENTS

Project Start Year: 2022

Scope: As currently operated, the Highway 75 BPS produces a firm capacity of approximately 1.4 mgd while throttling a discharge valve to control the operating flowrate. Based on hydraulic modeling results, the planned 853 West / South PRV (853S-V-01) will be capable of delivering approximately 0.5 mgd to the 853 South Zone during maximum day demand conditions. Therefore, the total firm capacity available from these two sources of supply is approximately 1.9 mgd, indicating a need for a zone supply improvement project when 853 South maximum day demands exceed 1.9 mgd.

Based on the demand projections detailed in Chapter 1, the 2030 maximum day demands in the 853 South Zone are projected to be approximately 2.5 mgd, indicating that the firm pumping capacity of the Highway 75 BPS should be increased to approximately 2.0 mgd (0.5 mgd would be supplied by the 853 West / South PRV) to meet 853 South zone demands through the end of the planning horizon.

As discussed in Chapter 3, Union County has observed that system growth in the 853 South Zone has been lower than projected, and may continue to remain low or potentially not grow at all. Union County should continue to monitor growth and demands in the 853 South Zone and initiate a capacity improvement project at the Highway 75 BPS that will be operational when 853 South Zone maximum day demands exceed 1.9 mgd.

The existing Highway 75 BPS contains pumps with rated heads well above the total dynamic head requirements of the pumps and therefore require a discharge valve to be throttled in order to control flow rate and keep the pumps operating on their performance curves. The most cost-effective improvement for increasing the firm capacity of the Highway 75 BPS should be evaluated during design and may include:

- Adjusting the position of the throttled valve to reduce back pressure and produce more flow (pump operations and performance will need to be evaluated with field testing)
- Modifying pump impellers
- Pump replacement (assumed for CIP cost estimate)

Primary Drivers: Growth, Capital Cost Savings

Project Objective and Benefits:

- As part of the 2011 Master Plan, a 38,000 ft, 12-inch main improvement project was recommended to be constructed in the 853 South Zone along Fletcher Broom Road, Helms Short Cut Road and Griffith Road to improve available fire flows and allow for increased supply to be provided by the 853 West / East PRV.

  Based on discussions with Union County, a new 12-inch main is currently under construction along South Rocky River Road. Following completion of this main, increasing supply to the 853 South Zone will more cost-effectively be accomplished by increasing the capacity of the Highway 75 BPS instead

of constructing the 38,000 ft of 12-inch main described above. Therefore, this approximately $5M main improvement project has been eliminated from the CIP for the current planning horizon.

- This pump station improvement project will enable projected maximum day demands to be supplied to the 853 South Zone throughout the planning horizon.

Estimated Cost (2015 Dollars): $960,000

Project Encumbrance Schedule:

PROJECT PHASE	FY 2022	FY 2023	TOTAL
Construction		$800,000	**$800,000**
Design and Engineering	$96,000	$64,000	**$160,000**
Land Acquisition	$0		**$0**
TOTAL	**$96,000**	**$864,000**	**$960,000**