SECTION 2:
Water Analysis

Section 2 Water Analysis

2.1 Water Distribution System Background, Programs and Goals

2.1.1 Background

The City contracted B&W to identify and plan for the necessary improvements required to meet future standards and growth demands to the City's water distribution system in order to update its Water Master Plan.

The purpose of the following Water Master Plan is to evaluate the existing water utility system and make recommendations for necessary improvements needed to maintain an adequate LOS for the anticipated short term (1 to 10 years) and long term (11 to 25 years) planning horizons. The evaluation and recommendations focus on improvements required to meet present and future system demands resulting from an increase in redevelopment projects, maintain compliance with federal, state and local regulatory requirements, and provide proper renewal and replacement of aging system components. The City owns and maintains a water distribution system that consists of the following:

- 249,250 linear feet (LF) of various diameter water main
- 4,032 water meters
- 281 fire hydrants

The City's water distribution system provides potable water to 12,528 residents. The City and City of Fort Lauderdale (FTL) have a Bulk Service Agreement dated September 7th, 2005 under resolution 05-154, with an expiration date of September 6, 2030. The City receives its potable water from FTL through the following three (3) connection points:

- Western Connection - 30"x6" connection at the intersection of of NW 26th St and NW 9th Ave
- Central Connection – 30"x8" connection at the intersection of E Oakland Blvd and N Andrews Ave
- Eastern Connection – 42"x10" connection at the intersection of NE 26th St and NE 9th Ave

Figure 2-1 shows the City's water distribution system along with the three (3) connections to the FTL water system.

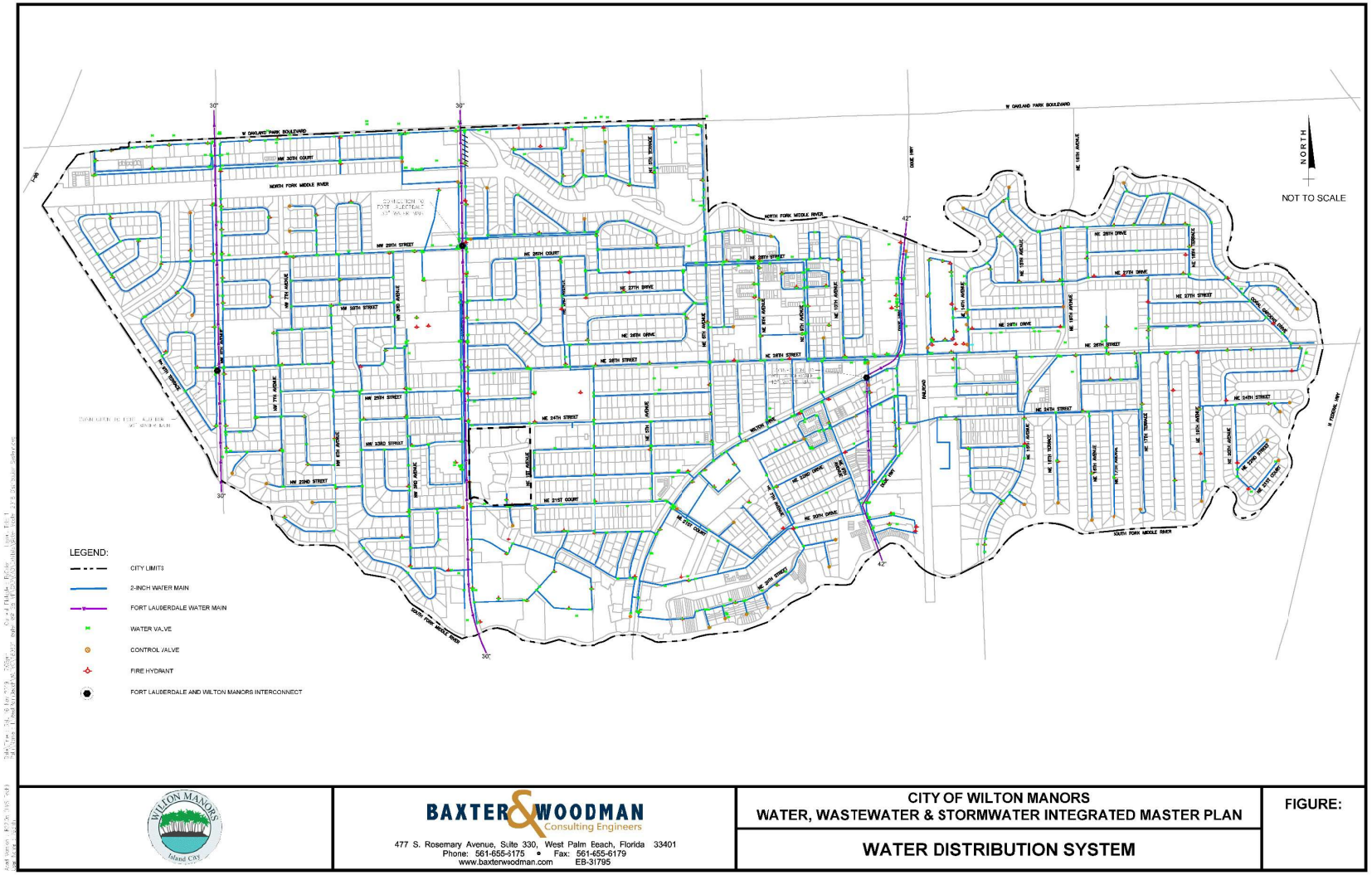

Figure 2-1: Water Distribution System

2.1.2 Water Distribution System Programs and Goals

Water system goals have been established by the City's Utility Department to optimize the operational performance of the system and to improve reliability in the system. These programs and goals are as follows:

- ***Rate Structure Program -*** The City has implemented a conservation based increase block rate structure as a means of reducing water demands

- ***Water Replacement Program –*** The City has completed and continues to schedule city wide water main replacement projects to ensure the water distribution system meets all existing and future demands. This program, along with the analysis performed within this document schedule required improvements to ensure a healthy capacity for water flow, pressure and chlorine residual concentrations.

- ***Fort Lauderdale Communication Program –*** The City continues to create channels of communication with FTL to guarantee a cooperative relationship with its water supplier. An example of this includes the recent upgrade of the three (3) water meters that continuously measure the water received from FTL. The City was the driving force behind the replacement to ensure that FTL and the City have accurate water supply data.

- ***Valve Exercising Program –*** The City shall schedule periodic exercising of the water distribution system valves. The valve exercising program's main objective is to provide assurance that in an event of a water main break, hydrant testing or everyday operation and maintenance of the water distribution system, the City can quickly and easily re-rout water flow around different portions of the City. This program can decrease boil water notices and the impacts to the public during construction or emergency events.

2.1.3 Conservation Program

The City implemented a Water Conservation Program within their Comprehensive Plan Infrastructure Element published in February 2019 which includes the following water conservation goals:

- ***Limitation of Lawn and Ornamental Irrigation Hours –*** The City's Code follows Broward County Ordinance No. 91-8 which restricts landscape irrigation to the following, as shown on the Broward County website:

    - In general, NO watering of lawns and landscapes is allowed on Monday, Tuesday, and Fridays. Residences and businesses with an odd-numbered street address may water lawns and landscapes on Wednesdays and/or Saturdays, only before 10:00 a.m. or after 4:00 p.m.

- Residences and businesses with an even-numbered street address, no street address, or those who irrigate both even and odd addresses within the same zones, which may include multi-family units and homeowners' associations, may water lawns and landscapes on Thursdays and/or Sundays, only before 10:00 a.m. or after 4:00 p.m.

- Residences and businesses that use reclaimed water for irrigation are allowed to water any day only before 10 a.m. or after 4:00 p.m. Special exceptions may also apply if using a smart irrigation controller with soil moisture sensor for more than 50% of a zone.

- Such restrictions can be found on the Broward County website at: (https://www.broward.org/waterresources/Pages/IrrigationRestrictions.aspx)

- ***Florida Friendly Landscape Principles*** – The City's Florida Friendly Landscape Principles are outlined in FTL's Unified Land Development Regulations (ULDR) Section 150-070. The principles outlined in the ULDR call for the use of drought tolerant landscape species, grouping of plant material by water requirements, the use of irrigation systems that conserve the use of potable and non-potable water supplies and restrictions of the amount of lawn areas. All landscaping used in new construction must also integrate these principles.

- ***Ultra-Low Volume Plumbing Fixtures*** – The City's Code follows Section 6 of Broward County Code which requires the City abide by standards as outlined in the South Florida Building Code. This requires all new construction to use ultra-low volume plumbing in new construction.

- ***Water Conservation Rate Structure*** – The City implements a conservation based rate structure as a means of reducing demands. Water usage rates are based on tiered usage where larger users are charged increased rates.

- ***Leak Detection Programs*** – The City plans to survey the entire main distribution system and implement an improved compound meter testing program to change out all meters over 5 years old.

- ***Rain Sensor Devices*** – The City's ULDR includes Section 150-210(A) which requires the installation of rain sensor devices on all newly installed automatic irrigation systems.

- ***Public Education Programs*** – The City maintains a public information campaign on water conservation and restrictions on irrigation using Code Compliance Enforcement Officers, and Police Officers. Information is provided to the public through a variety of brochures and literature and also on the City's website.

- ***Coordination with the City of Fort Lauderdale*** – The City coordinates with FTL to include water reduction goals, actions, and funding requirements to achieve goals and milestone dates for implementation.

2.2 Water Distribution System Analysis

2.2.1 Historical Potable Water Demands and Level of Service

The City's water LOS are listed in ***Table 2-1*** and are based on historical data provided by the City's Utility Department, as well as, standards established by the City's 2019 Comprehensive Plan. The population of 12,528 City residents, used for the following analysis, was interpolated for Year 2019 and pulled from the City's 2019 Comprehensive Plan.

Note, from November 2018 to February 2019, FTL replaced the three (3) master meters that collect continuous potable water consumption data for the City. The data collected by the outdated flow meters was thought to have inaccurate readings. Therefore, B&W based the water LOS upon flow data from 2009 to 2016, prior to when the master meters were experiencing complications.

Table 2-1: Waster Distribution System Level of Service

Service Item	Value	Unit
Average Per Capita Water Usage Rate	116	gpcd
Max. Month Flow: Average Month Flow Ratio	1.17	
Maximum Water Main Velocity	7.5	ft/s
Minimum Pressure	45	psi
Average Person Per Household[1]	1.81	Persons
Average Daily Water Usage Rate per Household[2]	211	gpedu

1. Source: U.S. Census Bureau, City of Wilton Manors, Florida, 2013-2017 data.

2. For comparison purposes, Broward County's LOS for single family residential is 300 gpd/unit (Ref: Broward County Code of Ordinances, Chapter 27, Article V, "Water Resource Management").

2.2.2 Population Projections

For use in this analysis, future population projections were provided by the City as outlined in their Comprehensive Plan Future Land Use Element published in February 2019. Refer to ***Table 2-2*** to show projected population through the Year 2040. These projections show a decrease in population from Year 2019 to Year 2040. This implies that the City is primarily built out and is not expected to undergo significant population growth from future development. However, the City is expected to undergo redevelopment in certain areas. These proposed redevelopment projects were provided to B&W by the City and the respective changes in population are discussed further in ***Section 2.4***.

Table 2-2: Population Projections through Year 2040

Year	2019	2020	2025	2030	2035	2040
Population	12,528	12,556	12,557	12,471	12,461	12,369
% Increase from Base Year 2015	-	0.89%	0.90%	0.21%	0.13%	-0.61%
% Increase from Base Year 2019	-	0.22%	0.23%	-0.46%	-0.54%	-1.27%
% Change from Previous Period	-	-	0.01%	-0.68%	-0.08%	-0.74%

Note: Population data derived from the City of Wilton Manors Comprehensive Plan Future Land Use Element, Table 1-3, February 2019

2.2.3 Water Loss Analysis

An evaluation was completed to determine the amount of non-revenue water loss in the City's water distribution system. Non-revenue water in utility systems is primarily due to leakage and meter under-registration, but it also includes theft and water used for fire-fighting, street washing, sewer flushing and other non-metered public services. Un-metered water and water lost due to leakage can have significant impacts on the utility, especially due to the financial consequences (higher pumping costs, capacity and repairs), impacts to water accountability and consumption use records reported to regulatory agencies, and the impacts to the quality of service (service interruptions, system pressure decrease). A water audit can assist water utilities to reduce water and revenue losses and to optimize operations.

B&W completed a water loss analysis based on six (6) months flow data from the newly installed master meters and customer billing data. The City has approximately 7.7% water loss through their distribution system. The South Florida Water Management District and American Water Works Association (AWWA) use 10% as a benchmark / maximum goal for non-revenue water loss. Although the City's water loss percentage is less than the 10% benchmark value, B&W recommends the City perform an in-depth water loss analysis through their system in order to further pinpoint where water loss is occurring. Refer to ***Figure 2-2*** for a graph showing the historic potable water consumption data from the FTL Master Meters from 1996 to Present.

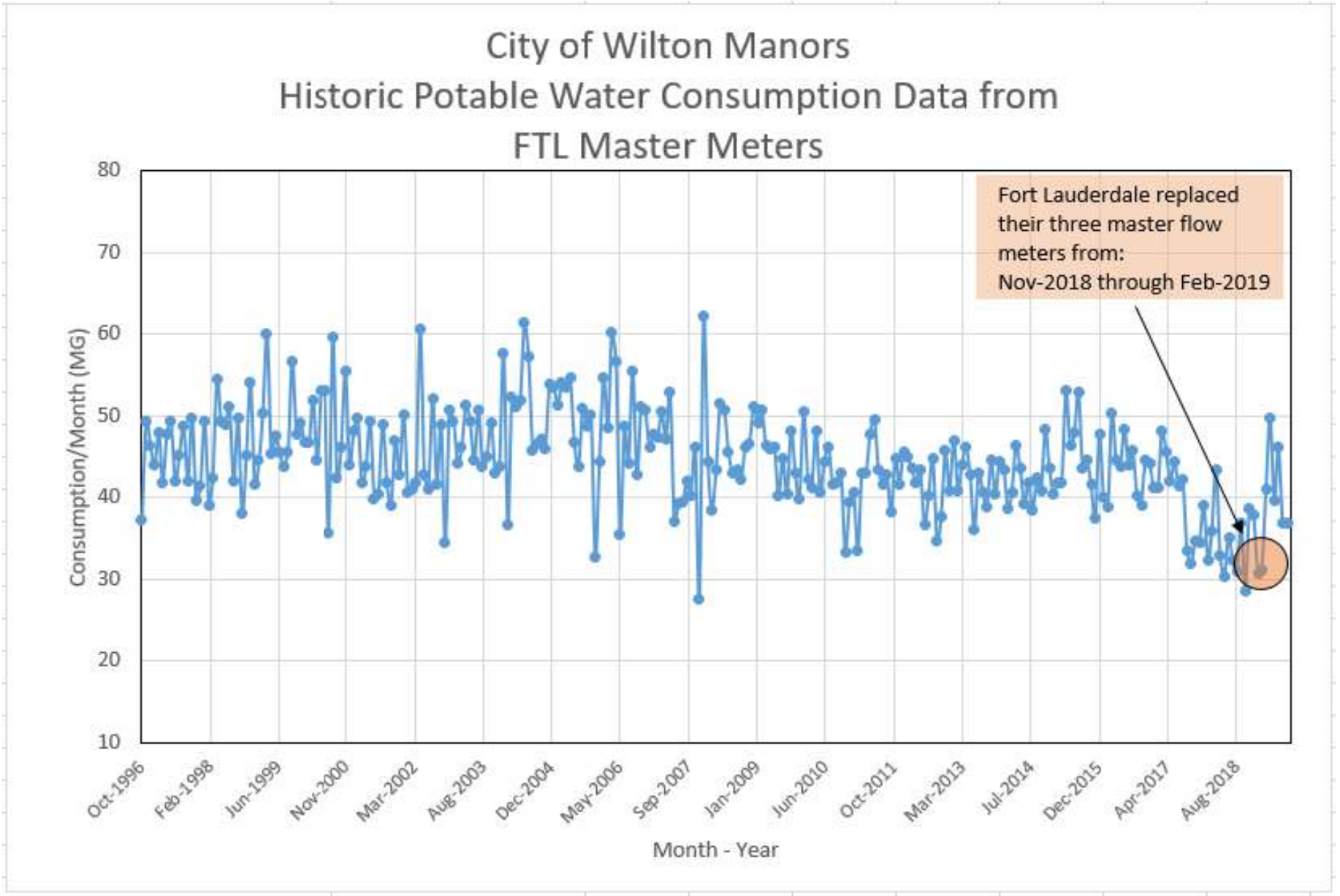

Figure 2-2: Historic Potable Water Consumption Data

2.2.4 Historical System Pressure Review

The City provided B&W with continuous operating pressure data collected by temporarily installing three (3) pressure recording devices at locations on the western, central and eastern portions of the water distribution system. The pressure was continuously recorded for a period of seven (7) days starting from February 27, 2019 and ending on March 5, 2019. The data was evaluated in hourly increments in order to observe general pressure trends over each day and to dampen any instantaneous spikes or dips that could results in inaccurate maximum and minimum values.

B&W analyzed the pressure data and determined that the average, maximum and minimum pressures were approximately 73, 88 and 53 pounds per square inch (PSI) respectively. The lowest pressure observed was 50 PSI, which was recorded at the central location of the City. This pressure is 5 PSI above the minimum 45 PSI recommended for an optimal water distribution system. The average, maximum and minimum water distribution pressures recorded during the observation period are summarized in ***Table 2-3*** below. ***Figures 2-3, 2-4*** and ***2-5*** display the continuous pressure data collected during the seven (7) day monitoring period for each location.

Table 2-3: Water Distribution Pressure Data

Location	Portion of City	Address	Pressure Data (PSI)		
			Average	Maximum	Minimum
1	West	2400 NW 9th Terrace	74	89	51
2	Central	649 Kensington Place	68	82	50
3	East	1900 NE 26th Drive	78	92	58

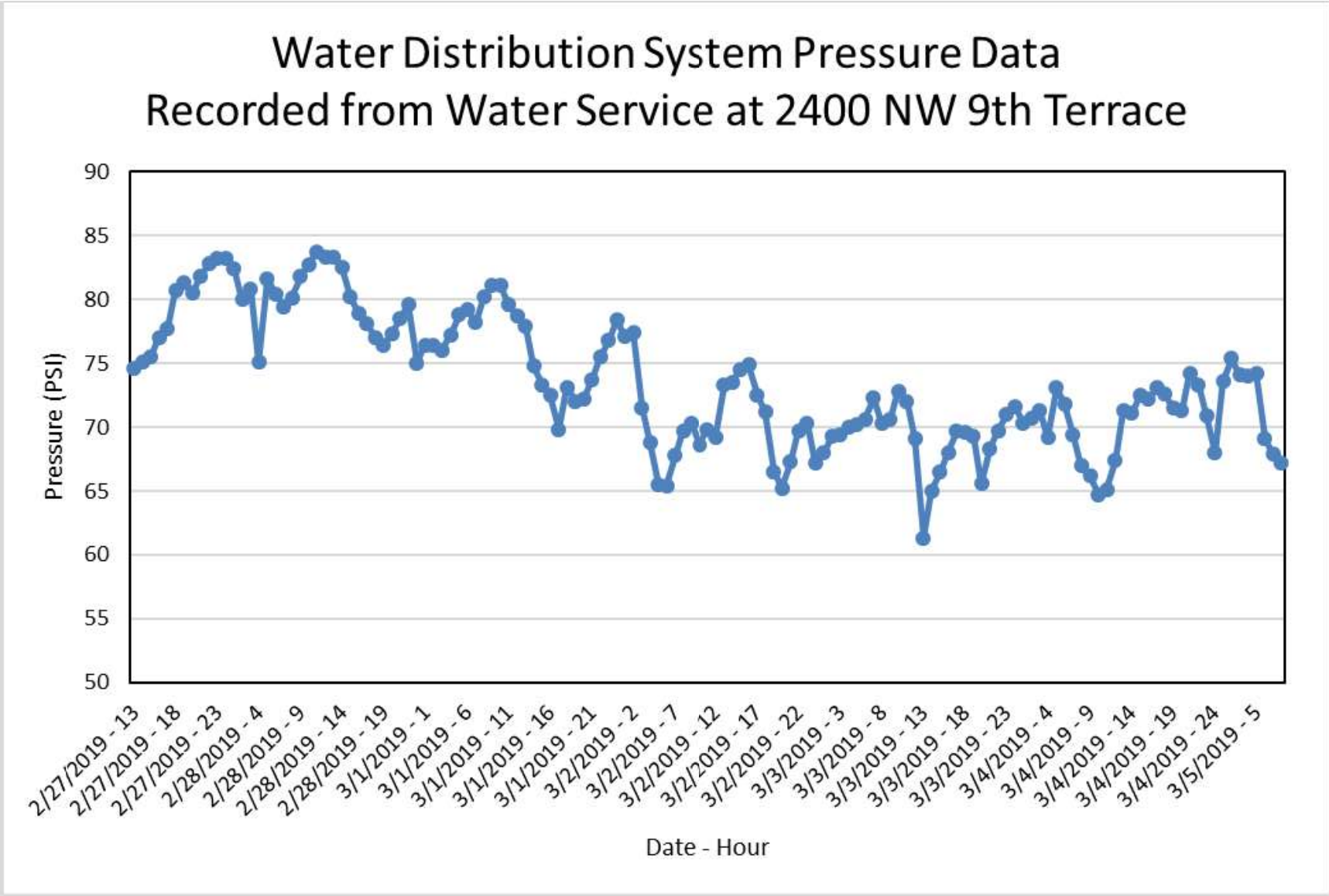

Figure 2-3: Pressure Data – 2400 NW 9th Terrace

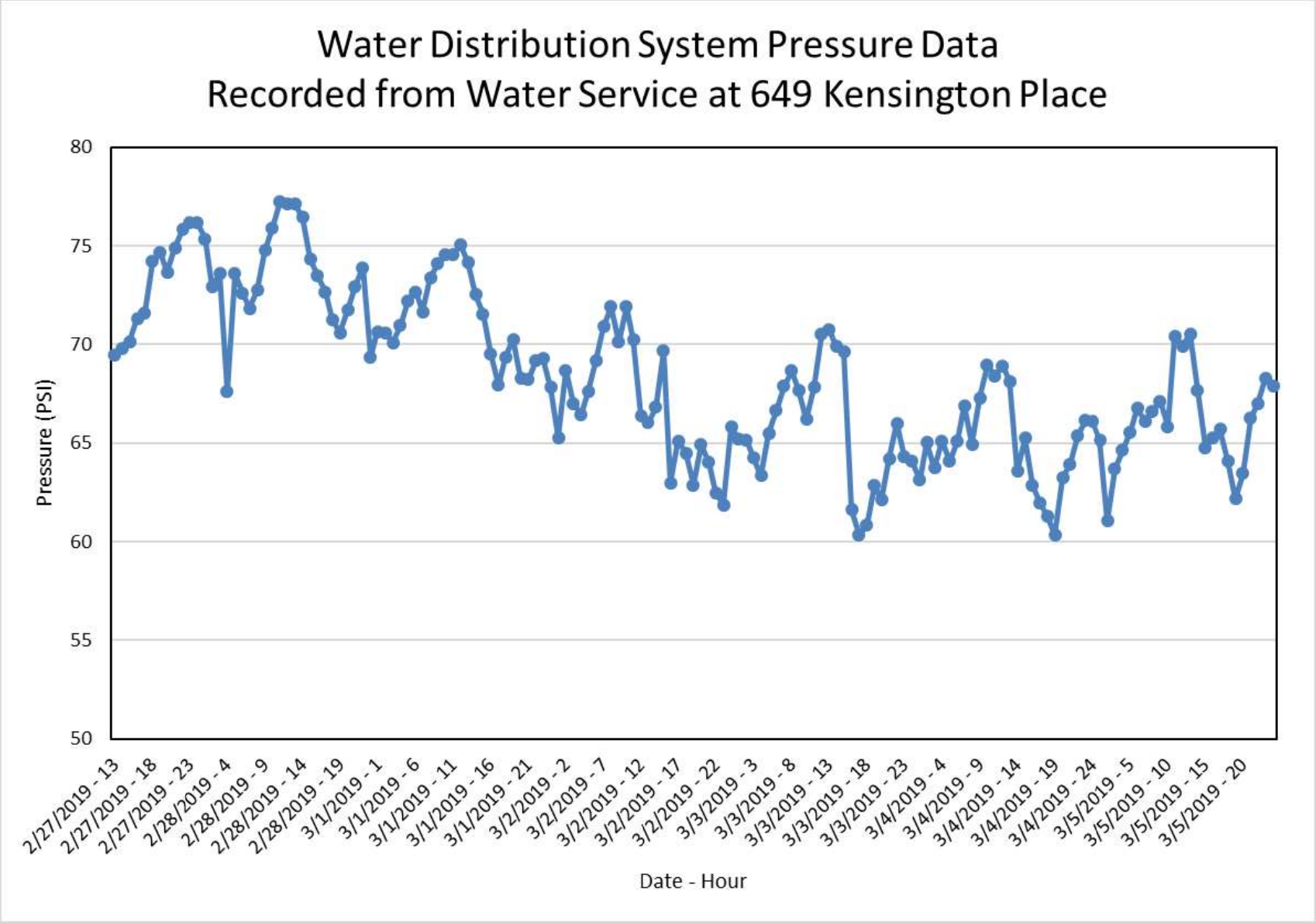

Figure 2-4: Pressure Data – 649 Kensington Place

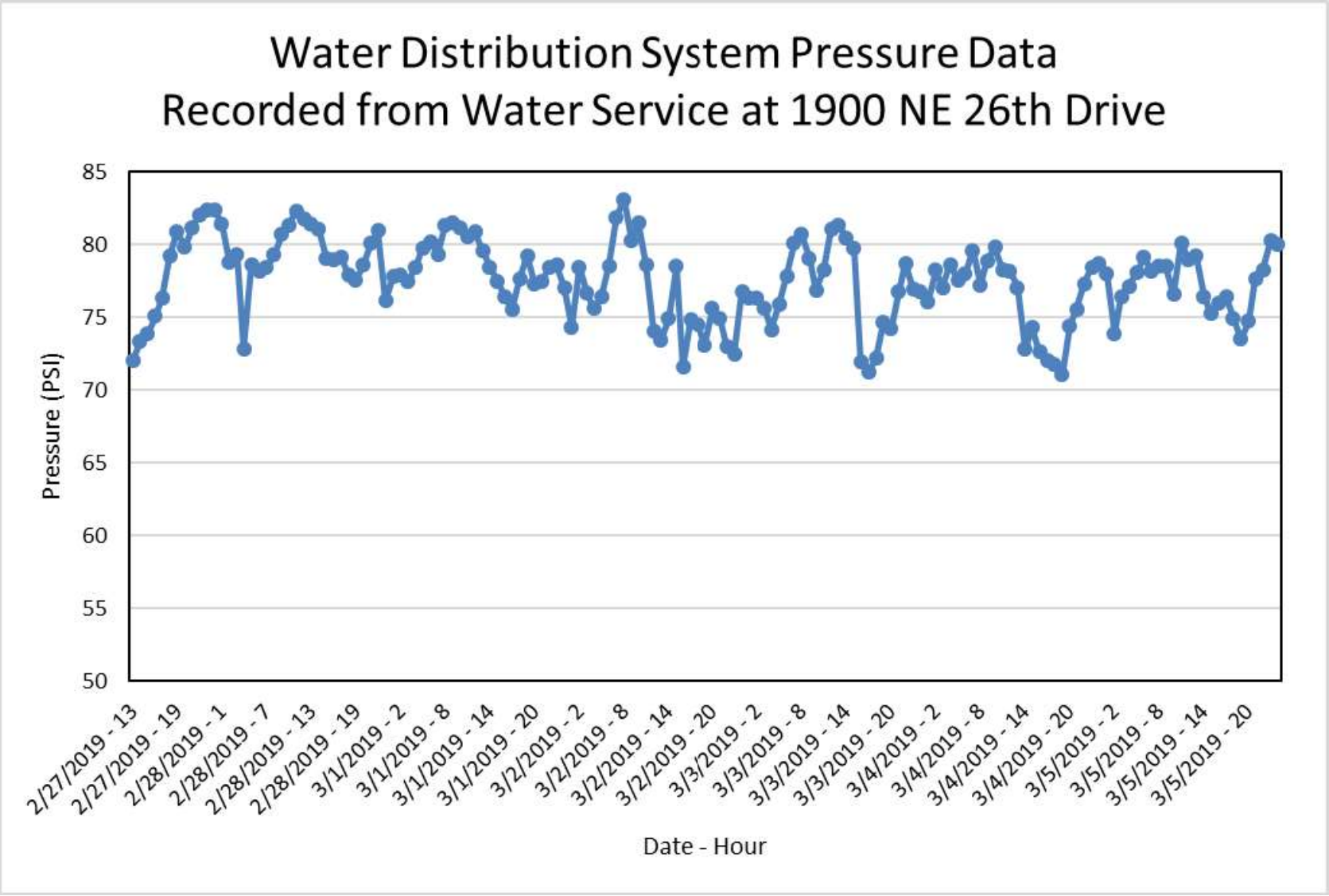

Figure 2-5: Pressure Data – 1900 NE 26th Drive

2.2.5 Historical Water Quality Review

The City provided B&W with chlorine residual testing results collected at three (3) sampling locations on the western, central and eastern portions of the water distribution system. The City tests the water distribution system approximately four (4) days a week at each of the three (3) locations. The City provided the chlorine residual testing results starting from June 14, 2016 and ending on January 29, 2019.

B&W analyzed the data and determined that the average, maximum and minimum chlorine residual levels were approximately 3.5, 5.1 and 0.4 mg/L respectively. The lowest testing result observed was 0.4 mg/L, recorded at the eastern location of the City on March 13, 2018. The minimum chlorine concentration of 0.4 mg/L is above the Florida Department of Environmental Protection (FDEP) drinking water regulation minimum chlorine residual concentration of 0.2 mg/L. The maximum chlorine residual concentration of 5.1 mg/L is above the FDEP drinking water regulation maximum chlorine residual concentration of 4.0 mg/L. FTL performs biannual chlorine burns which increase the chlorine concentration within the water distribution system for a short period of time. This accounts for the elevated chlorine levels above the FDEP standard of 4.0 mg/L.

The average, maximum and minimum water distribution chlorine residual testing results during the observation period are summarized in ***Table 2-4*** below. ***Figures 2-6, 2-7*** and ***2-8*** display the chlorine residual testing results collected during the thirty-one (31) month review for each location.

Table 2-4: Water Distribution Chlorine Residual Data

Location	Portion of City	Address	Chlorine Residual Data (mg/L)		
			Average	Maximum	Minimum
1	West	2600 NW 9th Lane	3.6	5.2	1.1
2	Central	225 NW 29th Street	3.6	5.2	1.2
3	East	2601 N Dixie Highway	3.3	4.8	0.4

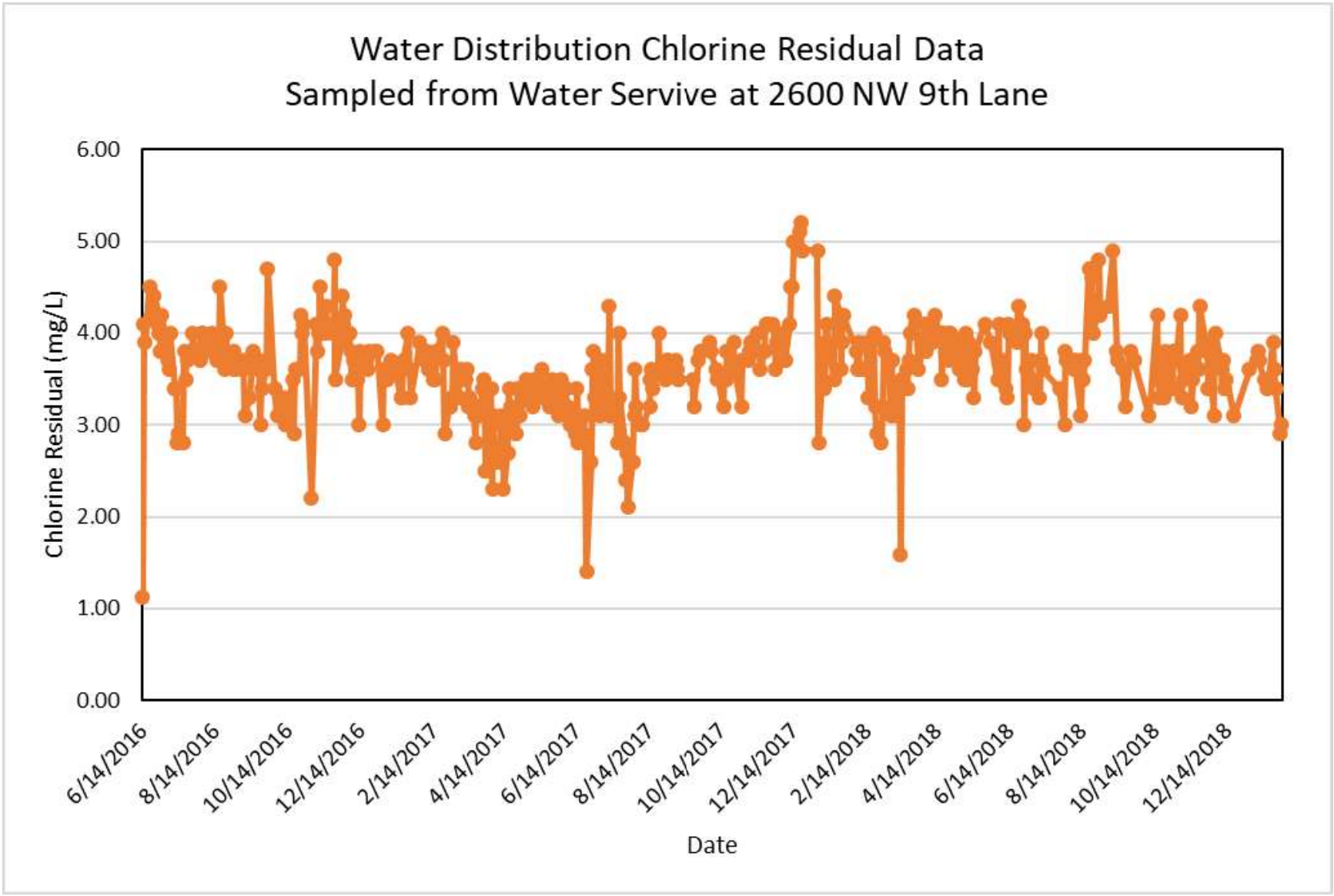

Figure 2-6: Chlorine Residual Data – 2600 NW 9th Lane

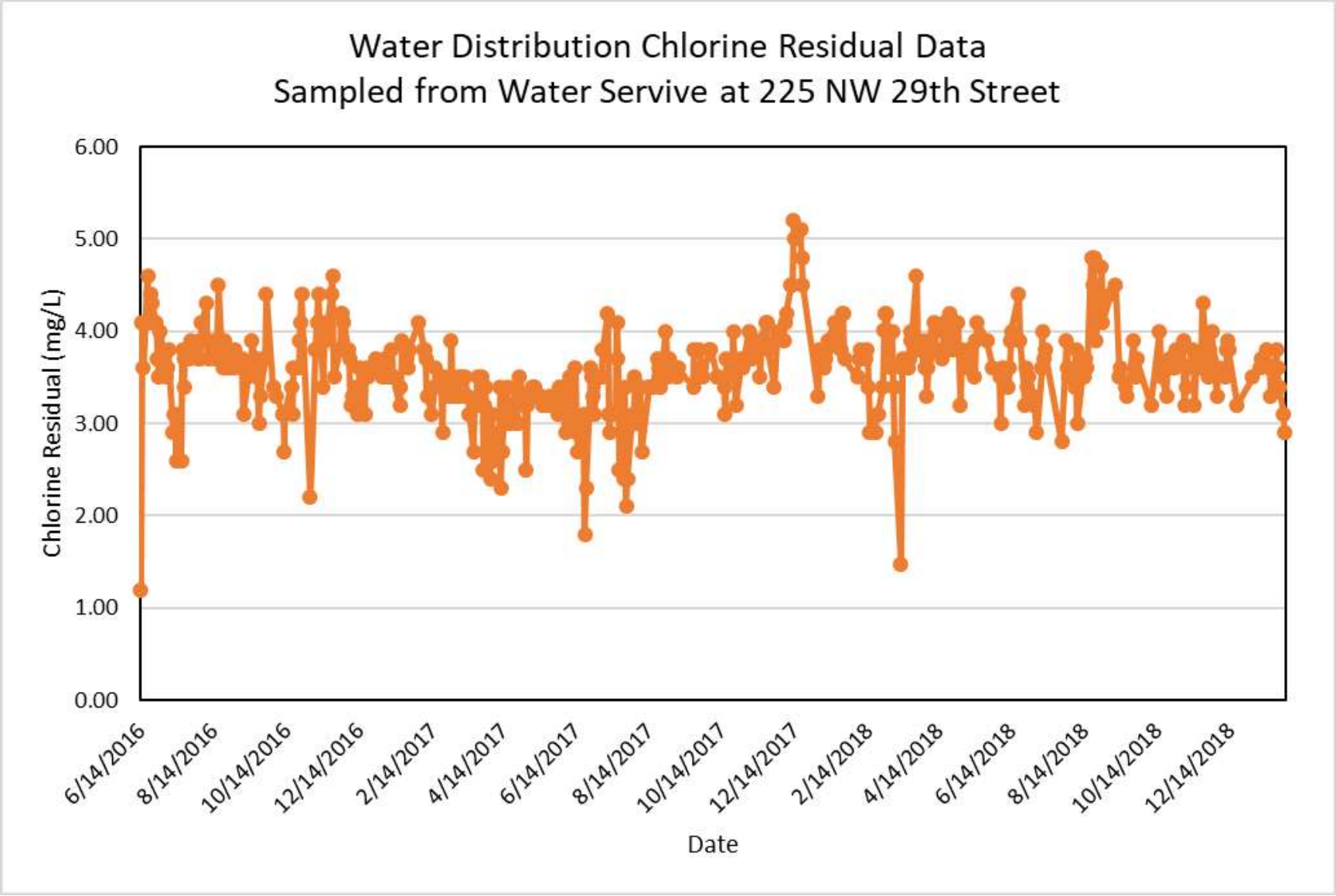

Figure 2-7: Chlorine Residual Data – 225 NW 29th Street

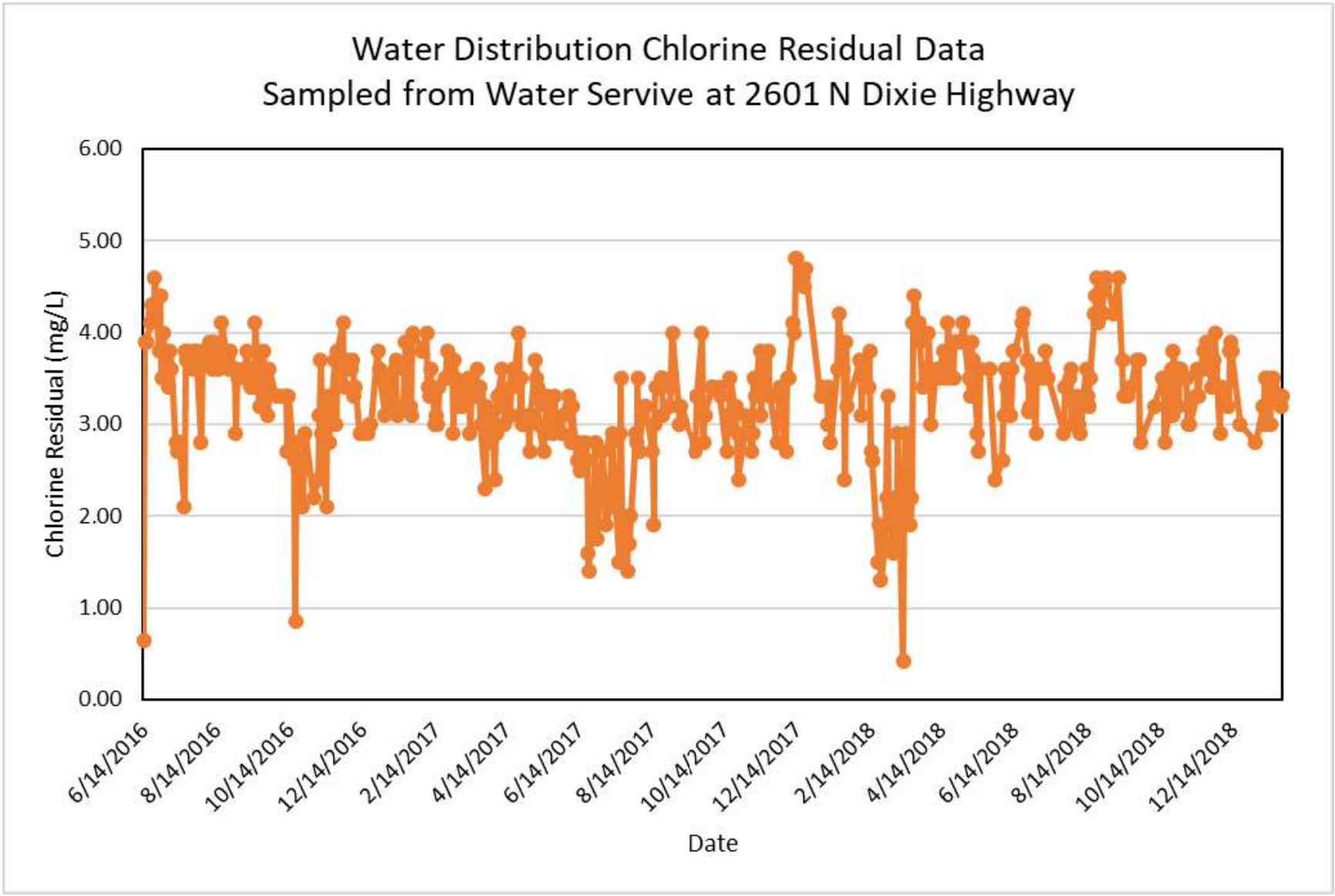

Figure 2-8: Chlorine Residual Data – 2601 N Dixie Highway

2.2.6 Future Level of Service

To establish historical potable water demands for the City, B&W evaluated ten (10) years of recorded data from the FTL master meters. The data showed that starting in 2017 the master meters began recording flow inaccurately. FTL replaced all three (3) master meters between November 2018 and February 2019. Therefore, any analysis utilizing data from the FTL master meters did not include flow from January 2017 through February 2019.

Consumption data records from the City's billing accounts were also reviewed as part of the water analysis. The City provided five (5) years of customer water usage data from November 2013 to September 2018.

According to the City's Comprehensive Plan Infrastructure Element published in February 2019 and consistent with the Bulk Service Agreement and the FTL Comprehensive Plan, the potable water average of LOS standard is 130 gallons per capita per day which is above the 116 gallons per capita calculated in ***Section 2.2.1***. B&W used 130 gallons per capita per day as the water consumption factor when calculating future flow.

2.2.7 Water Demand Projections

The population projections established under ***Section 2.2.2*** were coupled with the projected LOS established above to develop water demand projections. The water demand projection is listed below in ***Table 2-5***. These water demand projections include a 7.7% non-revenue water loss within the water distribution network.

Based on the projections presented below, the City is anticipated to have a total finished water demand (average day) of 1.61 mgd and a maximum day demand of 2.41 mgd in the Year 2040. The City's Bulk Service Agreement with FTL does not currently state a maximum use capacity.

Table 2-5: Water Demand Projections

Year	Projected Water Demand (gd)
2019	1,628,673
2020	1,632,280
2025	1,632,410
2030	1,621,230
2035	1,619,930
2040	1,607,970

2.2.8 Asset Evaluation and Assessment of Existing Structures and Equipment

B&W performed a field evaluation and assessment of the City's water distribution structures which include fire hydrants, canal and bridge crossings, air release valves (ARVs), three (3) FTL

master meters, permanent chlorine residual sampling points, and other City identified water distribution system structures. The assessment concluded the following:

- ***ARVs*** – Currently, the ARVs are not on an assessment and maintenance schedule. It is recommended to implement annual exercising and maintenance of all ARVs to ensure they are in operable condition.

- ***Fire Hydrants*** – B&W performed a visual inspection on approximately 5% of City fire hydrants located throughout different areas of the City. All hydrants visually assessed were in excellent condition with fresh coatings and no visible leaks.

- ***Canal and Bridge Crossings*** – Canal and bridge crossings appeared to be in good condition but it is recommended that all ARVs at these locations be exercised on a regular basis.

- ***FTL Master Meters*** – The three (3) master meters at the FTL interconnects were replaced between November 2018 to February 2019. These meters are owned and maintained by FTL. B&W performed a visual inspection and they appeared to be in good condition.

- ***Permanent Chlorine Residual Sampling Points*** – Chlorine residuals are monitored at several permanent potable water sampling stations which are owned and operated by FTL. Visual inspections of these stations showed that they appear to be fully functioning.

2.3 Water System Hydraulic Model

2.3.1 Model Development

B&W developed a hydraulic model using WaterCad® v8.0 software for the potable water main system. The model was created utilizing City GIS maps which identify the size and locations of all existing water mains and the location and identification number of all existing fire hydrants. The model includes pipe sizes 4-inches and larger. The City provided information regarding any future developments and/or modifications to the water system not yet reflected on the GIS maps and these projects were incorporated into the hydraulic model.

An average daily demand was determined based on consumer water consumption data. A leakage factor of 7.7% was added to the demand based on the unaccounted for water loss within the water distribution system. Individual demands were assigned to junction nodes and entered into the hydraulic model.

This hydraulic model uses the Hazen-Williams equation for pressure head loss through the pressure pipes. The relative roughness coefficient or C-Factors were established based on pipe material and age. ***Table 2-6*** lists the C-factors applied to the pipes through this hydraulic model.

Table 2-6: Hazen-Williams C-Factors used for Hydraulic Modeling

Pipe Age	0-9	10-19	20-29	30-39	40-49	50 and older
Material	C-Factor	C-Factor	C-Factor	C-Factor	C-Factor	C-Factor
PVC	150	145	145	140	140	135
A.C	135	130	130	125	125	120
P.E.	140	140	140	135	135	130
D.I.	140	140	140	135	135	130

Note: Factors based on industry standards

2.3.2 Model Performance Criteria

The criteria that determines whether a water distribution system and its representative hydraulic model is satisfactory or requires improvements is typically defined by its ability to deliver required peak hour flow rates, as well as the ability to deliver fire flow rates at a minimum system pressure during maximum daily flow.

The minimum requirements used for the fire flow element of this hydraulic model was Needed Fire Flow at 20 PSI (NFF_{20}). The water distribution system is required to provide the flow rates and pressure listed in ***Table 2-7*** for fire protection while maintaining a minimum system pressure of 20 PSI. These fire flow requirements were assigned to fire hydrants throughout the model based on surrounding building type.

Table 2-7: Needed Fire Flow

	Needed Fire Flow @ 20 PSI (min.) pressure (NFF20) (gpm)
Residential	1,000
Commercial	2,000
Condominiums	2,500

The City receives water from the City of Fort Lauderdale at three (3) locations within the City. Each location has a meter and pressure gauge. For the purpose of this analysis, the system was modeled as if each location was operating at the average pressure at that location.

2.3.3 Base Demand Distribution

The historical customer demand analysis was used to distribute the customer's individual demands to all of the water demand junctions. Using GIS, customer demand data was related between customer service addresses and junctions within the hydraulic model. This “base demand” was used as the initial run of the model. The historical billing data from October 2016 - September 2018 was used in this exercise.

In addition to the base demand, the water loss amount of 7.7% was added to the present base demand and future demand projections.

2.3.4 Model Calibration

Calibration of a hydraulic model is important to validate the model's output and provide confidence that the model is accurately representing the performance of the system. Calibration of the model is accomplished by comparing field collected data for flow and pressure and adjusting the various pipe friction characteristics, or C-Factors, in the model until flow and pressure results in the model match those found in the field. Pressure recorders were installed on various water hose bibs at lift stations located throughout the City. Pressure was recorded for one (1) week at each location. This pressure information was used to calibrate the hydraulic model.

2.3.5 Model Conditions and Scenarios

The "base demand" model described in ***Section 2.3.3*** was modified to analyze future condition by applying the future water demand projections and piping improvements required to meet fire flow requirements of the system. Models were developed to determine future annual average daily flow (AADF) conditions, maximum daily flow (MDF) conditions, peak flow (PHF) conditions, fire flow conditions, and water quality conditions which monitors chlorine residuals throughout the distribution system.

Based on population projections provided by the City, there is a projected negative population change from Year 2019 to Year 2040. In order to be conservative, future model conditions exhibit a net zero change in population and thus no change in demand. This assumes the existing LOS will remain the same and that the City will have the same amount of non-revenue water loss in the future. However, an additional model scenario was created based on projected redevelopment provided by the City which is discussed further in ***Section 2.4***.

The peaking factor applied for this Study follows typical industry standards for a PHF:AADF factor of 2.1. The MDF system demand was determined and distributed throughout the model similarly to the future demand projections by multiplying the AADF by the ratio of AADF to MDF. This ratio or peaking factor for MDF is 1.5. The minimum system performance criteria for normal system operation during MDF and PHF remains at 45 PSI.

2.3.6 Model Performance

The City's goal for peak hour flow is to maintain a system pressure greater than 45 PSI. The model produced very good results, as system pressures range between 68 and 77 PSI during PHF conditions. Since there is no anticipated increase in population or water demand, the existing water main network has ample capacity in order to sustain existing and future flow conditions.

The water distribution system similarly showed ample capacity to provide water for the future redevelopment projects. Under this scenario, model results showed a system pressure range between 68 and 77 PSI during PHF conditions.

2.3.7 Fire Flow Analysis

Satisfying the fire flow requirements of a water distribution system is a design limiting condition of the system. The WaterCAD® hydraulic modeling software is very useful and well adapted for this analysis. The fire flow requirements of the system are incorporated into the model so that a fire flow demand range is applied to each hydrant until the upper limit of the range is met and the minimum system pressure is reported; or, the available fire flow at that hydrant is reported for when any other junction in the system decreases to 20 PSI. This available fire flow at 20 PSI is referred to as AFF_{20}. For this analysis, the upper limit for the fire flow analysis was set at 3,500 gpm.

The initial model runs showed that the existing water distribution system performs very well. The results found six (6) hydrants out of 281 total hydrants were not able to provide the NFF_{20}. The deficient fire hydrants occur in the existing system (e.g. the deficiencies are not a result of future demand projections). The "Base Demand" model was modified to improve the performance of the six (6) underperforming fire hydrants and are addressed in recommended projects in order to ensure they meet current fire flow standards.

Under the model scenario which includes future redevelopment projects, one additional fire hydrant failed. This underperforming fire hydrant is addressed in a recommended project in order to meet fire flow standards and is discussed further in ***Section 2.4***.

2.3.8 Water Quality Analysis

The water quality analysis of the City's water distribution system for chlorine residuals was performed using the WaterCAD® hydraulic model developed for this project, along with the extended period simulation and water quality modeling features of the software. The results of this analysis are useful in refining the system's bacteriological and water quality testing efforts and the identification of specific locations in the system that require additional flushing and monitoring for water quality.

The water quality modeling analysis of the system is achieved by utilizing the model's hydraulic and subsequent detention time of the water traveling through the system, along with the decay characteristics of the chloramine disinfectant. There are two predominant mechanisms for the decay of the chloramine disinfectant in the water distribution system which are incorporated in this modeling software, they are: (1) the bulk reaction rates; and (2) the wall reaction rates. The detention time, or water age depends on the pipe's diameter and length, as well as the demand or flow of water through the pipe. The bulk reaction rate was set at -0.5 (mg/L)^(1-n)/day and the wall reaction rate was set at -0.66 and correlated to pipe roughness. The City provided two (2) years of chlorine residual data sampled at the three (3) separate connections with the FTL, the average chlorine residual at each location was used to replicate existing conditions within the model. The system was programmed to supply water at the western and central connection points with a concentration of 3.6 mg/L of total chlorine and the eastern connection point with a concentration of 3.3 mg/L of total chlorine.

The extended period simulation was performed for a period of 96-hours with 1-hour time steps for the existing average demand. This duration was required for the output to reach a steady-state from the initial concentrations programmed into the model. The City's historical water quality testing has demonstrated consistent regulatory compliance. However, the hydraulic model process has indicated that there are some areas of concern that the City should be aware of. Moving forward, B&W recommends the City start periodically testing some of the dead ends within the City and develop a data set to track water quality. If the City's test data shows lower than expected results, a flushing program should be implemented. There are no recommended projects based on the results of the water quality model. Refer to ***Figure 2-9*** for water quality modeling results.

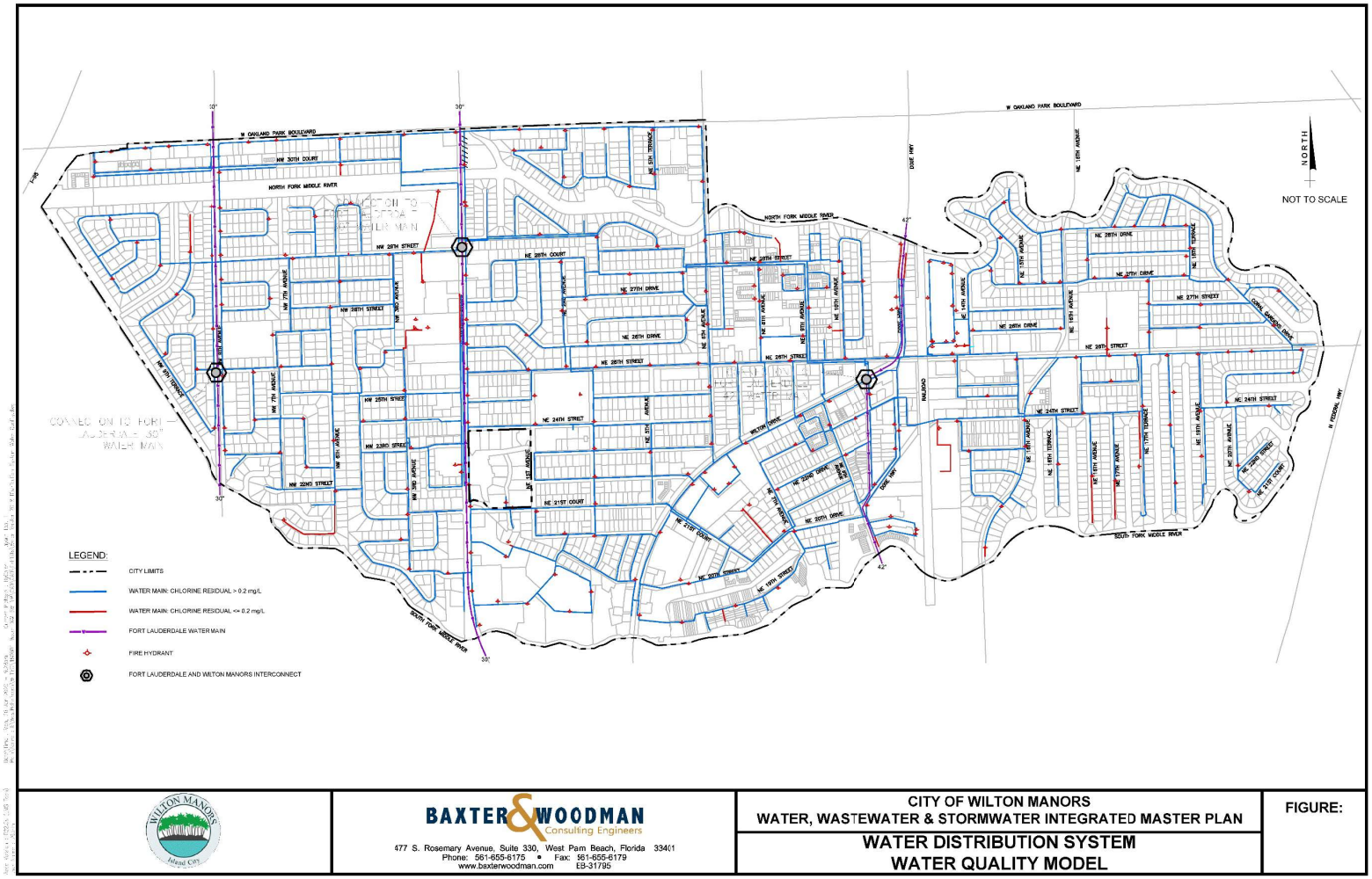

Figure 2-9: Water Quality Modeling Results

2.3.9 ISO Rating Analysis

Every five (5) years, the City's water distribution system is reviewed by the Insurance Services Office, Inc. (ISO). The ISO evaluates water distribution systems ability to provide fire suppression. The ISO provides the City with a Class rating from 1 to 10 where a Class 1 represents exemplary commitment to fire suppression. In 2015, the City received a Class 1 rating. The City will be required to renew their rating and complete the review process again in 2020.

2.4 Redevelopment Program Water Distribution System Evaluation

The City provided a list of anticipated redevelopment projects expected to be completed by Year 2025. These projects were incorporated into the water model as a future scenario. Under this scenario, the model still performed very well by providing sufficient system pressures throughout the water distribution system. There was one additional underperforming fire hydrant which will be addressed in the 10-Year CIP discussed further in ***Section 6***. Population projections including redevelopment projects are shown in ***Table 2-8***. ***Figure 2-10*** shows a map with redevelopment projects.

Table 2-8: Population Projections with Projected Redevelopment

Year	2019	2020	2025	2030	2035	2040
City Population from Comprehensive Plan[1]	12,528	12,556	12,557	12,471	12,461	12,369
Additional Population increase from Development Projects[2]	-	222	5,678	5,864	-	-
Total Population	**12,528**	**12,778**	**18,235**	**18,335**	**18,325**	**18,233**
Population Increased from Development, Base Year 2019 (%)	-	1.99%	45.55%	46.35%	46.27%	45.54%

1. Population data derived from the City of Wilton Manors Comprehensive Plan, Future Land Use Element, Table 1-3, February 2019
2. Population data derived from the City of Wilton Manors LUPA Development Projects, July 2019

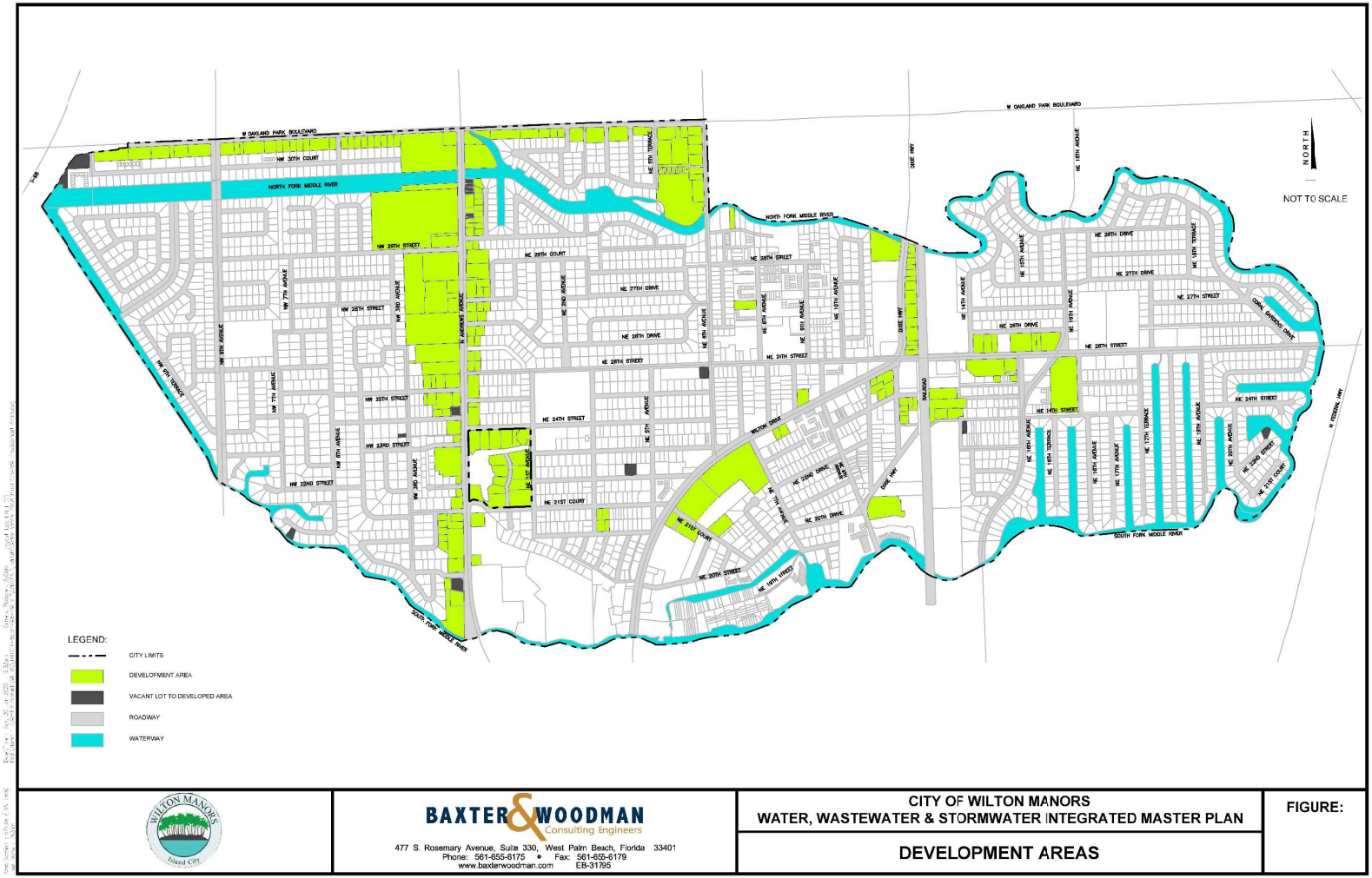

Figure 2-10: Development Map

2.5 Water Distribution System Recommended Improvements

The performance of the City's water distribution system overall is excellent for providing the required NFF_{20}. The hydraulic model demonstrates that much of the system exceeds the minimum NFF_{20}. Since there is no anticipated increase in demand, recommended improvements are based upon general rehabilitation for aging infrastructure and maintaining adequate system fire flow coverage. In order to address the under performing fire hydrants, it is recommend to upsize the water mains adjacent to these hydrants in order to provide additional capacity and fire flow. These projects are addressed in ***Section 6*** under proposed water improvement projects #3, #4 and #11.

The City provided a list of anticipated redevelopment projects. Flow for these projects were estimated based on use type (single-family, multi-family, commercial, etc.) and size. These projects were entered into a new model scenario. There is one (1) recommended project due to the redevelopment that is addressed under proposed water improvement project #2 in the 10-year CIP and is discussed further in ***Section 6.*** The majority of redevelopment projects are relatively small and do not require significant increase in water demand. However, the redevelopment of N. Andrews Avenue and Oakland Park Boulevard is a significant project and it is recommended to perform a separate study to analyze the impact on the City's water distribution system. In this case, impact fees may be established and required by the developer in order to upgrade water mains and appurtenances within the project area to be able to sustain the new development.

Figure 2-11 provides an overview of the recommended water distribution projects. Each of the recommended projects and associated cost estimates are included in ***Section 6***.

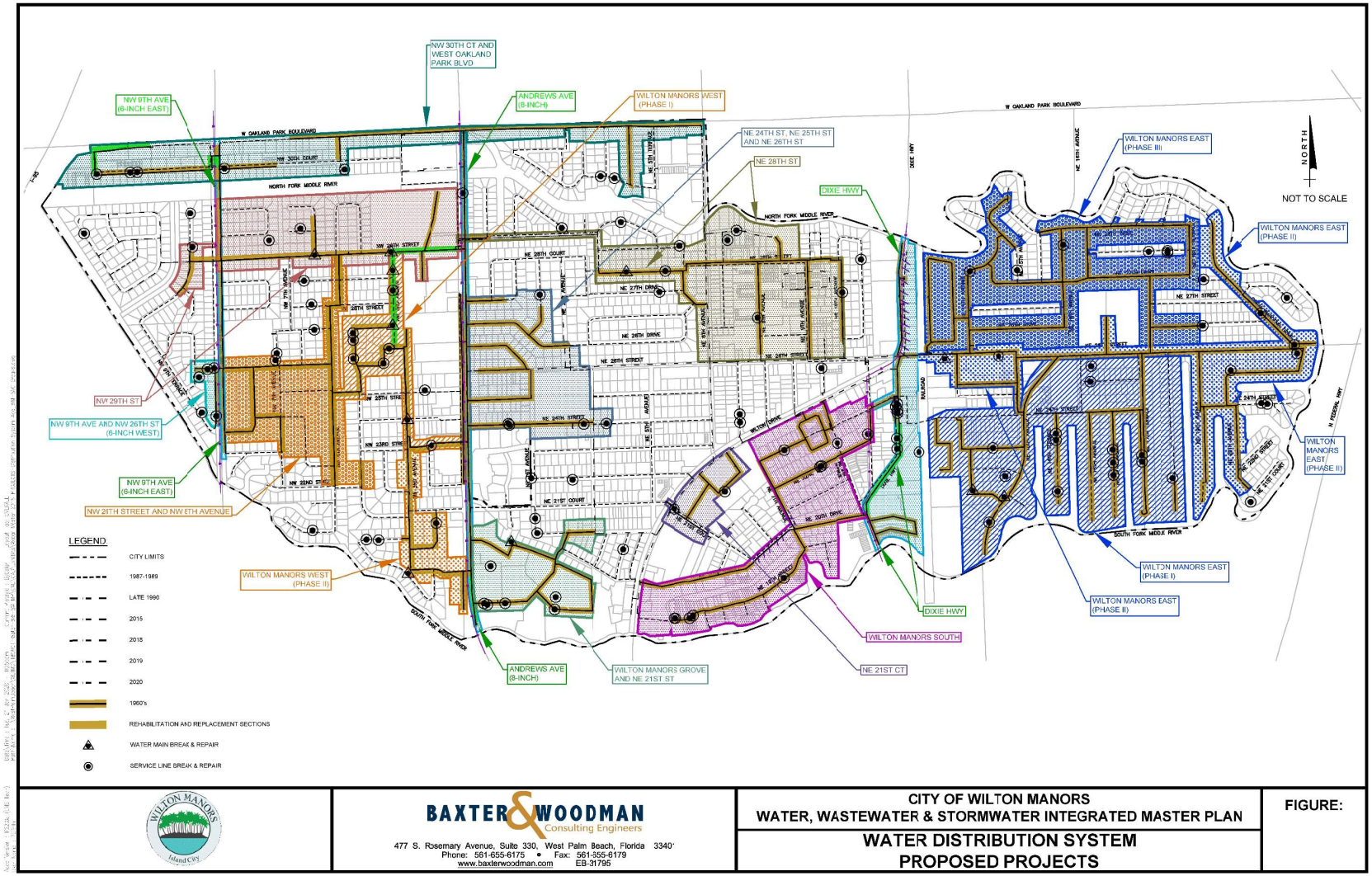

Figure 2-11: Water Distribution System Proposed Projects