Memorandum

October 29, 2019

To:	Eli Naffah, City Manager	Ref. No.:	11198797
From:	Patrick Sullivan, Steve Allen	Tel:	7074438326

Subject: City of Trinidad drinking water system model

Introduction

The City of Trinidad serves treated water to approximately 1,000 people within the City service area. Currently, the City's water is pumped from Luffenholtz Creek by the City's water treatment plant, located at 1313 Westhaven Dr. Trinidad CA, adjacent to Luffenholtz Creek. The treated water is pumped from the treatment plant directly into the City's distribution and storage system. That system includes conveyance pipes, valves, fire hydrants, customer service meters and storage tanks. The system has been operated and maintained by the City since the early 1970's. The City's water delivery and storage system has served the City for close to 50 years. While the City's public works staff have working knowledge of how the City's system functions and how to operate it, staff have not necessarily had the ability to forecast how potential system modifications, maintenance activities, or future demands may affect system operation and performance. To address this issue the City requested that GHD develop a computer model of the water distribution and storage system to provide a better understanding of the system under current conditions and to provide a framework for evaluating future changes as well.

The purpose of the memorandum is to summarize the development of the computer model of the City's water distribution and storage system. The model was developed to simulate the water flow through the City's distribution pipes and storage tanks. It provides information about the dynamic characteristics of how the system generally functions, which primarily encompasses the water pressure, flow rates, and capacity of major pipes throughout the system. The development of the model allows for the evaluation of how current and future demands on the system can affect system operational characteristics and can suggest the need for infrastructure improvements. System characteristics may be considered under a variety of water demand scenarios such as average day, maximum day, and fire flow conditions.

Water System Model

The City's water distribution and storage model was developed using Bentley Systems Water CAD V8i. The software allows for analysis of the basic design and function of the major components of system, performance under a variety of water demand scenarios including fire flow capacity, and consideration of water quality within the distribution as may be characterized by chlorine residual. The model was developed by identifying the major piping networks, storage tanks, and anticipated demands throughout the system. digitizing the City's pipe system into the model. The information was derived from the original As-Built drawings and the operator's service records. The modeled system consists of pipes, valves, storage tanks, and fire hydrants. As is typical water system modeling practice, the model focused on the major system components to provide insights into overall operations. Individual service connections were not included in this analysis, as this would require considerably more engineering effort and does not appreciably increase the usefulness of modeling results. The digitized water system is shown in Figure 1. The development of the water system framework shown in Figure 1 is based on including the major pipes and tanks as further described in the following sections.

Pipes

The City's distribution pipes are primarily constructed of asbestos cement (AC). This type of pipe was in common use for many years because it is relatively lightweight, is resistant to corrosion, and is generally durable. However, AC pipe but may become brittle and is prone to leaks as the pipe ages. AC pipe remains in service for water systems throughout the world, but as it reaches the end of its useful life it will need to be replaced with modern materials as AC pipe is no longer widely manufactured and installed due in part to concerns over the potential for airborne dust in the manufacturing process as well as from field cutting during installation. In Trinidad, AC pipe has been replaced by PVC pipe in some locations of the system when repairs were made or line extensions were required.

The system is comprised of approximately 40,700 feet of pipe of various diameters (2-in, 3-in, 4-in, 6-in, 8-in, and 10-in). Table 1 summarizes the pipe lengths by diameter and the location of the pipes is shown Figure 1.

Table 1. Pipe length by Size

Pipe Size (in)	Length (ft)
2	382
3	1,381
4	8,463
6	12,947
8	10,979
10	6,566
Total	40,718

The water model was developed to simulate flow rates and pressure throughout the system. The calculation of pressure is based in part on evaluating pressure losses loss due to friction losses in the pipes and fittings. Fittings include gate valves, check valves, air release valves, and bends such as elbows and tees. Friction loss in the pipes was calculated using the Hazen-Williams equation with coefficient of 150 for PVC and 140 for AC pipe.

Storage Tanks

The City's water distribution system is sustained by two water storage tanks that are located on the east side of Westhaven Drive near Lark Lane. The tanks are each approximately 36 ft 8 in in diameter and 20 ft tall, with a maximum storage height in the tanks at 18 ft. The location of the water tanks is shown on Figure 1. When both tanks are filled to the maximum storage height of 18 ft they store 285,650 gallons of water.

The tanks provide two main functions. The first function is to provide stored water to balance the variations in water demands by customers with the supply from the water treatment plant. The second function is to provide a free water surface at the appropriate elevation to maintain desired static pressure in the distribution system. Both tanks are connected to the distribution system and water flows back and forth between the tanks and the distribution piping.

The City manages water production at the treatment plant by the amount of water in the storage tanks. When the water level in the tanks drops below 16 feet, the treatment plant starts the pumps and supplies water to the system. The plant continues to produce water until the water level in the tanks reaches 18 ft. The amount of time it takes to fill the tanks depends upon the City water demand and the water treatment plant production rate. The demand for water varies throughout the day and daily demand varies from month to month with the highest demands in August. In the past 5 years the daily average flows have ranged from 50,000 gal to 160,000 gal, with an average of 80,000 gallons per day. It should be noted that these figures included water that is lost due to leaks in the system. For modeling purposes, it is assumed that the leaks are equally spread out through the system.

The water treatment plant can produce potable filtered water at a rate of between 60 and 120 gallons per minute (gpm). Currently, the treatment plant produces water at an optimal rate of 68 gpm. The treatment plant typically pumps for between 12 and 20 hours per day. During peak demand periods (such as weekends during tourist season in August or a major pipe failure or fire) the treatment plant may operate continually. A more detailed review of water production rates may be found in the City of Trinidad water demand and loss analysis memorandum (GHD September 6, 2019). Typically, the water level in the tanks cycles daily between 14 and 18 feet. As a general rule the City keeps the water level in the tanks at or above 12 feet (120,000 gallons of storage remaining in the tanks). This allows some flexibility for providing water during emergency situations such for a fire or to serve customers during brief interruptions of water supply or during repair of distribution system breaks.

System Pressure Analysis Under Maximum Day Demand

The model was used to simulate the piping and storage system under peak demand operating condition. The water demand was proportioned to each water line based upon the number service on each pipe line. The total water demand was applied the end of the water line in cases where the pipe ended or at the center of the pipe segment in cases where there was a loop connection. The water pressures in the system were evaluated for water delivered at a rate of 90,000 gallons per day. This was based upon the Trinidad water demand and loss analysis memorandum (GHD September 6, 2019) and accounts for normal peak demands rather than demands due to line breaks. This value is also consistent with what the operators observe on peak vacation weekends in August. The demand and subsequent flows in the system fluctuate throughout the day with the peak hour demand typically occurring during morning hours. The peak hour demand, based on typical peaking factors for similar sized communities, is 3.5 times the average daily demand. Using a high flow month (August), this yielded a peak hour demand of 218.75 gpm.

Water pressure in various areas of a water system is a key parameter for evaluating system performance. Water pressure varies throughout the system and is a function of several factors, including: size, age and type of conveyance pipes, length of pipe, flow in the system, elevation of the service, water supply pumping rate and level of water in the storage tanks. The City's water system was simulated based on a peak hour demand flow rate of 218.75 gpm. The results from the simulation indicate that pressures throughout the system were predominately between 40 and 80 psi. There were sections at the north end of Mill Creek Lane that were below 40 psi but above 30 psi. Water pressure above 80 psi may damage pipes or fixtures in and so pressure reducing valves may be used. Water pressure below 30 psi is considered too low.

Fire Water Demand

Part of the water stored by the City is reserved for fighting fires. Water stored in the tanks is conveyed through the distribution system pipes and is available to fire fighters through fire hydrants throughout the City. The locations of fire hydrants is shown on Figure 1. The required fire demand is typically specified by the municipality or in concurrence with the fire marshal. The determination of the required flow is a function of a building area and the calculation is defined by the California Fire Code, Appendix B The calculations defined in the Code consider the type of structure (residential or commercial), inhabitancy (single family or multiple family), and building area. The Code then specifies a flow rate and a duration for providing the flow rate. The City of Trinidad does not have a specified fire demand and has used a value of 1,500 gpm for two hours but a common fire demand used throughout the County is the ability to supply water at 500 gpm for three hours. At the 500 gpm, this equates to 90,000 gallons of water, which is 5.67 feet of water in the City's storage tank. At 1500 gpm for two hour, this equates to 180,000 gallons of water, which is 11.34 feet of water in the City's storage tank. It is possible to lessen the drain on the tanks during a fire event by operating the pumps at a higher pumping rate, up to 120 gpm. This would decrease the drain on the storage to approximately 71,000 gallons (~4.5 ft of storage in the tanks). While it would be beneficial to run the treatment plant pumps during an emergency event, it should not be counted upon to decrease the fire storage requirement. This means 5.67 feet of storage in the tanks is required to meet the minimum fire demand.

Because there is a wide range of potential fire demand flow and it is the jurisdiction of the City's fire department to determine the fire flows it is recommended that the City work with the City's fire department and with CalFire to clarify the required fire flows for the City's fire hydrants.

Fire Supply Analysis

In addition to having the firefighting water available in the storage tanks, the ability to of the system to convey the water to the fire hydrants should be considered. Friction losses in the delivery system increase as the velocity of the water in the pipes increases and as the size of the pipes decreases. Smaller diameter pipes with higher water velocities have much higher friction losses. Higher friction losses result in lower operating pressure in portions of the system. During a fire event, fire pumper trucks may connect to fire hydrants and pump water from the system. The design and sizing of the conveyance pipes is typically performed such that the fire demand is met at the point of delivery (fire hydrant) without lowering the water pressure in the system below a specified threshold. This is typically 30 pounds per square inch (psi). If the system cannot supply water at this pleasure the fire pumper truck could cause pressures to drop in portions of the system. If the pressure drop is severe enough, there is the potential for cross contamination caused by impurities being sucked into the water system through pipe leaks and service connections. Therefore, minimizing the potential for low pressure during file flow conditions is important for maintaining proper and healthy operation of the distribution system.

While the City's goal is to operate the water storage with sufficient capacity to meet basic fire demands, the ability to supply water to fire hydrants needs to be evaluated. To evaluate the existing water system, each fire hydrant was individually analyzed using the model. The simulated flow at the hydrant was held at 500 gpm for 3 hours and the pressure throughout the system was evaluated. Three conditions were observed:

- sufficient water quantity and pressure above 30 psi throughout the system,
- sufficient water quantity but pressure below 30 psi in the system,
- insufficient water quantity and pressure below 20 psi in the system.

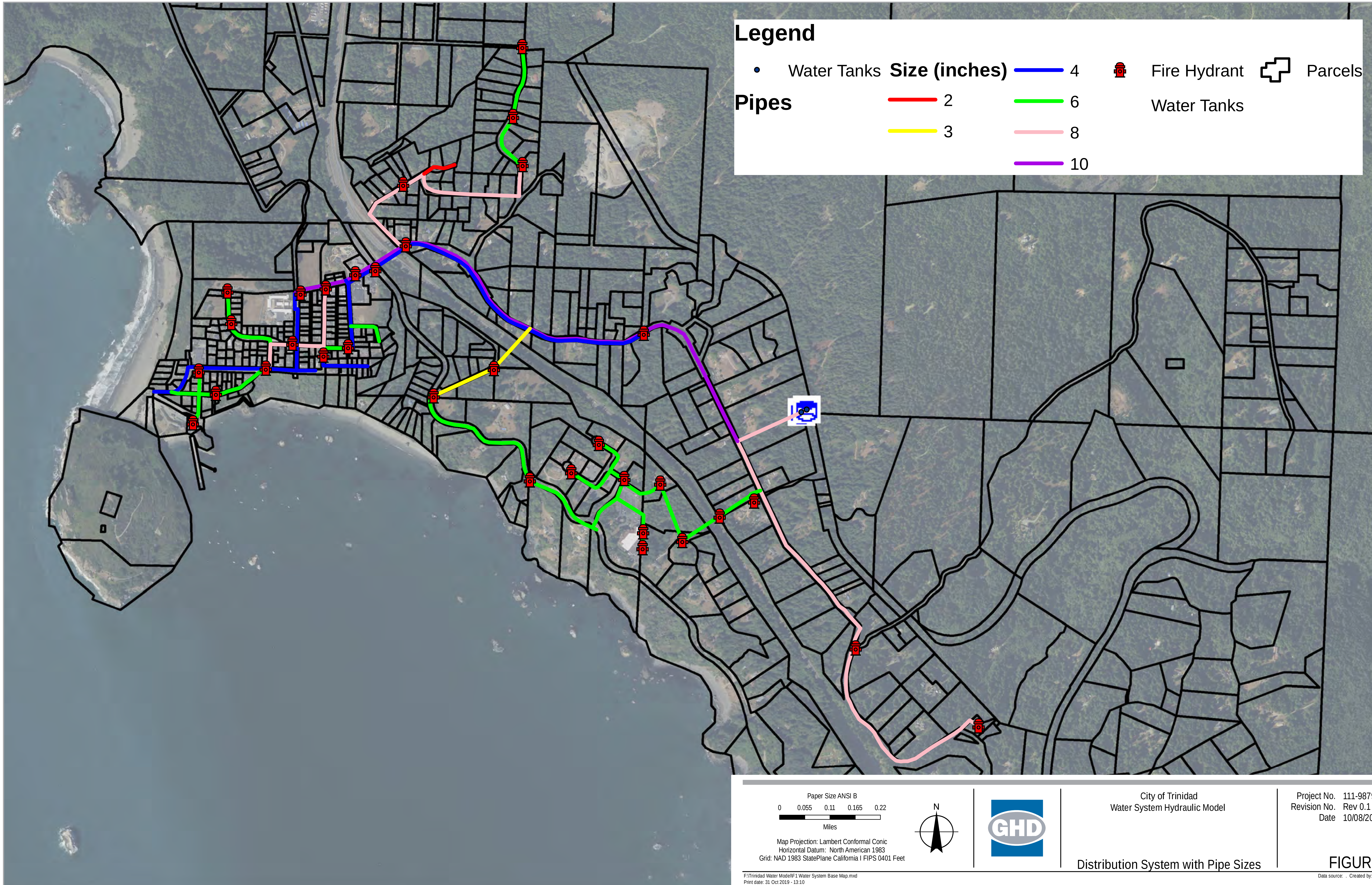
The analysis resulted in 27 hydrants that met the fire requirements (shown in green in Figure 2), 5 hydrants that met the fire demand requirements but resulted in low pressures in the system (shown in yellow in Figure 2), and 1 hydrants that did not meet the fire demand requirements (shown in red in Figure 2). While this is a preliminary assessment made to provide a methodology and provide an idea of the sufficiency of the system, it is recommended that the fire flow capacity be updated once the City and the fire department determine the required fire flow for each fire hydrant.

Conclusion

This memorandum summarizes the development of the City of Trinidad's WaterCAD distribution model of the trunk water distribution system and storage tanks. It evaluated the function of the distribution pipe network and found that the system is functioning adequately under peak demand conditions. While no new connections were evaluated under this effort, the model could be modified to evaluate future water demands and the potential impacts on the existing system.

The evaluation of the City's two 142,500 gallon water storage tanks (total of 285,000 gallons) indicate that there is sufficient storage to meet the City's existing average and peak water demand while maintaining sufficient fire suppression water assuming sufficient supply from the treatment system. The current storage tanks provide between one and two days' of water to meet regular demands without the treatment plant in operation and with the minimal fire flow demand requirements.

The evaluation of the City's fire hydrant capacity indicate that there is adequate capacity for almost all of the hydrants. While this is a preliminary assessment made to provide a methodology and provide an idea of the sufficiency of the system, it is recommended that the fire flow capacity be updated once the City and the fire department determine the required fire flow for each fire hydrant. There are a few locations that would result in low pressure conditions in the system. There was one location that did not meet the fire flow requirement. That hydrant is located on Van Wycke Street. This condition is due to a damaged pipe that runs from Edward Street west down Van Wycke Street. The broken and capped pipe causes flow to this section to be routed through a smaller pipe. While there is sufficient capacity for normal flow conditions, fire flow conditions cause pressure conditions to drop below threshold levels. This situation could be resolved by repairing the broken/capped pipeline.



City of Trinidad
Water System Hydraulic Model

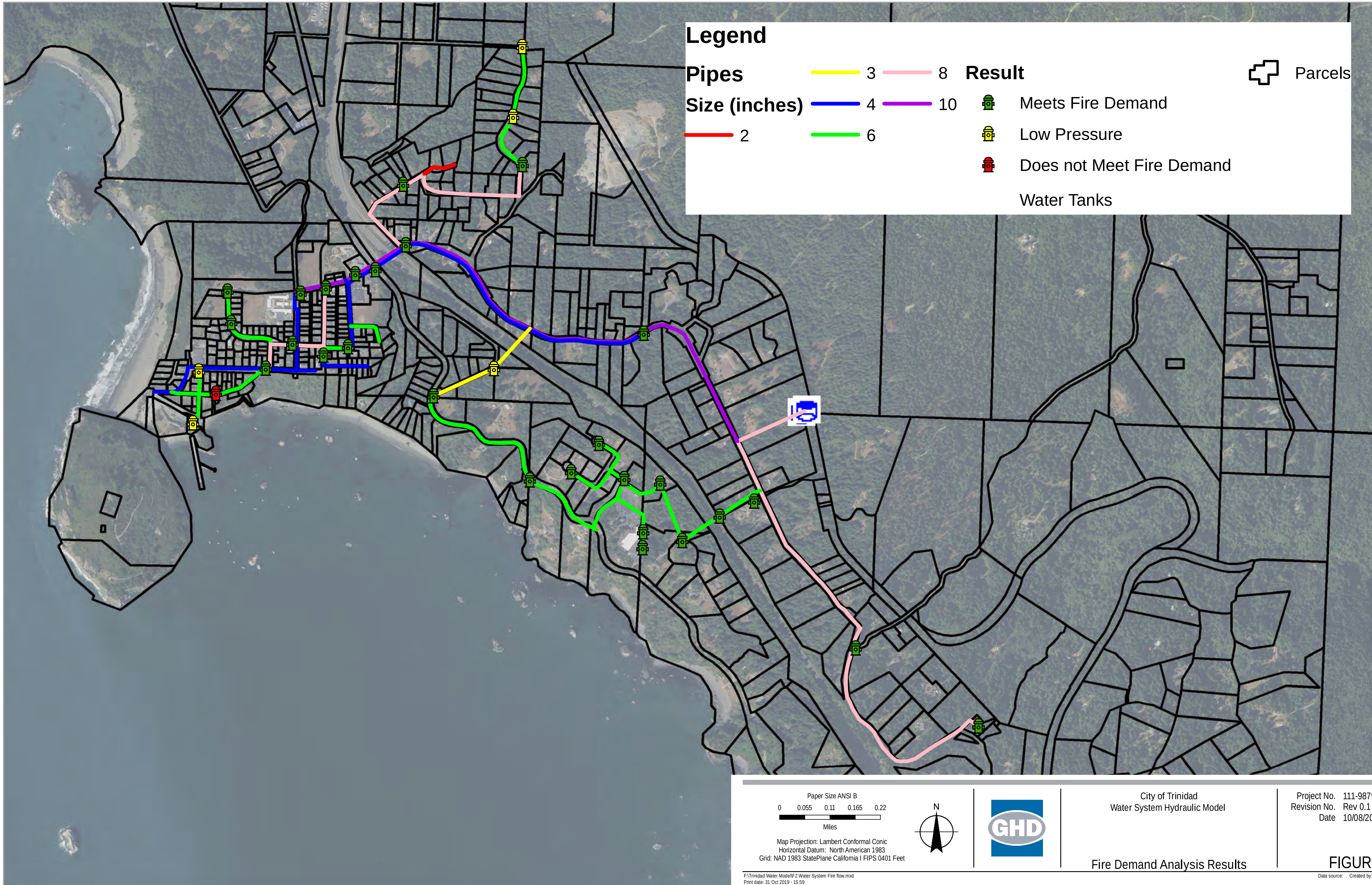
Distribution System with Pipe Sizes

Project No. 111-98797
Revision No. Rev 0.1
Date 10/08/2019

FIGURE 1

F:\Trinidad Water Model\F1 Water System Base Map.mxd
Print date: 31 Oct 2019 - 13:10

Data source: . Created by: pasullivan



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Fire Demand Analysis Results

FIGURE 2

F:\Trinidad Water Model\F2 Water System Fire flow.mxd
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