FOUNDER'S BRIDGE WATER SYSTEM

Powhatan County, Virginia

Preliminary Engineering Report

August 30, 2016

Bowman
CONSULTING

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COMMONWEALTH OF VIRGINIA
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I. INTRODUCTION

A. General

Bowman Consulting has been commissioned by GrayCo, Inc to develop a hydraulic model and preliminary engineering report for a new groundwater well and water treatment system to serve portions of the Founder's Bridge golf course community. Currently there are two connections to the Chesterfield County public water system that provide water to the development. Water demands within the community are higher than originally anticipated and exceed the allotment from the County. Therefore, a community Water Supply Well system is proposed, with the connections to Chesterfield County to remain as back up. This system would meet all community water supply requirements as required by the Virginia Department of Health Waterworks Regulations.

B. Objective

The objectives for this preliminary engineering report are as follows:

- Evaluate the existing water demands in order to establish average and peak demands
- Prepare a hydraulic model to determine the operating pressure for the new water system
- Identify desired settings for new pressure reducing valves at the connections to the Chesterfield County public water system
- Evaluate water quality and determine any required treatment
- Evaluate well yield data and determine how much of the water demand can be provided by the new system and how much will need to be provided by Chesterfield County
- Develop preliminary sizing and layouts for water treatment system

components

C. Service Area Description

The Founder's Bridge community is located in both Powhatan County and Chesterfield County, however, only the part of the community in Powhatan County is served by the Founder's Bridge Utility Company (FBUC). Water is currently provided to the community through two connections to the Chesterfield County system. The main connection and master meter vault is located near the intersection of Founder's Bridge Boulevard and Founder's Bridge Road. The second connection is located at the northernmost section of Founder's Creek Court. This connection is from the neighboring Bel Crest neighborhood which is also part of the FBUC system. A check valve allows water to flow only from Bel Crest to Founder's Bridge and not the other way around. The operating pressure in Founder's Bridge is typically higher than the operating pressure in Bel Crest, and therefore, water only flows through this connection to Founder's Bridge in the event that the system loses pressure.

The FBUC only serves the portions of the Founder's Bridge Community located in Powhatan County. The portions of the community that are located in Chesterfield County are served by the Chesterfield County water main that runs along Founder's Bridge Road. These units will continue to be served by Chesterfield County. In addition, FBUC serves the Bel Crest, Bel Bridge and the adjacent shopping center. As indicated on the service area map (Figure I-2), only the southern portion of the FBUC's service area will be served by the proposed system.

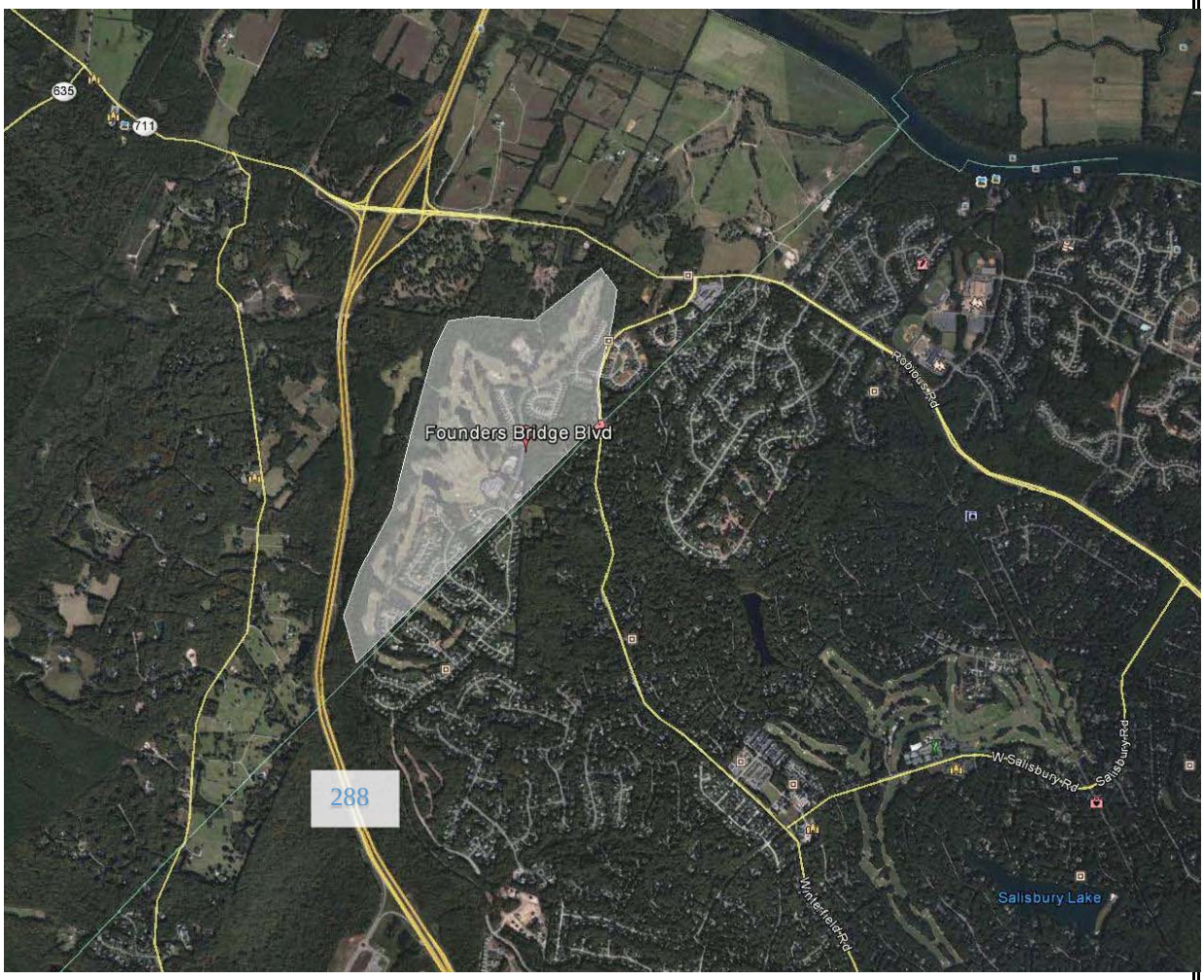
A project vicinity map is provided in Figure I-1. A detailed map showing the different service areas is provided in Figure I-2.

D. Definitions

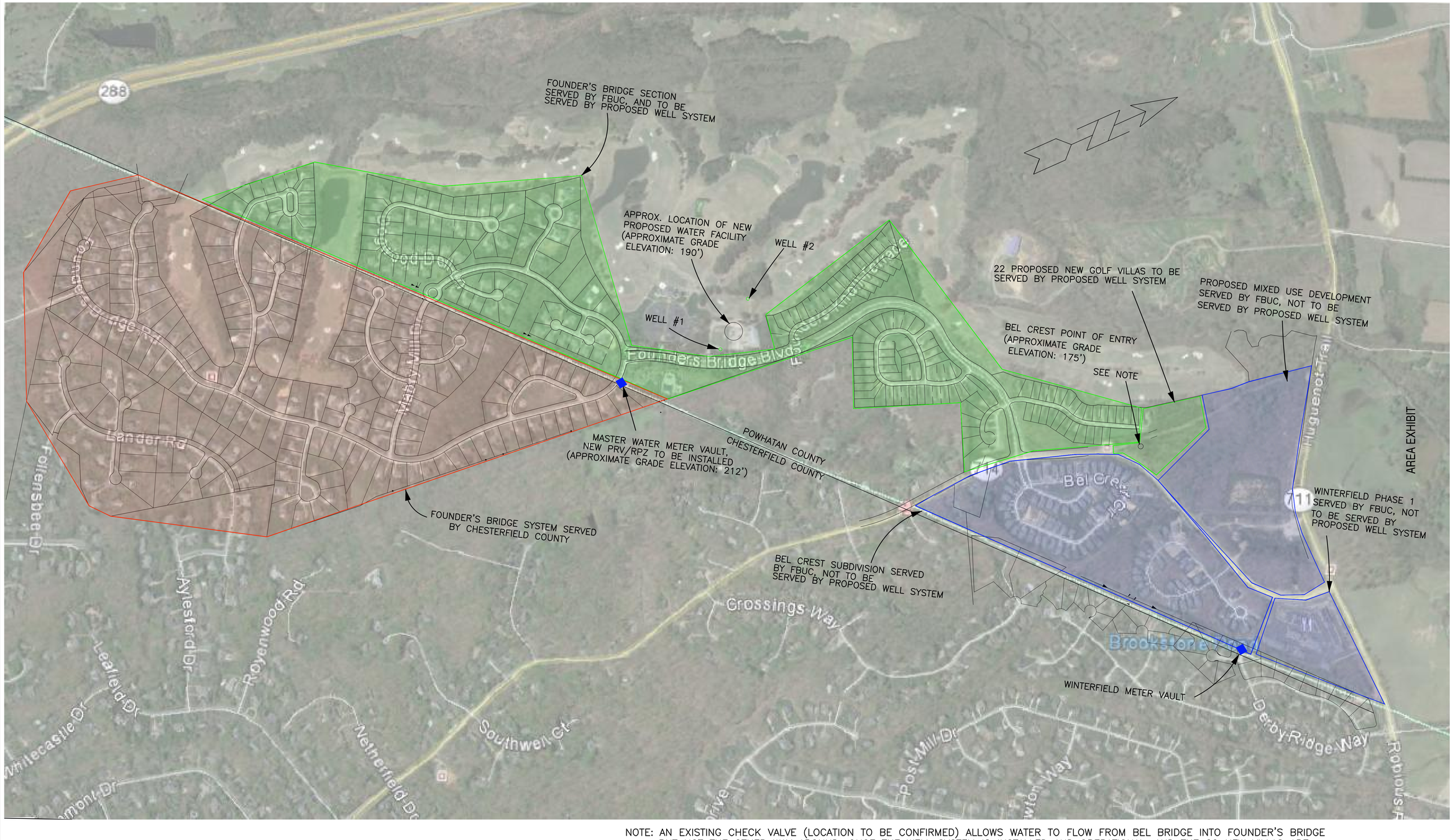
For the sake of this Preliminary Engineering Report, "Founder's Bridge" and "Founder's Bridge Water System" refer only to the portion of the Founder's Bridge development that is within the FBUC service area (located in Powhatan County) and to be served by the proposed well system, unless otherwise stated.

"Master Meter Vault" refers to the point of entry from the Chesterfield County water system into Founder's Bridge. This is the existing master meter vault located at the intersection of Founder's Bridge Boulevard and Founder's Bridge Road

"Bel Crest Point of Entry" refers to the point of entry from the Chesterfield County water system that is located at the northern portion of Founder's Creek Court. Currently this connection consists of a check valve that allows water to enter Founder's Bridge from Bel Crest.



Founder's Bridge Preliminary Engineering Report Powhatan County, Virginia Figure I-1: Project Vicinity Map	Bowman Consulting Group, Ltd. 460 McLaws Circle Suite 120 Williamsburg, VA 23185 (757) 229-1776



NOTE: AN EXISTING CHECK VALVE (LOCATION TO BE CONFIRMED) ALLOWS WATER TO FLOW FROM BEL BRIDGE INTO FOUNDER'S BRIDGE BUT NOT THE OTHER WAY AROUND. ONCE THE WELL SYSTEM IS INSTALLED AND OPERATIONAL, AND THE 22 NEW VILLAS ARE BUILT, AN RPZ AND PRV WILL BE INSTALLED TO ALLOW WATER TO FLOW INTO FOUNDER'S BRIDGE AT THE DESIRED PRESSURE. THE EXACT LOCATION OF THIS RPZ/PRV WILL BE COORDINATED WITH THE CONSTRUCTION OF THE NEW VILLAS.

P:\9372 - Founder's Bridge\9372-04-001 (ENG) - Water System\Engineering\Engineering Plans\Founders Bridge - Area Exhibit.dwg

NOTE: THESE PLANS AND SPECIFICATIONS INCLUDE PROPRIETARY INFORMATION. REPRODUCTION OF THESE PLANS AND SPECIFICATIONS IS NOT AUTHORIZED WITHOUT THE WRITTEN CONSENT OF BOWMAN CONSULTING GROUP, LTD.

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FIGURE 1-2
FOUNDER'S BRIDGE WATER SYSTEM
POWHATAN COUNTY RICHMOND, VIRGINIA

PROJECTNO
COUNTY PROJECT NUMBER

PLAN STATUS

DATE	DESCRIPTION	
KO DESIGN	TCW DRAWN	KO CHKD
SCALE	H: V:	
JOB No. 9372-04-001		
DATE : AUGUST 23, 2016		
FILE No. 9372-01-EXH		
SHEET 1 OF		

II. WATER DEMANDS

A. Community Water Demands

Two different sources for evaluating water demands were available.

- The master meter vault located at the intersection of Founder's Bridge Boulevard and Founder's Bridge Road reports the amount of water provided to the community by Chesterfield County. Since water rarely flows through the Bel Crest point of entry, this represent the majority of the water usage in Founder's Bridge. There is a main meter and a bypass meter in the master meter vault and both record data in 30 minute increments. The records used in this evaluation go back to 2012. This data is also available from the county's High Tide Telemetry site, however it is displayed in 1 hour increments and only goes back 3 months. This data was used to evaluate FBUC usage data and determine the overall reduction in usage that can be expected once the new well is operating.
- Individual meters at the residences provide usage data for each customer for billing purposes. Usage data is collected every two months. Spreadsheets from 2014 and 2015 were provided. This data was used to determine average and peak flow rates to assign demands to the homes in the hydraulic model.

Table II-I shows the average and peak summer system demands from 2012-2015:

		Average flow, GPD	Peak Flow, GPD
2012	June	94,557	136,882
	July	125,420	206,971
	August	85,672	136,724
	September	82,804	122,789
2013	June	78,267	124,492
	July	77,590	112,577
	August	65,989	94,349
	September	86,948	114,641
2014	June	99,570	151,300
	July	132,054	182,080
	August	93,554	139,110
	September	122,578	190,220
2015	June	86,547	168,400
	July	87,501	128,810
	August	97,194	126,430
4 Year Average of All Summer Months		94,400	
4 Year June Average		89,700	
4 Year July Average		105,600	
4 Year August Average		85,700	
3 Year September Average		97,400	

The average daily system demand during the summer is approximately 95,000 gpd. The maximum daily flow rate observed since 2012 was approximately 207,000 gpd.

Table II-II shows the average and peak flows during the non-irrigation season demands from 2015:

Winter		Average flow, GPD	Peak Flow, GPD
2015	January	22,523	25,630
	February	24,225	32,550
	March	26,935	35,510

The average daily system demand during the winter months is approximately

25,000 gpd.

B. Residential Demands

Billing data was evaluated in order to determine average and peak domestic flow rates as well as irrigation demands. The residential units have been divided between villa style homes and single family homes. Usage data suggests that the villa style homes generate average daily demands of approximately 100 gpd, while the single family homes generate average daily demands of approximately 140 gpd. The villa style homes are irrigated using the golf course irrigation system, which is not a part of the Founder's Bridge water system. The single family homes use Founder's Bridge water for irrigation and as such, many of these homes are provided with separate irrigation meters. Usage data from the month of June 2015 suggested irrigation demands between 200 and 1,500 gpd per home. Average irrigation demands were around 365 gpd.

The hydraulic model was prepared using a demand of 800 gpd per single family home. Since these averages are based on the summertime demands and are already somewhat representative of peak demands, a peaking factor of 2 was applied for use in the model. Therefore, single family homes were modeled based on a peak hour demand of 1.11 gpm.

For the villa style homes, an average demand of 160 gpd was used in the model, and a peaking factor of 4 was applied. Therefore, villa style homes were modeled based on a peak hour demand of 0.44 gpm.

C. Non-Residential Demands

In addition to the homes, there are other facilities within the community that generate demands. The following table describes these facilities. Peak demands are calculated over a period of 10 hours with a peaking factor of 4.

	Average Demand (gpd)	Peak Demand (gpm)
Sales office	2,670	18
Clubhouse	2,671	18
Golf Maintenance	903	6
Pool/Rec	972	7
#8/9/10 Irrigation	500	3
Restrooms	730	5
Dorm/JR Clubhouse	100	1

Therefore, the average non-residential demand is 8,546 gpd, or 14 gpm, with a peak hour demand of 58 gpm.

D. Hydraulic Modeling Demand Summary

The total demands utilized for the hydraulic model are presented below.

	Average Flow Rate Per Unit (gpd)	**No. of Units**	**Average Summer Demand (gpd)**	**Average Summer Demand (gpm)**	**Peaking Factor**	**Peak Flow Rate (gpd)**	**Peak Flow Rate (gpm)**
Villa	160	104	16,640	12	4	66,560	46
Single Family	800	80	64,000	44	2	128,000	89
Non-Residential			8,546	14	4	34,184	58
Total			**89,186**	**70**		**228,744**	**193**

The average demand for the system is estimated to be approximately 70 gpm. This is consistent with the data from the County's High Tide system from summer of 2015, which recorded an average demand of 61 gpm.

For modeling purposes, the peak demand for the existing system is estimated to be 228,744 gpd, or approximately 193 gpm. The data from the High Tide system indicated that most peak hour demands were between 150 gpm and 200 gpm.

In addition to the demands calculated above, there are 22 additional villas proposed at the northern part of Founder's Creek Court. Therefore, the hydraulic model was prepared based on a peak hour demand of 203 gpm.

III. EXISTING WATER SYSTEM INFRASTRUCTURE

Founder's Bridge (the Powhatan County portion) is currently served by two existing connections to the Chesterfield County public water system. The main connection to the subdivision is a 16" water line off Winterfield Road, which is routed to the Founder's Bridge master meter vault near the intersection of Founder's Bridge Boulevard and Founder's Bridge Road. A second connection is located off the backside of the Brookstone subdivision and enters the Founder's Bridge Community at the northernmost section of Founder's Creek Court. A check valve is located at the end of Founder's Creek Court and only allows water to flow from Bel Crest to Founder's Bridge. The operating pressure in Founder's Bridge is typically higher than the operating pressure in Bel Crest, and therefore, water only flows through this connection to Founder's Bridge in the event that the system loses pressure from the main connection. The water for the Bel Crest area is provided by Chesterfield County, and the connection into the Chesterfield County system is located at the Winterfield Meter Vault.

Pressure data was provided by Chesterfield County at the two meter vault connections. The data was collected between Tuesday, August 4, 2015 and Thursday August 6, 2015.

	Average Pressure, psi	Maximum Pressure, psi	Minimum Pressure, psi
Winterfield Meter Vault	80	89	64
Founders Bridge Master Meter Vault	90	120	80

The proposed community well system to be operated by FBUC will serve only the portions of the Founder's Bridge subdivision located in Powhatan County. This includes the villa style homes along Founder's Bridge Boulevard, as well as single family homes located along Mabry Mill Drive, Dogwood Dell Lane, Riverstone Road, Founder's Crest Court, and portions of Maple Hall Drive. The majority of the water lines that serve these portions of the development are 8", with some 6" waterlines at the end of a few of the

streets.

The portions of the development that are located in Chesterfield County will continue to be served by the Chesterfield County public water system.

To ensure that no water from FBUC goes backwards into the Chesterfield County systems, new backflow preventers will be provided at both points of entry into the portion of Founder's Bridge to be served by the proposed well system.

IV. WATER MODEL SUMMARY

A. Water Model Purpose and Approach

The new well system for Founder's Bridge will operate on a daily basis to provide domestic and irrigation water service to the community located in Powhatan County. The connections to the Chesterfield County system will remain in place as a backup supply in order to provide additional flows during peak demands beyond what the well system can supply, as well as fire flows. The average pressure at the master meter connection is approximately 90 psi. The average pressure at the Bel Crest point of entry is estimated to be 72 psi, based on the average pressure of 80 psi at the Winterfield vault and an approximate elevation difference of 20 feet. The hydraulic model anticipates that these average connection pressures result in pressures within Founder's Bridge between approximately 79 and 106 psi.

Pressure reducing valves will be installed at the two points of entry and set such that once the well system is operational, the pressure in Founder's Bridge will be greater than the downstream PRV setting. Should the Founder's Bridge community well system not be able to keep up with the demand, then water will enter the system from Chesterfield to provide adequate flows and pressures. Therefore, the purpose of the first model scenario was to determine how much the incoming pressure from Chesterfield County could be reduced and still provide adequate flows and pressures. Once those values were established, then the normal operating pressures for the new Founder's Bridge system were established so that these normal operating pressures exceed the recommended PRV settings.

Generally the minimum allowable system pressure for a residential subdivision is

35 psi, however, communities with high irrigation demands typically desire higher pressures. Therefore, for this analysis, a minimum pressure of 45 psi was evaluated. For the fire flow scenario, a minimum system pressure of 20 psi was evaluated.

As calculated in Section II.D, the peak domestic demand is approximately 203 gpm.

Fire flows will be provided by the Chesterfield County public water system. The model will determine whether fire flows of 1,000 gpm are available at residual pressures above 20 psi.

B. Scenario 1 – Pressure From Chesterfield County Points of Entry

This scenario was modeled with RPZ's and PRVs at both points of entry to the Founder's Bridge system. The PRV at the master meter was set with a downstream pressure of 60 psi. The PRV at the Bel Crest point of entry was set to a downstream pressure of 72 psi. With these PRV settings, pressures within the Founder's Bridge area are expected to range from 49 psi through 79 psi during peak hour demands.

Four different fire flow scenarios were evaluated with these pressure settings. The first scenario evaluated a fire flow scenario at the end of Dogwood Dell Lane, or Junction J-40. The second scenario evaluated a fire flow scenario at Maple Hall Drive, or Junction J-87. The third scenario evaluated a fire flow scenario at the end of the water line at Founder's Knoll Terrace, or Junction J-74. The fourth fire flow scenario is a 2,000 gpm demand at the golf course clubhouse. This resulted in a residual pressure of 21 psi.

For each scenario, the fire flow demand was applied on top of the peak hour demands. The following table summarizes the results of the fire flow scenarios.

Location	Junction	Fire Flow Demand, gpm	Residual Pressure, psi
Dogwood Dell Lane	J-40	1,000	27
Maple Hall Drive	J-87	1,000	31
Founders Knoll Terrace	J-74	1,000	45
Clubhouse	Clubhouse	2,000	24

Therefore, the PRV's that will be installed at the connection points will have downstream pressure settings of approximately 60 psi at the main point of entry and approximately 72 psi at the Bel Crest point of entry.

C. Scenario 2 - Founder's Bridge Water System Operating Pressure

The second scenario is representative of the water system once the new well and treatment system is operational. Peak hour demands and pressure will be provided by the well pumps and hydropneumatic tank. During this model run, the connections to the Chesterfield system were not activated. The model was prepared based on a system pressure of 75 psi at the new water treatment system site. This results in a pressure range throughout the community of 55 psi to 84 psi.

Based on this system pressure set point, the pressure at the master meter vault point of entry is 66 psi and the pressure at the Bel Crest point of entry is approximately 83 psi. These pressures are 6-11 psi above the recommended set points for the PRVs.

D. Pressure Reducing Valve Settings

The recommended downstream pressure setting for the PRV at the master

meter point of entry is approximately 60 psi. The recommended downstream pressure setting for the PRV at the Bel Crest point of entry is approximately 72 psi. During normal operation of the Founder's Bridge well and treatment system, pressures at the PRVs/points of entry will exceed 66 psi and 83 psi. In the event that the system loses pressure, water will flow into the system from Chesterfield County, which will provide adequate peak hour domestic flows and fire flows.

V. FOUNDER'S BRIDGE SOURCE WATER

A. Water Quality Results Summary

There are two wells proposed to provide water to the new system. Well #1 was drilled in 2014 and is currently being used as an irrigation well. Well #2 is a new well. Water quality data revealed that both wells have iron and manganese concentrations above the Secondary Maximum Contaminate Limits (SMCL) as summarized below.

	SMCL	Well #1	Well #2
Iron (mg/L)	0.30	0.77	0.42
Manganese (mg/L)	0.05	0.24	0.25

In addition to needing iron and manganese removal, the bacteriological results for Well #2 indicated that the water will require chlorination and contact time for 4 log removal.

B. Well Yield

The anticipated well yield for Well 1 is 69 gpm and the well yield for Well 2 is 50 gpm, for a total well yield of 119 gpm. Therefore, the treatment components will be designed based on 120 gpm, or 172,800 gpd (99,360 gpd for Well 1 and 72,000 gpd for Well 2 based on 24 hour operation).

C. Well System Impacts on Founder's Bridge Water Demands

Based on the data presented in Table II-1, the highest average summer demands were experienced in 2014. Therefore, water meter data from May 2014 through October 2014 was analyzed in order to predict the water demands on the new Founder's Bridge system as well as the reduced demand on the Chesterfield

County system.

The first analysis evaluated system demands based on the Founder's Bridge Well system operating at 50 gpm. The meter data presents the flows in gallons per half hour. These readings were translated to flow rates in gpm. For demands less than 50 gpm, it was assumed the well system would operate at that flow rate. For demands above 50 gpm, it was assumed the well system would operate at 50 gpm and then anything above that would be provided by Chesterfield County. Those demands in gallons per minute were then translated back to daily flows in gallons. This same analysis was performed based on a flow rate of 119 gpm for the new well system. The data is presented below.

	Average Daily Summertime Demands		**Maximum Daily Summertime Demands**	
New FB Well System Operating Rate	**Estimated Contribution from FB Wells (gpd)**	**Estimated Demand on the Chesterfield System (gpd)**	**Estimated Contribution from FB Wells (gpd)**	**Estimated Demand on the Chesterfield System (gpd)**
50 gpm	53,400	41,300	72,000	128,400
119 gpm	77,700	17,000	131,800	75,000

VI. FOUNDER'S BRIDGE WATER SYSTEM

A. Capacity

The well pumps will be designed to operate at a combined rate of 120 gpm. The well pumps will be equipped with a variable frequency drives (VFD) to be able to pump consistently into the hydropneumatic tank based on the pressure in the system.

Preliminary layouts for the site and building are provided in Appendix C.

B. Hydropneumatic Tank

A 10,000 gallon hydropneumatic tank will be provided for pressure control, as well as contact time. Based upon the results of the hydraulic modeling, the hydropneumatic tank should be set with a pressure range of approximately 70-80 psi.

C. Disinfection

1. Chlorination for 4 log Removal

The system will be disinfected using chloramines, however, the contact time will occur after the addition of hypochlorite and before the addition of liquid ammonium sulfate. Therefore, the CT calculations are based on Table L-9 of the Virginia Waterworks Regulations for inactivation of viruses by free chlorine. The average water temperature for the water is 55° F (13° C), with an assumed minimum temperature of 50° F (10° C). In order to achieve 4 log inactivation of viruses a CT value of 6 min-mg/L is required.

A 10,000 gallon hydropneumatic tank is proposed, and it is assumed the tank will be operated at 60% capacity. A baffling factor of 0.3 is assumed based on a poor baffling condition.

T = 6,000 gallons / 120 gpm = 50 minutes

T10 = 50 minutes x 0.3 = 15 minutes

The assumed feed rate for hypochlorite is 2.0 mg/L with a residual of 1 mg/L following filtration. Therefore the actual CT value is calculated as follows:

CT = 15 minutes x 1 mg/L = 15 min-mg/L > 6 min-mg/L

2. Caustic Feed

A sodium hydroxide solution will be fed to the raw water in the same general location as the hypochlorite feed to assist in the removal of iron and manganese while matching the pH range of the Chesterfield system. The pH target level is set to improve the effectiveness of both the chloramine and the orthophosphate additives.

A sodium carbonate solution will not be injected in order to avoid additional scaling at the chemical injectors as a result of the hardness of the well water

3. Ammonia Feed

Liquid ammonium sulfate (LAS) will be fed after the contact time before the water enters the distribution system. The free chlorine and ammonia

concentration within the Founder's Bridge system will be monitored daily so that the operator can adjust the feed rates to match the water quality in the Chesterfield system.

- The Founder's Bridge system will mirror the chloramine level in the Chesterfield system which is maintained at 2 mg/L for effective disinfection.
- The chlorine to ammonia ratio (measured as free chlorine to ammonia) will be maintained between 3 and 4 in order to produce stable chloramines.
- The chloramine concentration will be monitored by measuring the total chlorine near the far reaches of the Founder's Bridge Utility Company's distribution system.

4. Orthophosphate Feed

An orthophosphate solution will be fed to the distribution water in the same general location as the ammonia feed to match the Chesterfield system. The target concentration level will maintain the existing pipeline coating established by the current Chesterfield system.

D. Atmospheric Storage Tank

No atmospheric storage tank is required since the system will rely on the hydropneumatic tank for contact time and Chesterfield County connections to satisfy the peak demands.

E. Water Treatment for Iron and Manganese Removal

Iron and manganese removal will be required. Two (2) 42" diameter by 60" tall

AdEdge filters with a 6.5 gpm/ft^2 loading rate are proposed. The AdEdge system is a pre-packaged, skid mounted treatment system that includes the necessary controls for an automated system. To maximize system performance, a low dose of hypochlorite will be fed to the raw water prior to the filter. A backwash holding tank and VPDES discharge permit will be required for the settling and disposal of the backwash water. Backwash water will not be disposed of to the existing sewer system.

F. Operational Summary

The well pumps will operate based on the pressure in the hydropneumatic tank. When the pressure in the tank drops and the well is called to run, the well pump will transfer water through the iron and manganese filtration system and into the hydropneumatic tank. An air compressor will be provided to maintain the air and water balance and keep the tank pressurized. The hydropneumatic tank will operate based on maintaining system pressure between 70 psi and 80 psi.

The iron and manganese removal filters will require backwashing at regular intervals. Backwash water will be provided by the distribution system at a rate of approximately 20 gpm/ft^2, or 190 gpm. Backwashing will last for approximately 10 minutes per vessel, generating a volume of approximately 1,900 gallons per vessel for a total of approximately 3,800 gallons per backwash event. The low iron and manganese concentrations of this application allow for a backwash interval of up to 7 days which is the recommended maximum limit for media maintenance. Regularly fluidizing the media will decrease the likely hood of channeling in the media bed which would cause premature manganese breakthrough.

G. Atmospheric Storage Tank Alternative

As an alternative to the 10,000 gallon hydropneumatic tank, a 20,000 gallon horizontal ground storage tank could be installed. The storage tank would allow for the system to provide additional water beyond 120 gpm during peak hour demands and would further reduce the demand to the Chesterfield County system. Assuming peak hour demands of 182 gpm (as calculated in Section II), and assuming that the well pumps operate at 119 gpm, 20,000 gallons of storage could provide approximately 6 hours of storage before a demand would be placed on the Chesterfield system.

For this alternatives, the well pumps would transfer water through the filters and into the storage tank. Booster pumps would draw the water from the storage tank and pump into a small hydropneumatic tank which would provide the contact time as well as pressure control for the system. A 5,000 gallon hydropneumatic tank at 60% full would provide adequate contact time.

XI. CONCLUSIONS AND RECOMMENDATIONS

The Founder's Bridge residential development located within Powhatan County can effectively be served by the proposed community water system and Chesterfield County water connections. The proposed water system, served by community wells, will have a design capacity of 119 gpm to satisfy the average day demands and most of the peak day demands. During periods when the well system can't meet the peak demands, the Chesterfield County water distribution system will satisfy the demand.

The predicted average demand during irrigation season is approximately 95,000 gpd. The proposed well system will be capable of producing up to 99,360 gpd from Well 1 and 72,000 gpd from Well 2 (up to 170,000 gpd from both wells.) Due to the nature of when the peak demands occur, there will be periods within a given day where the wells will not completely satisfy the peak demands, such as during a fire fighting event or on a day when a large number of homes are running their irrigation systems simultaneously. During these events, the pressure will drop to a point where water will flow into the water system from two points of entry from the Chesterfield system. Pressure reducing valves will be provided to ensure that water only flows into Founder's Bridge when there is a loss of system pressure. To ensure that no water from FBUC goes backwards into the Chesterfield County systems, backflow preventers will be provided downstream of the existing meters. The proposed PRVs and backflow devices will be owned and operated by FBUC.

Through the hydraulic modeling of the system, it has been determined that the normal system pressure within the Founder's Bridge system will be maintained between 55 and 84 psi. The pressure setting at the master meter point of entry will be approximately 60 psi and the pressure setting at the Bel Crest point of entry will be approximately 72 psi. These pressure settings will allow for adequate flow and pressure into Founder's Bridge during peak hour or fire flow demands.

The proposed water system will consist of two wells, an iron and manganese removal system, disinfection, and a hydropneumatic tank. The chemical feed system and iron and manganese filters will be located inside a building.

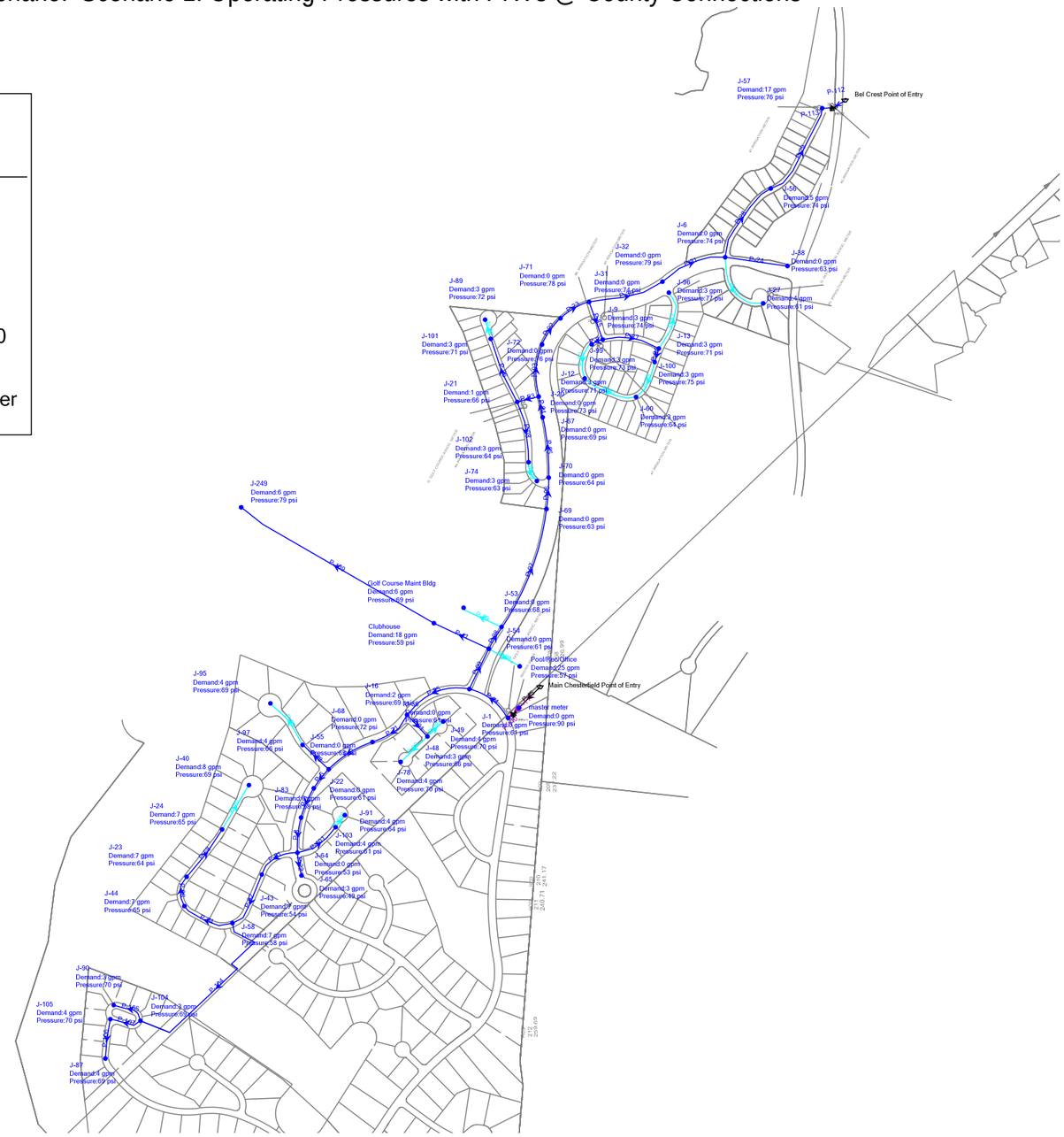
APPENDIX A

Hydraulic Model Output Scenario 1 – Pressure and Flow From Chesterfield County

Active Scenario: Scenario 1: Operating Pressures with PRVs @ County Connections

Color Coding Legend	
Pipe: Diameter (in)	
<=	6.0
<=	8.0
<=	16.0
	Other

Color Coding Legend	
Junction: Pressure (psi)	
<=	35
<=	90
<=	100
	Other



Scenario: Scenario 1: Operating Pressures with PRVs @ County Connections
Current Time Step: 0.000 h
FlexTable: Pipe Table

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Has User Defined Length?	Length (User Defined) (ft)
683	P-1	861	J-25	J-61	16.0	130.0	(N/A)	(N/A)	False	0
684	P-2	1,009	J-61	J-34	16.0	130.0	(N/A)	(N/A)	False	0
685	P-3	1,924	J-34	J-37	16.0	130.0	(N/A)	(N/A)	False	0
688	P-4	541	J-37	J-80	16.0	130.0	(N/A)	(N/A)	False	0
692	P-5	334	J-68	J-55	8.0	130.0	77	0.49	False	0
693	P-6	156	J-55	J-22	8.0	130.0	68	0.43	False	0
697	P-8	227	J-83	J-64	8.0	130.0	68	0.43	False	0
699	P-9	205	J-22	J-83	8.0	130.0	68	0.43	False	0
700	P-10	177	J-75	J-28	8.0	130.0	(N/A)	(N/A)	False	0
701	P-11	161	J-28	J-3	8.0	130.0	(N/A)	(N/A)	False	0
702	P-12	361	J-19	J-11	8.0	130.0	(N/A)	(N/A)	False	0
703	P-13	382	J-8	J-42	16.0	130.0	(N/A)	(N/A)	False	0
704	P-14	707	J-42	J-11	16.0	130.0	(N/A)	(N/A)	False	0
710	P-15	532	J-47	J-45	16.0	130.0	(N/A)	(N/A)	False	0
711	P-16	283	J-45	J-79	16.0	130.0	(N/A)	(N/A)	False	0
712	P-17	373	J-79	J-41	16.0	130.0	(N/A)	(N/A)	False	0
713	P-18	256	J-41	J-51	16.0	130.0	(N/A)	(N/A)	False	0
714	P-19	383	J-51	J-73	6.0	130.0	(N/A)	(N/A)	False	0
715	P-20	631	J-79	J-46	8.0	130.0	(N/A)	(N/A)	False	0
716	P-21	400	J-46	J-76	6.0	130.0	(N/A)	(N/A)	False	0
718	P-22	149	J-65	J-64	8.0	130.0	-3	0.02	False	0
720	P-23	213	J-31	J-71	8.0	130.0	-45	0.29	False	0
723	P-24	403	J-6	J-38	8.0	130.0	0	0.00	False	0
724	P-25	303	J-3	J-19	8.0	130.0	(N/A)	(N/A)	False	0
725	P-26	485	J-81	J-11	16.0	130.0	(N/A)	(N/A)	False	0
726	P-27	301	J-33	J-8	6.0	130.0	(N/A)	(N/A)	False	0
727	P-28	544	J-6	J-56	8.0	130.0	22	0.14	False	0
728	P-29	631	J-56	J-57	8.0	130.0	17	0.11	False	0
729	P-30	493	J-31	J-32	8.0	130.0	26	0.16	False	0
730	P-31	445	J-32	J-6	8.0	130.0	26	0.16	False	0
731	P-32	442	J-6	J-27	6.0	130.0	4	0.04	False	0
522	P-33	400	J-30	J-51	16.0	130.0	(N/A)	(N/A)	False	0
397	P-34	642	J-30	J-59	16.0	130.0	(N/A)	(N/A)	False	0
656	P-35	452	J-14	J-59	16.0	130.0	(N/A)	(N/A)	False	0
649	P-36	725	J-25	J-14	16.0	130.0	(N/A)	(N/A)	False	0
671	P-37	451	J-93	J-80	16.0	130.0	(N/A)	(N/A)	False	0
514	P-38	139	J-48	J-49	6.0	130.0	4	0.05	False	0
616	P-39	236	J-78	J-48	6.0	130.0	-4	0.05	False	0
739	P-41	388	J-54	Clubhouse	8.0	130.0	24	0.15	False	0
665	P-42	592	J-2	master meter	16.0	130.0	(N/A)	(N/A)	False	0
679	P-43	1,392	J-94	J-2	16.0	130.0	(N/A)	(N/A)	False	0
745	P-44	95	R-1	well house	24.0	130.0	(N/A)	(N/A)	True	1
747	P-45	190	Main Chesterfield Point of Entry	master meter	24.0	130.0	203	0.14	True	1
750	P-46	396	J-50	J-62	8.0	130.0	(N/A)	(N/A)	False	0
751	P-47	300	J-62	J-15	8.0	130.0	(N/A)	(N/A)	False	0
752	P-48	297	J-15	J-84	8.0	130.0	(N/A)	(N/A)	False	0
753	P-49	320	J-84	J-88	6.0	130.0	(N/A)	(N/A)	False	0
754	P-50	389	J-88	J-87	6.0	130.0	(N/A)	(N/A)	False	0
614	P-51	288	J-64	J-43	8.0	130.0	56	0.36	False	0
363	P-53	142	J-20	J-21	8.0	130.0	12	0.07	False	0
756	P-54	301	J-15	J-35	8.0	130.0	(N/A)	(N/A)	False	0
757	P-55	179	J-35	J-66	6.0	130.0	(N/A)	(N/A)	False	0
662	P-56	489	J-28	J-92	6.0	130.0	(N/A)	(N/A)	False	0
758	P-57	238	J-85	J-81	16.0	130.0	(N/A)	(N/A)	False	0
674	P-58	899	J-17	J-3	6.0	130.0	(N/A)	(N/A)	False	0
759	P-59	281	J-85	J-18	6.0	130.0	(N/A)	(N/A)	False	0
760	P-60	321	J-18	J-10	6.0	130.0	(N/A)	(N/A)	False	0
625	P-61	219	J-81	J-82	6.0	130.0	(N/A)	(N/A)	False	0
761	P-62	378	J-43	J-58	8.0	130.0	50	0.32	False	0
382	P-63	85	J-26	J-4	6.0	130.0	(N/A)	(N/A)	False	0
762	P-64	346	J-58	J-44	8.0	130.0	28	0.18	False	0
630	P-65	273	J-77	J-26	6.0	130.0	(N/A)	(N/A)	False	0
763	P-66	204	J-44	J-23	8.0	130.0	21	0.13	False	0
611	P-67	232	J-77	J-33	6.0	130.0	(N/A)	(N/A)	False	0
764	P-68	380	J-23	J-24	8.0	130.0	14	0.09	False	0
765	P-70	331	J-24	J-40	6.0	130.0	8	0.09	False	0
586	P-71	293	J-68	J-16	8.0	130.0	-77	0.49	False	0
431	P-75	118	J-36	J-1	16.0	130.0	(N/A)	(N/A)	False	0
434	P-77	250	J-4	J-36	16.0	130.0	(N/A)	(N/A)	False	0
676	P-79	566	J-8	J-4	16.0	130.0	(N/A)	(N/A)	False	0
771	P-81	361	J-60	J-12	6.0	130.0	-2	0.02	False	0
653	P-82	510	J-52	J-85	16.0	130.0	(N/A)	(N/A)	False	0
524	P-84	187	J-52	J-50	16.0	130.0	(N/A)	(N/A)	False	0
782	P-84	318	J-1	J-86	8.0	130.0	203	1.29	False	0
773	P-85	256	J-9	J-31	8.0	130.0	-19	0.12	False	0
783	P-85	457	J-86	J-16	8.0	130.0	91	0.58	False	0
520	P-86	236	J-50	J-47	16.0	130.0	(N/A)	(N/A)	False	0
774	P-87	374	J-9	J-13	8.0	130.0	9	0.06	False	0

786	P-87	396	J-96	J-13	6.0	130.0	-3	0.04	False	0
776	P-88	228	Pool/Rec/Office	J-54	6.0	130.0	-25	0.28	False	0
788	P-88	229	J-55	J-97	8.0	130.0	9	0.06	False	0
778	P-89	276	J-53	Golf Course Maint Bldg	6.0	130.0	6	0.07	False	0
789	P-89	341	J-97	J-95	6.0	130.0	4	0.05	False	0
779	P-90	200	Golf Course Maint Bldg	well house	6.0	130.0	(N/A)	(N/A)	False	0
570	P-91	190	J-16	J-48	8.0	130.0	12	0.08	False	0
792	P-91	316	J-98	J-75	8.0	130.0	(N/A)	(N/A)	False	0
596	P-92	207	J-71	J-72	8.0	130.0	-45	0.29	False	0
795	P-92	244	J-12	J-99	6.0	130.0	-5	0.05	False	0
642	P-93	340	J-72	J-20	8.0	130.0	-45	0.29	False	0
796	P-93	78	J-99	J-9	8.0	130.0	-7	0.05	False	0
583	P-94	134	J-67	J-20	8.0	130.0	57	0.36	False	0
799	P-94	91	J-13	J-100	8.0	130.0	3	0.02	False	0
664	P-95	389	J-70	J-67	8.0	130.0	57	0.36	False	0
800	P-95	261	J-100	J-60	6.0	130.0	1	0.01	False	0
591	P-96	202	J-69	J-70	8.0	130.0	57	0.36	False	0
802	P-96	439	J-21	J-101	8.0	130.0	5	0.03	False	0
677	P-97	816	J-53	J-69	8.0	130.0	57	0.36	False	0
803	P-97	128	J-101	J-89	6.0	130.0	3	0.03	False	0
529	P-98	162	J-53	J-54	8.0	130.0	-63	0.40	False	0
805	P-98	396	J-21	J-102	8.0	130.0	5	0.03	False	0
640	P-99	286	J-86	J-54	8.0	130.0	112	0.71	False	0
806	P-99	138	J-102	J-74	6.0	130.0	3	0.03	False	0
808	P-100	97	J-91	J-103	6.0	130.0	-4	0.05	False	0
809	P-101	303	J-103	J-64	8.0	130.0	-9	0.06	False	0
812	P-102	319	check valve	J-57	8.0	130.0	(N/A)	(N/A)	False	0
819	P-104	1,254	J-58	J-104	8.0	130.0	15	0.10	False	0
820	P-105	217	J-104	J-90	8.0	130.0	3	0.02	False	0
822	P-106	255	J-87	J-105	8.0	130.0	-4	0.03	False	0
823	P-107	208	J-105	J-104	8.0	130.0	-9	0.06	False	0
829	P-109	1,442	Clubhouse	J-249	8.0	130.0	6	0.04	False	0
836	P-110	45	master meter	PRV-1	12.0	130.0	203	0.58	False	0
837	P-111	50	PRV-1	J-1	12.0	130.0	203	0.58	False	0
839	P-112	86	Bel Crest Point of Entry	PRV-2	8.0	130.0	0	0.00	False	5
840	P-113	73	PRV-2	J-57	8.0	130.0	0	0.00	False	5

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Scenario: Scenario 1: Operating Pressures with PRVs @ County Connections
Current Time Step: 0.000 h
FlexTable: Junction Table

ID	Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
738	Clubhouse	214.00	18	350.32	59
777	Golf Course Maint Bldg	191.78	6	350.31	69
257	J-1	210.00	0	350.72	61
263	J-2	233.00	(N/A)	(N/A)	(N/A)
271	J-3	240.00	(N/A)	(N/A)	(N/A)
277	J-4	217.00	(N/A)	(N/A)	(N/A)
290	J-6	179.00	0	350.11	74
313	J-8	236.00	(N/A)	(N/A)	(N/A)
319	J-9	179.00	3	350.13	74
322	J-10	254.00	(N/A)	(N/A)	(N/A)
326	J-11	245.00	(N/A)	(N/A)	(N/A)
330	J-12	185.00	3	350.13	71
331	J-13	187.00	3	350.13	71
345	J-14	195.00	(N/A)	(N/A)	(N/A)
350	J-15	219.00	(N/A)	(N/A)	(N/A)
354	J-16	191.00	2	350.32	69
357	J-17	210.00	(N/A)	(N/A)	(N/A)
359	J-18	232.00	(N/A)	(N/A)	(N/A)
361	J-19	237.00	(N/A)	(N/A)	(N/A)
364	J-20	181.00	0	350.17	73
365	J-21	197.00	1	350.17	66
371	J-22	209.00	0	350.20	61
377	J-23	203.00	7	350.09	64
378	J-24	199.00	7	350.08	65
380	J-25	193.00	(N/A)	(N/A)	(N/A)
383	J-26	216.00	(N/A)	(N/A)	(N/A)
386	J-27	209.00	4	350.11	61
388	J-28	243.00	(N/A)	(N/A)	(N/A)
398	J-30	199.00	(N/A)	(N/A)	(N/A)
406	J-31	179.00	0	350.13	74
410	J-32	168.00	0	350.12	79
413	J-33	220.00	(N/A)	(N/A)	(N/A)
423	J-34	213.00	(N/A)	(N/A)	(N/A)
427	J-35	222.00	(N/A)	(N/A)	(N/A)
432	J-36	209.00	(N/A)	(N/A)	(N/A)
445	J-37	355.00	(N/A)	(N/A)	(N/A)
447	J-38	205.00	0	350.11	63
455	J-40	190.00	8	350.08	69
457	J-41	222.00	(N/A)	(N/A)	(N/A)
466	J-42	223.00	(N/A)	(N/A)	(N/A)
481	J-43	226.00	7	350.12	54
490	J-44	201.00	7	350.09	65
494	J-45	220.00	(N/A)	(N/A)	(N/A)
508	J-46	215.00	(N/A)	(N/A)	(N/A)
512	J-47	225.00	(N/A)	(N/A)	(N/A)
515	J-48	197.00	3	350.32	66
516	J-49	189.00	4	350.32	70
521	J-50	233.00	(N/A)	(N/A)	(N/A)
523	J-51	204.00	(N/A)	(N/A)	(N/A)
525	J-52	231.00	(N/A)	(N/A)	(N/A)
530	J-53	194.00	0	350.31	68
531	J-54	210.00	0	350.33	61
533	J-55	204.00	0	350.22	63
542	J-56	180.00	5	350.10	74
551	J-57	175.00	17	350.10	76
553	J-58	216.00	7	350.10	58
555	J-59	194.00	(N/A)	(N/A)	(N/A)

560	J-60	202.00	3	350.13	64
562	J-61	199.00	(N/A)	(N/A)	(N/A)
565	J-62	220.00	(N/A)	(N/A)	(N/A)
575	J-64	227.00	0	350.15	53
576	J-65	236.00	3	350.15	49
578	J-66	216.00	(N/A)	(N/A)	(N/A)
584	J-67	190.00	0	350.19	69
587	J-68	184.00	0	350.28	72
592	J-69	205.00	0	350.24	63
593	J-70	203.00	0	350.22	64
597	J-71	171.00	0	350.14	78
598	J-72	174.00	0	350.15	76
601	J-73	199.00	(N/A)	(N/A)	(N/A)
604	J-74	205.00	3	350.17	63
606	J-75	239.00	(N/A)	(N/A)	(N/A)
610	J-76	186.00	(N/A)	(N/A)	(N/A)
612	J-77	217.00	(N/A)	(N/A)	(N/A)
617	J-78	189.00	4	350.32	70
619	J-79	230.00	(N/A)	(N/A)	(N/A)
621	J-80	333.00	(N/A)	(N/A)	(N/A)
626	J-81	240.00	(N/A)	(N/A)	(N/A)
627	J-82	245.00	(N/A)	(N/A)	(N/A)
632	J-83	215.00	0	350.18	58
636	J-84	217.00	(N/A)	(N/A)	(N/A)
639	J-85	224.00	(N/A)	(N/A)	(N/A)
641	J-86	209.00	0	350.42	61
644	J-87	190.00	4	350.09	69
645	J-88	190.00	(N/A)	(N/A)	(N/A)
652	J-89	183.00	3	350.17	72
655	J-90	189.00	3	350.09	70
658	J-91	203.00	4	350.15	64
663	J-92	215.00	(N/A)	(N/A)	(N/A)
672	J-93	357.00	(N/A)	(N/A)	(N/A)
680	J-94	290.00	(N/A)	(N/A)	(N/A)
694	J-95	190.00	4	350.22	69
784	J-96	171.00	3	350.12	77
787	J-97	198.38	4	350.22	66
790	J-98	240.00	(N/A)	(N/A)	(N/A)
794	J-99	180.45	3	350.13	73
798	J-100	177.42	3	350.13	75
801	J-101	186.16	3	350.17	71
804	J-102	202.94	3	350.17	64
807	J-103	208.01	4	350.15	61
818	J-104	190.00	3	350.09	69
821	J-105	189.00	4	350.09	70
828	J-249	168.00	6	350.32	79
775	Pool/Rec/Office	218.00	25	350.31	57
811	check valve	175.00	(N/A)	(N/A)	(N/A)
280	master meter	212.00	0	420.00	90
741	well house	190.00	(N/A)	(N/A)	(N/A)

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Scenario: Scenario 1: Operating Pressures with PRVs @ County Connections
Current Time Step: 0.000 h
FlexTable: Reservoir Table

ID	Label	Elevation (ft)	Zone	Flow (Out net) (gpm)	Hydraulic Grade (ft)
824	Bel Crest Point of Entry	341.00	<None>	0	341.00
746	Main Chesterfield Point of Entry	420.00	<None>	203	420.00
744	R-1	364.00	<None>	(N/A)	(N/A)

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Scenario: Scenario 1: Operating Pressures with PRVs @ County Connections
Current Time Step: 0.000 h
FlexTable: PRV Table

ID	Label	Elevation (ft)	Diameter (Valve) (in)	Minor Loss Coefficient (Local)	Hydraulic Grade Setting (Initial) (ft)	Pressure Setting (Initial) (psi)	Flow (gpm)	Hydraulic Grade (From) (ft)	Hydraulic Grade (To) (ft)	Headloss (ft)
838	PRV-2	175.00	6.0	0.000	341.36	72	0	345.55	350.10	0.00
835	PRV-1	212.00	6.0	0.000	350.63	60	203	419.81	350.73	69.09

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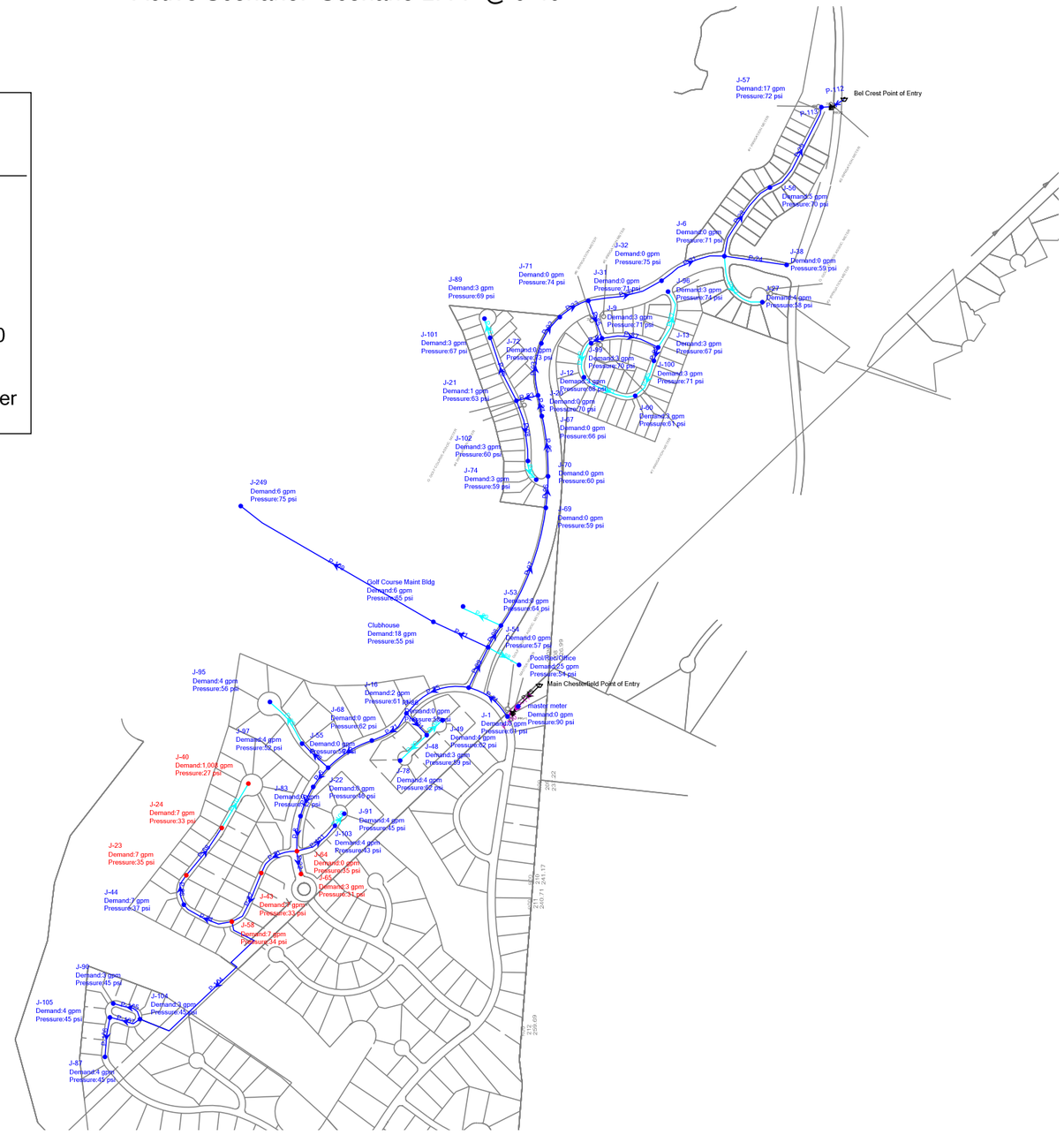
Active Scenario: Scenario 1: FF @ J-40

Color Coding Legend		
Pipe: Diameter (in)		
	<=	6.0
	<=	8.0
	<=	16.0
		Other

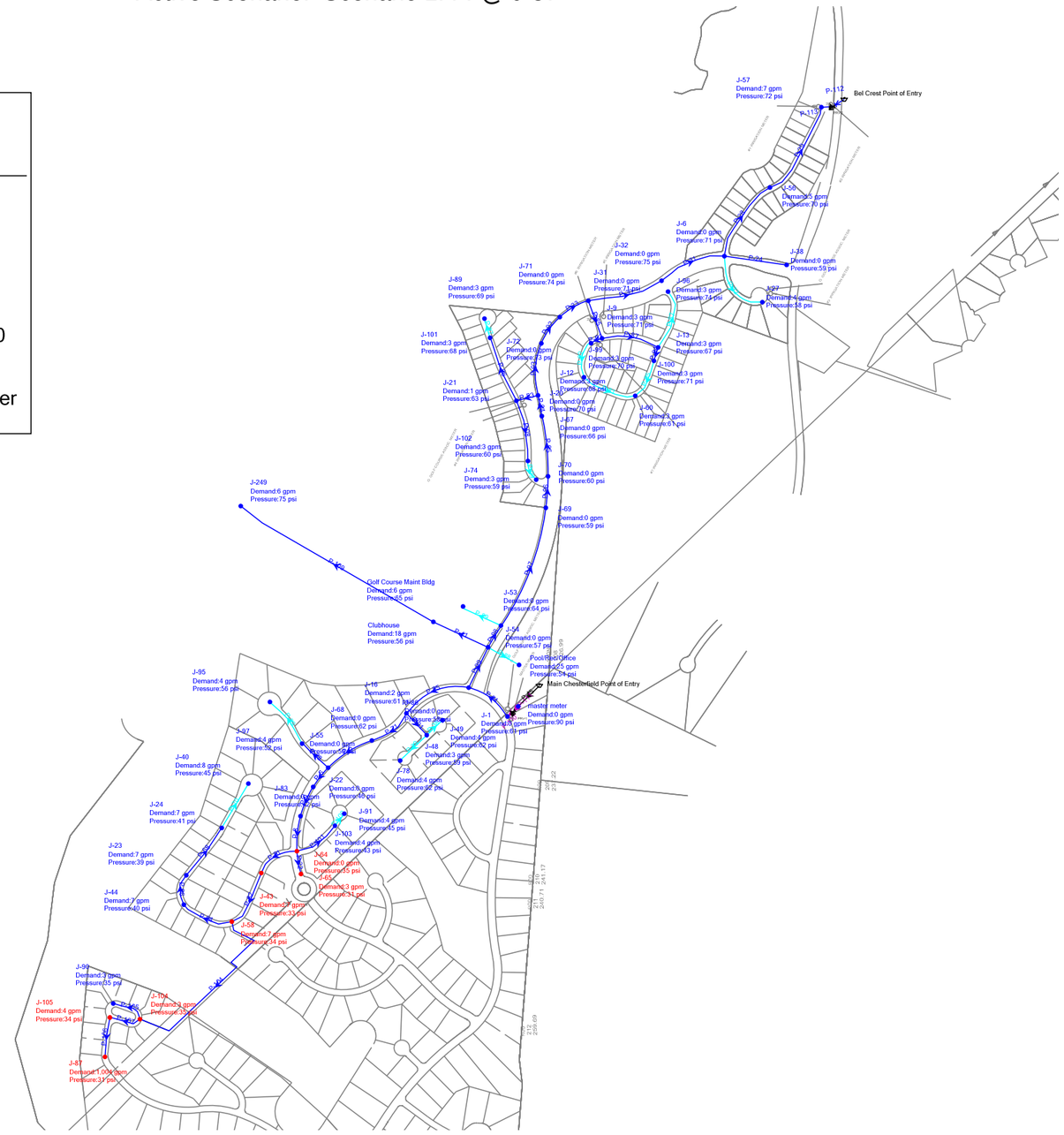
Color Coding Legend		
Junction: Pressure (psi)		
	<=	35
	<=	90
	<=	100
		Other



Active Scenario: Scenario 1: FF@ J-87

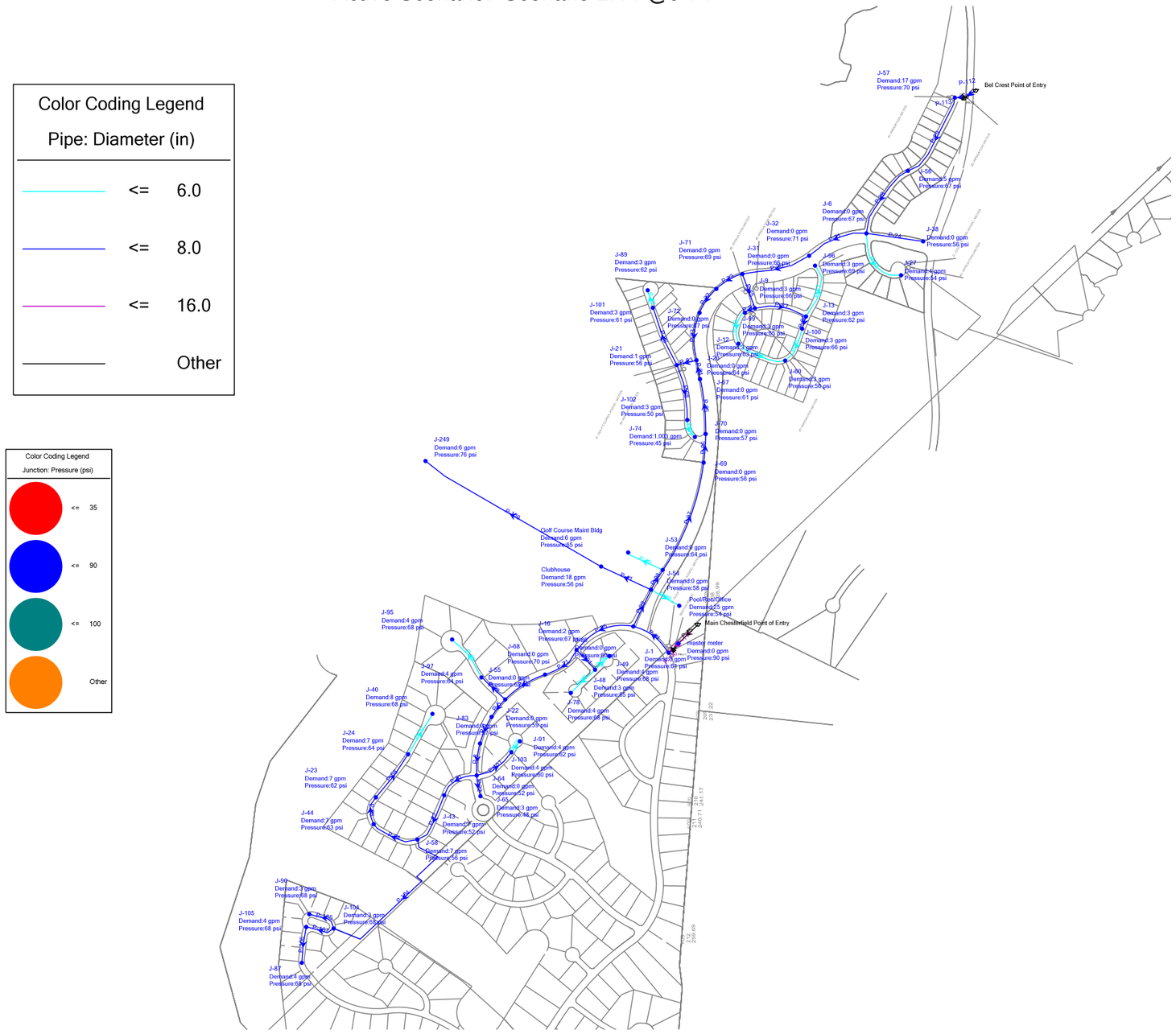
Color Coding Legend		
Pipe: Diameter (in)		
	<=	6.0
	<=	8.0
	<=	16.0
		Other

Color Coding Legend		
Junction: Pressure (psi)		
	<=	35
	<=	90
	<=	100
		Other



Active Scenario: Scenario 1: FF@J-74

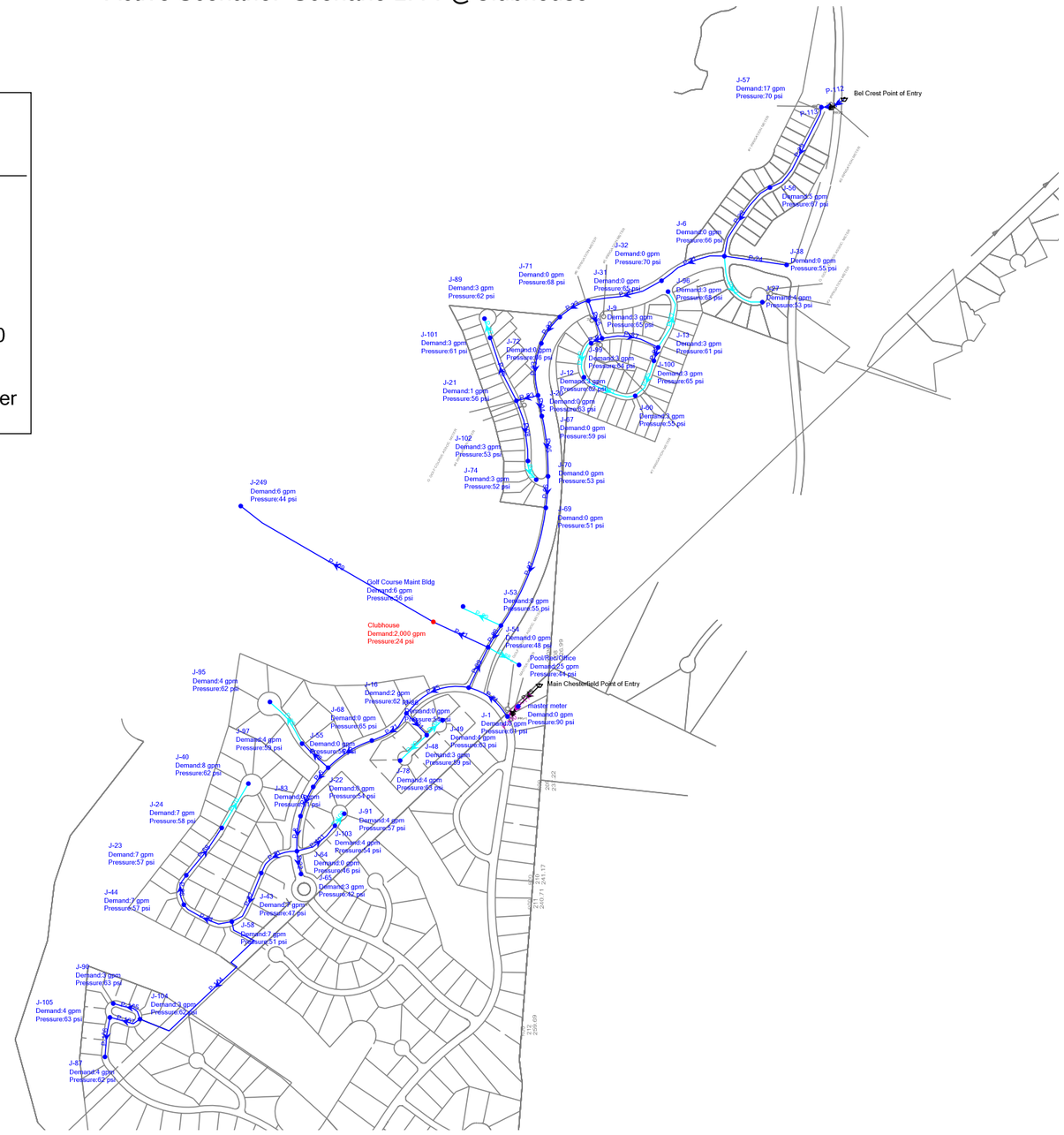
Color Coding Legend		
Pipe: Diameter (in)		
	<=	6.0
	<=	8.0
	<=	16.0
		Other



Active Scenario: Scenario 1: FF@Clubhouse

Color Coding Legend		
Pipe: Diameter (in)		
	<=	6.0
	<=	8.0
	<=	16.0
		Other

Color Coding Legend		
Junction: Pressure (psi)		
	<=	35
	<=	90
	<=	100
		Other



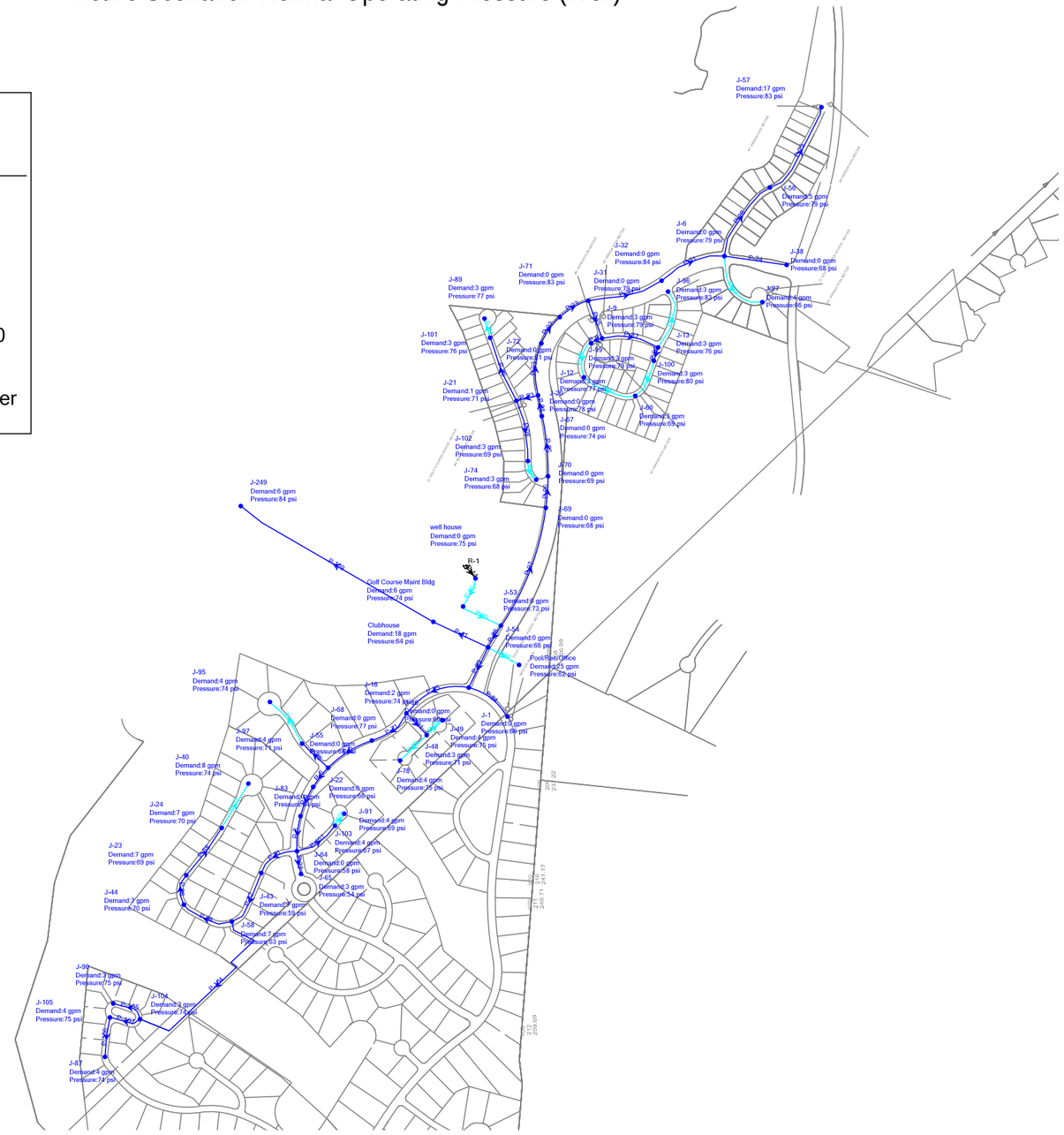
APPENDIX B

Hydraulic Model Output Scenario 2– Founder's Bridge Normal Operating Pressure

Active Scenario: Normal Operating Pressure (Well)

Color Coding Legend	
Pipe: Diameter (in)	
<=	6.0
<=	8.0
<=	16.0
	Other

Color Coding Legend	
Junction: Pressure (psi)	
<=	35
<=	90
<=	100
	Other



Scenario: Normal Operating Pressure (Well)
Current Time Step: 0.000 h
FlexTable: Pipe Table

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)	Has User Defined Length?	Length (User Defined) (ft)
683	P-1	861	J-25	J-61	16.0	130.0	(N/A)	(N/A)	False	0
684	P-2	1,009	J-61	J-34	16.0	130.0	(N/A)	(N/A)	False	0
685	P-3	1,924	J-34	J-37	16.0	130.0	(N/A)	(N/A)	False	0
688	P-4	541	J-37	J-80	16.0	130.0	(N/A)	(N/A)	False	0
692	P-5	334	J-68	J-55	8.0	130.0	77	0.49	False	0
693	P-6	156	J-55	J-22	8.0	130.0	68	0.43	False	0
697	P-8	227	J-83	J-64	8.0	130.0	68	0.43	False	0
699	P-9	205	J-22	J-83	8.0	130.0	68	0.43	False	0
700	P-10	177	J-75	J-28	8.0	130.0	(N/A)	(N/A)	False	0
701	P-11	161	J-28	J-3	8.0	130.0	(N/A)	(N/A)	False	0
702	P-12	361	J-19	J-11	8.0	130.0	(N/A)	(N/A)	False	0
703	P-13	382	J-8	J-42	16.0	130.0	(N/A)	(N/A)	False	0
704	P-14	707	J-42	J-11	16.0	130.0	(N/A)	(N/A)	False	0
710	P-15	532	J-47	J-45	16.0	130.0	(N/A)	(N/A)	False	0
711	P-16	283	J-45	J-79	16.0	130.0	(N/A)	(N/A)	False	0
712	P-17	373	J-79	J-41	16.0	130.0	(N/A)	(N/A)	False	0
713	P-18	256	J-41	J-51	16.0	130.0	(N/A)	(N/A)	False	0
714	P-19	383	J-51	J-73	6.0	130.0	(N/A)	(N/A)	False	0
715	P-20	631	J-79	J-46	8.0	130.0	(N/A)	(N/A)	False	0
716	P-21	400	J-46	J-76	6.0	130.0	(N/A)	(N/A)	False	0
718	P-22	149	J-65	J-64	8.0	130.0	-3	0.02	False	0
720	P-23	213	J-31	J-71	8.0	130.0	-45	0.29	False	0
723	P-24	403	J-6	J-38	8.0	130.0	0	0.00	False	0
724	P-25	303	J-3	J-19	8.0	130.0	(N/A)	(N/A)	False	0
725	P-26	485	J-81	J-11	16.0	130.0	(N/A)	(N/A)	False	0
726	P-27	301	J-33	J-8	6.0	130.0	(N/A)	(N/A)	False	0
727	P-28	544	J-6	J-56	8.0	130.0	22	0.14	False	0
728	P-29	631	J-56	J-57	8.0	130.0	17	0.11	False	0
729	P-30	493	J-31	J-32	8.0	130.0	26	0.16	False	0
730	P-31	445	J-32	J-6	8.0	130.0	26	0.16	False	0
731	P-32	442	J-6	J-27	6.0	130.0	4	0.04	False	0
522	P-33	400	J-30	J-51	16.0	130.0	(N/A)	(N/A)	False	0
397	P-34	642	J-30	J-59	16.0	130.0	(N/A)	(N/A)	False	0
656	P-35	452	J-14	J-59	16.0	130.0	(N/A)	(N/A)	False	0
649	P-36	725	J-25	J-14	16.0	130.0	(N/A)	(N/A)	False	0
671	P-37	451	J-93	J-80	16.0	130.0	(N/A)	(N/A)	False	0
514	P-38	139	J-48	J-49	6.0	130.0	4	0.05	False	0
616	P-39	236	J-78	J-48	6.0	130.0	-4	0.05	False	0
739	P-41	388	J-54	Clubhouse	8.0	130.0	24	0.15	False	0
665	P-42	592	J-2	master meter	16.0	130.0	(N/A)	(N/A)	False	0
679	P-43	1,392	J-94	J-2	16.0	130.0	(N/A)	(N/A)	False	0
745	P-44	95	R-1	well house	24.0	130.0	203	0.14	True	1
747	P-45	190	Main Chesterfield Point of Entry	master meter	24.0	130.0	(N/A)	(N/A)	True	1
750	P-46	396	J-50	J-62	8.0	130.0	(N/A)	(N/A)	False	0
751	P-47	300	J-62	J-15	8.0	130.0	(N/A)	(N/A)	False	0
752	P-48	297	J-15	J-84	8.0	130.0	(N/A)	(N/A)	False	0
753	P-49	320	J-84	J-88	6.0	130.0	(N/A)	(N/A)	False	0
754	P-50	389	J-88	J-87	6.0	130.0	(N/A)	(N/A)	False	0
614	P-51	288	J-64	J-43	8.0	130.0	56	0.36	False	0
363	P-53	142	J-20	J-21	8.0	130.0	12	0.07	False	0
756	P-54	301	J-15	J-35	8.0	130.0	(N/A)	(N/A)	False	0
757	P-55	179	J-35	J-66	6.0	130.0	(N/A)	(N/A)	False	0
662	P-56	489	J-28	J-92	6.0	130.0	(N/A)	(N/A)	False	0
758	P-57	238	J-85	J-81	16.0	130.0	(N/A)	(N/A)	False	0
674	P-58	899	J-17	J-3	6.0	130.0	(N/A)	(N/A)	False	0
759	P-59	281	J-85	J-18	6.0	130.0	(N/A)	(N/A)	False	0
760	P-60	321	J-18	J-10	6.0	130.0	(N/A)	(N/A)	False	0
625	P-61	219	J-81	J-82	6.0	130.0	(N/A)	(N/A)	False	0
761	P-62	378	J-43	J-58	8.0	130.0	50	0.32	False	0
382	P-63	85	J-26	J-4	6.0	130.0	(N/A)	(N/A)	False	0
762	P-64	346	J-58	J-44	8.0	130.0	28	0.18	False	0
630	P-65	273	J-77	J-26	6.0	130.0	(N/A)	(N/A)	False	0
763	P-66	204	J-44	J-23	8.0	130.0	21	0.13	False	0
611	P-67	232	J-77	J-33	6.0	130.0	(N/A)	(N/A)	False	0
764	P-68	380	J-23	J-24	8.0	130.0	14	0.09	False	0
765	P-70	331	J-24	J-40	6.0	130.0	8	0.09	False	0
586	P-71	293	J-68	J-16	8.0	130.0	-77	0.49	False	0
431	P-75	118	J-36	J-1	16.0	130.0	(N/A)	(N/A)	False	0
434	P-77	250	J-4	J-36	16.0	130.0	(N/A)	(N/A)	False	0
676	P-79	566	J-8	J-4	16.0	130.0	(N/A)	(N/A)	False	0
771	P-81	361	J-60	J-12	6.0	130.0	-2	0.02	False	0
653	P-82	510	J-52	J-85	16.0	130.0	(N/A)	(N/A)	False	0
524	P-84	187	J-52	J-50	16.0	130.0	(N/A)	(N/A)	False	0
782	P-84	318	J-1	J-86	8.0	130.0	0	0.00	False	0
773	P-85	256	J-9	J-31	8.0	130.0	-19	0.12	False	0
783	P-85	457	J-86	J-16	8.0	130.0	91	0.58	False	0
520	P-86	236	J-50	J-47	16.0	130.0	(N/A)	(N/A)	False	0
774	P-87	374	J-9	J-13	8.0	130.0	9	0.06	False	0

786	P-87	396	J-96	J-13	6.0	130.0	-3	0.04	False	0
776	P-88	228	Pool/Rec/Office	J-54	6.0	130.0	-25	0.28	False	0
788	P-88	229	J-55	J-97	8.0	130.0	9	0.06	False	0
778	P-89	276	J-53	Golf Course Maint Bldg	6.0	130.0	-197	2.23	False	0
789	P-89	341	J-97	J-95	6.0	130.0	4	0.05	False	0
779	P-90	200	Golf Course Maint Bldg	well house	6.0	130.0	-203	2.30	False	0
570	P-91	190	J-16	J-48	8.0	130.0	12	0.08	False	0
792	P-91	316	J-98	J-75	8.0	130.0	(N/A)	(N/A)	False	0
596	P-92	207	J-71	J-72	8.0	130.0	-45	0.29	False	0
795	P-92	244	J-12	J-99	6.0	130.0	-5	0.05	False	0
642	P-93	340	J-72	J-20	8.0	130.0	-45	0.29	False	0
796	P-93	78	J-99	J-9	8.0	130.0	-7	0.05	False	0
583	P-94	134	J-67	J-20	8.0	130.0	57	0.36	False	0
799	P-94	91	J-13	J-100	8.0	130.0	3	0.02	False	0
664	P-95	389	J-70	J-67	8.0	130.0	57	0.36	False	0
800	P-95	261	J-100	J-60	6.0	130.0	1	0.01	False	0
591	P-96	202	J-69	J-70	8.0	130.0	57	0.36	False	0
802	P-96	439	J-21	J-101	8.0	130.0	5	0.03	False	0
677	P-97	816	J-53	J-69	8.0	130.0	57	0.36	False	0
803	P-97	128	J-101	J-89	6.0	130.0	3	0.03	False	0
529	P-98	162	J-53	J-54	8.0	130.0	140	0.89	False	0
805	P-98	396	J-21	J-102	8.0	130.0	5	0.03	False	0
640	P-99	286	J-86	J-54	8.0	130.0	-91	0.58	False	0
806	P-99	138	J-102	J-74	6.0	130.0	3	0.03	False	0
808	P-100	97	J-91	J-103	6.0	130.0	-4	0.05	False	0
809	P-101	303	J-103	J-64	8.0	130.0	-9	0.06	False	0
812	P-102	319	check valve	J-57	8.0	130.0	(N/A)	(N/A)	False	0
819	P-104	1,254	J-58	J-104	8.0	130.0	15	0.10	False	0
820	P-105	217	J-104	J-90	8.0	130.0	3	0.02	False	0
822	P-106	255	J-87	J-105	8.0	130.0	-4	0.03	False	0
823	P-107	208	J-105	J-104	8.0	130.0	-9	0.06	False	0
829	P-109	1,442	Clubhouse	J-249	8.0	130.0	6	0.04	False	0
836	P-110	45	master meter	PRV-1	16.0	130.0	(N/A)	(N/A)	False	0
837	P-111	50	PRV-1	J-1	16.0	130.0	(N/A)	(N/A)	False	0
839	P-112	86	Bel Crest Point of Entry	PRV-2	8.0	130.0	(N/A)	(N/A)	True	4
840	P-113	73	PRV-2	J-57	8.0	130.0	(N/A)	(N/A)	True	1

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Scenario: Normal Operating Pressure (Well)
Current Time Step: 0.000 h
FlexTable: Junction Table

ID	Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
738	Clubhouse	214.00	18	362.14	64
777	Golf Course Maint Bldg	191.78	6	363.23	74
257	J-1	210.00	0	362.08	66
263	J-2	233.00	(N/A)	(N/A)	(N/A)
271	J-3	240.00	(N/A)	(N/A)	(N/A)
277	J-4	217.00	(N/A)	(N/A)	(N/A)
290	J-6	179.00	0	362.02	79
313	J-8	236.00	(N/A)	(N/A)	(N/A)
319	J-9	179.00	3	362.04	79
322	J-10	254.00	(N/A)	(N/A)	(N/A)
326	J-11	245.00	(N/A)	(N/A)	(N/A)
330	J-12	185.00	3	362.04	77
331	J-13	187.00	3	362.03	76
345	J-14	195.00	(N/A)	(N/A)	(N/A)
350	J-15	219.00	(N/A)	(N/A)	(N/A)
354	J-16	191.00	2	361.98	74
357	J-17	210.00	(N/A)	(N/A)	(N/A)
359	J-18	232.00	(N/A)	(N/A)	(N/A)
361	J-19	237.00	(N/A)	(N/A)	(N/A)
364	J-20	181.00	0	362.08	78
365	J-21	197.00	1	362.08	71
371	J-22	209.00	0	361.87	66
377	J-23	203.00	7	361.75	69
378	J-24	199.00	7	361.75	70
380	J-25	193.00	(N/A)	(N/A)	(N/A)
383	J-26	216.00	(N/A)	(N/A)	(N/A)
386	J-27	209.00	4	362.02	66
388	J-28	243.00	(N/A)	(N/A)	(N/A)
398	J-30	199.00	(N/A)	(N/A)	(N/A)
406	J-31	179.00	0	362.04	79
410	J-32	168.00	0	362.03	84
413	J-33	220.00	(N/A)	(N/A)	(N/A)
423	J-34	213.00	(N/A)	(N/A)	(N/A)
427	J-35	222.00	(N/A)	(N/A)	(N/A)
432	J-36	209.00	(N/A)	(N/A)	(N/A)
445	J-37	355.00	(N/A)	(N/A)	(N/A)
447	J-38	205.00	0	362.02	68
455	J-40	190.00	8	361.74	74
457	J-41	222.00	(N/A)	(N/A)	(N/A)
466	J-42	223.00	(N/A)	(N/A)	(N/A)
481	J-43	226.00	7	361.79	59
490	J-44	201.00	7	361.75	70
494	J-45	220.00	(N/A)	(N/A)	(N/A)
508	J-46	215.00	(N/A)	(N/A)	(N/A)
512	J-47	225.00	(N/A)	(N/A)	(N/A)
515	J-48	197.00	3	361.98	71
516	J-49	189.00	4	361.98	75
521	J-50	233.00	(N/A)	(N/A)	(N/A)
523	J-51	204.00	(N/A)	(N/A)	(N/A)
525	J-52	231.00	(N/A)	(N/A)	(N/A)
530	J-53	194.00	0	362.22	73
531	J-54	210.00	0	362.14	66
533	J-55	204.00	0	361.89	68
542	J-56	180.00	5	362.01	79
551	J-57	170.00	17	362.01	83
553	J-58	216.00	7	361.76	63
555	J-59	194.00	(N/A)	(N/A)	(N/A)

560	J-60	202.00	3	362.03	69
562	J-61	199.00	(N/A)	(N/A)	(N/A)
565	J-62	220.00	(N/A)	(N/A)	(N/A)
575	J-64	227.00	0	361.81	58
576	J-65	236.00	3	361.81	54
578	J-66	216.00	(N/A)	(N/A)	(N/A)
584	J-67	190.00	0	362.10	74
587	J-68	184.00	0	361.94	77
592	J-69	205.00	0	362.15	68
593	J-70	203.00	0	362.13	69
597	J-71	171.00	0	362.05	83
598	J-72	174.00	0	362.06	81
601	J-73	199.00	(N/A)	(N/A)	(N/A)
604	J-74	205.00	3	362.08	68
606	J-75	239.00	(N/A)	(N/A)	(N/A)
610	J-76	186.00	(N/A)	(N/A)	(N/A)
612	J-77	217.00	(N/A)	(N/A)	(N/A)
617	J-78	189.00	4	361.98	75
619	J-79	230.00	(N/A)	(N/A)	(N/A)
621	J-80	333.00	(N/A)	(N/A)	(N/A)
626	J-81	240.00	(N/A)	(N/A)	(N/A)
627	J-82	245.00	(N/A)	(N/A)	(N/A)
632	J-83	215.00	0	361.84	64
636	J-84	217.00	(N/A)	(N/A)	(N/A)
639	J-85	224.00	(N/A)	(N/A)	(N/A)
641	J-86	209.00	0	362.08	66
644	J-87	190.00	4	361.75	74
645	J-88	190.00	(N/A)	(N/A)	(N/A)
652	J-89	183.00	3	362.08	77
655	J-90	189.00	3	361.75	75
658	J-91	203.00	4	361.81	69
663	J-92	215.00	(N/A)	(N/A)	(N/A)
672	J-93	357.00	(N/A)	(N/A)	(N/A)
680	J-94	290.00	(N/A)	(N/A)	(N/A)
694	J-95	190.00	4	361.88	74
784	J-96	171.00	3	362.03	83
787	J-97	198.38	4	361.89	71
790	J-98	240.00	(N/A)	(N/A)	(N/A)
794	J-99	180.45	3	362.04	79
798	J-100	177.42	3	362.03	80
801	J-101	186.16	3	362.08	76
804	J-102	202.94	3	362.08	69
807	J-103	208.01	4	361.81	67
818	J-104	190.00	3	361.75	74
821	J-105	189.00	4	361.75	75
828	J-249	168.00	6	362.14	84
775	Pool/Rec/Office	218.00	25	362.13	62
811	check valve	175.00	(N/A)	(N/A)	(N/A)
280	master meter	212.00	(N/A)	(N/A)	(N/A)
741	well house	190.00	0	364.00	75

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Scenario: Normal Operating Pressure (Well)
Current Time Step: 0.000 h
FlexTable: Reservoir Table

ID	Label	Elevation (ft)	Zone	Flow (Out net) (gpm)	Hydraulic Grade (ft)
824	Bel Crest Point of Entry	340.00	<None>	(N/A)	(N/A)
746	Main Chesterfield Point of Entry	340.00	<None>	(N/A)	(N/A)
744	R-1	364.00	<None>	203	364.00

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Scenario: Normal Operating Pressure (Well)
Current Time Step: 0.000 h
FlexTable: PRV Table

ID	Label	Elevation (ft)	Diameter (Valve) (in)	Minor Loss Coefficient (Local)	Hydraulic Grade Setting (Initial) (ft)	Pressure Setting (Initial) (psi)	Flow (gpm)	Hydraulic Grade (From) (ft)	Hydraulic Grade (To) (ft)	Headloss (ft)
835	PRV-1	0.00	6.0	0.000	350.63	60	(N/A)	(N/A)	(N/A)	(N/A)
838	PRV-2	205.13	6.0	0.000	341.36	72	(N/A)	(N/A)	(N/A)	(N/A)

P:\9372 - Founder's Bridge\9372-04-001 (ENG) - Water System\Engineering\Design Documents\WaterCAD\9372 Water Model updated july 2016.wtg

APPENDIX C

Preliminary Layouts

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

NOTE: THESE PLANS AND SPECIFICATIONS INCLUDE PROPRIETARY INFORMATION. REPRODUCTION OF THESE PLANS AND SPECIFICATIONS IS NOT AUTHORIZED WITHOUT THE WRITTEN CONSENT OF BOWMAN CONSULTING GROUP, LTD.

Dig With CARE. Keep Virginia Safe!

- *C Call Miss Utility @ 811 before you dig.*
- *A Allow required time for marking.*
- *R Respect the marks.*
- *E Excavate carefully.*

811

PRELIMINARY ENGINEERING REPORT

PRELIMINARY SITE PLAN

FOUNDERS BRIDGE WATER STYSTEM

HUGUENOT MAGISTERIAL DISTRICT POWHATAN COUNTY, VA.

Bowman Consulting Group, Ltd.
469 McLaws Circle
Suite 202
Williamsburg, Virginia 23185

Phone: (757) 229-1776
Fax: (757) 229-4683
www.bowmanconsulting.com

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Bowman CONSULTING

COUNTY PROJECT NUMBER

PLAN STATUS

DATE	DESCRIPTION

KMB	DWD	KMB
DESIGN	DRAWN	CHKD

SCALE H: 1"=20' V: N/A

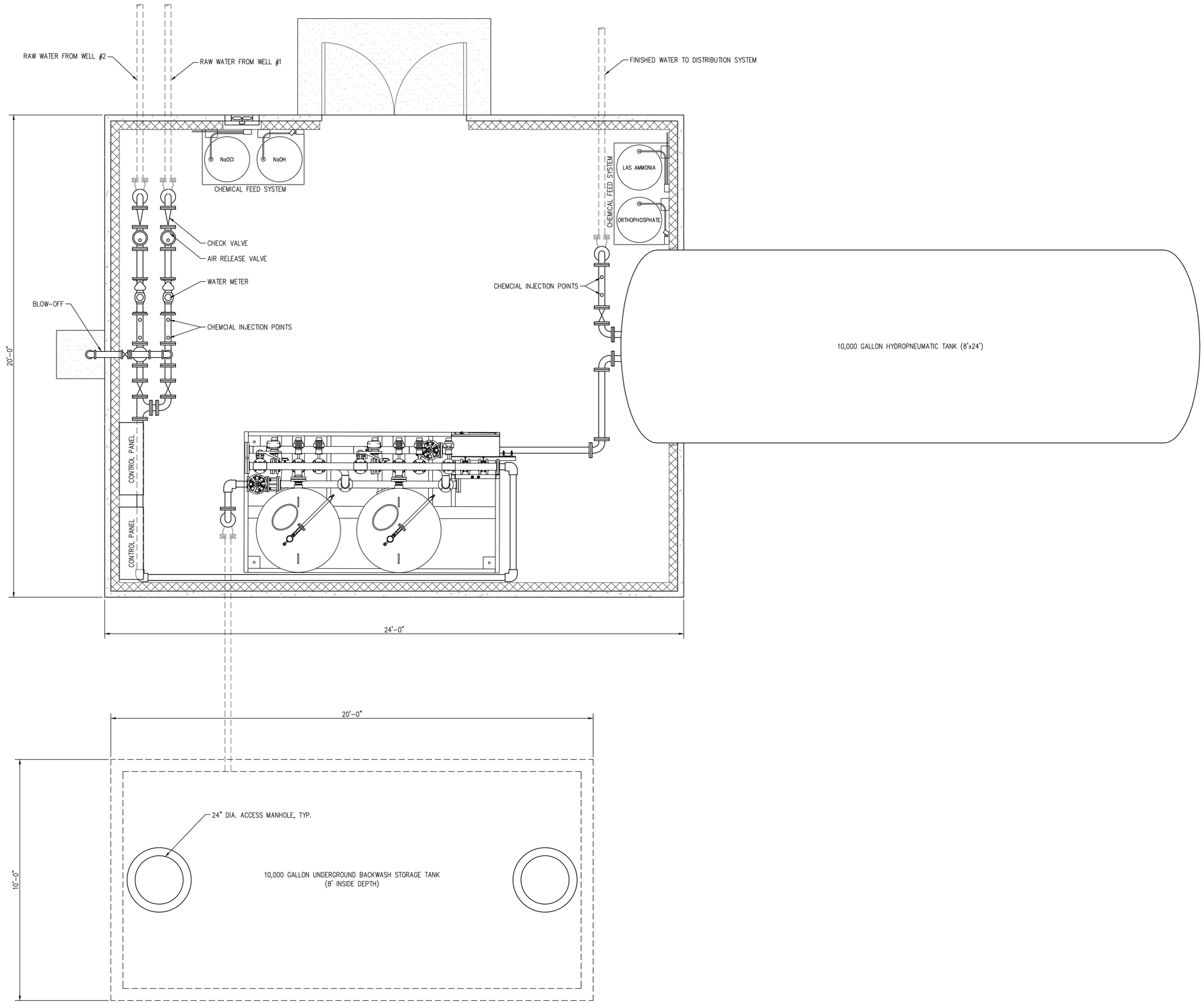
JOB No. 9372-04-001

DATE : DATE

FILE No. 9372-04-001_PER

SHEET 1 OF 2

P:\9372 - Founder's Bridge\9372-04-001 (ENG) - Water System\Engineering\Engineering Plans\9372-04-001-PER_SIT.dwg



FLOOR PLAN

SCALE: 1/2" = 1'

NOTE: THESE PLANS AND SPECIFICATIONS INCLUDE PROPRIETARY INFORMATION. REPRODUCTION OF THESE PLANS AND SPECIFICATIONS IS NOT AUTHORIZED WITHOUT THE WRITTEN CONSENT OF BOWMAN CONSULTING GROUP, LTD.

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- R *Respect the marks.*
- E *Excavate carefully.*

811

PRELIMINARY ENGINEERING REPORT

BUILDING FLOOR PLAN

FOUNDERS BRIDGE WATER STYSTEM

HUGUENOT MAGISTERIAL DISTRICT POWHATAN COUNTY, VA.

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Bowman CONSULTING

COUNTY PROJECT NUMBER

PLAN STATUS

DATE	DESCRIPTION

KMB	DWD	KMB
DESIGN	DRAWN	CHKD

SCALE H: AS NOTED V: N/A

JOB No. 9372-04-001

DATE : DATE

FILE No. 9372-04-001_PER

SHEET 2 OF 2

P:\9372 - Founder's Bridge\9372-04-001 (ENG) - Water System\Engineering\Engineering Plans\9372-04-001-PER_MCH.dwg

APPENDIX D

Water Well Completion Reports

Prepared By:

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