WILSON ENGINEERING
805 Dupont Street, Ste. #7, Bellingham, Washington 98225
Telephone: (360) 733-6100 • Facsimile: (360) 647-9061

MEMORANDUM

TO: Bill Hunter, PE, LWWSD

FROM: Brian Smith, PE and Ben Gibson, PE

SUBJECT: Fire Flow Improvements – Friction Factor Flow Testing

DATE: January 18, 2021, updated December 28, 2021 to include Attachment 2

Introduction

The District's 2017 Water System Plan identified a need for further calibration of the hydraulic model for the District's South Shore water system. The data and analysis contained in this technical memorandum are an effort to refine the Hazen-Williams C value used in the hydraulic model for the South Shore system. Doing so will help to calibrate the hydraulic model to more accurately reflect real-life system performance and identify needed improvements. Specifically, the results of this analysis will help to determine whether certain previously-identified areas within the South Shore system are capable of providing 500 gpm fire flows while maintaining 20 psi throughout the system. These areas (junctions J1428 and J1914 in the model) are discussed in further detail in the attached "LWWSD South Shore Fire Flow Analysis" technical memorandum, submitted to the District in May, 2018.

Executive Summary

Five unidirectional flush tests were performed on pipes within the District's South Shore water system. The collected data resulted in C values of 127, 127, 84, 126, and 105, for an average of 114. To be conservative, a C value of 100 is recommended for the Sudden Valley portion of the District's South Shore water system. This modifies the 2017 Water System Plan information in which a C factor of 70 was applied to the Sudden Valley portion of the water system. Reasons for the change are discussed in this report. The hydraulic model was updated to reflect the new recommendation of a C value of 100, and this change results in **all** of the fire hydrants within the South Shore system being capable of providing 500 gpm while maintaining 20 psi throughout the system, as required by DOH.

Analysis

Background

As part of the 2017 Water System Plan, some limited flushing data was collected and analyzed that resulted in the recommendation to apply a C value of 70 for the Sudden Valley portion of the distribution system (see Appendix E of WSP). The data collected represented only a small portion of the distribution system, and the flushing that was done was not unidirectional but instead occurred at a location near the pressure data logger. Because flushing was not unidirectional, the magnitude of the measured pressure drops was quite low, making it susceptible to system variabilities. For these reasons, it was decided for this current effort to collect additional data from portions of the distribution system where flushing could be unidirectional and headloss could be precisely quantified for a given segment of distribution pipe.

Data Collection

The general approach for collecting the data necessary for this analysis consisted of isolating a section of pipe to obtain unidirectional flow by closing the necessary valves, installing data loggers at two locations along the isolated pipe, and then flushing the line by opening a hydrant and monitoring the flowrate out of the hydrant. The data loggers recorded the water pressure at 30 second intervals before, during, and after the flush. The lines were flushed for a minimum of five minutes in order to stabilize the pressures and provide a sufficient dataset.

Flushing data was collected from five pipe sections within the South Shore system, as shown in Figure 1. These pipe sections are referred to in this analysis as Stable Lane, Jubilee, Sunnyside, Lost Lake, and Polo Park. District staff performed the flushes and data collection, and provided the data to Wilson Engineering.

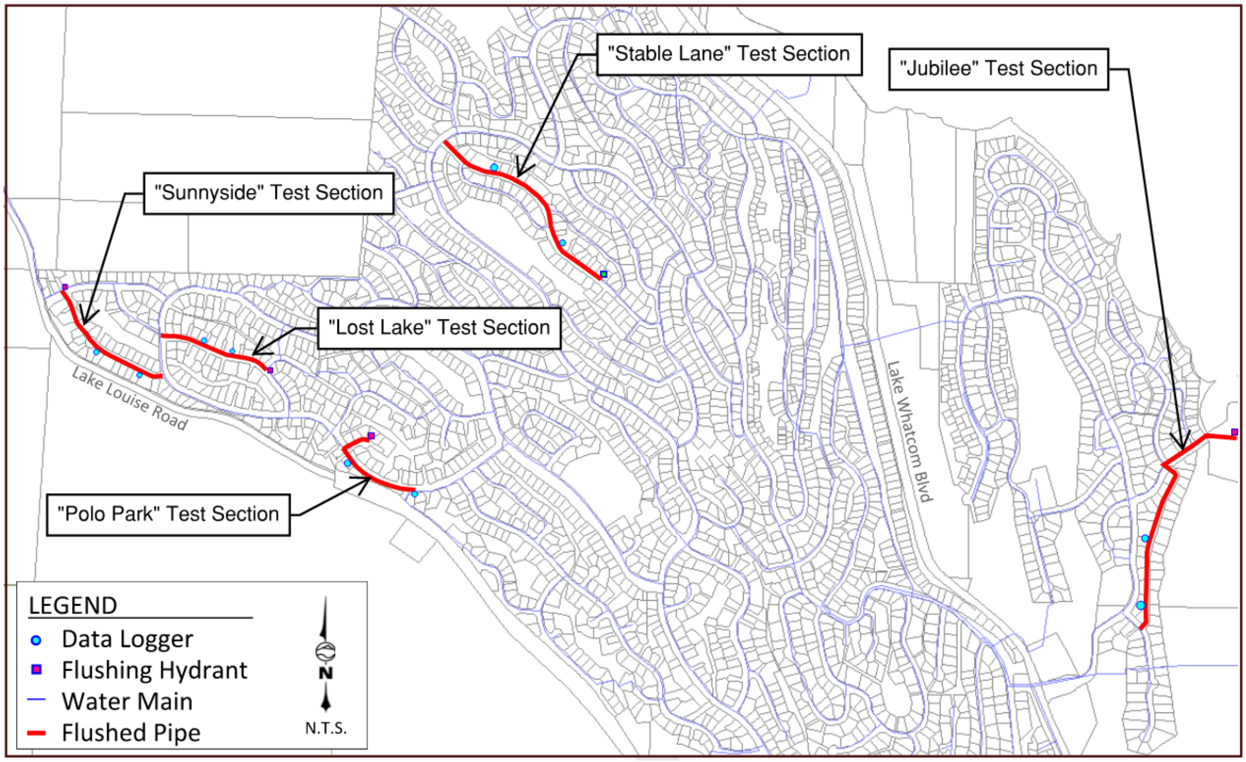


Figure 1 – LWWSD South Shore System Data Collection Locations

Figures 2-6 show graphs of the pressures recorded by each data logger before, during, and after the flush for each section of pipe (except for Sunnyside, where post-flush data is not available because the logger was removed from the hydrant immediately following the flush). In general these graphs show reasonable trends, with the exception of a few fluctuations in the recorded pressures. These outliers are most likely due to pressure transients, but could also be instances of pressure drops due to local demands (unlikely), or simply equipment issues. Whatever the case, these outliers were omitted when calculating average pressures before/after and during each flush.

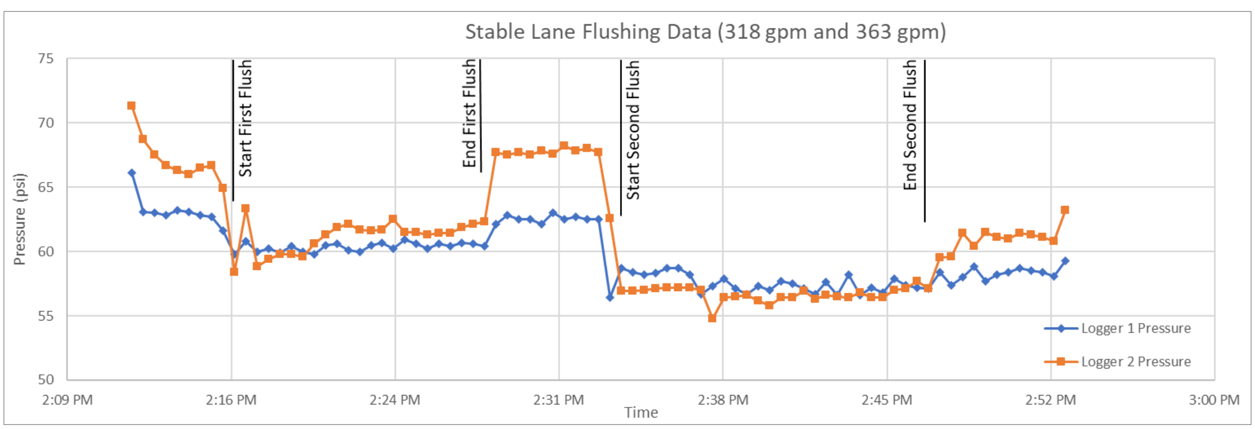


Figure 2 – Stable Lane Pressure Graph

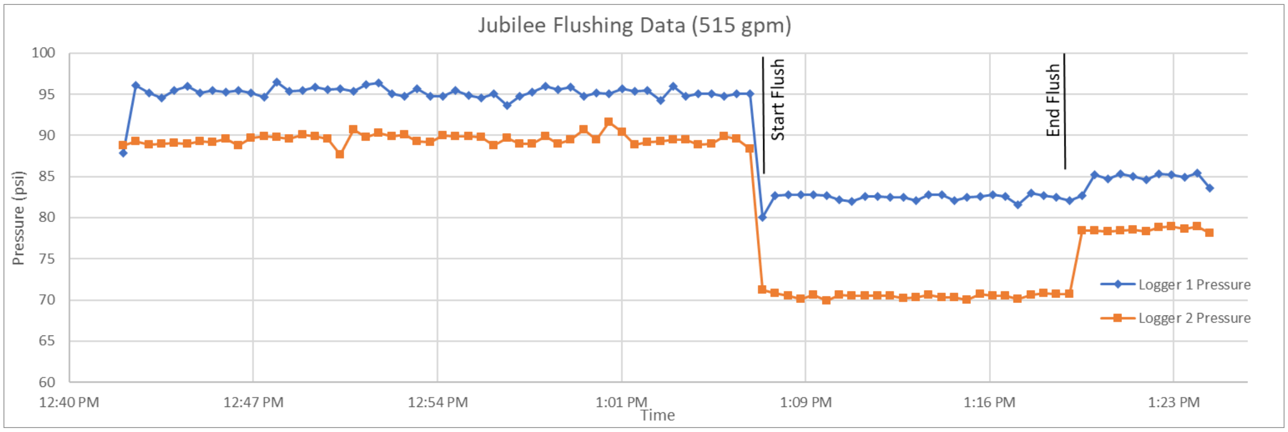


Figure 3 – Jubilee Pressure Graph

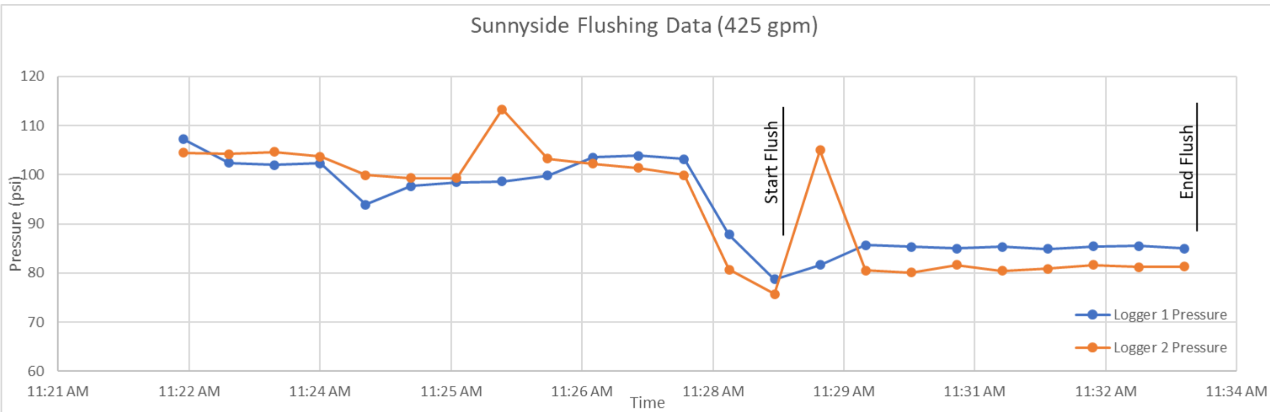


Figure 4 – Sunnyside Pressure Graph

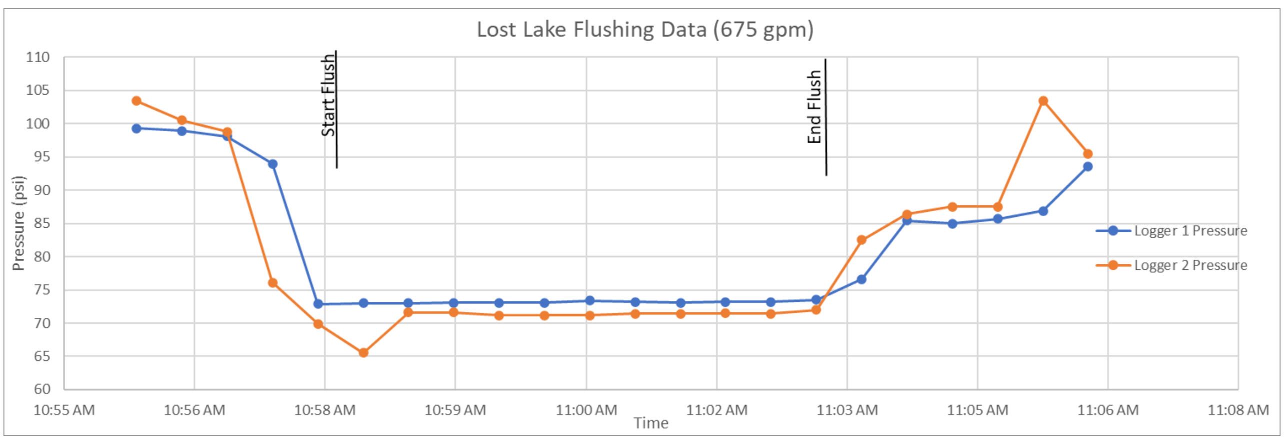


Figure 5 – Lost Lake Pressure Graph

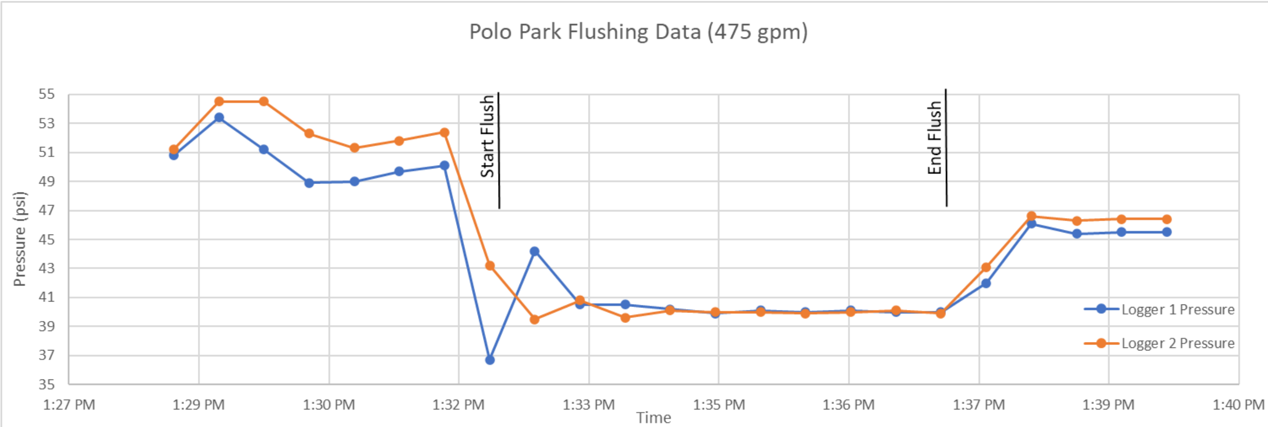


Figure 6 – Polo Park Pressure Graph

One interesting trend shown in Figures 2-6 is that the post-flush pressure consistently does not recover to the pre-flush pressure, at least not within the ~5 minutes that the logger remains in place after the flush. The primary explanation for this relates to the system's Pressure Reducing Valves (PRVs). With the exception of Stable Lane, all of these zones are fed through PRV stations that control zone pressures, and each station consists of two PRVs: a smaller one, which handles lower flows, and a larger one which handles the larger flows (fire flow). The larger PRV is set to a slightly lower downstream pressure than the smaller PRV so that the typical domestic demand preferentially goes through the smaller PRV. So, one explanation is that system pressures are regulated by the smaller PRV before the flush occurs, and then flushing triggers the larger PRV to control pressure during flush, and for some interval after the flush (the time for this depends on there being demand in the system and getting flow through the PRV station for the small PRV to regain control of the downstream pressure setpoint). Both pre- and post-flush pressures were taken into account when calculating recommended C values, which is discussed in further detail in the following *Headloss Calculations* section.

Data Reliability

In the flush tests at Stable and Jubilee (data collected in 2019), flow was measured as a volume with a meter, and the amount of time per 100 gallons was recorded. This seems to have resulted in a fairly accurate and precise flow rate. For the Sunnyside, Lost Lake, and Polo Park flushes (data collected in 2020), a different meter was utilized, which provided instantaneous flowrates instead of volume. This appears to have diminished the precision of the recorded flowrate. The observed flows were reported as a range with between 7% and 37% difference (presumably because the flow rate on the display was fluctuating between these values during the flush). As such, the mean value of the given range was utilized for headloss calculations.

It is worth noting that for future flush tests, it is important that the flow be recorded as accurately as possible during flushing. The formula for calculating headloss involves a multiplier of “velocity raised to the 1.85”, so any deviation in flow gets compounded and can significantly influence the results.

Headloss Calculations

The “observed” headloss for each section of pipe was derived using a form of Bernoulli’s equation with the recorded pressures from both data loggers before and after (averaged) and during the flush. Using this observed headloss, as well as the observed flow rate and known pipe characteristics, the C value for each pipe section was calculated using the Hazen-Williams equation, and are summarized in Table 1.

Table 1: Pipe Characteristics

	Stable Lane	Jubilee	Sunnyside	Lost Lake	Polo Park
Pipe Diameter	6 inch	6 inch	6 inch	6 inch	8 inch
Pipe Length (distance between data loggers)	900 ft	574 ft	405 ft	258 ft	448 ft
Average Observed Flowrate(s)[1]	318 gpm 363 gpm	515 gpm	425 gpm	675 gpm	475 gpm
Observed Headloss(es)[1]	8.88 ft 10.58 ft	13.70 ft	13.76 ft	9.79 ft	3.11 ft
Calculated C value[1]	**127**	**127**	**84**	**126**	**105**

1. Two flush tests were performed for Stable Lane. The resultant C values for both tests were then averaged.

As discussed previously, the recorded pressures after flushing (post-flush) are consistently lower than before flushing (by about 5-15 psi, with the only exception being Stable Lane 1, which makes sense because Stable Lane is fed by gravity from the Div 22 reservoir instead of through a PRV station). As such, separate headlosses were calculated based on the pre-flush, post-flush, and average pre/post-flush pressures (compared to average pressure during flushing). This resulted in a range of C values, which are summarized in Table 2. While calculations based on comparison to post-flush pressures is likely the most accurate given the previous description and concept that pressure during and immediately after the flush is controlled by the larger of the two PRVs in the PRV station, we analyzed the data and concluded that averaging the C values from pre- and post-flush pressures is slightly more conservative. Therefore these are the values that are reported in the Executive Summary. The only exception to this is the Sunnyside data because the data logger was removed immediately following the flush and no post-flush pressure data was collected.

Table 2 – C Values based on Pre-, Post-, and Average of Pre- and Post-Flush Pressures

<table>
<tr><th></th><th>Pre-Flush</th><th>Post-Flush</th><th colspan="2">Average Pre/Post</th></tr>
<tr><td>Stable Lane 1</td><td>137</td><td>115</td><td>125</td><td rowspan="2">127</td></tr>
<tr><td>Stable Lane 2</td><td>113</td><td>156</td><td>130</td></tr>
<tr><td>Jubilee</td><td>122</td><td>132</td><td colspan="2">127</td></tr>
<tr><td>Sunnyside</td><td>84</td><td>--</td><td colspan="2">--</td></tr>
<tr><td>Lost Lake</td><td>124</td><td>129</td><td colspan="2">126</td></tr>
<tr><td>Polo Park</td><td>100</td><td>109</td><td colspan="2">105</td></tr>
</table>

Discussion

The average of the calculated C values (bold values in Table 2) from the five flushing locations is 114. The Ductile Iron Pipe Research Association (DIPRA) recommends a C value of 140 for the design of new pipe networks, which they claim for cement lined pipe (a standard feature for ductile iron pipe since the 40's), is valid for the life of the pipe (*Cement-Mortar Linings for Ductile Iron Pipe,* DIPRA, 2017). However, for cast iron pipe, where cement lining has historically not been the norm, the C value declines over time due to tuberculation within the pipe. This could help to explain the broad range of resulting C values – particularly the lower values of 84 and 105. Based on a number of documented "full-circle" water main breaks in the South Shore system, it appears that portions of the system may be cast iron (which is more brittle than ductile iron, and thus more prone to full-circle breaks). Based on the collected data, we hypothesize that the tested portion of the Sunnyside main, and perhaps the Polo Park main, could be unlined cast iron pipe. Future flushing, data collection, and analysis could potentially be used to identify segments of cast iron pipe.

Summary of Previous Calibration Efforts

The current Water System Plan (updated 2017), Appendix E, addresses the most recent model calibration effort and resulting parameters, prior to this current effort. Flushing and data collection had been performed in Sudden Valley as part of that effort, and it resulted in a recommended C value of 70 for the Sudden Valley portion of the south shore system. The recommended C value for the Geneva portion of the south shore system remained 100.

For context, the previous flushing effort simply opened hydrants and recorded pressures and flows. It did not identify pipe segments that could be isolated to perform a unidirectional flush as the current data collection performed. It is expected that the unidirectional flushing as part of the current effort resulted in a greater magnitude of headloss during the flush and minimization of other factors that could influence the results and interpretation of results. Therefore, we recommend that the current data and analysis replace the previous analysis and recommendations.

Recommendations

Based on these findings, a C value of 100 is recommended for the entire South Shore system hydraulic model (Sudden Valley and Geneva). The value of 100 should be conservative (below the average measured value) and accounts for the possible mix of ductile iron and cast iron pipes within the system.

Impacts

The previous C value of 70 for the Sudden Valley portion of the South shore system resulted in an apparent system deficiency due to a number of fire hydrants that were unable to provide 500 gpm flow while maintaining the minimum system pressure of 20 psi. This is discussed in further detail in the "LWWSD South Shore Fire Flow Analysis" technical memorandum, attached for reference. Specifically, page 3 of the memo states:

> *"The reason these two junctions (hydrants) are currently problems is due to the newly-adjusted C factor for all pipes in Sudden Valley. The calibration effort described in the WSP determined that a C factor of 70 was appropriate for the limited areas where flow testing occurred. But pipes in the vicinity of Basinview and Highwood were not tested. It is possible that a C factor of 70 is not appropriate for these pipes. If the C factor in these vicinities is re-assessed and found to be 95 or greater, they will be capable of providing 500 gpm at 20 psi. Results for these scenarios are shown in Tables 3B-1 and 3C-1.*
>
> *If the C factor is assessed and found to be less than 95, there are segments of existing pipe near each of these hydrants that could be replaced with new 8-inch pipe that would solve the pressure issue. These would be on the order of a couple hundred feet of new 8-inch pipe for each."*

Therefore, since the appropriate C-factor was determined to be 100, the noted junctions (model nodes J1429 and J1914) are not problematic.

We updated the south shore hydraulic model to conform to this updated recommendation with a C-factor of 100 for the Sudden Valley portion of the South shore water system. We re-ran the hydraulic model to get fire flow results for LWWSD's use. These fire flow results are included in

Attachment 2 of this memo, and these should replace the results in Table E-2 of the current LWWSD Water System Plan (Appendix E).

Attachments:

- Attachment 1: Technical Memorandum – LWWSD South Shore Fire Flow Analysis, May 2, 2018
- Attachment 2: Updated fire flow hydraulic model results (these replace WSP Appendix E, Table E-2)

WILSON ENGINEERING
805 Dupont Street, Ste. #7, Bellingham, Washington 98225
Telephone: (360) 733-6100 • Facsimile: (360) 647-9061

MEMORANDUM

TO:	LWWSD – Bill Hunter, PE
FROM:	Brian Smith, PE and Melanie Mankamyer, PE
SUBJECT:	LWWSD South Shore Fire Flow Analysis
DATE:	May 2, 2018

Introduction

The recently submitted 2017 LWWSD Water System Plan indicated in Appendix E that there may be some hydrants in the system that cannot provide the required 500 gpm under Maximum Day Demand (MDD) while maintaining 20 psi pressure throughout the system. This evaluation analyzes the situation in further detail and presents potential projects to address specific issues.

The LWWSD South Shore system pressure is provided by gravity from water storage reservoirs (with two exceptions of small closed pressure zones fed by booster stations). In the Sudden Valley area, there are some services and hydrants near the storage reservoirs that have pressures below the required minimum pressures because of their proximity to the reservoirs, as explained in Appendix E of the WSP. This complicates the analysis of available fire flow rates to the system because some junctions are near or below the required 20 psi under MDD without fire flow demand.

The fire flow analysis results shown in Table E-2 indicated 32 junctions at which available fire flow was less than 500 gpm to maintain 20 psi throughout the system. The analysis shown there ignored junctions near the reservoirs that started with pressures below 20 psi.

Impact of Flowing 500 GPM

In order to assess the real impact to pressures throughout the water system under 500 gpm fire flow, this investigation assesses worst-case hydrants on a case-by-case basis and the lowest pressure junctions are analyzed. To provide a baseline, Table 1 shows junction pressures under MDD with no fireflow, ordered from lowest pressure to highest pressure. Only the first page of the model results are shown because the other 12 pages of results are not of interest to this analysis. Table 1 shows that three of the junctions have pressures below 20 psi without fire flow (J1288, J203, J1540). J1288 and J203 are near the Division 22 reservoirs, and J1540 is near the Division 7 reservoir. The map in Figure 1 depicts these locations and all locations of interest in the current investigation.

Because each of these junctions have static pressures less than 20 psi, they were not included in the analysis in Appendix E of the WSP. The automated fire flow analysis of the model was not able to compute fire flows based on these junctions limiting because they began below 20 psi.

Hydrants at Bases of Reservoirs

In order to see the impact to pressure that a fire flow event of 500 gpm would have at the base of each of the three reservoirs, the fire flow at these locations was manually entered into the model. Results can be seen in Tables 2A, 2B, and 2C. These Tables show that the first hydrant at the base of each of the reservoirs (J203, J1072, and J482) can provide 500 gpm with very little impact to system pressures. There are a few junctions that are below 20 psi, but the maximum decrease in pressure as compared to Table 1 is less than 1.5 psi at any of the junctions. So this impact is negligible and we can say that 500 gpm is available at each of these hydrants.

3 Other Hydrants

As explained in Appendix E of the WSP, there are three other hydrants in the zone fed by gravity from Division 22 that have potential issues. The first is J1822FH, a fire hydrant at the end of Kinglet Ct. It is high in elevation and at the end of a non-looped portion of 6-inch pipe. Table 3A shows the fire flow results if the model is forced at 500 gpm at this location. As indicated by the negative pressure, this hydrant cannot provide 500 gpm.

A second hydrant with an issue is J1428. Table 3B shows junction pressures if the flow rate at this hydrant is 500 gpm. System pressures are decreased and a couple are brought from above 20 psi to below 20 psi, but the lowest system pressure is 8.02 psi, so this does not depressurize the water system. In Table E-2 of the WSP, most of the 32 hydrants that were limited to less than 500 gpm were limited by J1428. In all of those scenarios, the pressure at J1428 would be brought below 20 psi at 500 gpm, but the pressure at all junctions would be higher than the worst-case scenario shown in Table 3B.

J1914 is the third hydrant with an issue. If it provides 500 gpm, junction pressures are shown in Table 3C. System pressures are decreased about the same amount as the scenario shown in Table 3B.

Potential Projects to Address Issues

As described previously, there are three areas where 500 gpm cannot be provided without significant pressure loss in the system. Potential methods of addressing each of these are discussed below.

J1822FH

For J1822FH (hydrant on Kinglet), a simple alternative would be to leave the hydrant as-is and either label the hydrant in a way to explain that it cannot provide 500 gpm or install some sort of orifice plates at each of the ports to limit flow so that it does not depressurize the system locally. Another simple alternative would be to remove this hydrant. The hydrant on Kinglet near the intersection of Kinglet and Sudden Valley Drive is approximately 600 ft from the farthest parcels at the end of Kinglet, so even with the J1822FH hydrant removed, this area would be in compliance with the District's standard hydrant spacing of 600 ft.

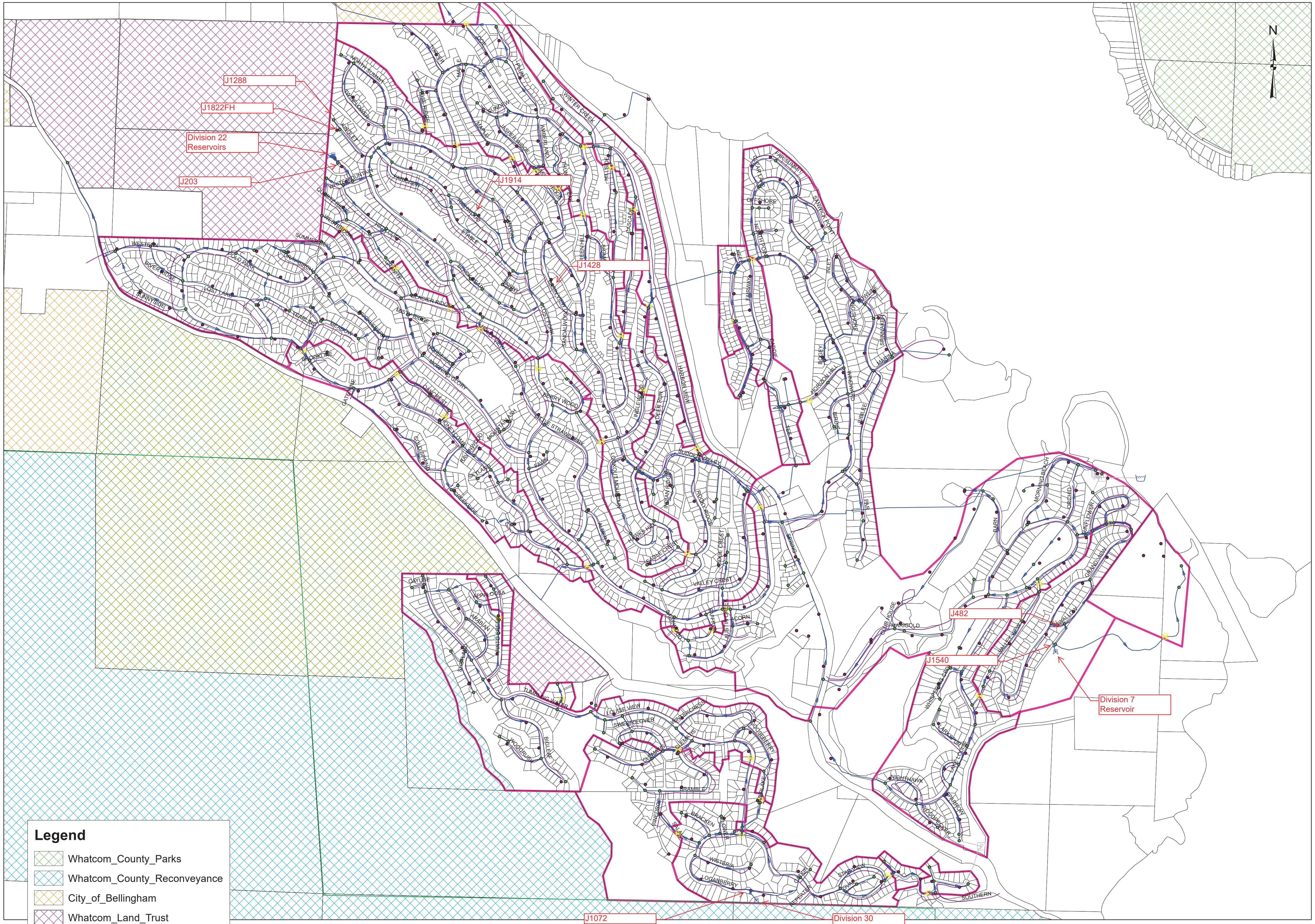
A second option could be to add an 8 inch pipe from the Division 22 reservoirs directly to this hydrant to create a loop. This would require a new easement and roughly 350 ft of 8 inch pipe, but would result in 500 gpm being available at J1822FH in a similar manner to the other hydrants at the bases of the reservoirs. Junction pressures for this scenario are shown in Table 3A-1.

J1428 and J1914

The reason these two junctions (hydrants) are currently problems is due to the newly-adjusted C factor for all pipes in Sudden Valley. The calibration effort described in the WSP determined that a C factor of 70 was appropriate for the limited areas where flow testing occurred. But pipes in the vicinity of Basinview and Highwood were not tested. It is possible that a C factor of 70 is not appropriate for these pipes. If the C factor in these vicinities is re-assessed and found to be 95 or greater, they will be capable of providing 500 gpm at 20 psi. Results for these scenarios are shown in Tables 3B-1 and 3C-1.

If the C factor is assessed and found to be less than 95, there are segments of existing pipe near each of these hydrants that could be replaced with new 8-inch pipe that would solve the pressure issue. These would be on the order of a couple hundred feet of new 8-inch pipe for each.

ATTACHMENT 1 - 2018 MEMO



SHEET 1 OF 1

DATE 3/12/2018

SCALE As Shown

JOB NUMBER 2016-096

LAKE WHATCOM WATER AND SEWER DISTRICT

WHATCOM COUNTY WASHINGTON

FIGURE 1 – SUDDEN VALLEY FIRE FLOW

Coordinate System:
State Plane Washington North
North American Datum 1983

Data Source:
City of Bellingham Public Works Dept.,
Whatcom County Planning & Assessor

WILSON ENGINEERING, LLC
805 DUPONT STREET
BELLINGHAM, WA 98225
(360)733-6100FAX(360)647-9061
www.wilsonengineering.com

Wilson
SURVEY/ENGINEERING

ATTACHMENT 1 - 2018 MEMO

Table 1

Junction pressures (MDD, transmission pumps off, no fireflow)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	825.48	11.47
2	☐	J203	0.00	800.00	827.30	11.83
3	☐	J1540	0.00	668.00	695.80	12.05
4	☐	J1072	2.90	1,003.00	1,050.05	20.39
5	☐	J1822FH	0.00	778.00	825.48	20.57
6	☐	J1847	0.00	780.00	828.14	20.86
7	☐	J482	0.85	643.63	695.65	22.54
8	☐	J768	0.49	771.38	826.43	23.85
9	☐	J602	0.24	770.35	826.43	24.30
10	☐	J54	1.33	763.82	826.46	27.14
11	☐	J1896	0.00	621.00	685.16	27.80
12	☐	J356	4.23	624.96	695.57	30.60
13	☐	J1428	1.09	748.96	821.07	31.25
14	☐	J566	5.82	613.00	685.14	31.26
15	☐	J276	2.78	747.08	820.98	32.02
16	☐	J592	1.69	745.84	821.00	32.57
17	☐	J1914	0.85	749.04	824.47	32.68
18	☐	J590	0.96	742.98	821.00	33.80
19	☐	J1620	0.00	824.81	903.38	34.05
20	☐	J502	2.29	736.59	821.09	36.61
21	☐	J1845	0.00	600.00	685.11	36.88
22	☐	J912	2.42	740.34	825.93	37.09
23	☐	J1900	2.90	470.00	556.94	37.67
24	☐	J1464	4.70	597.00	685.09	38.17
25	☐	J1054	3.14	605.35	694.61	38.68
26	☐	J1494	1.09	730.96	820.98	39.01
27	☐	J104	0.00	811.31	903.38	39.90
28	☐	J1394	2.42	726.45	821.78	41.31
29	☐	J1920	2.90	804.37	903.37	42.90
30	☐	J882	1.69	625.79	725.40	43.16
31	☐	J56	1.21	726.07	826.03	43.31
32	☐	J1482	0.00	625.06	725.41	43.48
33	☐	J1843	1.34	584.00	685.10	43.81
34	☐	J1272	0.00	797.55	898.74	43.85
35	☐	J1438	1.21	722.99	824.49	43.98
36	☐	J704	3.14	723.58	825.48	44.15
37	☐	J102	3.50	801.05	903.38	44.34
38	☐	J580	1.81	482.57	586.99	45.25
39	☐	J201	0.51	580.00	684.78	45.40
40	☐	J1882	0.67	580.00	684.82	45.42
41	☐	J448	0.00	480.78	586.46	45.79
42	☐	J1086	0.00	477.58	584.45	46.30
43	☐	J1924	1.81	712.03	822.21	47.74
44	☐	J1472	4.11	446.29	556.94	47.95
45	☐	J1004	0.00	611.15	721.84	47.96
46	☐	J1618	3.87	472.94	584.45	48.32
47	☐	J1672	0.00	677.35	789.85	48.75
48	☐	J185	0.00	572.00	685.01	48.97
49	☐	J1052	0.45	571.00	685.01	49.40
50	☐	J798	0.49	711.04	825.14	49.44

ATTACHMENT 1 - 2018 MEMO

Table 2A

Junction pressures (MDD, transmission pumps off, 500 gpm at J203 Div 22)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	823.14	10.46
2	☐	J203	500.00	800.00	824.96	10.81
3	☐	J1540	0.00	668.00	695.80	12.05
4	☐	J1822FH	0.00	778.00	823.14	19.56
5	☐	J1072	2.90	1,003.00	1,050.05	20.39
6	☐	J1847	0.00	780.00	828.11	20.85
7	☐	J482	0.85	643.63	695.65	22.54
8	☐	J768	0.49	771.38	824.09	22.84
9	☐	J602	0.24	770.35	824.09	23.28
10	☐	J54	1.33	763.82	824.12	26.13
11	☐	J1896	0.00	621.00	685.16	27.80
12	☐	J1428	1.09	748.96	818.73	30.23
13	☐	J356	4.23	624.96	695.57	30.60
14	☐	J276	2.78	747.08	818.63	31.00
15	☐	J566	5.82	613.00	685.14	31.26
16	☐	J592	1.69	745.84	818.66	31.55
17	☐	J1914	0.85	749.04	822.13	31.67
18	☐	J590	0.96	742.98	818.65	32.79
19	☐	J1620	0.00	824.81	903.38	34.05
20	☐	J502	2.29	736.59	818.74	35.60
21	☐	J912	2.42	740.34	823.59	36.07
22	☐	J1845	0.00	600.00	685.11	36.88
23	☐	J1900	2.90	470.00	556.94	37.67
24	☐	J1494	1.09	730.96	818.64	37.99
25	☐	J1464	4.70	597.00	685.09	38.17
26	☐	J1054	3.14	605.35	694.61	38.68
27	☐	J104	0.00	811.31	903.38	39.90
28	☐	J1394	2.42	726.45	819.44	40.29
29	☐	J56	1.21	726.07	823.69	42.30
30	☐	J1920	2.90	804.37	903.37	42.90
31	☐	J1438	1.21	722.99	822.15	42.96
32	☐	J704	3.14	723.58	823.14	43.14
33	☐	J882	1.69	625.79	725.40	43.16
34	☐	J1482	0.00	625.06	725.41	43.48
35	☐	J1843	1.34	584.00	685.10	43.81
36	☐	J1272	0.00	797.55	898.74	43.85
37	☐	J102	3.50	801.05	903.38	44.34
38	☐	J580	1.81	482.57	586.99	45.25
39	☐	J201	0.51	580.00	684.78	45.40
40	☐	J1882	0.67	580.00	684.82	45.42
41	☐	J448	0.00	480.78	586.46	45.79
42	☐	J1086	0.00	477.58	584.45	46.30
43	☐	J1924	1.81	712.03	819.86	46.72
44	☐	J1472	4.11	446.29	556.94	47.95
45	☐	J1004	0.00	611.15	721.84	47.96
46	☐	J1618	3.87	472.94	584.45	48.32
47	☐	J798	0.49	711.04	822.79	48.42
48	☐	J1672	0.00	677.35	789.85	48.75
49	☐	J185	0.00	572.00	685.01	48.97
50	☐	J1384	1.21	707.63	820.78	49.03

ATTACHMENT 1 - 2018 MEMO

Table 2B

Junction pressures (MDD, transmission pumps off, 500 gpm at J1072 Div 30

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	825.48	11.47
2	☐	J203	0.00	800.00	827.30	11.83
3	☐	J1540	0.00	668.00	695.80	12.05
4	☐	J1072	502.90	1,003.00	1,046.83	18.99
5	☐	J1822FH	0.00	778.00	825.48	20.57
6	☐	J1847	0.00	780.00	828.14	20.86
7	☐	J482	0.85	643.63	695.65	22.54
8	☐	J768	0.49	771.38	826.43	23.85
9	☐	J602	0.24	770.35	826.43	24.30
10	☐	J54	1.33	763.82	826.46	27.14
11	☐	J1896	0.00	621.00	685.16	27.80
12	☐	J356	4.23	624.96	695.57	30.60
13	☐	J1428	1.09	748.96	821.07	31.25
14	☐	J566	5.82	613.00	685.14	31.26
15	☐	J276	2.78	747.08	820.98	32.02
16	☐	J592	1.69	745.84	821.00	32.57
17	☐	J1914	0.85	749.04	824.47	32.68
18	☐	J590	0.96	742.98	821.00	33.80
19	☐	J1620	0.00	824.81	903.38	34.05
20	☐	J502	2.29	736.59	821.09	36.61
21	☐	J1845	0.00	600.00	685.11	36.88
22	☐	J912	2.42	740.34	825.93	37.09
23	☐	J1900	2.90	470.00	556.94	37.67
24	☐	J1464	4.70	597.00	685.09	38.17
25	☐	J1054	3.14	605.35	694.61	38.68
26	☐	J1494	1.09	730.96	820.98	39.01
27	☐	J104	0.00	811.31	903.38	39.90
28	☐	J1394	2.42	726.45	821.78	41.31
29	☐	J1920	2.90	804.37	903.37	42.90
30	☐	J882	1.69	625.79	725.40	43.16
31	☐	J56	1.21	726.07	826.03	43.31
32	☐	J1482	0.00	625.06	725.41	43.48
33	☐	J1843	1.34	584.00	685.10	43.81
34	☐	J1272	0.00	797.55	898.74	43.85
35	☐	J1438	1.21	722.99	824.49	43.98
36	☐	J704	3.14	723.58	825.48	44.15
37	☐	J102	3.50	801.05	903.38	44.34
38	☐	J580	1.81	482.57	586.99	45.25
39	☐	J201	0.51	580.00	684.78	45.40
40	☐	J1882	0.67	580.00	684.82	45.42
41	☐	J448	0.00	480.78	586.46	45.79
42	☐	J1086	0.00	477.58	584.45	46.30
43	☐	J1924	1.81	712.03	822.21	47.74
44	☐	J1472	4.11	446.29	556.94	47.95
45	☐	J1004	0.00	611.15	721.84	47.96
46	☐	J1618	3.87	472.94	584.45	48.32
47	☐	J1672	0.00	677.35	789.85	48.75
48	☐	J185	0.00	572.00	685.01	48.97
49	☐	J1052	0.45	571.00	685.01	49.40
50	☐	J798	0.49	711.04	825.14	49.44

ATTACHMENT 1 - 2018 MEMO

Table 2C

Junction pressures (MDD, transmission pumps off, 500 gpm at J482 Div 7)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	825.48	11.47
2	☐	J1540	0.00	668.00	694.90	11.65
3	☐	J203	0.00	800.00	827.30	11.83
4	☐	J1072	2.90	1,003.00	1,050.05	20.39
5	☐	J1822FH	0.00	778.00	825.48	20.57
6	☐	J1847	0.00	780.00	828.14	20.86
7	☐	J482	500.85	643.63	692.30	21.09
8	☐	J768	0.49	771.38	826.43	23.85
9	☐	J602	0.24	770.35	826.43	24.30
10	☐	J54	1.33	763.82	826.46	27.14
11	☐	J1896	0.00	621.00	685.16	27.80
12	☐	J356	4.23	624.96	692.23	29.15
13	☐	J1428	1.09	748.96	821.07	31.25
14	☐	J566	5.82	613.00	685.14	31.26
15	☐	J276	2.78	747.08	820.98	32.02
16	☐	J592	1.69	745.84	821.00	32.57
17	☐	J1914	0.85	749.04	824.47	32.68
18	☐	J590	0.96	742.98	821.00	33.80
19	☐	J1620	0.00	824.81	903.38	34.05
20	☐	J502	2.29	736.59	821.09	36.61
21	☐	J1845	0.00	600.00	685.11	36.88
22	☐	J912	2.42	740.34	825.93	37.09
23	☐	J1054	3.14	605.35	691.27	37.23
24	☐	J1900	2.90	470.00	556.94	37.67
25	☐	J1464	4.70	597.00	685.09	38.17
26	☐	J1494	1.09	730.96	820.98	39.01
27	☐	J104	0.00	811.31	903.38	39.90
28	☐	J1394	2.42	726.45	821.78	41.31
29	☐	J1920	2.90	804.37	903.37	42.90
30	☐	J882	1.69	625.79	725.40	43.16
31	☐	J56	1.21	726.07	826.03	43.31
32	☐	J1482	0.00	625.06	725.41	43.48
33	☐	J1843	1.34	584.00	685.10	43.81
34	☐	J1272	0.00	797.55	898.74	43.85
35	☐	J1438	1.21	722.99	824.49	43.98
36	☐	J704	3.14	723.58	825.48	44.15
37	☐	J102	3.50	801.05	903.38	44.34
38	☐	J580	1.81	482.57	586.99	45.25
39	☐	J201	0.51	580.00	684.78	45.40
40	☐	J1882	0.67	580.00	684.82	45.42
41	☐	J448	0.00	480.78	586.46	45.79
42	☐	J1086	0.00	477.58	584.45	46.30
43	☐	J1924	1.81	712.03	822.21	47.74
44	☐	J1472	4.11	446.29	556.94	47.95
45	☐	J1004	0.00	611.15	721.84	47.96
46	☐	J1618	3.87	472.94	584.45	48.32
47	☐	J1672	0.00	677.35	789.85	48.75
48	☐	J185	0.00	572.00	685.01	48.97
49	☐	J1052	0.45	571.00	685.01	49.40
50	☐	J798	0.49	711.04	825.14	49.44

ATTACHMENT 1 - 2018 MEMO

Table 3A

Junction pressures (MDD, transmission pumps off, 500 gpm at J1822FH Kinglet)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	773.90	-10.87
2	☐	J1822FH	500.00	778.00	773.90	-1.78
3	☐	J203	0.00	800.00	824.96	10.81
4	☐	J1540	0.00	668.00	695.80	12.05
5	☐	J1072	2.90	1,003.00	1,050.05	20.39
6	☐	J1847	0.00	780.00	828.11	20.85
7	☐	J768	0.49	771.38	821.75	21.82
8	☐	J602	0.24	770.35	821.75	22.27
9	☐	J482	0.85	643.63	695.65	22.54
10	☐	J54	1.33	763.82	821.80	25.13
11	☐	J1428	1.09	748.96	813.04	27.77
12	☐	J1896	0.00	621.00	685.16	27.80
13	☐	J276	2.78	747.08	812.95	28.54
14	☐	J592	1.69	745.84	812.98	29.09
15	☐	J1914	0.85	749.04	816.37	29.17
16	☐	J590	0.96	742.98	812.97	30.32
17	☐	J356	4.23	624.96	695.57	30.60
18	☐	J566	5.82	613.00	685.14	31.26
19	☐	J502	2.29	736.59	813.06	33.14
20	☐	J1620	0.00	824.81	903.38	34.05
21	☐	J912	2.42	740.34	820.71	34.83
22	☐	J1494	1.09	730.96	812.95	35.53
23	☐	J1845	0.00	600.00	685.11	36.88
24	☐	J1900	2.90	470.00	556.94	37.67
25	☐	J1394	2.42	726.45	813.75	37.83
26	☐	J1464	4.70	597.00	685.09	38.17
27	☐	J1054	3.14	605.35	694.61	38.68
28	☐	J104	0.00	811.31	903.38	39.90
29	☐	J1438	1.21	722.99	816.38	40.47
30	☐	J704	3.14	723.58	817.08	40.51
31	☐	J56	1.21	726.07	820.09	40.74
32	☐	J1920	2.90	804.37	903.37	42.90
33	☐	J882	1.69	625.79	725.40	43.16
34	☐	J1482	0.00	625.06	725.41	43.48
35	☐	J1843	1.34	584.00	685.10	43.81
36	☐	J1272	0.00	797.55	898.74	43.85
37	☐	J1924	1.81	712.03	814.18	44.26
38	☐	J102	3.50	801.05	903.38	44.34
39	☐	J580	1.81	482.57	586.99	45.25
40	☐	J201	0.51	580.00	684.78	45.40
41	☐	J1882	0.67	580.00	684.82	45.42
42	☐	J448	0.00	480.78	586.46	45.79
43	☐	J798	0.49	711.04	816.80	45.82
44	☐	J1086	0.00	477.58	584.45	46.30
45	☐	J1384	1.21	707.63	815.23	46.63
46	☐	J1386	1.45	707.43	815.20	46.70
47	☐	J1334	3.38	706.64	816.37	47.54
48	☐	J604	0.49	710.12	820.72	47.93
49	☐	J1472	4.11	446.29	556.94	47.95
50	☐	J1004	0.00	611.15	721.84	47.96

ATTACHMENT 1 - 2018 MEMO

Table 3B

Junction pressures (MDD, transmission pumps off, 500 gpm at J1428 Basinview)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	817.51	8.02
2	☐	J1428	501.09	748.96	770.17	9.19
3	☐	J203	0.00	800.00	824.96	10.81
4	☐	J1540	0.00	668.00	695.80	12.05
5	☐	J1822FH	0.00	778.00	817.51	17.12
6	☐	J592	1.69	745.84	787.00	17.83
7	☐	J276	2.78	747.08	789.72	18.47
8	☐	J590	0.96	742.98	789.75	20.27
9	☐	J1072	2.90	1,003.00	1,050.05	20.39
10	☐	J1847	0.00	780.00	828.11	20.85
11	☐	J768	0.49	771.38	821.74	21.82
12	☐	J602	0.24	770.35	821.73	22.26
13	☐	J482	0.85	643.63	695.65	22.54
14	☐	J502	2.29	736.59	791.56	23.82
15	☐	J54	1.33	763.82	821.80	25.13
16	☐	J1494	1.09	730.96	789.12	25.20
17	☐	J1896	0.00	621.00	685.16	27.80
18	☐	J1914	0.85	749.04	813.58	27.96
19	☐	J1394	2.42	726.45	796.40	30.31
20	☐	J356	4.23	624.96	695.57	30.60
21	☐	J566	5.82	613.00	685.14	31.26
22	☐	J1620	0.00	824.81	903.38	34.05
23	☐	J912	2.42	740.34	820.45	34.71
24	☐	J1845	0.00	600.00	685.11	36.88
25	☐	J1900	2.90	470.00	556.94	37.67
26	☐	J1924	1.81	712.03	799.22	37.78
27	☐	J1464	4.70	597.00	685.09	38.17
28	☐	J1054	3.14	605.35	694.61	38.68
29	☐	J1438	1.21	722.99	813.63	39.28
30	☐	J104	0.00	811.31	903.38	39.90
31	☐	J704	3.14	723.58	817.51	40.70
32	☐	J56	1.21	726.07	820.12	40.75
33	☐	J1386	1.45	707.43	805.96	42.70
34	☐	J1384	1.21	707.63	806.17	42.70
35	☐	J1920	2.90	804.37	903.37	42.90
36	☐	J882	1.69	625.79	725.40	43.16
37	☐	J1482	0.00	625.06	725.41	43.48
38	☐	J1843	1.34	584.00	685.10	43.81
39	☐	J1272	0.00	797.55	898.74	43.85
40	☐	J102	3.50	801.05	903.38	44.34
41	☐	J274	4.47	685.47	789.50	45.07
42	☐	J580	1.81	482.57	586.99	45.25
43	☐	J201	0.51	580.00	684.78	45.40
44	☐	J798	0.49	711.04	815.86	45.42
45	☐	J1882	0.67	580.00	684.82	45.42
46	☐	J1442	2.05	684.18	789.30	45.55
47	☐	J448	0.00	480.78	586.46	45.79
48	☐	J1086	0.00	477.58	584.45	46.30
49	☐	J1334	3.38	706.64	813.54	46.32
50	☐	J604	0.49	710.12	820.46	47.81

ATTACHMENT 1 - 2018 MEMO

Table 3C

Junction pressures (MDD, transmission pumps off, 500 gpm at J1914 Highwood)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	817.52	8.03
2	☐	J203	0.00	800.00	824.96	10.81
3	☐	J1540	0.00	668.00	695.80	12.05
4	☐	J1914	500.85	749.04	778.27	12.67
5	☐	J1822FH	0.00	778.00	817.52	17.13
6	☐	J1072	2.90	1,003.00	1,050.05	20.39
7	☐	J1847	0.00	780.00	828.11	20.85
8	☐	J768	0.49	771.38	821.74	21.82
9	☐	J602	0.24	770.35	821.73	22.26
10	☐	J482	0.85	643.63	695.65	22.54
11	☐	J54	1.33	763.82	821.80	25.13
12	☐	J1428	1.09	748.96	808.36	25.74
13	☐	J276	2.78	747.08	808.27	26.51
14	☐	J592	1.69	745.84	808.29	27.06
15	☐	J1896	0.00	621.00	685.16	27.80
16	☐	J590	0.96	742.98	808.29	28.30
17	☐	J356	4.23	624.96	695.57	30.60
18	☐	J502	2.29	736.59	808.38	31.11
19	☐	J566	5.82	613.00	685.14	31.26
20	☐	J1438	1.21	722.99	798.99	32.93
21	☐	J1494	1.09	730.96	808.27	33.50
22	☐	J1620	0.00	824.81	903.38	34.05
23	☐	J912	2.42	740.34	820.43	34.70
24	☐	J1394	2.42	726.45	809.07	35.80
25	☐	J1845	0.00	600.00	685.11	36.88
26	☐	J1900	2.90	470.00	556.94	37.67
27	☐	J1464	4.70	597.00	685.09	38.17
28	☐	J1054	3.14	605.35	694.61	38.68
29	☐	J104	0.00	811.31	903.38	39.90
30	☐	J704	3.14	723.58	817.52	40.70
31	☐	J56	1.21	726.07	820.12	40.75
32	☐	J1334	3.38	706.64	801.67	41.17
33	☐	J1924	1.81	712.03	809.50	42.23
34	☐	J1920	2.90	804.37	903.37	42.90
35	☐	J882	1.69	625.79	725.40	43.16
36	☐	J1482	0.00	625.06	725.41	43.48
37	☐	J1843	1.34	584.00	685.10	43.81
38	☐	J1272	0.00	797.55	898.74	43.85
39	☐	J1386	1.45	707.43	809.41	44.19
40	☐	J1384	1.21	707.63	809.90	44.32
41	☐	J102	3.50	801.05	903.38	44.34
42	☐	J1410	2.54	700.54	804.65	45.11
43	☐	J580	1.81	482.57	586.99	45.25
44	☐	J201	0.51	580.00	684.78	45.40
45	☐	J1882	0.67	580.00	684.82	45.42
46	☐	J798	0.49	711.04	815.89	45.43
47	☐	J448	0.00	480.78	586.46	45.79
48	☐	J1086	0.00	477.58	584.45	46.30
49	☐	J1434	2.65	699.30	808.18	47.18
50	☐	J604	0.49	710.12	820.45	47.81

ATTACHMENT 1 - 2018 MEMO

Table 3A-1

Junction pressures (MDD, transmission pumps off, 500 gpm at J1822FH Kinglet, new 8-inch pipe loop)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	826.11	11.75
2	☐	J203	0.00	800.00	827.38	11.86
3	☐	J1540	0.00	668.00	695.80	12.05
4	☐	J1072	2.90	1,003.00	1,050.05	20.39
5	☐	J1847	0.00	780.00	828.11	20.85
6	☐	J1822FH	500.00	778.00	826.11	20.85
7	☐	J482	0.85	643.63	695.65	22.54
8	☐	J768	0.49	771.38	826.62	23.93
9	☐	J602	0.24	770.35	826.62	24.38
10	☐	J54	1.33	763.82	826.64	27.22
11	☐	J1896	0.00	621.00	685.16	27.80
12	☐	J356	4.23	624.96	695.57	30.60
13	☐	J566	5.82	613.00	685.14	31.26
14	☐	J1428	1.09	748.96	821.39	31.38
15	☐	J276	2.78	747.08	821.30	32.16
16	☐	J592	1.69	745.84	821.32	32.70
17	☐	J1914	0.85	749.04	824.80	32.82
18	☐	J590	0.96	742.98	821.31	33.94
19	☐	J1620	0.00	824.81	903.38	34.05
20	☐	J502	2.29	736.59	821.41	36.75
21	☐	J1845	0.00	600.00	685.11	36.88
22	☐	J912	2.42	740.34	826.14	37.18
23	☐	J1900	2.90	470.00	556.94	37.67
24	☐	J1464	4.70	597.00	685.09	38.17
25	☐	J1054	3.14	605.35	694.61	38.68
26	☐	J1494	1.09	730.96	821.30	39.14
27	☐	J104	0.00	811.31	903.38	39.90
28	☐	J1394	2.42	726.45	822.10	41.45
29	☐	J1920	2.90	804.37	903.37	42.90
30	☐	J882	1.69	625.79	725.40	43.16
31	☐	J56	1.21	726.07	826.27	43.42
32	☐	J1482	0.00	625.06	725.41	43.48
33	☐	J1843	1.34	584.00	685.10	43.81
34	☐	J1272	0.00	797.55	898.74	43.85
35	☐	J1438	1.21	722.99	824.81	44.12
36	☐	J704	3.14	723.58	825.82	44.30
37	☐	J102	3.50	801.05	903.38	44.34
38	☐	J580	1.81	482.57	586.99	45.25
39	☐	J201	0.51	580.00	684.78	45.40
40	☐	J1882	0.67	580.00	684.82	45.42
41	☐	J448	0.00	480.78	586.46	45.79
42	☐	J1086	0.00	477.58	584.45	46.30
43	☐	J1924	1.81	712.03	822.53	47.88
44	☐	J1472	4.11	446.29	556.94	47.95
45	☐	J1004	0.00	611.15	721.84	47.96
46	☐	J1618	3.87	472.94	584.45	48.32
47	☐	J1672	0.00	677.35	789.85	48.75
48	☐	J185	0.00	572.00	685.01	48.97
49	☐	J1052	0.45	571.00	685.01	49.40
50	☐	J38	5.80	472.32	586.44	49.45

ATTACHMENT 1 - 2018 MEMO

Table 3B-1

Junction pressures (MDD, transmission pumps off, 500 gpm at J1428 Basinview, C = 95)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	821.97	9.96
2	☐	J203	0.00	800.00	826.28	11.39
3	☐	J1540	0.00	668.00	695.82	12.06
4	☐	J1822FH	0.00	785.00	821.97	16.02
5	☐	J1072	2.90	1,005.00	1,050.09	19.54
6	☐	J1428	501.09	748.96	795.45	20.14
7	☐	J1847	0.00	780.00	828.12	20.85
8	☐	J482	0.85	643.63	695.74	22.58
9	☐	J768	0.49	771.38	824.39	22.97
10	☐	J602	0.24	770.35	824.39	23.41
11	☐	J592	1.69	745.84	805.11	25.68
12	☐	J276	2.78	747.08	806.74	25.85
13	☐	J54	1.33	763.82	824.43	26.26
14	☐	J590	0.96	742.98	806.76	27.63
15	☐	J1896	0.00	621.00	685.14	27.79
16	☐	J1914	0.85	749.04	819.73	30.63
17	☐	J356	4.23	624.96	695.69	30.65
18	☐	J502	2.29	736.59	807.70	30.82
19	☐	J566	5.82	613.00	685.13	31.26
20	☐	J1494	1.09	730.96	806.38	32.68
21	☐	J1620	0.00	824.81	903.39	34.05
22	☐	J912	2.42	740.34	823.58	36.07
23	☐	J1394	2.42	726.45	810.47	36.40
24	☐	J1845	0.00	600.00	685.09	36.87
25	☐	J1900	2.90	470.00	556.95	37.67
26	☐	J1464	4.70	597.00	685.06	38.16
27	☐	J1054	3.14	605.35	695.14	38.91
28	☐	J104	0.00	811.31	903.39	39.90
29	☐	J1438	1.21	722.99	819.76	41.93
30	☐	J56	1.21	726.07	823.44	42.19
31	☐	J704	3.14	723.58	821.97	42.63
32	☐	J1920	2.90	804.37	903.38	42.90
33	☐	J1924	1.81	712.03	812.01	43.32
34	☐	J1843	1.34	584.00	685.08	43.80
35	☐	J1272	0.00	797.55	898.75	43.85
36	☐	J102	3.50	801.05	903.39	44.34
37	☐	J882	1.69	625.79	728.97	44.71
38	☐	J1482	0.00	625.06	728.97	45.03
39	☐	J580	1.81	482.57	587.01	45.26
40	☐	J201	0.51	580.00	684.67	45.35
41	☐	J1882	0.67	580.00	684.72	45.37
42	☐	J448	0.00	480.78	586.71	45.90
43	☐	J1086	0.00	477.58	585.55	46.78
44	☐	J1384	1.21	707.63	815.68	46.82
45	☐	J1386	1.45	707.43	815.55	46.85
46	☐	J798	0.49	711.04	821.03	47.66
47	☐	J1472	4.11	446.29	556.95	47.95
48	☐	J1004	0.00	611.15	723.27	48.58
49	☐	J1672	0.00	677.35	789.92	48.78
50	☐	J1618	3.87	472.94	585.55	48.79

Table 3C-1

Junction pressures (MDD, transmission pumps off, 500 gpm at J1914 Highwood, C=95)

		ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
1	☐	J1288	0.00	799.00	821.98	9.96
2	☐	J203	0.00	800.00	826.28	11.39
3	☐	J1540	0.00	668.00	695.82	12.06
4	☐	J1822FH	0.00	785.00	821.98	16.02
5	☐	J1072	2.90	1,005.00	1,050.09	19.54
6	☐	J1847	0.00	780.00	828.12	20.85
7	☐	J1914	500.85	749.04	799.44	21.84
8	☐	J482	0.85	643.63	695.74	22.58
9	☐	J768	0.49	771.38	824.39	22.97
10	☐	J602	0.24	770.35	824.39	23.41
11	☐	J54	1.33	763.82	824.43	26.26
12	☐	J1896	0.00	621.00	685.14	27.79
13	☐	J1428	1.09	748.96	817.10	29.52
14	☐	J276	2.78	747.08	817.05	30.32
15	☐	J356	4.23	624.96	695.69	30.65
16	☐	J592	1.69	745.84	817.06	30.86
17	☐	J566	5.82	613.00	685.13	31.26
18	☐	J590	0.96	742.98	817.06	32.10
19	☐	J1620	0.00	824.81	903.39	34.05
20	☐	J502	2.29	736.59	817.09	34.88
21	☐	J912	2.42	740.34	823.57	36.07
22	☐	J1845	0.00	600.00	685.09	36.87
23	☐	J1494	1.09	730.96	817.05	37.30
24	☐	J1900	2.90	470.00	556.95	37.67
25	☐	J1464	4.70	597.00	685.06	38.16
26	☐	J1438	1.21	722.99	811.35	38.29
27	☐	J1054	3.14	605.35	695.14	38.91
28	☐	J1394	2.42	726.45	817.48	39.44
29	☐	J104	0.00	811.31	903.39	39.90
30	☐	J56	1.21	726.07	823.44	42.19
31	☐	J704	3.14	723.58	821.98	42.64
32	☐	J1920	2.90	804.37	903.38	42.90
33	☐	J1843	1.34	584.00	685.08	43.80
34	☐	J1272	0.00	797.55	898.75	43.85
35	☐	J102	3.50	801.05	903.39	44.34
36	☐	J882	1.69	625.79	728.97	44.71
37	☐	J1482	0.00	625.06	728.97	45.03
38	☐	J580	1.81	482.57	587.01	45.26
39	☐	J201	0.51	580.00	684.67	45.35
40	☐	J1882	0.67	580.00	684.72	45.37
41	☐	J1924	1.81	712.03	817.68	45.78
42	☐	J448	0.00	480.78	586.71	45.90
43	☐	J1334	3.38	706.64	812.92	46.05
44	☐	J1086	0.00	477.58	585.55	46.78
45	☐	J798	0.49	711.04	821.04	47.66
46	☐	J1386	1.45	707.43	817.55	47.71
47	☐	J1384	1.21	707.63	817.81	47.74
48	☐	J1472	4.11	446.29	556.95	47.95
49	☐	J1004	0.00	611.15	723.27	48.58
50	☐	J1672	0.00	677.35	789.92	48.78

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

		ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
1	☐	J1428	501.09	569.72	J1428	20.00	22.53	20.00	569.72	20.00
2	☐	J1914	500.85	601.54	J1914	20.00	23.82	20.00	601.52	20.24
3	☐	J840	501.81	677.15	J840	20.00	32.43	20.00	677.15	20.01
4	☐	J998	500.00	707.93	J998	20.00	57.86	20.00	707.93	20.35
5	☐	J1272	500.00	712.36	J1272	20.00	31.39	20.00	712.36	20.16
6	☐	J1442	752.05	727.73	J1442	20.00	17.54	20.00	727.73	20.00
7	☐	J592	751.69	776.82	J1428	19.15	19.87	20.00	746.99	20.86
8	☐	J900	500.00	843.54	J996	5.64	55.98	20.00	759.27	37.97
9	☐	J996	503.98	763.26	J996	20.00	55.98	20.00	763.26	20.15
10	☐	J1284	751.45	767.02	J1284	20.00	20.58	20.00	767.02	20.00
11	☐	J1554	750.85	770.82	J1554	20.00	22.27	20.00	770.82	20.02
12	☐	J1052	750.45	792.76	J1052	20.00	22.76	20.00	792.76	20.09
13	☐	J980	750.67	1,127.11	J1052	-4.91	23.33	20.00	802.53	46.14
14	☐	J276	752.78	817.86	J1428	19.79	21.42	20.00	809.79	20.22
15	☐	J522	751.69	1,847.96	J1428	-6.14	21.48	20.00	811.02	55.87
16	☐	J1994	751.93	2,129.39	J1428	-14.37	21.48	20.00	811.27	70.28
17	☐	J1796	752.05	958.85	J1428	16.00	21.48	20.00	811.38	31.33
18	☐	J558	752.78	1,112.49	J1428	11.36	21.48	20.00	812.11	49.74
19	☐	J274	754.47	1,417.85	J1428	0.75	21.48	20.00	813.80	44.41
20	☐	J222	502.42	889.95	J996	8.00	59.54	20.00	814.06	32.41
21	☐	J532	752.65	1,334.09	J1428	4.02	21.64	20.00	819.20	38.68
22	☐	J498	501.45	819.49	J498	20.00	41.93	20.00	819.22	20.49
23	☐	J872	753.38	1,013.42	J1428	14.64	21.64	20.00	819.93	49.90
24	☐	J1724	750.85	931.01	J1428	17.07	21.70	20.00	820.26	33.46
25	☐	J1330	752.91	987.72	J1052	8.29	24.22	20.00	820.50	31.96
26	☐	J1484	501.81	841.28	J1484	20.00	41.74	20.00	841.28	20.01
27	☐	J788	752.42	1,214.45	J1428	10.41	22.15	20.00	843.17	40.90
28	☐	J502	752.29	1,031.44	J1428	15.06	22.16	20.00	843.77	25.06
29	☐	J1172	756.94	1,314.29	J1052	-15.10	25.74	20.00	853.48	55.25
30	☐	J1438	751.21	1,197.80	J1914	8.92	22.83	20.00	856.92	31.40
31	☐	J1460	751.45	858.96	J1460	20.00	27.56	20.00	858.95	20.00
32	☐	J1482	500.00	901.24	J1482	20.00	35.78	20.00	901.22	20.02
33	☐	J402	751.33	903.76	J402	20.00	35.04	20.00	903.76	20.15
34	☐	J1334	753.38	1,438.29	J1914	4.32	24.29	20.00	934.16	37.17
35	☐	J1394	752.42	1,349.03	J1428	10.12	24.10	20.00	954.08	29.90
36	☐	J630	753.26	1,025.38	J1428	18.40	24.10	20.00	954.93	24.81
37	☐	J1984	500.00	971.57	J1984	20.00	51.16	20.00	971.51	20.00
38	☐	J1670	500.00	971.62	J1670	20.00	45.52	20.00	971.62	20.00
39	☐	J410	750.00	1,459.30	J1428	6.74	24.95	20.00	971.94	52.08
40	☐	J210	750.00	1,022.89	J1428	18.74	24.95	20.00	971.94	22.63
41	☐	J1730	750.00	1,522.71	J1428	4.80	24.95	20.00	971.94	71.31
42	☐	J408	750.00	1,287.54	J1428	11.58	24.95	20.00	971.95	34.96
43	☐	J816	755.67	4,090.74	J1428	-54.24	24.19	20.00	984.04	111.31
44	☐	J272	750.90	986.46	J272	20.00	36.17	20.00	986.46	20.19
45	☐	J1480	501.45	1,007.25	J1480	20.00	43.44	20.00	1,007.17	20.35
46	☐	J182	750.00	3,939.94	J1428	-44.90	24.29	20.00	1,009.65	97.64
47	☐	J1246	500.00	1,017.62	J1246	20.00	56.31	20.00	1,017.56	20.22
48	☐	J1924	751.81	1,667.47	J1428	3.81	25.05	20.00	1,021.19	36.22
49	☐	J1548	750.00	1,659.19	J1428	7.97	24.63	20.00	1,030.02	49.05

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

	ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
50	J1324	750.00	2,733.02	J1428	-11.42	24.63	20.00	1,030.02	74.21
51	J1946	750.00	1,337.61	J482	18.62	21.07	20.00	1,038.47	36.60
52	J464	750.73	1,562.12	J482	17.41	21.07	20.00	1,039.20	52.42
53	J482	750.85	1,039.31	J482	20.00	21.07	20.00	1,039.31	20.00
54	J580	751.81	2,641.14	J482	11.89	21.07	20.00	1,040.27	44.12
55	J1054	753.14	1,127.41	J482	19.63	21.07	20.00	1,041.61	22.38
56	J454	500.00	1,042.54	J454	20.00	61.78	20.00	1,042.51	20.17
57	J356	754.23	1,639.52	J482	16.97	21.07	20.00	1,042.70	25.80
58	J742	751.09	2,777.36	J482	11.66	21.07	20.00	1,043.02	53.58
59	J164	500.00	1,915.62	J1428	-2.78	30.36	20.00	1,043.08	58.01
60	J400	755.67	1,651.47	J482	16.91	21.07	20.00	1,044.14	54.47
61	J1716	500.00	1,569.91	J1428	6.35	30.40	20.00	1,047.27	62.87
62	J1590	500.00	1,401.09	J1428	10.67	30.38	20.00	1,050.09	36.72
63	J1042	751.69	2,844.23	J482	10.79	21.07	20.00	1,058.88	49.06
64	J1156	753.14	3,526.14	J1428	-29.88	25.06	20.00	1,062.30	83.60
65	J606	751.33	2,657.78	J482	12.46	21.07	20.00	1,065.41	67.15
66	J1358	503.50	1,579.06	J1428	6.97	30.44	20.00	1,069.64	68.98
67	J199	750.26	1,079.64	J199	20.00	38.29	20.00	1,079.64	20.00
68	J784	753.02	2,101.06	J1428	-5.91	25.84	20.00	1,088.77	46.26
69	J912	752.42	1,088.87	J912	20.00	28.62	20.00	1,088.87	20.00
70	J32	750.00	2,301.56	J482	14.15	21.07	20.00	1,089.04	63.64
71	J768	750.49	1,089.55	J768	20.00	22.04	20.00	1,089.55	20.00
72	J160	752.78	2,324.82	J482	13.98	21.07	20.00	1,100.62	64.76
73	J712	753.74	2,908.97	J1428	-13.22	25.60	20.00	1,100.71	86.63
74	J158	752.78	2,372.80	J482	13.76	21.07	20.00	1,102.07	65.68
75	J448	750.00	2,519.45	J482	12.92	21.11	20.00	1,103.56	41.27
76	J1556	751.21	1,108.18	J1556	20.00	49.41	20.00	1,108.16	20.83
77	J728	751.33	1,281.36	J912	14.74	28.94	20.00	1,109.90	29.11
78	J1732	500.00	2,138.45	J1428	-4.79	30.53	20.00	1,110.47	84.40
79	J730	751.45	1,112.65	J730	20.00	44.20	20.00	1,112.65	20.45
80	J538	751.21	2,702.89	J482	12.16	21.07	20.00	1,112.66	65.06
81	J832	500.00	1,113.89	J832	20.00	59.35	20.00	1,113.89	20.09
82	J1204	750.85	2,690.18	J482	12.54	21.14	20.00	1,118.64	58.03
83	J1434	752.65	1,807.76	J1914	1.92	26.76	20.00	1,119.01	40.20
84	J1112	751.33	2,768.10	J482	11.52	21.17	20.00	1,119.21	47.80
85	J1050	501.93	1,385.55	J1482	5.22	38.36	20.00	1,124.15	34.88
86	J426	502.42	1,480.74	J1482	-2.35	38.42	20.00	1,133.29	45.75
87	J252	502.78	1,389.93	J1482	5.47	38.42	20.00	1,133.66	37.98
88	J278	750.49	3,191.69	J482	9.63	21.20	20.00	1,134.30	63.34
89	J38	755.80	1,842.87	J482	16.73	21.19	20.00	1,135.49	36.71
90	J1030	751.57	2,938.32	J482	10.74	21.20	20.00	1,138.65	52.94
91	J1410	752.54	1,429.99	J1914	13.36	26.98	20.00	1,139.90	31.53
92	J250	502.05	1,552.36	J1482	-7.97	38.49	20.00	1,141.03	56.17
93	J1694	750.36	1,141.37	J1694	20.00	44.38	20.00	1,141.37	20.00
94	J806	501.57	1,493.19	J1482	-2.64	38.50	20.00	1,141.67	53.63
95	J82	502.54	1,444.18	J1482	1.46	38.50	20.00	1,143.14	53.04
96	J544	502.29	1,450.97	J1482	0.90	38.51	20.00	1,143.64	54.19
97	J1048	503.50	1,598.82	J1482	-11.98	38.50	20.00	1,144.55	61.90
98	J302	502.29	1,657.28	J1482	-17.51	38.52	20.00	1,145.07	70.35

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

		ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
99	☐	J1584	504.71	1,509.37	J1670	1.27	47.42	20.00	1,147.63	38.69
100	☐	J324	502.65	1,533.78	J1482	-5.80	38.54	20.00	1,148.10	56.89
101	☐	J1174	501.33	1,427.56	J1482	3.14	38.55	20.00	1,148.39	50.93
102	☐	J700	750.00	2,654.85	J482	12.43	21.25	20.00	1,149.96	94.19
103	☐	J300	503.38	1,673.21	J1482	-18.57	38.55	20.00	1,150.36	73.23
104	☐	J628	501.81	1,651.99	J1482	-16.53	38.57	20.00	1,151.34	72.43
105	☐	J58	501.09	1,355.87	J1482	9.18	38.57	20.00	1,151.61	36.11
106	☐	J698	751.69	3,075.09	J482	10.18	21.25	20.00	1,151.65	100.91
107	☐	J1990	502.29	1,360.75	J1272	10.03	38.66	20.00	1,153.62	30.32
108	☐	J36	751.69	3,296.80	J482	9.18	21.26	20.00	1,154.31	72.73
109	☐	J1894	750.00	1,942.57	J482	16.28	21.26	20.00	1,154.34	71.66
110	☐	J1892	750.00	3,203.24	J482	9.56	21.26	20.00	1,154.34	95.36
111	☐	J598	501.21	1,368.51	J1482	8.51	38.63	20.00	1,158.14	41.43
112	☐	J600	501.81	1,526.52	J1482	-4.39	38.65	20.00	1,160.38	57.53
113	☐	J1064	750.73	1,614.81	J482	18.12	21.25	20.00	1,161.04	56.01
114	☐	J1062	750.73	2,902.45	J482	11.65	21.25	20.00	1,161.04	76.07
115	☐	J550	751.33	3,380.54	J482	8.70	21.28	20.00	1,163.74	76.76
116	☐	J1982	502.05	1,203.96	J1984	17.48	54.74	20.00	1,167.62	22.07
117	☐	J1238	752.24	1,173.24	J1238	20.00	65.34	20.00	1,173.23	20.69
118	☐	J1704	501.69	1,449.30	J1482	2.77	38.73	20.00	1,173.86	50.72
119	☐	J1384	751.21	1,185.30	J1384	20.00	37.30	20.00	1,185.30	20.02
120	☐	J1364	500.00	1,186.21	J1364	20.00	54.31	20.00	1,186.21	20.09
121	☐	J682	750.85	2,925.92	J482	11.80	21.31	20.00	1,187.85	84.34
122	☐	J1708	500.85	1,568.10	J1482	-6.93	38.94	20.00	1,189.75	47.06
123	☐	J868	753.14	4,179.37	J1428	-42.14	26.48	20.00	1,194.04	91.22
124	☐	J1476	757.85	3,301.97	J482	9.51	21.35	20.00	1,198.83	69.07
125	☐	J838	500.00	1,733.02	J840	-6.93	43.18	20.00	1,200.73	47.09
126	☐	J1414	750.00	2,771.32	J482	12.85	21.34	20.00	1,201.15	79.04
127	☐	J1232	751.79	1,201.73	J1232	20.00	38.48	20.00	1,201.73	20.01
128	☐	J1002	751.33	1,206.58	J1002	20.00	51.52	20.00	1,206.57	20.00
129	☐	J197	750.26	1,576.34	J199	-2.96	41.96	20.00	1,213.45	42.98
130	☐	J1104	751.57	2,102.65	J482	16.31	21.37	20.00	1,215.96	63.78
131	☐	J1310	500.00	1,221.27	J1310	20.00	49.64	20.00	1,221.18	20.00
132	☐	J1386	751.45	1,664.47	J1428	11.66	26.96	20.00	1,225.05	33.01
133	☐	J60	501.45	1,419.22	J1482	8.60	39.17	20.00	1,238.84	38.03
134	☐	J1448	500.00	1,507.24	J1482	3.84	38.77	20.00	1,241.12	29.28
135	☐	J858	500.00	2,419.89	J1482	-30.90	38.77	20.00	1,241.12	54.38
136	☐	J304	501.69	1,248.13	J304	20.00	66.98	20.00	1,248.13	20.00
137	☐	J1234	751.69	3,108.03	J1428	-16.08	27.39	20.00	1,249.69	59.05
138	☐	J908	500.00	1,258.18	J908	20.00	59.56	20.00	1,258.18	20.01
139	☐	J670	503.62	2,013.59	J1428	4.21	30.93	20.00	1,260.19	72.16
140	☐	J1928	751.79	1,265.14	J1928	20.00	41.55	20.00	1,265.13	20.01
141	☐	J1636	751.93	3,941.39	J1428	-32.29	27.05	20.00	1,267.12	74.29
142	☐	J442	750.00	1,396.96	J1428	17.28	28.91	20.00	1,275.16	24.82
143	☐	J1086	750.00	1,949.43	J1428	5.69	28.95	20.00	1,275.98	38.83
144	☐	J328	750.00	1,543.78	J1428	13.73	28.98	20.00	1,276.92	33.36
145	☐	J1616	750.00	1,831.06	J1428	7.70	29.05	20.00	1,278.50	51.08
146	☐	J412	750.00	1,828.38	J1428	7.78	29.08	20.00	1,279.01	60.12
147	☐	J726	750.00	1,888.22	J1428	6.72	29.11	20.00	1,279.50	55.34

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

		ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
148	☐	J1754	751.57	1,881.54	J1428	6.84	29.15	20.00	1,281.87	59.02
149	☐	J414	753.87	1,841.03	J1428	7.58	29.05	20.00	1,282.26	50.82
150	☐	J1536	751.93	1,625.03	J1428	11.94	29.18	20.00	1,282.66	31.58
151	☐	J1298	753.87	1,877.64	J1428	6.94	29.11	20.00	1,283.34	53.46
152	☐	J756	502.18	1,683.28	J840	2.22	43.88	20.00	1,287.77	40.60
153	☐	J1534	752.90	2,085.71	J1428	3.79	29.45	20.00	1,289.69	43.91
154	☐	J1106	751.57	1,295.55	J1106	20.00	86.45	20.00	1,295.53	21.63
155	☐	J526	501.33	1,295.77	J526	20.00	57.49	20.00	1,295.78	20.09
156	☐	J256	503.74	1,629.38	J1482	-5.39	39.86	20.00	1,297.24	46.21
157	☐	J1236	752.65	3,393.19	J1428	-20.70	27.75	20.00	1,298.91	64.59
158	☐	J1720	750.00	1,495.31	J1914	16.33	28.29	20.00	1,302.50	29.18
159	☐	J1566	750.00	3,474.71	J482	9.86	21.52	20.00	1,306.82	98.54
160	☐	J1998	750.00	2,417.21	J1428	-0.31	29.59	20.00	1,311.68	54.10
161	☐	J620	752.18	2,474.65	J1428	-0.89	29.60	20.00	1,315.70	56.38
162	☐	J116	754.26	1,865.12	J199	-13.36	43.99	20.00	1,316.15	53.38
163	☐	J1256	500.00	1,475.34	J1482	8.65	39.89	20.00	1,316.98	33.02
164	☐	J1058	750.67	1,322.10	J1058	20.00	53.47	20.00	1,322.11	20.64
165	☐	J144	750.00	2,392.76	J1428	0.34	29.68	20.00	1,322.30	77.30
166	☐	J142	751.33	2,282.22	J1428	1.61	29.69	20.00	1,323.81	73.80
167	☐	J702	750.00	1,930.18	J1428	6.88	29.70	20.00	1,324.04	62.90
168	☐	J1656	752.18	3,414.42	J1428	-19.92	27.41	20.00	1,324.28	49.08
169	☐	J496	753.02	2,429.83	J1428	-0.03	29.69	20.00	1,326.02	79.58
170	☐	J1662	500.00	1,792.99	J1482	-15.78	39.86	20.00	1,326.19	58.92
171	☐	J760	500.00	1,462.57	J1428	17.30	32.45	20.00	1,334.36	34.48
172	☐	J758	751.45	2,882.18	J1428	-5.31	29.80	20.00	1,335.67	96.18
173	☐	J946	751.21	2,813.23	J1428	-4.49	29.80	20.00	1,335.74	69.21
174	☐	J1544	753.02	2,370.03	J482	15.99	21.53	20.00	1,337.16	71.24
175	☐	J1996	751.21	2,174.37	J1428	3.72	29.87	20.00	1,343.49	47.89
176	☐	J1078	750.00	1,345.73	J1078	20.00	62.23	20.00	1,345.73	20.01
177	☐	J268	750.36	2,894.04	J1428	-5.07	29.93	20.00	1,348.44	75.56
178	☐	J1760	752.02	1,354.56	J1760	20.00	68.58	20.00	1,354.56	20.00
179	☐	J318	500.00	1,383.04	J1482	18.80	39.88	20.00	1,365.23	23.49
180	☐	J638	500.85	1,945.31	J1482	-22.26	39.88	20.00	1,366.08	68.48
181	☐	J1750	751.34	1,471.93	J1232	15.55	41.34	20.00	1,370.39	25.43
182	☐	J794	751.57	1,554.27	J1232	11.77	41.34	20.00	1,370.62	28.25
183	☐	J1592	752.42	2,859.34	J1428	-3.91	30.06	20.00	1,375.21	78.84
184	☐	J1452	752.65	2,453.90	J1428	0.77	30.06	20.00	1,375.44	74.75
185	☐	J746	750.85	2,979.80	J1428	-5.42	30.08	20.00	1,380.20	74.72
186	☐	J1854	751.09	1,637.15	J1460	7.41	43.47	20.00	1,381.15	32.43
187	☐	J1970	751.69	2,350.39	J482	16.35	21.57	20.00	1,382.02	71.58
188	☐	J1108	751.69	1,923.80	J1428	10.87	27.96	20.00	1,383.07	38.33
189	☐	J1496	500.00	2,054.73	J1428	7.16	31.26	20.00	1,384.87	69.55
190	☐	J62	501.57	1,452.58	J1002	15.53	65.49	20.00	1,390.92	24.90
191	☐	J430	753.59	3,337.97	J1052	-41.18	41.75	20.00	1,408.09	82.39
192	☐	J1568	750.49	2,145.41	J482	17.35	21.61	20.00	1,411.21	69.82
193	☐	J1398	751.81	3,240.46	J482	12.03	21.61	20.00	1,412.53	93.13
194	☐	J1318	750.00	2,938.67	J1428	-9.50	27.83	20.00	1,413.34	59.82
195	☐	J50	751.34	2,227.90	J199	-24.20	46.16	20.00	1,448.21	64.23
196	☐	J836	751.12	1,451.46	J836	20.00	46.34	20.00	1,451.46	20.02

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

	ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
197	J1308	505.19	1,730.80	J1310	7.83	51.27	20.00	1,451.65	31.79
198	J1828	501.69	2,853.05	J1482	-38.46	39.93	20.00	1,456.32	56.10
199	J1922	752.69	2,521.68	J1052	-30.28	40.36	20.00	1,457.00	70.29
200	J436	753.36	1,457.56	J436	20.00	77.07	20.00	1,457.55	20.31
201	J1952	751.81	3,047.97	J768	10.86	22.88	20.00	1,465.67	51.99
202	J52	751.57	1,469.84	J52	20.00	45.27	20.00	1,469.84	20.03
203	J490	500.00	1,570.67	J840	16.51	44.97	20.00	1,472.35	28.76
204	J280	751.69	1,922.85	J768	17.56	22.90	20.00	1,474.73	39.12
205	J1926	750.90	1,785.10	J1928	5.86	44.88	20.00	1,481.28	37.64
206	J1368	752.65	1,752.05	J768	18.63	22.91	20.00	1,487.23	36.78
207	J986	501.57	2,077.79	J1428	10.05	31.54	20.00	1,490.22	62.96
208	J584	753.02	1,593.49	J768	19.51	22.92	20.00	1,494.96	25.04
209	J1712	750.67	1,595.77	J272	14.80	49.38	20.00	1,495.80	25.20
210	J1644	750.85	1,496.78	J1644	20.00	53.66	20.00	1,496.78	20.00
211	J928	500.00	1,498.89	J928	20.00	71.85	20.00	1,498.89	20.00
212	J1096	751.12	2,386.64	J199	-29.35	46.83	20.00	1,499.15	71.89
213	J796	751.57	2,917.80	J768	10.92	22.93	20.00	1,501.41	43.33
214	J56	751.21	3,535.55	J768	5.59	22.93	20.00	1,501.56	38.41
215	J894	751.93	1,627.54	J768	19.38	22.93	20.00	1,501.77	25.06
216	J1136	753.14	1,598.01	J768	19.53	22.93	20.00	1,502.98	24.13
217	J704	753.14	2,889.08	J768	11.16	22.93	20.00	1,503.25	36.74
218	J54	751.33	2,105.60	J768	16.72	22.94	20.00	1,506.88	23.31
219	J822	500.49	1,855.66	J1482	-1.57	40.15	20.00	1,513.63	49.59
220	J416	500.00	2,014.20	J1364	-8.50	57.37	20.00	1,517.55	46.38
221	J80	500.70	1,846.97	J1364	1.86	57.37	20.00	1,518.25	47.57
222	J1678	501.57	1,744.60	J1364	7.87	57.37	20.00	1,519.13	38.12
223	J1818	502.29	1,949.89	J1364	-4.30	57.37	20.00	1,519.85	44.45
224	J286	751.93	3,344.81	J1428	-5.82	30.51	20.00	1,524.44	68.33
225	J234	752.69	3,516.88	J1052	-38.94	43.65	20.00	1,563.50	78.50
226	J694	751.34	2,591.59	J199	-35.43	47.62	20.00	1,567.01	80.43
227	J914	751.57	1,574.67	J914	20.00	88.24	20.00	1,574.67	20.01
228	J652	751.12	1,575.69	J652	20.00	41.27	20.00	1,575.69	20.00
229	J1758	500.00	1,576.70	J1758	20.00	85.69	20.00	1,576.70	20.00
230	J1860	502.18	2,106.91	J1484	-3.56	51.87	20.00	1,583.66	43.62
231	J1138	751.34	2,398.58	J199	-15.62	47.62	20.00	1,602.20	64.40
232	J1282	752.24	1,833.24	J199	11.59	47.85	20.00	1,610.60	38.52
233	J1182	750.45	1,841.50	J199	11.39	48.04	20.00	1,617.90	41.49
234	J1862	751.12	2,346.89	J199	-12.38	48.02	20.00	1,618.64	63.46
235	J1124	750.45	1,792.72	J199	13.50	48.12	20.00	1,622.53	35.56
236	J774	751.12	1,702.70	J199	17.18	48.19	20.00	1,629.40	25.58
237	J1834	751.57	1,965.32	J1928	6.22	46.53	20.00	1,636.69	35.61
238	J138	751.79	2,393.57	J199	-14.13	48.33	20.00	1,641.91	66.93
239	J140	751.79	2,205.97	J199	-4.28	48.33	20.00	1,641.91	59.81
240	J446	752.24	2,125.08	J52	-1.28	47.16	20.00	1,642.65	42.16
241	J1422	752.46	2,049.20	J1232	5.27	44.43	20.00	1,662.27	34.78
242	J690	500.00	1,664.16	J690	20.00	62.21	20.00	1,664.16	20.14
243	J874	501.93	1,681.17	J874	20.00	71.33	20.00	1,681.17	20.00
244	J586	750.90	2,137.79	J199	0.61	48.78	20.00	1,683.26	42.25
245	J1804	752.24	3,377.78	J1052	-25.84	45.41	20.00	1,693.31	64.24

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

		ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
246	☐	J738	752.46	1,710.96	J738	20.00	52.12	20.00	1,710.96	20.00
247	☐	J1512	750.00	3,427.12	J1428	-2.84	31.11	20.00	1,711.06	73.94
248	☐	J1486	750.00	2,131.63	J482	18.84	21.84	20.00	1,714.86	42.27
249	☐	J34	750.00	2,652.43	J482	17.12	21.84	20.00	1,714.86	63.24
250	☐	J846	752.46	1,824.49	J52	15.85	47.82	20.00	1,717.15	27.46
251	☐	J1400	759.30	2,890.90	J482	16.27	21.84	20.00	1,724.16	68.05
252	☐	J1120	500.00	1,725.17	J1120	20.00	75.19	20.00	1,725.17	20.05
253	☐	J1270	500.96	1,860.82	J840	15.97	45.89	20.00	1,725.91	29.91
254	☐	J1920	502.90	2,299.51	J840	1.39	45.89	20.00	1,727.84	36.90
255	☐	J102	503.50	2,407.72	J840	-2.56	45.89	20.00	1,728.44	41.45
256	☐	J1864	753.36	1,880.46	J436	5.27	84.11	20.00	1,730.77	35.48
257	☐	J922	751.57	2,102.07	J199	4.42	49.25	20.00	1,732.94	31.52
258	☐	J470	752.46	1,969.60	J52	10.84	47.99	20.00	1,736.55	36.12
259	☐	J1178	752.91	2,307.60	J498	3.51	37.97	20.00	1,753.98	63.18
260	☐	J462	753.59	3,147.98	J1052	-19.23	44.45	20.00	1,758.45	82.57
261	☐	J920	750.00	2,679.51	J199	-22.34	49.55	20.00	1,764.36	65.59
262	☐	J146	752.91	2,711.39	J199	-22.74	49.66	20.00	1,780.98	65.78
263	☐	J1524	750.00	3,442.47	J1428	-1.52	31.31	20.00	1,784.41	74.21
264	☐	J904	751.34	1,788.96	J904	20.00	73.75	20.00	1,788.95	20.00
265	☐	J1240	753.59	1,789.71	J1240	20.00	73.39	20.00	1,789.71	20.01
266	☐	J916	750.00	2,649.20	J199	-17.73	49.84	20.00	1,801.70	60.53
267	☐	J1960	750.00	1,814.57	J1960	20.00	82.53	20.00	1,814.57	20.28
268	☐	J1660	753.80	2,360.83	J498	4.23	38.67	20.00	1,815.48	62.67
269	☐	J148	752.91	2,709.27	J1928	-17.05	47.93	20.00	1,817.29	61.53
270	☐	J106	501.57	1,838.63	J768	19.91	24.18	20.00	1,819.47	20.89
271	☐	J460	500.00	2,865.17	J1482	-22.22	41.13	20.00	1,830.45	51.60
272	☐	J1606	501.57	2,888.98	J768	14.12	24.18	20.00	1,839.71	58.93
273	☐	J1430	753.13	2,747.06	J1052	-5.49	45.03	20.00	1,841.80	67.14
274	☐	J662	504.59	3,513.06	J768	9.90	24.17	20.00	1,845.82	70.33
275	☐	J1602	502.78	2,508.37	J1670	-11.92	51.08	20.00	1,847.77	51.93
276	☐	J1756	503.50	2,486.65	J768	16.75	24.19	20.00	1,855.73	49.04
277	☐	J1342	502.42	2,066.54	J908	8.79	63.49	20.00	1,867.61	30.56
278	☐	J312	750.00	3,661.20	J1052	-24.62	46.28	20.00	1,869.11	54.33
279	☐	J372	750.00	2,544.30	J482	18.24	21.92	20.00	1,869.78	46.35
280	☐	J1278	750.90	1,873.10	J1278	20.00	67.31	20.00	1,873.10	20.00
281	☐	J108	501.81	2,149.66	J1482	9.34	41.19	20.00	1,887.29	30.76
282	☐	J1728	500.00	2,384.48	J768	17.61	24.22	20.00	1,890.44	35.93
283	☐	J762	501.33	2,341.79	J1670	0.29	51.08	20.00	1,899.47	40.55
284	☐	J1166	500.73	3,117.32	J1670	-45.23	52.61	20.00	1,942.52	88.93
285	☐	J528	501.09	2,115.76	J768	19.25	24.25	20.00	1,947.45	27.35
286	☐	J964	752.02	1,981.11	J964	20.00	99.57	20.00	1,981.11	20.00
287	☐	J1230	504.34	3,390.83	J768	13.03	24.26	20.00	1,984.47	51.67
288	☐	J1840	500.00	2,962.68	J1670	-30.57	53.56	20.00	1,986.18	81.01
289	☐	J1938	753.74	3,414.50	J482	16.00	21.98	20.00	1,987.57	67.74
290	☐	J154	504.59	2,603.66	J768	17.33	24.22	20.00	1,988.08	45.82
291	☐	J1902	500.00	2,278.42	J1310	9.39	52.99	20.00	1,990.86	38.69
292	☐	J156	502.90	3,171.25	J768	14.56	24.22	20.00	2,003.38	68.72
293	☐	J1958	750.00	2,409.35	J498	9.61	41.57	20.00	2,006.07	50.63
294	☐	J1468	500.00	2,931.91	J1670	-26.59	54.02	20.00	2,009.23	70.82

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

		ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
295	☐	J724	751.79	2,772.59	J1232	-2.95	46.91	20.00	2,055.75	43.68
296	☐	J648	751.12	2,079.54	J648	20.00	78.03	20.00	2,079.54	20.00
297	☐	J1336	750.26	2,601.39	J1232	4.11	46.98	20.00	2,079.80	52.82
298	☐	J382	751.57	3,384.66	J1232	-25.00	46.98	20.00	2,081.11	72.45
299	☐	J902	751.85	2,117.19	J1232	19.00	46.98	20.00	2,081.39	22.10
300	☐	J346	751.57	3,153.73	J1232	-15.26	47.05	20.00	2,090.62	64.62
301	☐	J804	502.29	3,757.92	J768	11.49	24.29	20.00	2,125.41	62.24
302	☐	J1194	751.12	3,380.84	J1232	-19.27	47.34	20.00	2,168.29	67.90
303	☐	J1806	500.00	2,664.46	J1310	-2.48	53.26	20.00	2,172.25	52.89
304	☐	J952	503.14	2,372.17	J1670	12.78	56.86	20.00	2,183.12	29.36
305	☐	J676	503.98	3,377.58	J1428	5.64	33.09	20.00	2,185.30	72.64
306	☐	J1402	751.34	2,552.13	J652	9.17	44.61	20.00	2,207.96	30.87
307	☐	J1630	501.57	2,285.45	J1364	18.45	60.13	20.00	2,239.87	21.56
308	☐	J1904	500.73	2,930.87	J1310	-10.46	53.28	20.00	2,270.42	59.77
309	☐	J1634	752.24	3,732.81	J1052	-20.80	45.29	20.00	2,308.10	70.34
310	☐	J510	751.57	2,762.36	J652	4.80	45.00	20.00	2,342.42	36.22
311	☐	J988	750.90	2,503.74	J652	15.27	45.10	20.00	2,368.50	25.14
312	☐	J1876	502.42	2,800.77	J1310	3.16	54.24	20.00	2,377.01	44.10
313	☐	J1918	750.00	2,402.41	J1918	20.00	74.31	20.00	2,402.41	20.00
314	☐	J512	751.57	2,596.96	J652	13.52	45.18	20.00	2,409.85	28.45
315	☐	J710	752.91	3,069.12	J1052	3.42	47.81	20.00	2,431.13	38.58
316	☐	J910	752.02	2,432.38	J910	20.00	98.79	20.00	2,432.38	20.00
317	☐	J1654	755.82	2,950.43	J652	0.65	45.29	20.00	2,445.93	41.87
318	☐	J744	750.00	2,512.69	J648	19.13	80.95	20.00	2,495.65	20.90
319	☐	J1082	750.90	2,501.72	J1082	20.00	92.26	20.00	2,499.82	20.00
320	☐	J1530	750.45	2,824.97	J652	7.99	45.46	20.00	2,500.29	36.22
321	☐	J211	1,750.00	3,448.36	J1428	10.13	25.94	20.00	2,502.31	78.21
322	☐	J1696	750.00	2,691.10	J652	14.45	45.71	20.00	2,533.03	26.31
323	☐	J1944	751.12	3,040.83	J652	1.07	45.58	20.00	2,539.82	43.56
324	☐	J640	752.91	3,639.52	J1052	-5.95	45.95	20.00	2,564.54	47.71
325	☐	J926	751.34	2,576.79	J926	20.00	93.21	20.00	2,576.79	20.01
326	☐	J96	751.12	3,042.91	J652	3.82	45.76	20.00	2,601.48	43.86
327	☐	J16	751.57	3,187.97	J1232	8.35	48.84	20.00	2,680.99	39.20
328	☐	J68	751.57	2,700.54	J68	20.00	103.04	20.00	2,700.55	20.19
329	☐	J974	752.91	3,094.71	J1232	12.11	48.95	20.00	2,736.18	33.33
330	☐	J844	752.24	2,762.25	J844	20.00	83.93	20.00	2,762.25	20.01
331	☐	J548	753.59	4,062.11	J1052	-8.61	46.36	20.00	2,786.77	59.91
332	☐	J1843	751.34	2,799.72	J1843	20.00	41.42	20.00	2,799.72	20.04
333	☐	J812	751.57	3,475.08	J652	-2.69	46.32	20.00	2,825.94	48.76
334	☐	J818	752.02	3,940.00	J1052	-0.97	48.13	20.00	2,865.70	51.48
335	☐	J180	751.57	3,267.55	J652	6.65	46.48	20.00	2,869.34	37.19
336	☐	J70	751.79	3,291.19	J652	9.38	46.73	20.00	2,961.51	32.65
337	☐	J1214	751.79	3,819.51	J1052	4.34	47.98	20.00	3,004.13	40.58
338	☐	J72	753.80	3,098.83	J652	17.18	46.82	20.00	3,006.82	23.46
339	☐	J566	755.82	3,046.66	J566	20.00	30.19	20.00	3,046.64	20.06
340	☐	J1849	750.00	3,098.93	J1849	20.00	70.01	20.00	3,098.93	20.09
341	☐	J686	751.34	3,130.57	J686	20.00	52.83	20.00	3,130.57	20.00
342	☐	J1522	754.48	3,705.62	J566	16.60	30.27	20.00	3,193.64	29.14
343	☐	J244	752.24	3,442.06	J566	18.93	30.30	20.00	3,269.77	25.68

Attachment 2: Updated Fire Flow Model Results

REPLACEMENT Table E-2: South Shore Fire Flow Model Results

		ID	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)	Critical Pressure for Design Run (psi)	Hydrant Design Flow (gpm)	Hydrant Pressure at Design Flow (psi)
344	☐	J956	750.90	3,695.33	J566	17.37	30.31	20.00	3,282.54	32.12
345	☐	J1146	752.46	4,113.37	J1052	7.88	48.02	20.00	3,407.68	39.02
346	☐	J680	750.00	4,241.67	J566	14.66	30.58	20.00	3,431.98	47.03
347	☐	J1196	755.37	4,012.16	J566	16.41	30.58	20.00	3,433.76	35.83
348	☐	J440	752.69	3,630.05	J566	18.90	30.59	20.00	3,453.53	28.65
349	☐	J1896	750.00	2,725.65	J272	61.06	61.06			