SPF WATER ENGINEERING

TECHNICAL MEMORANDUM

DATE: January 29, 2020

TO: Brian Yeager, P.E., P.L.S., City of Hailey

FROM: Scott McGourty, P.E., SPF

CC: Mike Boeck, P.E., SPF

PROJECT NO: 330.0351

RE: Northridge Area Pressure Study – Summary of Results

Executive Summary

In January 2019, the City of Hailey, Idaho (the City) retained SPF Water Engineering (SPF) to conduct a study of water pressures in the City's water distribution system, with a specific geographic focus on the Northridge and Old Cutters areas (the Study Area). The overall goals of the study were to; 1) gain a better understanding of how the existing water system operates and what range of pressures customers are likely to experience, 2) identify system deficiencies that result in low pressures within the Study Area, and 3) develop solutions for improving pressures in the Study Area. The results of the study are presented in four parts, as follows:

1. **Part 1 – Field Data Collection and Review** The study first gathered field data from the water system including service line pressure and water meter data from residential locations, and other system data on the City's water system equipment such as tank levels and pump operating criteria. Water system data were evaluated for completeness, and sufficiency in performing hydraulic analysis. The data were determined to be complete and sufficient for use in hydraulic modeling. See SPF, 2019a (enclosed).

2. **Part 2 – Hydraulic Model Calibration** The hydraulic model was calibrated using water system data gathered during Part 1. The goals of the hydraulic model were to assure reasonably accurate representation of the City's water system, and to identify the "worst case" scenario for low pressures within the study area. The hydraulic model was calibrated to a high degree of accuracy (as measured by several metrics) through simulating eight scenarios observed in the field data. A worst-case scenario was also identified and simulated. See SPF, 2019b (enclosed). The worst-case scenario identified in Part 2 was subsequently revised during Part 4 to reflect slightly different conditions with the potential to result in even lower pressures.

3. **Part 3 – Conceptual Improvement Alternatives** The calibrated model from Part 2 was used to simulate over two dozen potential system improvements and the anticipated impacts to minimum pressures within the Study Area. A wide range of improvements were considered including a variety of piping and valve modifications,

additional pumps, and additional supply well at various locations throughout the City. Part 3 also presented a cost versus performance analysis for the alternatives. See SPF, 2019c (enclosed).

4. **Part 4 – Recommended Improvements** Part 4 consists of further discussion of three selected alternatives, and evaluation of these alternatives against a revised version of the worst-case scenario identified in Part 2. Part 4 provides recommendations for implementing three alternatives; construction of a new 16-inch pipeline, modification of pump controls, and a new supply well. See SPF, 2020a (enclosed).

Enclosed (4):

Part 1 – SPF, 2019a. Northridge Area Pressure Study – Field Data Review. Prepared for the City of Hailey, October 2019.

Part 2 – SPF, 2019b. Northridge Area Pressure Study – Hydraulic Model Calibration. Prepared for the City of Hailey, November 2019.

Part 3 – SPF, 2019c. Northridge Area Pressure Study – Conceptual Improvement Alternatives. Prepared for the City of Hailey, December 2019.

Part 4 – SPF, 2020a. Northridge Area Pressure Study – Recommended Improvements. Prepared for the City of Hailey, January 2020.

MEMORANDUM

DATE: October 23, 2019

TO: Brian Yeager, P.E., P.L.S., City of Hailey

FROM: Scott McGourty, P.E., SPF, Eric Landsberg, P.E., SPF

PROJECT NO: 330.0350

RE: Part 1: Northridge Area Pressure Study – Field Data Review

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1.0 Introduction

The City of Hailey, Idaho (the City) has commissioned a study of water pressures in the City's public drinking water distribution system, with a specific geographic focus on the Northridge Area. The Study Area is bounded by West Meadow Drive to the north, by Kintail Lane and Heroic Road to the east, by McKercher Boulevard to the south, and by North 2nd Avenue to the west.

The purpose of the study is to identify portions of the City's water distribution system within the study area that may experience low water pressure and to quantify the intensity, frequency, potential causes, and possible options to increase pressures. This memorandum has been prepared by SPF Water Engineering (SPF) to summarize the results the City's water system performance based on field measurements conducted by City staff from August to September 2019.

Pressure is both a regulatory and aesthetic criterion for public drinking water distribution systems. In terms of regulatory requirements, the Idaho Department of Environmental Quality (IDEQ) specifies minimum pressures which must be met during specific conditions (Idaho Administrative Procedure Act [IDAPA] 58.01.08.552.01.b.i-v). Regulatory requirements for pressure include a minimum of 40 pounds per square inch (psi) during peak hour demand (PHD) conditions, and 20 psi during fire flow events plus maximum day demand (FF+MDD). Public drinking water systems may provide higher pressure subject to a maximum of 80 psi per IDAPA.

Beyond regulatory requirements, water pressure as experienced by customers is also an aesthetic matter with preferences varying by community. IDEQ required minimum pressures are specified at the point of connection to the distribution system (typically on the municipal side of the service line, or at the water meter), however several factors influence the actual pressure experience at the point of use on private property.

The goal of this memorandum is to establish a baseline understanding of current system performance to provide stakeholders including water customers, City Staff, and local public

officials with additional data to determine appropriate system performance goals and potential solutions for increasing pressure where desired. The final engineering deliverable as part of the study will incorporate the field measurements into a hydraulic model of the City's water distribution system, and will be submitted to the City under separate cover.

2.0 Method

SPF Water Engineering and the City of Hailey Public Works Department have targeted a geographic area of the City of Hailey for detailed engineering analysis based on reports of low pressure by water customers. The scope of this study included a limited field effort (the field study) to record water system performance parameters at selected locations throughout the study area. The residential monitoring locations were selected based on a review of the City's infrastructure layout with the goal of obtaining optimal coverage of the geographic area and water system infrastructure within the study area. The field data were gathered by City staff and reviewed by SPF. SPF also reviewed additional system monitoring data provided by the City from the water system supervisory control and data acquisition (SCADA) system which included parameter such as storage tank levels, supply flow rates, and booster pump operating logs (pressure and flow rates), and recent water demand data in the form of water meter billing data dating from June 27, 2019 to October 1, 2019.

The field study involved the following:

1. temporary installation of pressure data loggers at eight locations (residential monitoring locations) within the study area:
    1. 440 W Meadow Drive
    2. 710 Kintail Drive
    3. 1710 Northridge Drive
    4. 1740 2nd Avenue North
    5. 1320 Heroic Drive
    6. 1420 2nd Avenue North
    7. 154 South Hiawatha Drive
    8. 158 South Hiawatha Drive
2. flow testing of service lines at the residential monitoring locations

The residential monitoring locations are shown on Figure 1.

Residential monitoring locations were monitored in pairs of two (locations 1&2, 3&4, 5&6, 7&8) for approximately one week for each pair. Pressure data loggers were installed in the service line at each residential monitoring location, which required temporary removal of the water meter. At the end of each monitoring period (approximately one week), the pressure data loggers were removed from the water service line, the water meter reinstalled, and the pressure data loggers were installed in the service lines of the next residential monitoring location pair.

Flow testing involved full flow test of the service line capacity at each residential monitoring location, and recording of the flow rate, residual pressure, estimated pipe length from the distribution main to meter vault, and service line size. The full flow test involved opening a temporary valve installed on the service line to full throttle.

The field study data as well as the SCADA data from July 1, 2016 to October 2, 2019 were transmitted electronically by the City to SPF.

3.0 Data Analysis

The data reviewed as part of this study are grouped into the following categories:

1. Field study data (eight residential monitoring locations)
    - Pressure at point of delivery to service lines
    - Service line flow test data
2. Water meter billing data (eight residential monitoring locations)
3. SCADA data
    - Pump station flow and pressure data
        - Northridge, 3rd Avenue, Woodside, River Street
    - Storage tank level data
        - Turbine and Quigley tanks
            - Tank levels, inflow, outflow
    - Sources
        - Indian Springs

The review of the data followed the following general process:

1. Quality control review
2. Statistical summary
3. Analysis of cyclic and temporal trends
4. Correlation evaluation
5. Data interpretation

Quality Control Reivew

The first step of the data review involved identifying an appropriate quality control rubric. The goal of the quality control review is to identify whether the data gathered are adequate in both quantity and quality to support stakeholders involved in decision making processes during the next steps of the pressure evaluation study.

The following five metrics are proposed for evaluating the overall quality of the data; data quality, data sufficiency, comparability, consistency, and completeness. The criteria of the data evaluation rubric for each metric are discussed below.

Table 1

Data Quality Control Rubric

Parameter	Description and Objectives
1. Quality	Determine whether data were collected at the proper times/intervals and whether appropriate procedures were employed.
2. Sufficiency	Determine if the minimum number of data/measurements (electronic equipment).
3. Comparability	Evaluate the degree to which data recorded at in the field appear to be consistent with the magnitude and range of similar SCADA measurements. Include any system outages or events in this comparison.
4. Consistency	Evaluate the continuity, standard deviation, and range of data measurements for individual data collection sources.
5. Completeness	Evaluate whether a sufficient number of data points exist to make a valid decision for compliance determination.

Data Quality

Field data were logged by the dynamic pressure recorder at a time interval of 2 minutes. A 2-minute resolution is more than adequate to evaluate temporal trends at a wide range of scales including, hourly, daily, and monthly. The SCADA data are logged at a time interval of 15 minutes. A 15-minute resolution is adequate to support evaluation at a wide range of scales ranging from hourly to monthly. Based on information regarding the routine maintenance and calibration practices employed by the City in the general upkeep and operation of the water system data recording equipment (including flow meters, transducers, and electronic logging devices), and the high resolution of the data points, the overall quality of the data for this study appears to be adequate to the support the anticipated use of the study results (use in infrastructure planning and policy decisions by the City of Hailey and public stakeholders).

Data Sufficiency

A total of sixteen parameters were recorded by the SCADA system for use in the Northridge pressure study:

- Time and date
- River Street pump station flow
- Quigley Tank level
- 3rd Avenue pump station flow
- 3rd Avenue pump station discharge pressure
- Northridge pump station discharge pressure
- Northridge pump station flow

- Northridge Well 1 flow
- Northridge Well 2 flow
- Northridge Well 3 flow
- Woodside pump station discharge pressure
- Woodside pump station flow
- Indian Springs Flow
- Turbine Tank level
- Turbine Tank outflow rate
- Turbine Tank Inflow rate

Residential monitoring location data included the following eight parameters:

- Location
- Time and date
- Residual pressure
- Flow rate
- Distance from distribution main to meter vault
- Service line size
- Dynamic pressure
- Meter totalizing data

These parameters were selected based on general engineering principals and their applicability to hydraulic modeling. The residential monitoring data were gathered from eight locations as discussed in Section 2 based on spatial and infrastructure coverage. These parameters are sufficient to complete an evaluation of the observed behavior of the hydraulic system in the Northridge area.

Data Comparability

Figures 2-17 (enclosed with this memo) present pressures recorded by the dynamic pressure loggers at each residential monitoring location compared to the pressures recorded by the City's SCADA system. All pressures are presented on a scale from 40-80 psi over the course of the study period. The graphs for both the SCADA equipment and the field monitoring equipment display a high degree of correlation, the same general magnitudes, and similar ranges. Collectively, and in each two-variable comparison, the data show a high degree of comparability which also suggests that the data validity is high.

Data Consistency

The consistency metric evaluates whether the recorded data values fall within ranges that would reasonably be expected from the performance of typical water distribution equipment (pressures between 0 to 100 psi, flow rates from 0 to 3,000 gpm). As noted in the comparability metric, Figures 2-17 present data that do not reveal anomalous readings that would indicate equipment malfunction or other data validity problems. The data shown in

Figures 2-17 also show a high degree of continuity, with no or small data gaps which indicate little to no equipment offline during the study period.

Data Completeness

The target study period for each residential monitoring pair was approximately one week. This period was selected to capture a typical full weekly irrigation cycle. The mean data log for each residential location was approximately 5 days, with a standard deviation of 2 days. In general, the range of the study length (mean data length plus standard deviation) is within the targeted length for the study period. The SCADA data were provided for a period of approximately 1,187 days (July 1, 2016 - October 1, 2019). The general quantity of data appears to be adequate to evaluate a wide range of trends including diurnal, weekly, monthly, seasonal, and annual cycles, and to identify reasonable estimates for average day, maximum day, and peak hour factors. The exception to this general observation is the water meter data, where limited records yielded flow from late August to September 2019 only. However, since the limited data generally spans the field effort study period, the data appear to be adequate.

Statistical Summary

Tables 2 through 5 present summary statistics for residential pressure data, water meter totalizer flow data (water demand, during the study period), and key SCADA equipment data (Northridge pump station pressure data and Turbine tank levels). Additional summary data are included as Figures 18-21 as an enclosure to this memo. Water meter data are not available for the days when the dynamic pressure loggers were installed, as the loggers were temporarily installed in place of the water meters at residential monitoring locations.

Residential Field Location Pressure Measurments

Summary statistics for field measurement location pressure data are presented in Table 3. Additional summary data are presented in the form of “box and whisker” plots in Figure 18.

Table 2

Residential Monitoring Locations

ID #	Location Address	Start Day/Time	End Day/Time
1	440 W Meadow Dr	8/13/2019 11:06	8/19/2019 9:56
2	710 Kintail Dr	8/13/2019 10:24	8/15/2019 12:54
3	1710 Northridge Dr	8/19/2019 13:22	8/22/2019 11:22
4	1740 2nd Ave N	8/19/2019 13:10	8/22/2019 10:28
5	1320 Heroic Dr	8/22/2019 13:56	8/27/2019 13:24
6	1420 2nd Ave N	8/22/2019 13:34	8/27/2019 13:26
7	154 S Hiawatha Dr	8/27/2019 14:36	9/4/2019 11:26
8	158/7 S Hiawatha Dr	8/27/2019 15:52	9/4/2019 11:26

Key observations for the field measurement pressure data include the following:

- The lowest recorded pressures were observed at 710 Kintail Drive (41.0 psi) and 154 S Hiawatha Dr (41.1 psi).
- The lowest mean pressure was observed at 710 Kintail Drive (52 psi).
- The largest pressure range was observed at 1420 2nd Ave North (34 psi change)
- The highest pressure observed was 78 psi at 1420 2nd Ave North
- The average pressure range was 22 psi

Table 3

Field Measurement Pressure Statistics (psi)

Parameter	440 W Meadow Dr	710 Kintail Dr	1710 Northridge Dr	1740 2nd Ave N	1320 Heroic Dr	1420 2nd Ave N	154 S Hiawatha Dr	158 S Hiawatha Dr
Mean	61	52	56	64	59	66	58	58
Standard Error	0.08	0.07	0.07	0.12	0.06	0.13	0.05	0.05
Median	63	53	57	66	60	70	59	59
Mode	65	54	58	68	62	72	62	61
Standard Deviation	5.2	2.8	3.2	5.4	3.7	7.8	3.8	3.8
Sample Variance	27.0	7.6	10.2	29.0	13.5	60.5	14.8	14.3
Kurtosis	2.1	1.7	0.8	1.9	0.6	-0.6	3.3	-0.6
Skewness	-1.7	-1.3	-1.2	-1.6	-1.1	-0.9	-1.7	-0.7
Range	26	15	16	26	19	34	23	19
Minimum	42	41	45	45	46	44	41	45
Maximum	68	56	61	71	65	78	64	64
Count	4286	1516	2101	2080	3490	3509	5638	5612

Residential Field Location Water Meter Data

Summary statistics for field measurement location water meter data are presented in Table 4. Additional summary data are presented in the form of "box and whisker" plots in Figure 19.

Table 4

Residential Water Meter Data Summary

Location Address	Mean (gpd)	Min (gpd)	Max (gpd)
440 w Meadow Drive	1,163	10	3,461
710 Kintail Drive	1,013	0	3,136
1710 Northridge Drive	1,041	56	1,481
1740 2nd Ave North	2,025	122	5,927
1320 Heroic Drive	1,686	233	3,103
1420 2nd Ave N	2,060	12	5,329
154 S Hiawatha	1,380	0	5,020
158/7 S Hiawatha	1,061	36	4,745
Average	1,429	58	4,025

Key observations for the field measurement pressure data include the following:

- The highest daily water demand was observed at 1420 2nd Ave N at 5,927 gallons per day (gpd)
- Water meter data were provided for the period of June 27, 2019 to October 1, 2019, however the data were often reported as zero until late August, when typical flow rates are generally reported.

Table 2

Residential Water Meter Summary Statistics

Water Meter Data (8/13/19 to 9/4/19)		
Mean	1,450	(gpd)
Standard Error	74	(gpd)
Median	1,154	(gpd)
Mode	0.30	(gpd)
Standard Deviation	1,275	(gpd)
Range	5,927	(gpd)
Minimum	0	(gpd)
Maximum	5,927	(gpd)
Sum	426,336	(gal)
Count	294	ea.

City of Hailey Water System SCADA Data

Summary statistics for field measurement location water meter data are presented in Table 6. Additional summary data are presented in the form of "box and whisker" plots in Figures 20-21.

Table 3

SCADA Data Summary Statistics

Parameter	Quigley Tank (ft)	Northridge Pressure (psi)	Turbine Tank (ft)
Mean	17	72	11
Median	18	73	11
Mode	14	73	10
Standard Deviation	3	2	1
Sample Variance	12	6	1
Range	11	28	4
Minimum	11	55	8
Maximum	23	83	13

Field Flow Tests

City staff conducted flow tests at each field monitoring location (see Table 8). Calculated flow velocities ranged from 8.6 to 20.2 ft/s. The flow rates correspond to the lowest velocities, and lowest residual pressures. The lowest flow/pressure location at the time of flow testing was 1710 Northridge Dr, which was tested at 1:18 pm and yielded a pressure

reading of 45 psi at 11.8 gpm. The highest flow test results was produced at 710 Kintail Drive (the field monitoring point with the highest topographic elevation), which yielded 27.9 gpm at 53 psi at 10:17 am. Estimated headlosses from the distribution main to the meter vault indicated high pressure loss as a result of the service line size (reported to be ¾-inch at all residential monitoring locations) at the flow rates measured during the pressure tests.

Table 4

Field Flow Tests

Location	Date	Time	Int.	Flow	Dist. Main to vault	Dia.	Vel.	Headloss		C (est)
Address			(psi)	(gpm)	(ft)	(in)	(ft/s)	(ft)	(psi)	
710 Kintail	8/13/2019	10:17 a.m.	53	27.9	26	0.75	20.2	73.94	32.01	120
440 W. Meadow Dr.	8/13/2019	10:50 a.m.	60	19.5	67	0.75	14.2	98.72	42.73	120
1740 2nd Ave. N.	8/19/2019	1:05 p.m.	68	20.4	55	0.75	14.8	87.44	37.85	120
1710 Northridge Dr.	8/19/2019	1:18 p.m.	45	11.8	10	0.75	8.6	5.80	2.51	120
1320 Heroic Dr.	8/22/2019	1:50 p.m.	50	25.6	15.8	0.75	18.6	38.40	16.62	120
1420 N. 2nd Ave.	8/22/2019	1:29 p.m.	60	21.4	50.4	0.75	15.5	87.74	37.98	120
154 S. Hiawatha Dr.	8/27/2019	2:30 p.m.	50	22.3	38	0.75	16.2	71.37	30.90	120
157 S. Hiawatha Dr.	8/27/2019	3:50 p.m.	48	19.6	5	0.75	14.2	7.38	3.20	120

Cyclical and Temporal Trends

Data from the field study and SCADA records were analyzed for a range of temporal trends including the following cycles: multi-year trends, seasonal, monthly, day of week, and daily/diurnal cycles.

Multi-Year Trends

SCADA data from July 1, 2016 to October 2, 2019 are summarized in Table 8 for the Northridge pump station (mean discharge pressure). Table 8 indicates that the mean daily discharge pressure for the Northridge pump station resides between 70-80 psi for approximately 90% of the year. However, since 2016 the share of annual time spent at lower pressures has been increasing. Data provided for 2019 show a continued decrease in mean daily discharge pressure for the Northridge booster pump station, however the 2019 data may not be weighted comparably to the data for past full years due to the irrigation season having comprised a larger proportion of the year without 4th quarter data. However, per Table 8, the distribution of the mean daily pressure at Northridge pump station in 2018 shifted lower by 5% compared to 2017 in terms of annual time spent within each pressure interval (90.2% down from 95.5%).

Table 5

Northridge Pump Station: Percentage Annual at Time Pressure Intervals (Mean)

Start	End	0-10 (psi)	10-50 (psi)	50-60 (psi)	60-70 (psi)	70-80 (psi)	80-90 (psi)	90-100 (psi)
7/1/2016	12/31/2016	0.01%	0.00%	0.01%	4.3%	95.6%	0.07%	0.00%
1/1/2017	12/31/2017	0.00%	0.00%	0.01%	4.5%	95.5%	0.00%	0.00%
1/1/2018	12/31/2018	0.00%	0.00%	0.01%	9.8%	90.2%	0.01%	0.00%
1/1/2019	10/2/2019	0.01%	0.00%	0.53%	11.2%	88.3%	0.01%	0.00%

Figures 22 and 23 continue to reveal additional multi-year fluctuations spanning 2016-2019. The mean daily tank level for Turbine tank seems to be centered around 11 feet in 2016-2017, 12 feet in 2018, and 10 feet in 2019.

Seasonal and Monthly Cycles

Seasonal and monthly cycles capture fluctuations in water system operating conditions due to factors such as seasonal irrigation practices and weather. Increased water demand due to seasonal fluctuations will impact pressures within the water distribution system. SCADA data from 2019 (through October) are summarized by month and day in Table 9 for the Northridge pump station (mean daily discharge pressure). Table 9 shows clear effects of seasonal impacts, with the lowest discharge pressures at the Northridge pump station occurring during the summer months. The lowest mean daily discharge pressure occurred on July 17 (68.8 psi). Figures 2, 4, 6, 8, 10, 12, 14, and 16 illustrate the pressure delta between the Northridge pump station discharge and the service connections at the eight residential monitoring locations, which range from a few psi to over 20 psi. Note, the pressures shown in Tables 9-10 are mean daily pressures and do not present intra-day fluctuations which can result in more shorter-term lower pressures.

Table 6

2019 Mean Daily Discharge Pressure: Northridge Pump Station (psi)

Day of Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	73.4	73.1	73.2	72.8	74.0	72.0	70.7	71.5	71.3
2	73.4	73.2	73.2	72.8	73.8	71.6	70.9	71.5	71.3
3	73.3	73.2	73.2	72.8	73.2	71.6	70.8	71.4	71.5
4	73.3	73.0	73.2	72.9	72.6	71.3	70.9	71.5	71.3
5	73.4	73.2	73.2	72.7	72.9	70.8	70.6	71.1	71.7
6	73.5	73.1	73.2	72.8	72.8	71.6	70.7	71.4	71.8
7	73.8	73.1	72.9	72.8	73.0	71.5	70.7	71.5	71.6
8	73.7	73.3	72.8	72.8	72.2	71.5	71.3	71.8	72.0
9	73.3	73.5	72.8	72.7	72.1	70.4	71.0	71.5	72.0
10	73.4	74.7	72.9	72.8	71.5	70.7	70.8	71.5	72.1
11	73.4	74.6	72.9	72.9	71.2	70.8	72.3	71.3	72.0
12	73.3	74.5	72.8	72.8	70.9	71.0	70.7	71.6	72.2
13	73.4	74.0	72.9	72.8	71.2	70.8	70.5	71.6	71.8
14	73.4	73.8	72.8	72.9	71.1	71.7	70.5	71.5	71.8
15	73.3	73.6	72.8	72.8	71.0	70.7	70.7	71.6	71.6
16	73.4	73.5	72.7	72.5	71.7	70.9	70.7	71.4	71.8
17	73.5	73.4	72.8	72.3	71.7	71.3	68.8	71.3	72.1
18	73.3	73.3	72.8	72.6	72.3	71.4	70.8	71.3	72.0
19	73.4	73.2	72.7	72.6	71.9	70.8	70.7	71.5	72.0
20	73.4	73.2	72.8	72.8	72.2	71.5	70.6	71.5	71.9
21	73.1	73.2	72.8	72.7	72.6	70.9	70.7	71.4	72.0
22	73.0	73.3	72.8	72.7	72.9	70.9	71.4	71.4	71.9
23	73.1	73.2	72.9	72.8	72.8	70.7	70.6	71.5	71.6
24	73.0	73.2	72.8	72.8	73.1	70.9	71.7	71.3	71.8
25	73.1	73.2	72.7	73.5	73.2	71.0	71.6	71.2	71.7
26	73.1	73.2	72.7	74.3	73.5	71.1	71.7	71.5	71.8
27	73.2	73.3	72.7	74.3	73.0	70.9	71.5	71.4	71.8
28	73.1	73.2	72.8	74.3	72.7	70.9	71.5	71.6	72.4
29	73.3		72.7	74.3	72.8	70.7	71.7	71.4	72.2
30	73.1		72.8	74.3	73.1	70.8	71.7	71.5	72.5
31	73.2		72.9		72.5		71.9	71.5	

Similar data are provided in Table 9 for 2018. Similar seasonal trends are observable, with the lowest pressure at the Northridge pump station occurring on May 8th. In general, pressures appear to be lower in 2019 than in 2018.

Table 7

2018 Mean Daily Discharge Pressure: Northridge Pump Station (psi)

Day of Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	73.1	73.0	72.7	72.8	72.4	71.3	71.0	71.4	71.8	72.0	73.5	73.7
2	73.3	73.1	72.6	72.8	72.4	71.0	71.1	71.7	72.1	72.0	73.5	73.7
3	73.4	73.1	72.9	72.9	72.1	70.9	71.3	71.9	71.8	72.1	73.6	73.7
4	73.4	73.0	72.7	72.8	71.4	70.8	71.3	71.8	72.1	72.4	73.5	73.5
5	73.2	73.0	72.8	72.9	70.9	70.8	71.3	71.7	72.0	72.4	73.5	73.3
6	73.2	73.0	72.7	72.8	70.8	70.8	71.3	71.9	72.2	72.5	73.4	73.3
7	73.1	73.0	72.8	72.8	71.0	71.0	71.3	71.6	72.0	72.4	73.5	73.3
8	73.2	73.0	72.9	72.8	70.5	70.9	71.3	71.8	72.0	72.5	73.6	73.3
9	73.1	73.1	72.7	72.8	71.2	70.7	71.3	71.8	71.9	72.8	73.6	73.4
10	73.1	73.1	72.9	72.8	71.1	70.7	71.4	71.8	72.1	72.7	73.7	73.5
11	73.2	73.0	72.6	72.7	71.0	71.2	71.4	71.6	72.2	72.5	73.6	73.4
12	73.2	73.0	72.8	72.8	71.4	70.9	71.4	71.6	72.2	72.6	73.5	73.4
13	73.2	73.0	72.8	72.8	71.2	72.0	71.3	71.8	72.2	72.7	73.6	73.3
14	73.2	73.0	72.6	72.8	71.1	71.2	71.4	71.8	72.1	72.9	73.6	73.4
15	73.1	72.9	72.8	72.8	70.9	71.3	71.3	71.7	72.1	73.2	73.6	73.4
16	73.2	73.1	72.8	72.8	71.1	71.3	71.9	72.0	72.1	73.4	73.7	73.5
17	73.1	72.9	72.7	72.7	70.9	71.4	71.0	71.9	72.1	73.6	73.6	73.7
18	73.1	73.2	72.9	72.6	71.1	71.4	70.9	71.9	72.2	73.6	73.7	73.5
19	73.2	72.9	72.7	72.6	71.1	71.6	70.7	71.7	72.1	73.6	73.7	73.4
20	73.2	72.9	72.7	72.7	71.1	71.3	70.8	72.1	72.2	73.6	73.6	73.5
21	73.2	72.8	72.7	72.7	71.0	71.2	71.2	71.9	72.1	73.6	73.7	73.7
22	73.1	72.8	72.8	72.6	71.3	71.2	71.3	72.1	72.0	73.7	73.7	73.4
23	73.1	72.8	72.8	72.5	71.2	71.4	71.2	71.9	72.0	73.6	73.7	73.3
24	73.1	72.6	72.7	72.7	71.4	71.2	71.3	71.9	72.2	73.4	73.6	73.6
25	73.1	72.9	72.7	72.4	70.9	71.1	71.1	71.9	71.8	73.5	73.6	73.6
26	73.2	72.7	72.7	72.4	71.3	71.3	71.2	72.0	71.9	73.6	73.5	73.4
27	73.1	72.8	72.6	72.4	71.2	71.1	71.1	72.1	72.1	73.5	73.7	73.3
28	73.0	72.8	72.7	72.3	71.1	71.3	71.3	72.1	71.9	73.4	73.7	73.3
29	72.9		72.9	72.0	71.3	71.2	71.3	72.0	71.8	73.4	73.7	73.7
30	73.1		72.8	72.2	71.3	71.3	71.4	72.1	72.0	73.5	73.7	73.6
31	73.1		72.6		71.8		71.8	72.1		73.6		73.4

Weekly Cycles

Irrigation practices and other factors can also impact water system pressures on a weekly cycle. Figures 18, 20, and 21 provide data sorted by day of the week for residential monitoring location pressures, 2019 Northridge pump station mean discharge pressures,

and mean minimum daily water level in Turbine tank respectively. Based on Figures 20-21, there do not appear to be pronounced weekly cycles on an annual basis in the mean daily Turbine tank level or the mean daily Northridge pump station discharge pressure. During the study period, pressure ranges for each field location appeared to be similar throughout the week.

Daily/Diurnal Cycles

The most pronounced fluctuation in system pressure occurs on an intra-day basis (diurnal cycles). Figures 24-25 provide a 3-dimensional surface presenting a view of daily, weekly, and monthly trends in the minimum daily discharge pressure at the Northridge pump station. Observations of Figures 24 include the following:

- Weekly trends consist of seven similarly shaped “saddles”, which illustrates how similar the days of the week are to each other, underscoring the fact that weekly cycles do not appear to represent the dominant influence for the subject parameter.
- In the “x-axis”, a relatively large influence on minimum pressure is represented by monthly cycles, which incorporate the effects of seasonality.
- Diurnal effects are captured along the “y-axis”, which is shown by the blue low points on either end of the y-axis of the surface. These low points correspond to early in the morning and late at night, which presumably correlate with cooler temperatures during the summer irrigation season when residential sprinkler systems characteristically reach peak water demand.

Correlation Evaluation

Several multivariable graphs are provided to for the purpose of evaluating which aspects of the City’s water distribution system appear to affect or mirror the pressures in the study area most strongly.

SCADA Data

Figures 26 presents the Turbine and Quigley tank levels and Northridge pump station discharge pressure by month for 2019. From Figure 26, the mean discharge pressure from the Northridge pump station appears to be more closely correlated to the Turbine tank level than the Quigley tank level, which is likely due to the closer physical proximity.

Figures 27 presents the Turbine and Quigley tank levels and Northridge pump station flow (total daily flow in 10,000-gal), ordered by minimum daily discharge pressure at the Northridge pump station. Figure 27 indicates a relatively flat weekly trend across both tank levels, and total daily flow and minimum pressure from the Northridge pump station, and a relatively weak correlation between pump station minimum daily pressure and total daily output.

Figures 28-29 present the Northridge pump station pressure versus the Turbine and Quigley tank levels respectively, with each dot representing a 2-minute spot reading. Figure 28 indicates that lowest discharge pressures at the Northridge pump station occur when

the water level in the Turbine tank is above 10-feet. Figure 29 indicates a similar relationship between Quigley tank and the discharge pressure at the Northridge pump station (the lowest pressures at the pump station occur when tank levels are high).

Figures 30-32 present the Northridge pump station pressure versus the discharge pressures of other pump stations; Woodside, 3rd Ave, and River Street respectively. These figures suggest a weak correlation between the pressure observed at the Northridge pump station and the 3rd Ave and River St pump stations, and no apparent correlation to pressures at the Woodside pump station.

Figures 33-35 present the Northridge pump station pressure versus the inflow and outflow rates of Turbine tank, and the discharge flow rate from Indian Springs respectively. Figure 33 indicates that the lowest pressures at the Northridge pump station occur when outflow from the Turbine tank is high. However, the reverse is not true; high outflows are occasionally observed at Turbine tank when pressures are high at the Northridge pump station. Low outflows from Turbine tank and low pressures at Northridge pump station do not co-occur. In general, as outflow from Turbine tank decreases, the pressure at the Northridge pump station increases, suggesting both variables are a function of system demand.

Similar to Figure 33, Figure 34 indicates that the lowest pressures observed at the Northridge pump station occur when inflows into Turbine tank are high. Two inflow regimes into Turbine tank are observable; 800-gpm and 1,100-1,400 gpm. The lower inflow regime does not co-occur with low pressures at the Northridge pump station.

Figure 35 offers similar insight with respect to flow rates at Indian Springs. The higher flow range at Indian Springs (1,600 gpm) does not co-occur with low pressures at the Northridge pump station, again suggesting a common factor such as system demand influencing both variables.

Figures 36-39 present the Northridge pump station pressure versus the discharge flow rates of pump stations, including the Northridge pump station itself, River Street, 3rd Ave., and Woodside respectively. Figures 36-39 indicate that the lowest pressures at the Northridge pump station occur only when the Northridge, River Street and 3rd Avenue pump stations are off and the Woodside pump station is on.

Field Study Data

Figures 2-17 provide a graph of recorded pressure at each field study location versus the pressure at the Northridge pump station and the Turbine tank level. The following observations are suggested by the figures:

- The pressures at all of the residential field monitoring locations are highly correlated to both the pressure at the Northridge pump station and the Turbine tank levels.
- Turbine tank level appears to be a lagging indicator of pressures at residential delivery points (Figure 3, Figure 5).

- Pressure at the Northridge pump station appears to be very closely related in time to customer pressures in the field study area (Figures 2, 4, 6, 8), although customer pressures sometimes stay low after pressures at the pump station have recovered (Figures 8, 10).
- Customer pressures recover faster than levels rise in Turbine tank (Figure 3).
- Pressures at 1420 2nd Ave experience frequent sharp changes (Figures 12-13), mirror the changes at the Northridge pump station but appear to be amplified. This may be due to the location of 1420 2nd Ave closer to the interface between the Northridge service area and the Northridge pumps station.

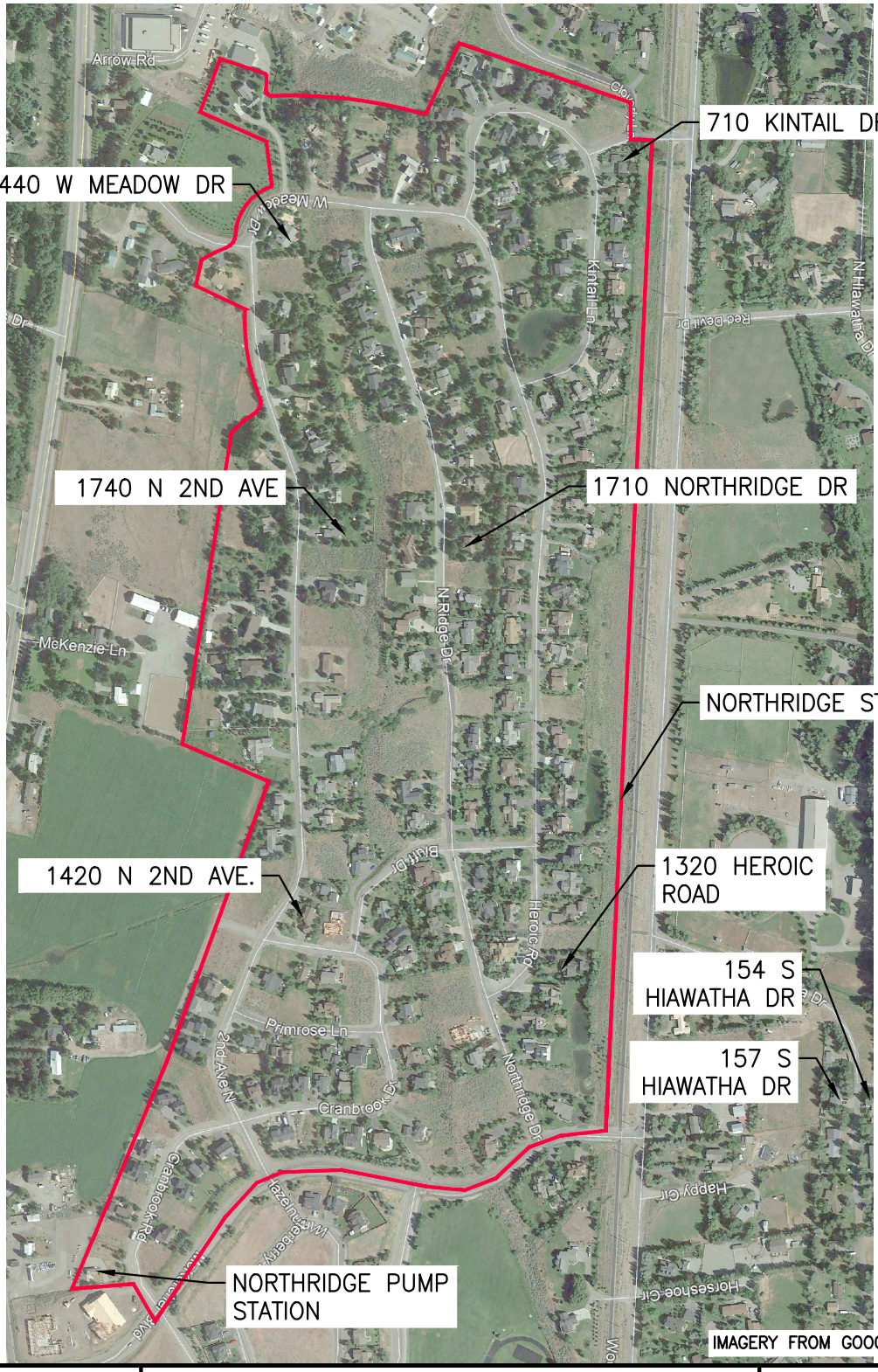
Figures 40-43 depict the relationship between customer pressures and the Northridge pump station flow rate. In Figure 40, both high and low pressures are observed at 1420 N 2nd Ave while the pump station is on and while it is off. In Figures 40-42, the lowest pressures are observed at 1320 Heroic Ave when the pump station is on, while at 710 Kintail Drive and 440 W Meadow Drive the lowest pressures occur only when the pump station is off.

Figure 42 indicates that for the highest elevation customer (710 Kintail), the lowest pressures occur when the Northridge pump station is off, outflows from Turbine tank are relatively low (500-1,000 gpm), and Turbine tank levels are high.

4.0 Conclusions and Recommendations

Based on analysis of data from the City of Hailey water distribution system, SPF concludes the following:

- Seasonal and diurnal trends influence pressures in the Northridge area, with the strongest impacts observed from May-August during the irrigation season. SCADA data indicate the lowest pressures occur at the Northridge pump station from 9pm to 3am.
- Customer pressures in the Northridge Area are strongly correlated to pressures at the Northridge pump station and the Turbine tank levels. The Turbine tank levels appear to be a lagging indicator, while changes in the Northridge pump station pressure are nearly co-occurring with changes in customer pressure.
- Based on SCADA data from 2016-2019, the field effort likely did not take place during the period of the year when the lowest pressures in the system typically occur. SPF recommends that the City's current hydraulic model be calibrated based on the pressures and operating conditions observed during the field effort, and that additional hydraulic modeling scenarios be conducted to match the lowest pressures in the SCADA data records to determine approximate lower bounds for pressures likely to occur in the Northridge Area during worst case conditions.



600 0 600 1200
SCALE OF FEET

FIGURE 1 – PROJECT VICINITY MAP

CITY OF HAILEY
NORTHRIDGE AREA PRESSURE STUDY

SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140
Fax (208) 383-4156

Path: S:\PROJECTS\A thru D Projects\C Projects\City of Hailey_330\0350_Northridge Pressure Evaluation\CAD\EXHIB Filename: 8X11 Plot date: Oct 23, 2019–12:34:24pm CAD User: SMcGourty.
Xref Filename: |

Figure 2. Min. 440 W Meadow vs Min. Northridge Pump Station Pressure

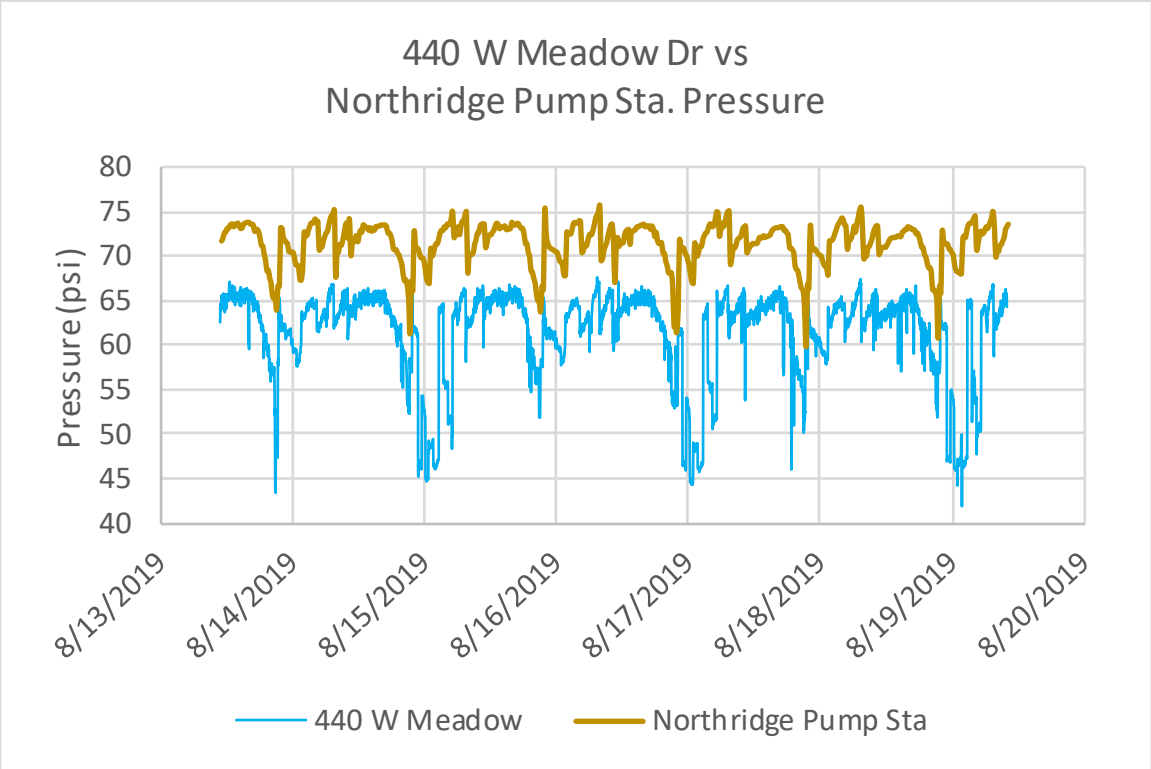


Figure 3. Min. 440 W Meadow vs Min. Turbine Tank Level

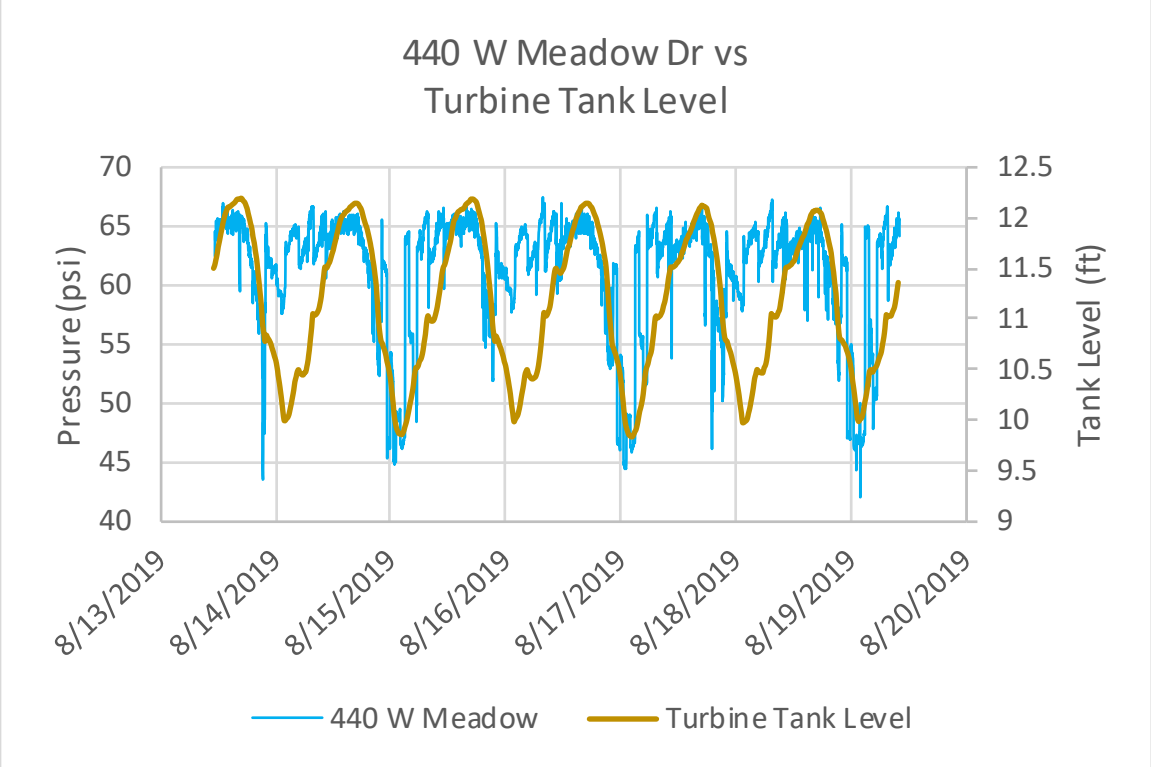


Figure 4. Min. 710 Kintail Drive vs Min. Northridge Pump Station Pressure

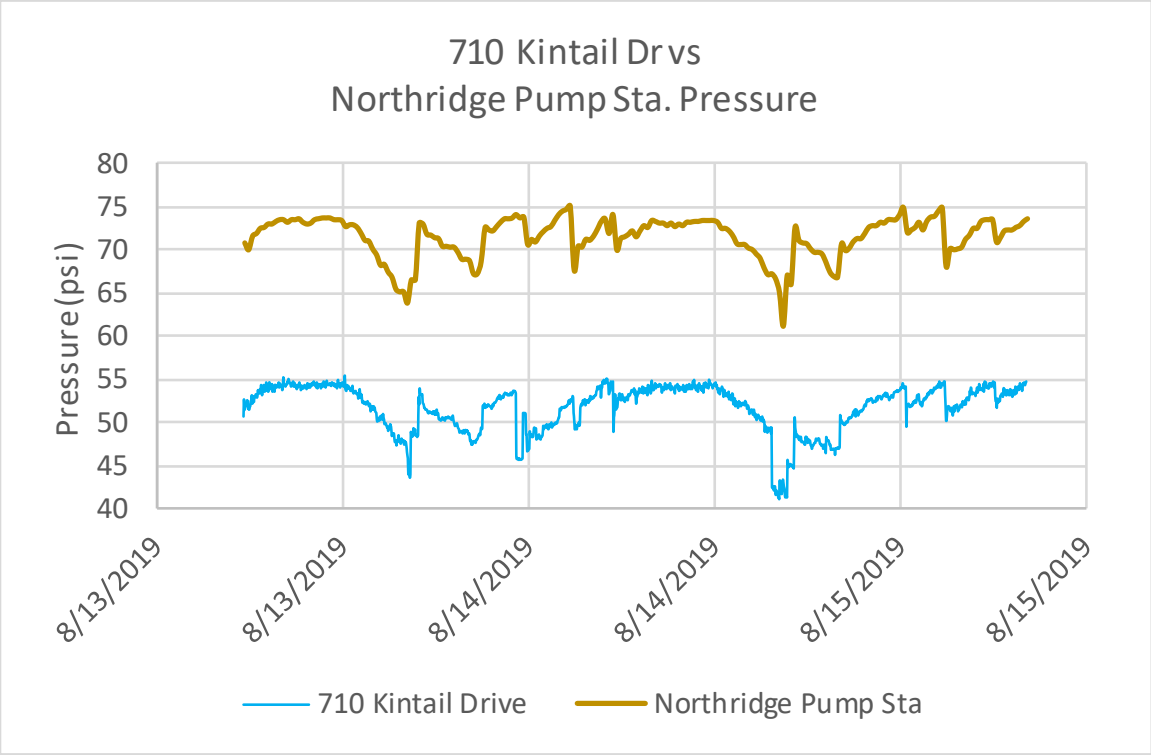


Figure 5. Min. 710 Kintail Drive vs Min. Turbine Tank Level

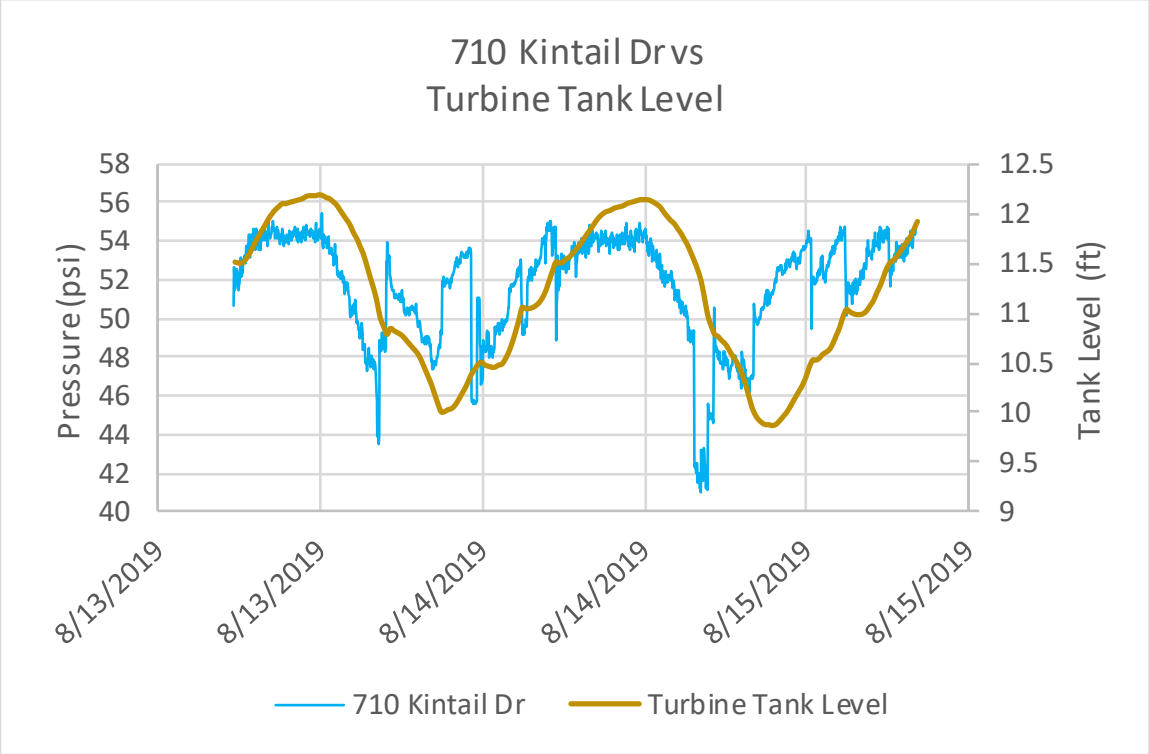


Figure 6. Min. 1710 Northridge Drive vs Min. Northridge Pump Station Pressure

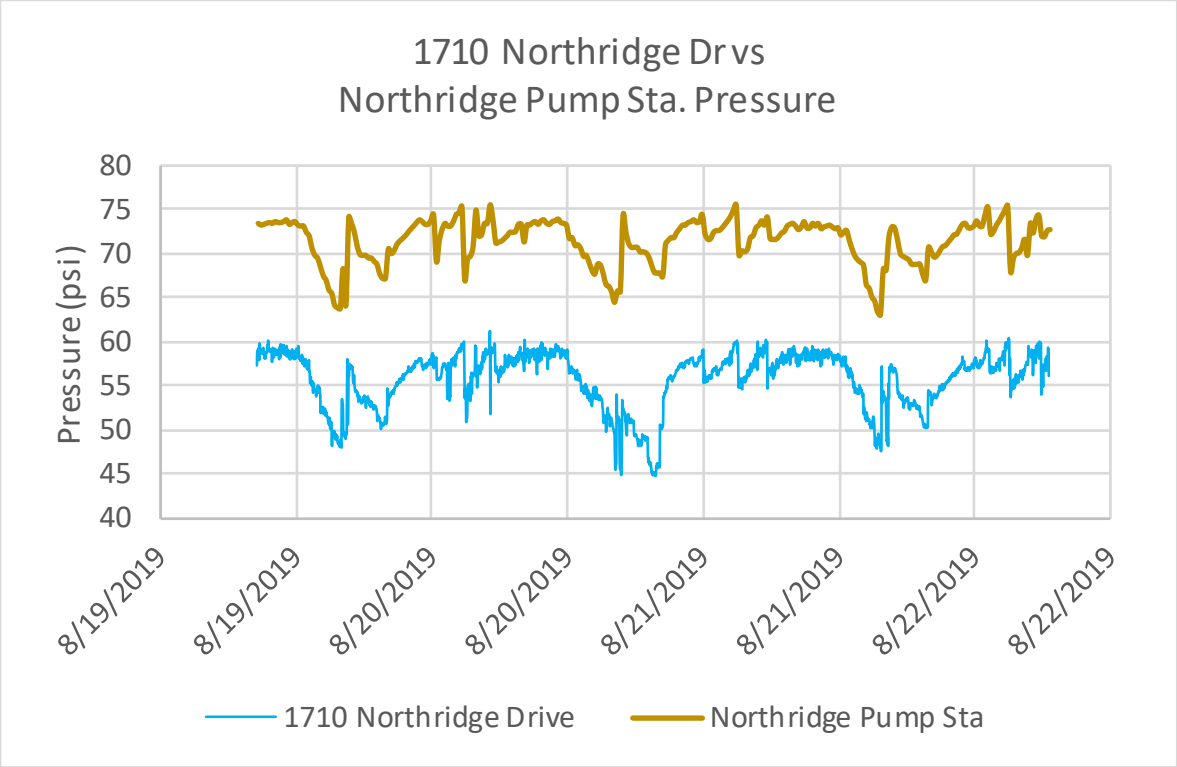


Figure 7. Min. 1710 Northridge Drive Meadow vs Min. Turbine Tank Level

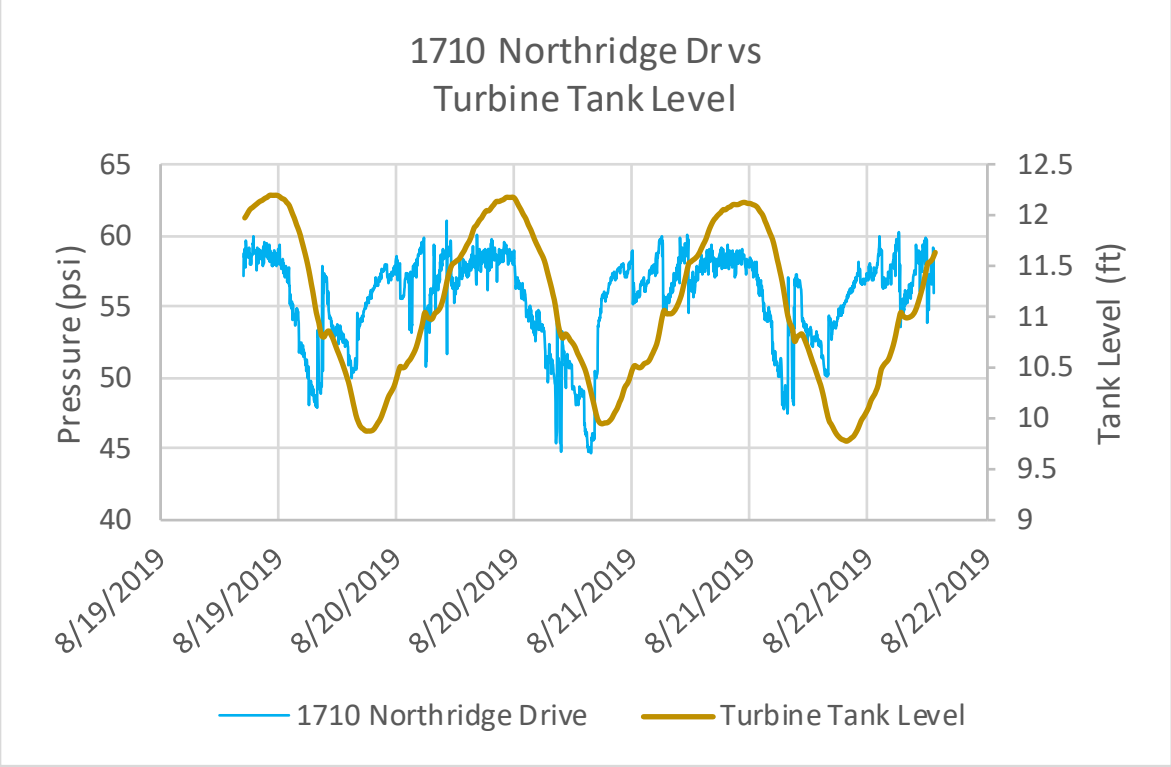


Figure 8. Min. 1740 2nd Ave North vs Min. Northridge Pump Station Pressure

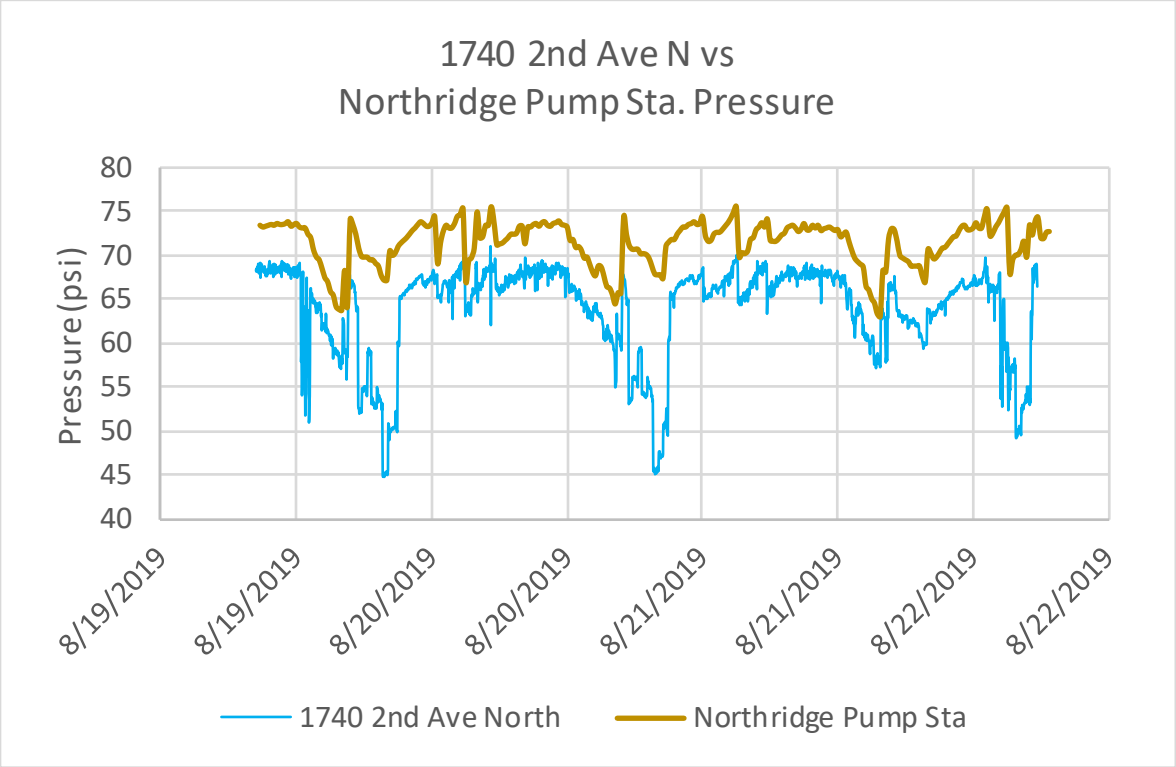


Figure 9. Min. 1740 2nd Ave North Meadow vs Min. Turbine Tank Level

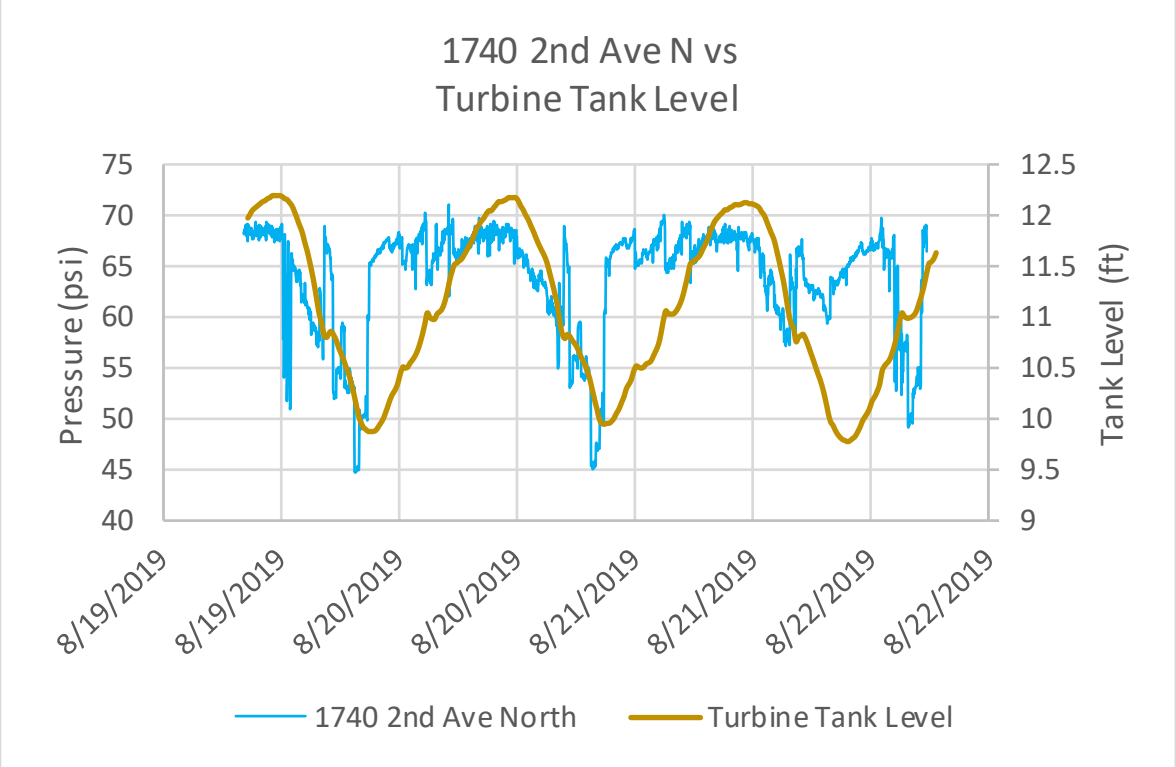


Figure 10. Min. 1320 Heroic Drive vs Min. Northridge Pump Station Pressure

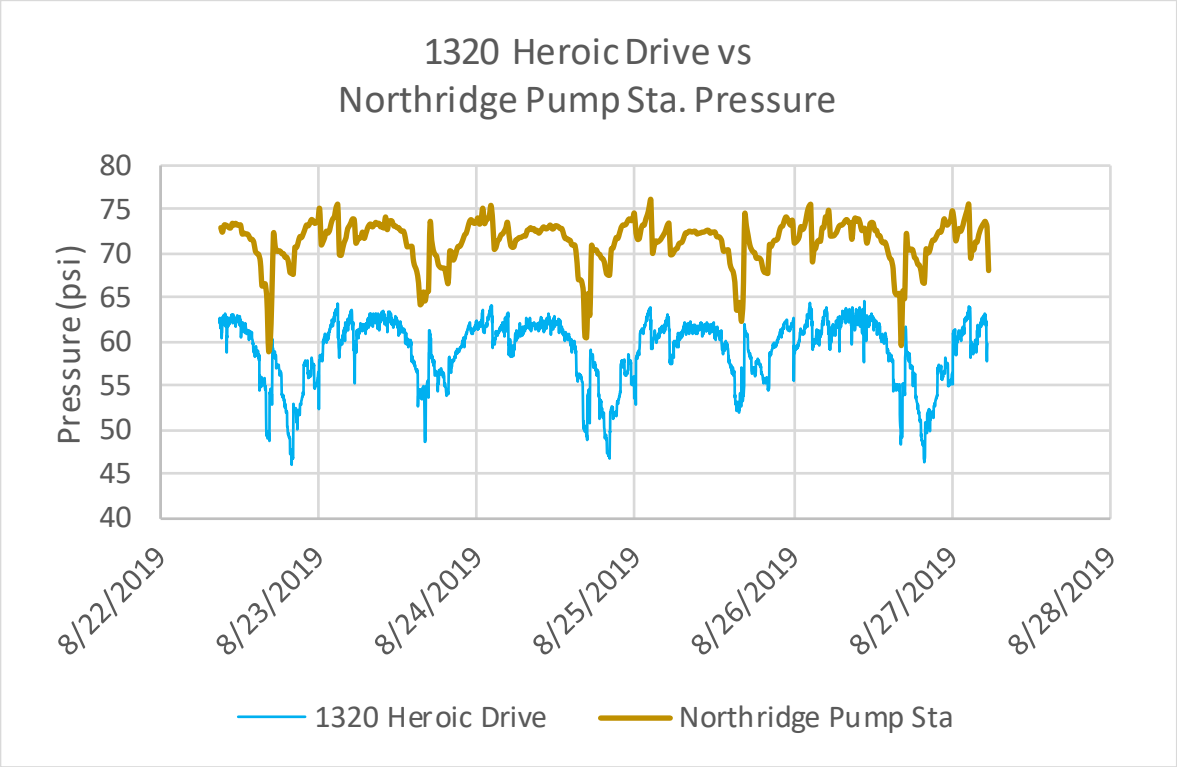


Figure 11. Min. 1320 Heroic Drive vs Min. Turbine Tank Level

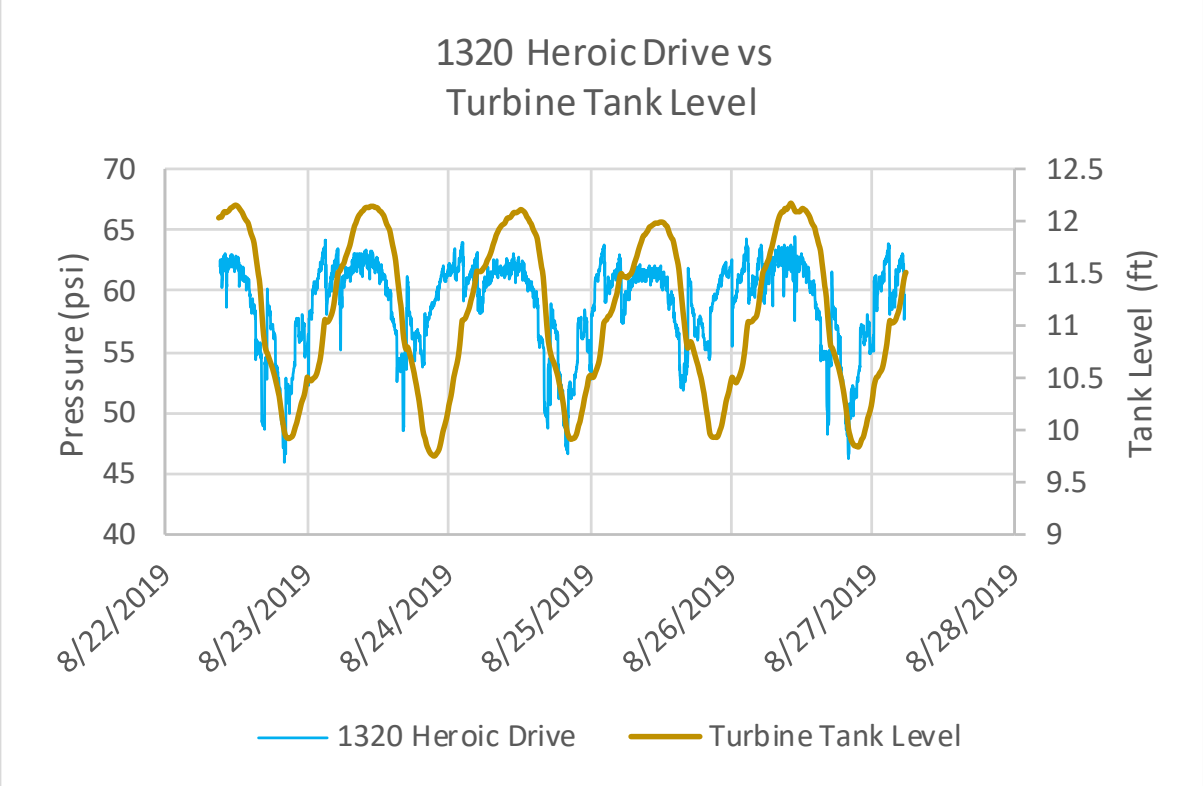


Figure 12. Min. 1420 2nd Ave North vs Min. Northridge Pump Station Pressure

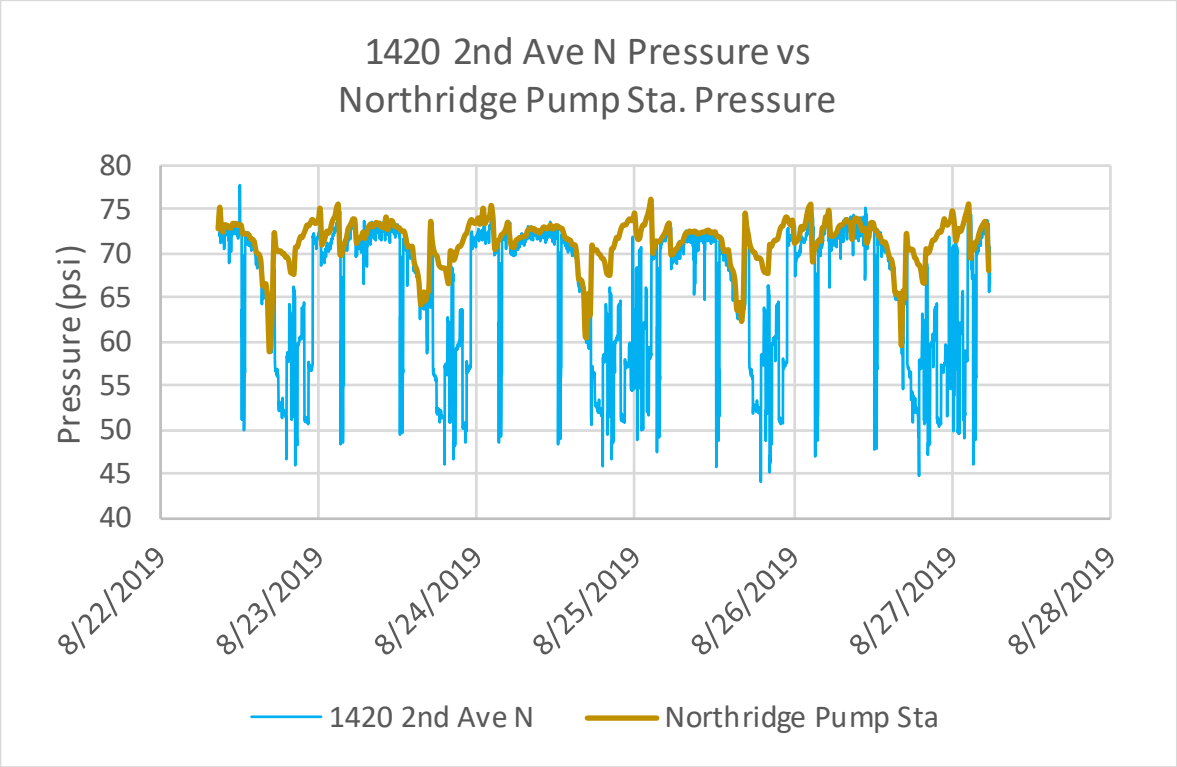


Figure 13. Min. 1420 2nd Ave North vs Min. Turbine Tank Level

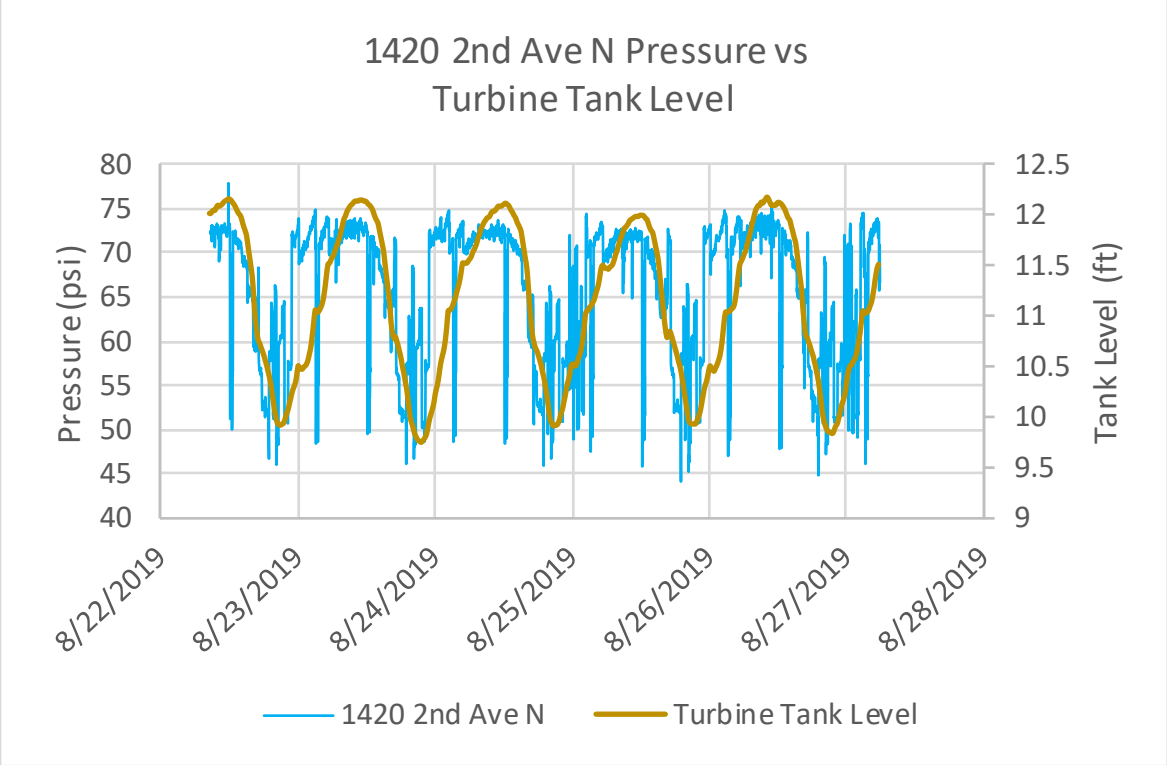


Figure 14. Min. 154 S Hiawatha Drive vs Min. Northridge Pump Station Pressure

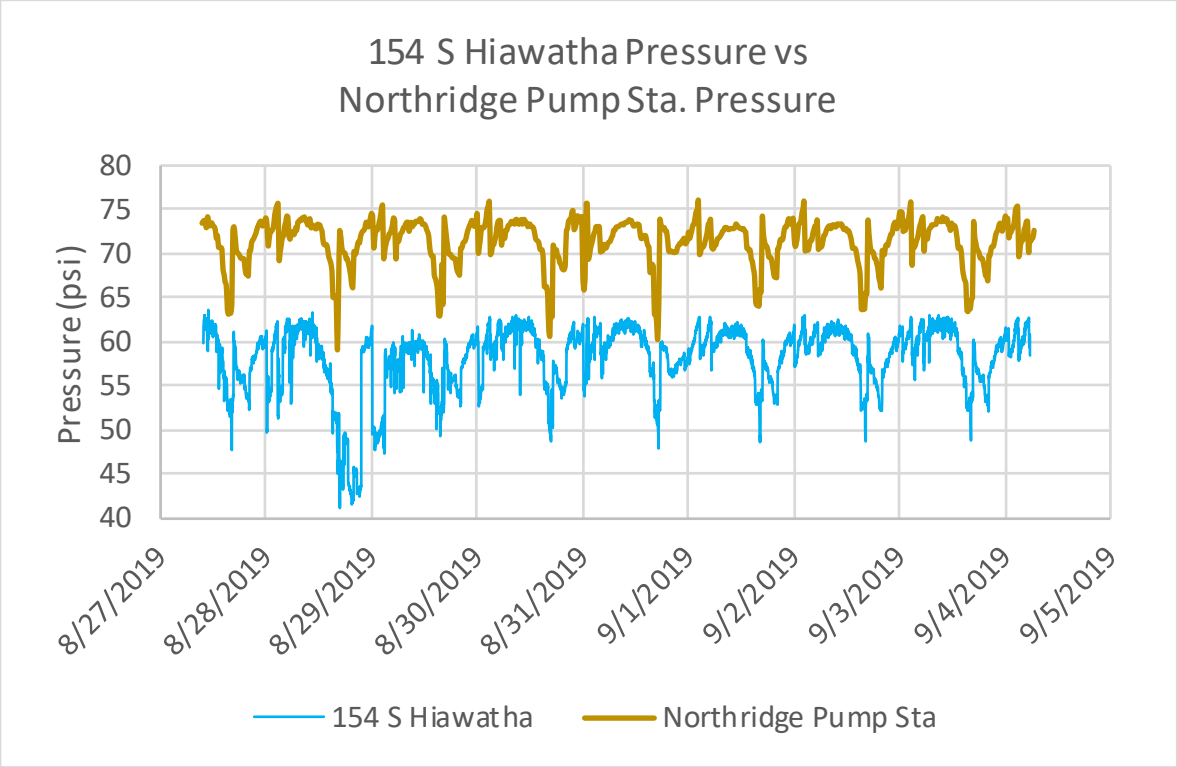


Figure 15. Min. 154 S Hiawatha Drive vs Min. Turbine Tank Level

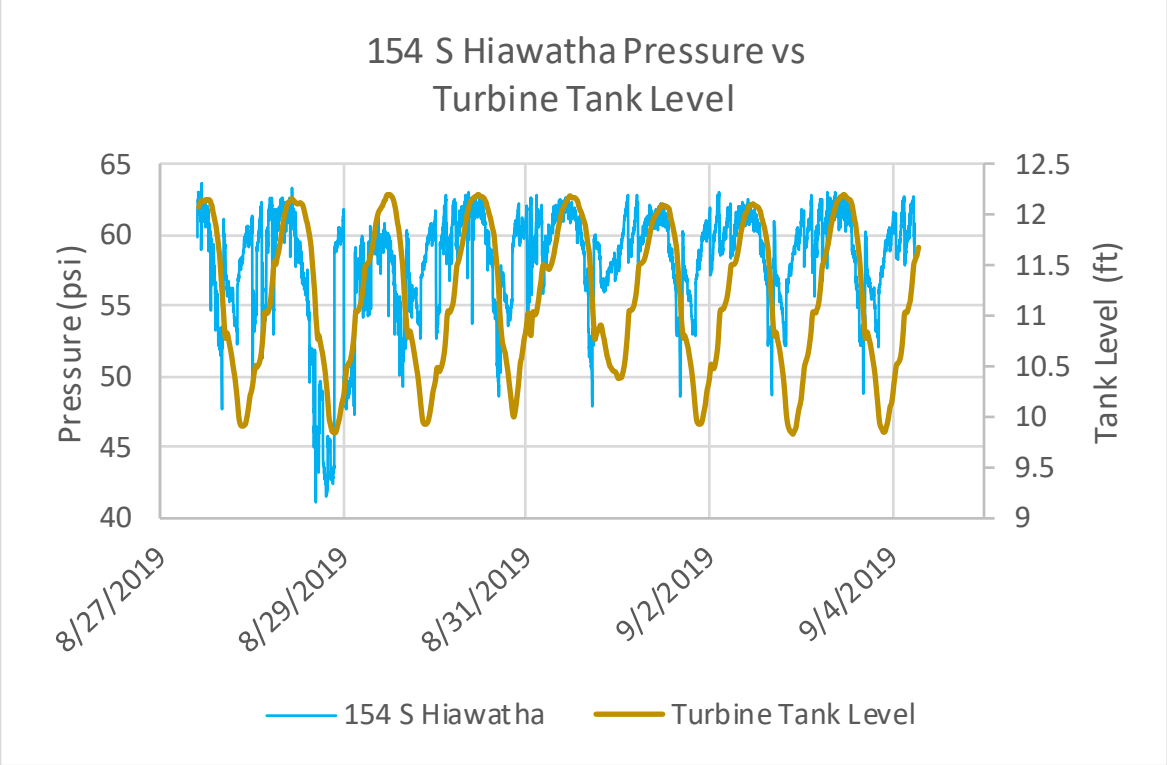


Figure 16. Min. 157 Hiawatha Drive vs Min. Northridge Pump Station Pressure

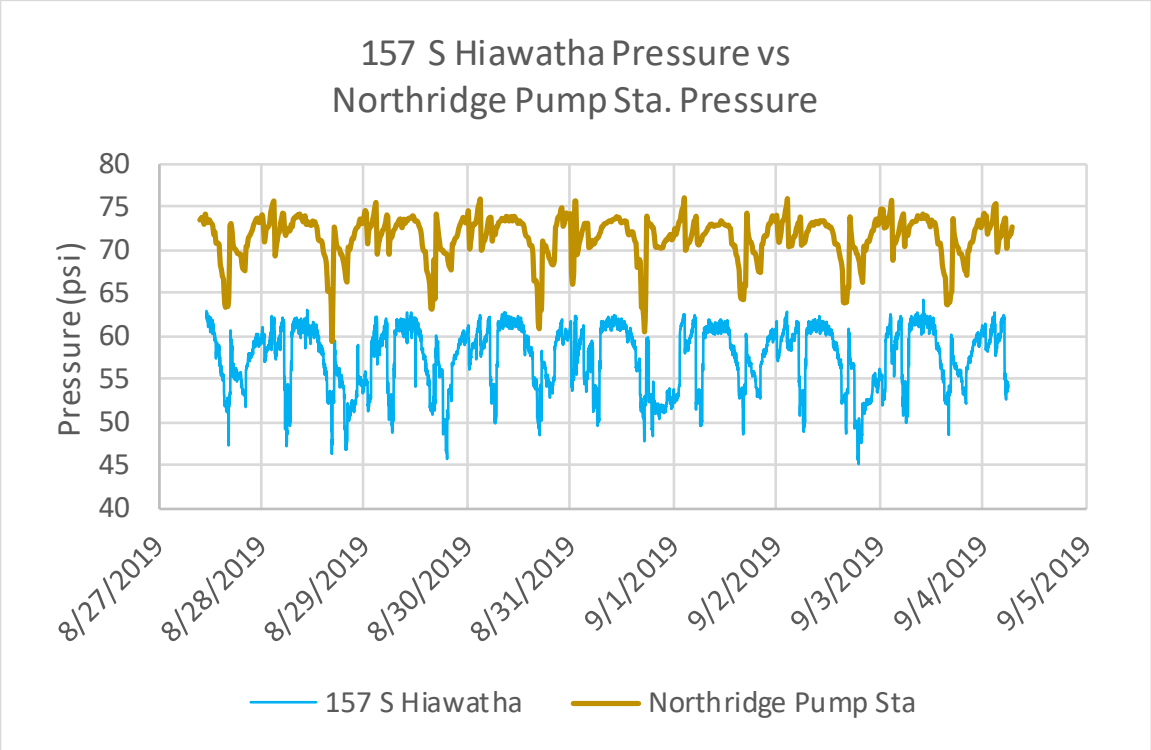


Figure 17. Min. 157 Hiawatha Drive vs Min. Turbine Tank Level

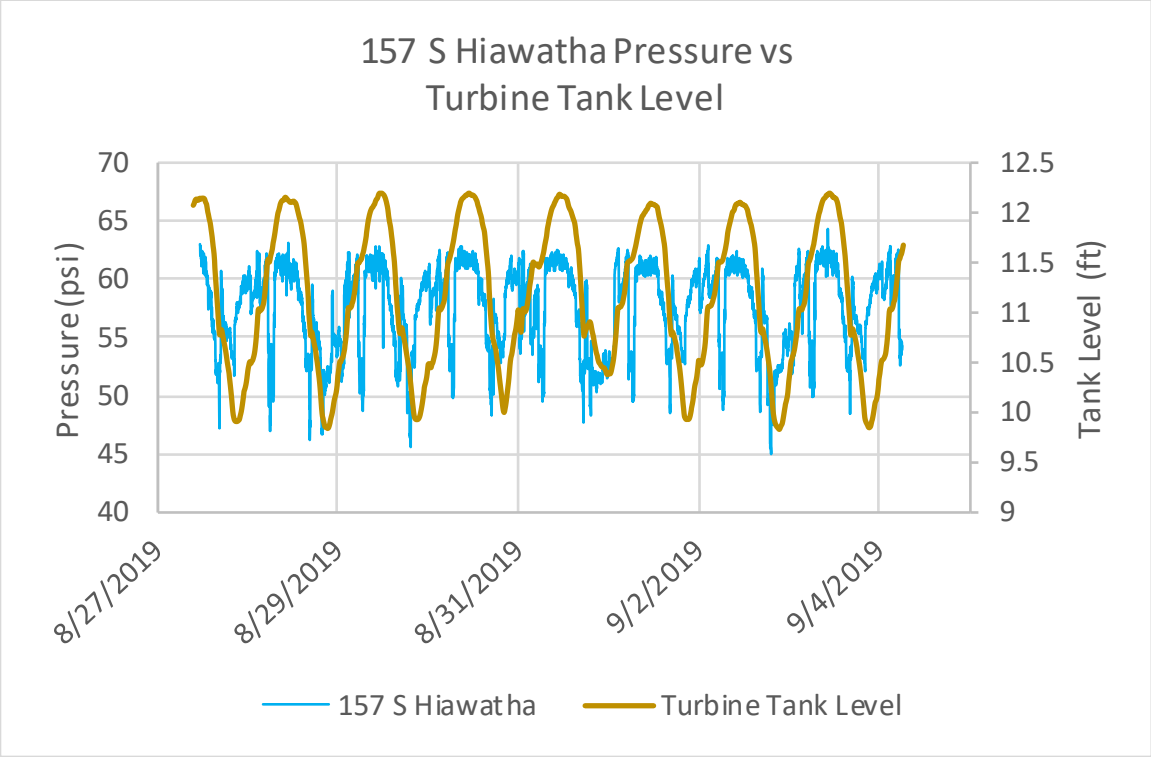


Figure 18. Mean Pressure at Residential Monitoring Locations by Day of Week

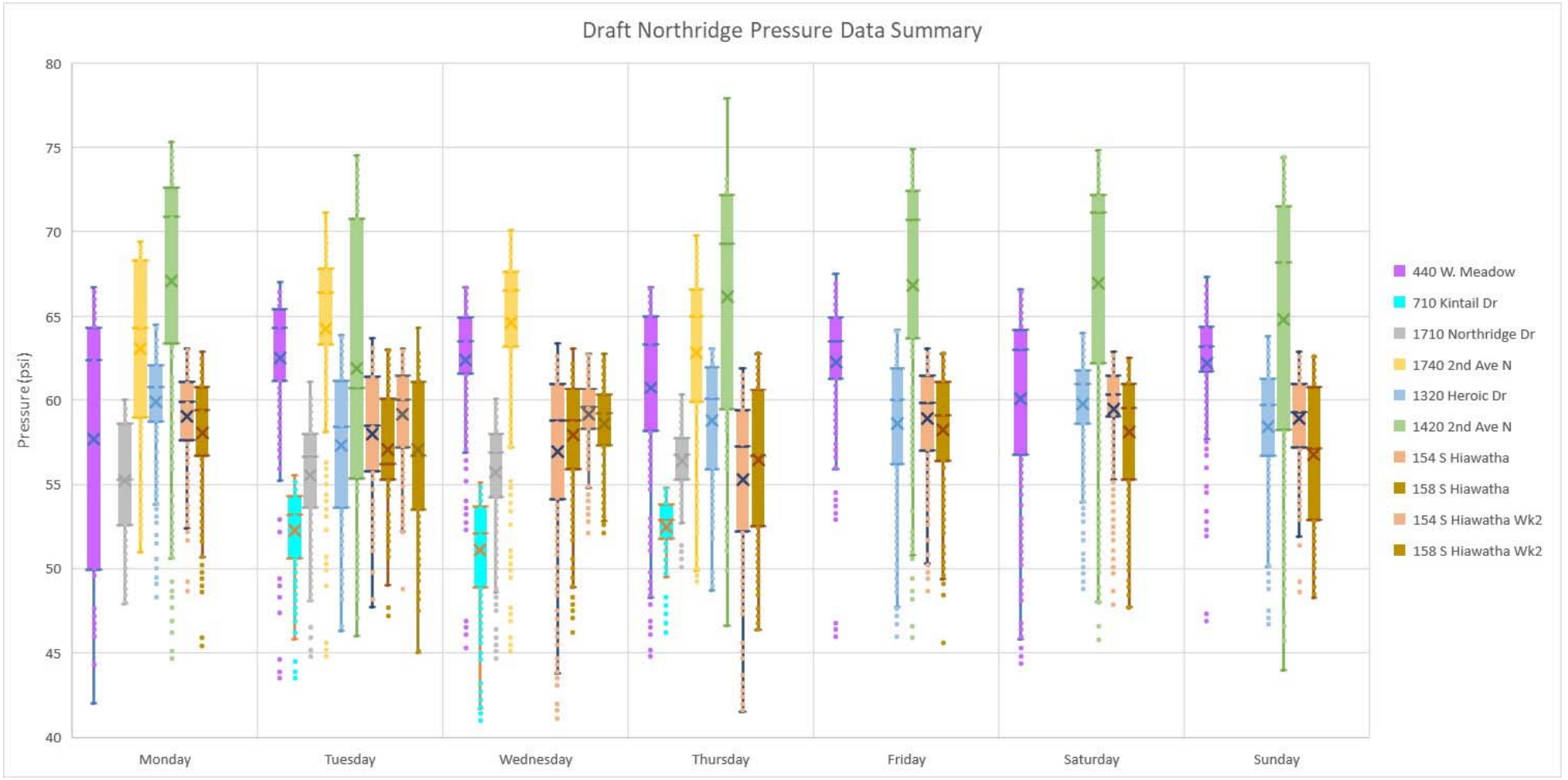


Figure 19. Water Meter Data Box & Whisker Statistics

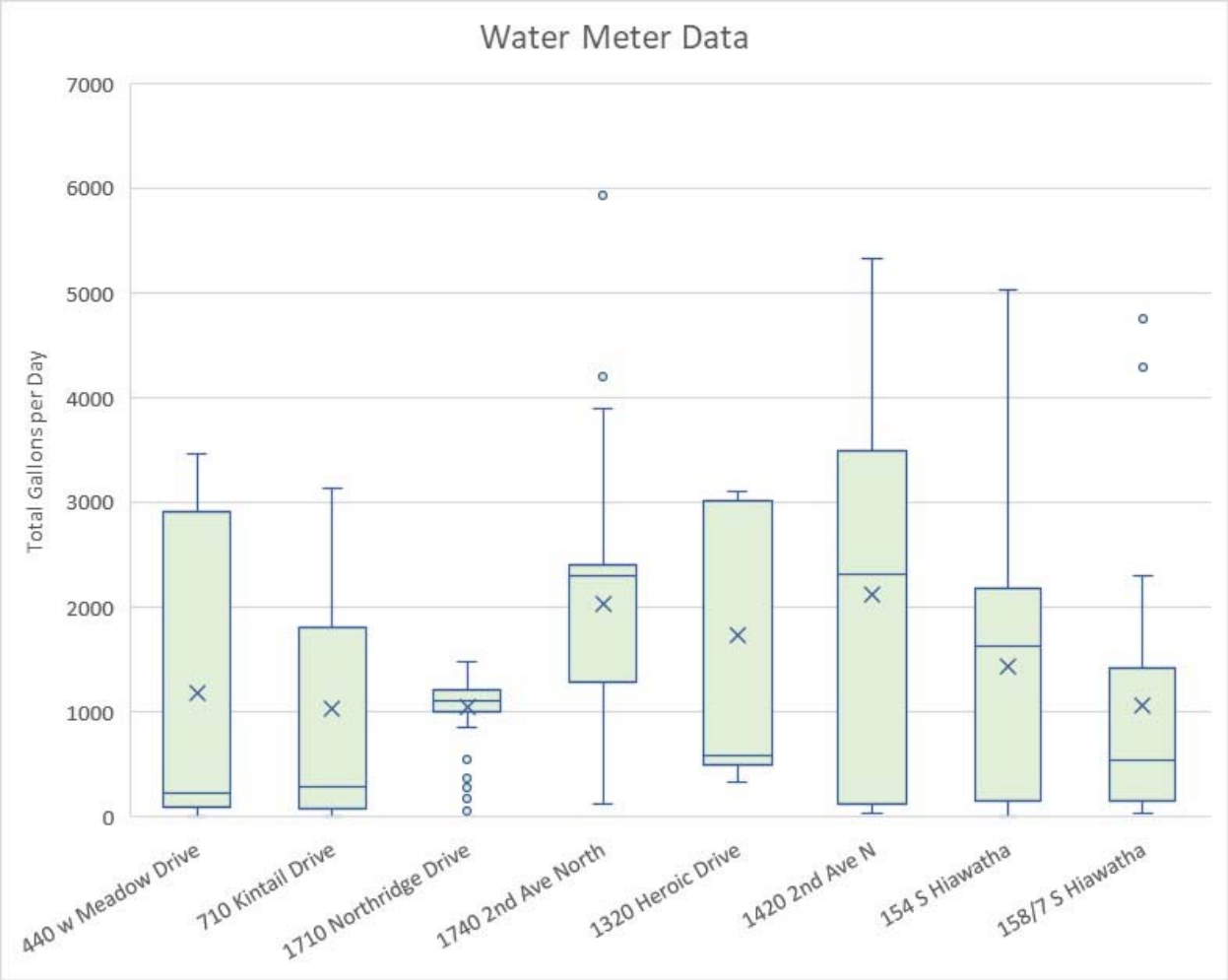


Figure 20. SCADA Box & Whisker Statistics: Northridge Pump Station

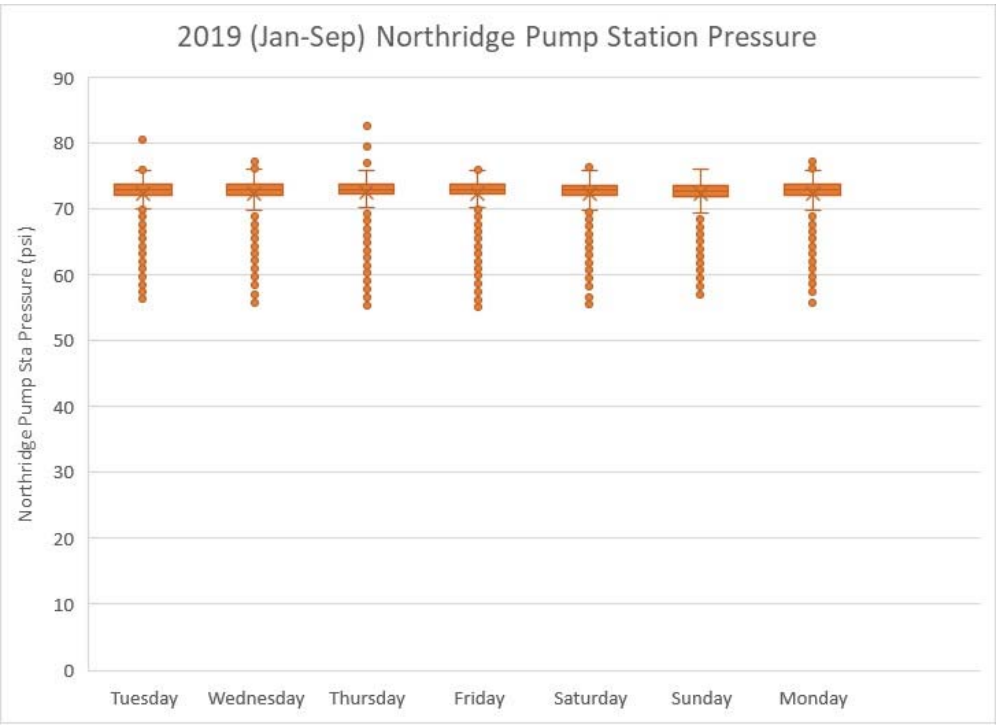


Figure 21. SCADA Box & Whisker Statistics: Turbine Tank Level

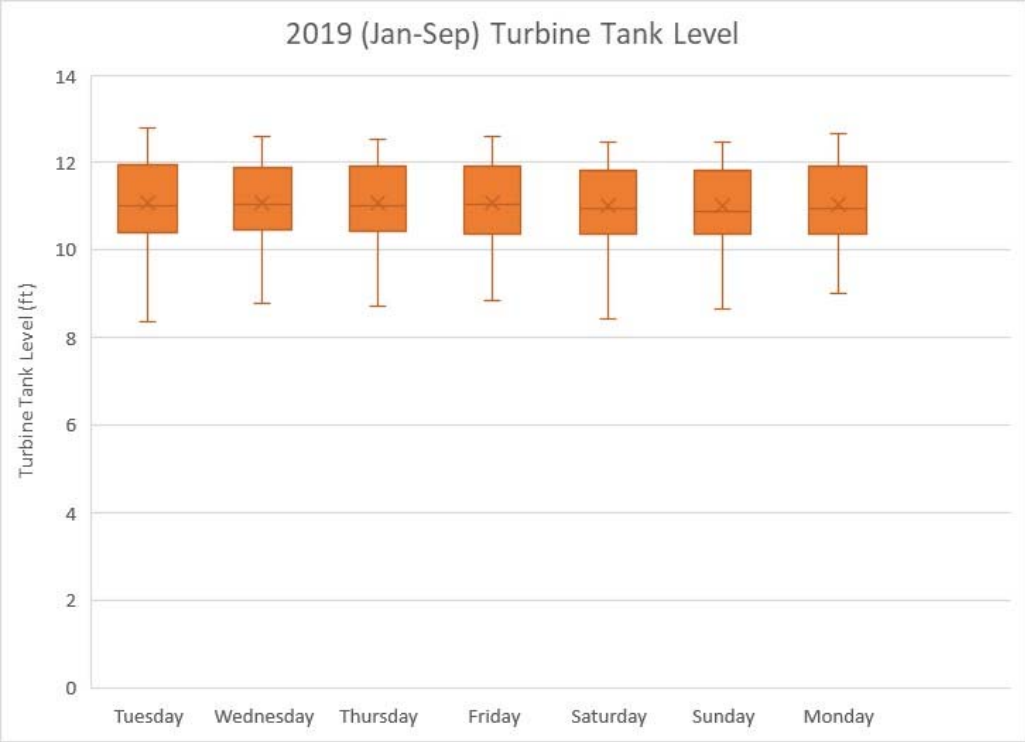


Figure 22. Multi-Year Mean Pressure Distribution: Northridge Pump Station

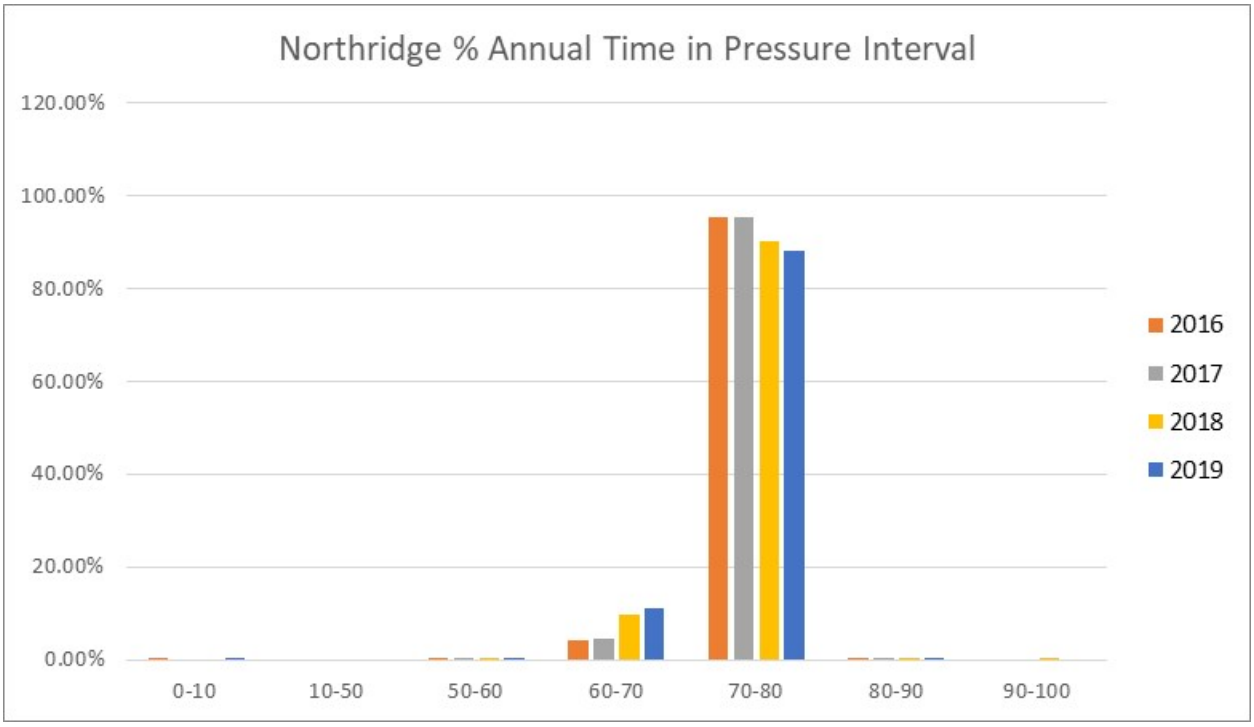


Figure 23. Multi-Year Mean Tank Levels: Turbine Tank

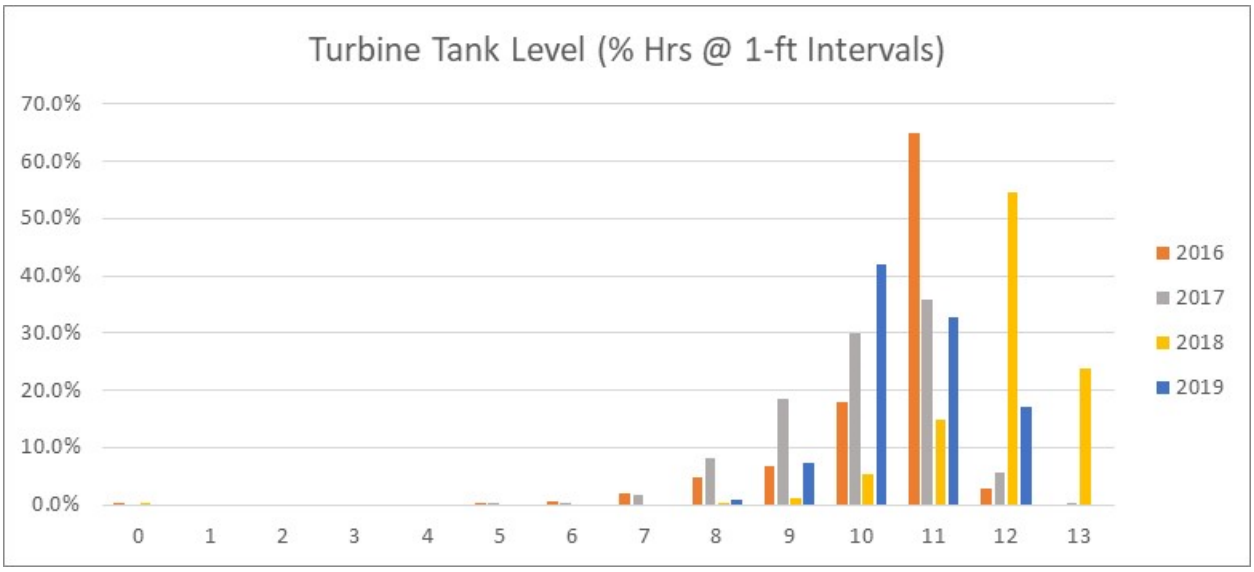


Figure 24. 2019 Summary of Temporal Cycles: Northridge Pump Station Discharge Pressure

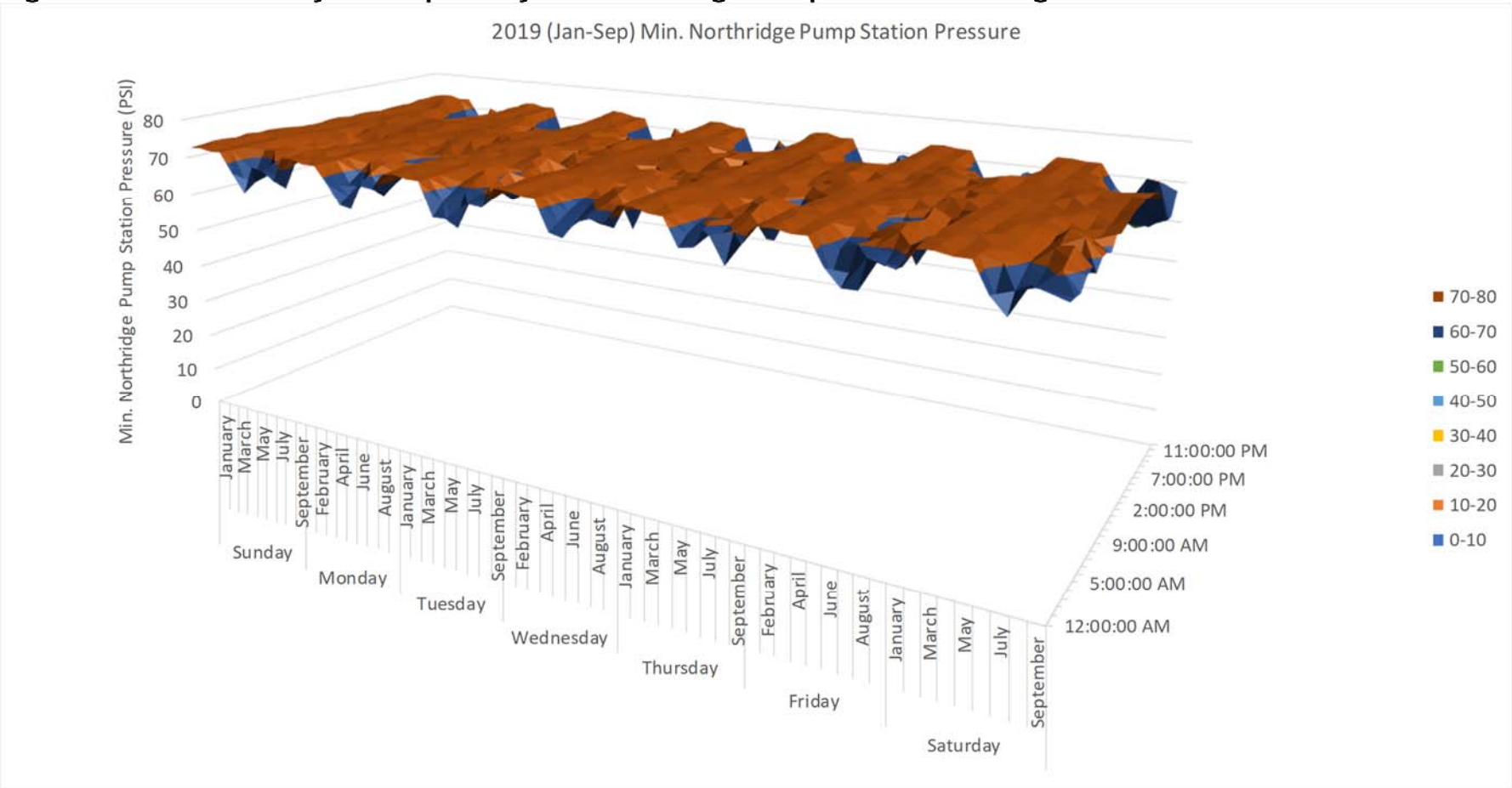


Figure 25. 2018 Summary of Temporal Cycles: Northridge Pump Station Discharge Pressure

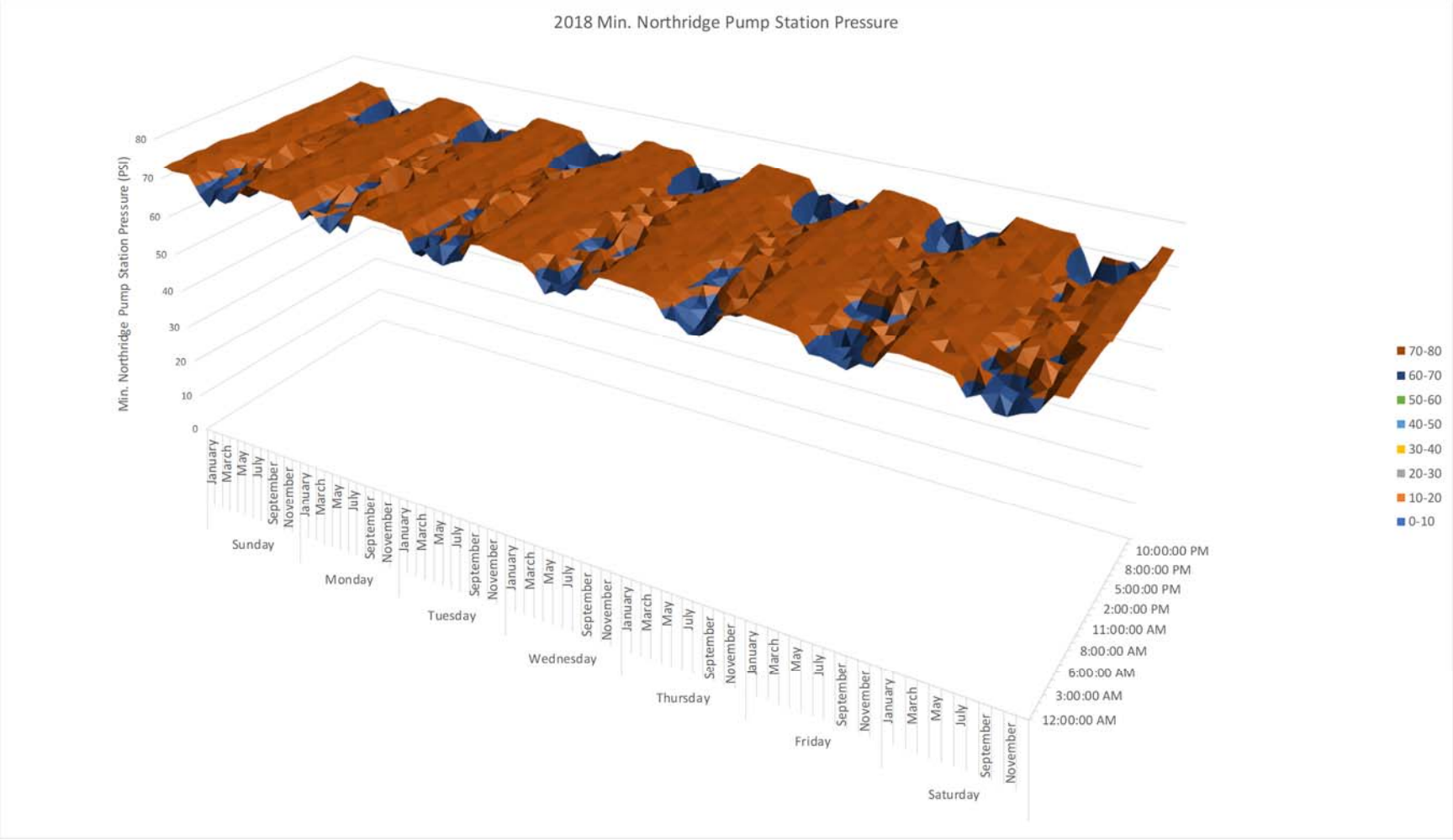


Figure 26. 2019 Min. 440 W Meadow vs Min. Northridge Pump Station Pressure

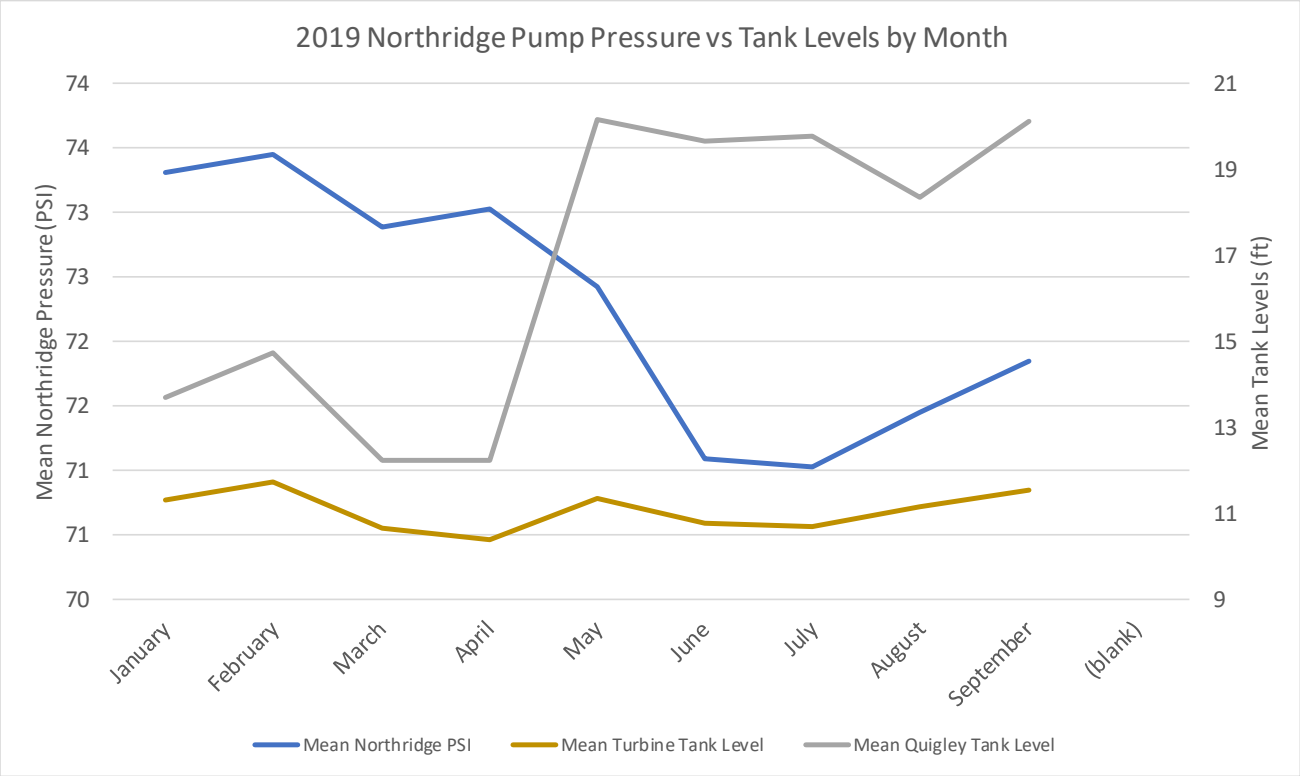


Figure 27. 2019 Min. 440 W Meadow vs Min. Northridge Pump Station Pressure

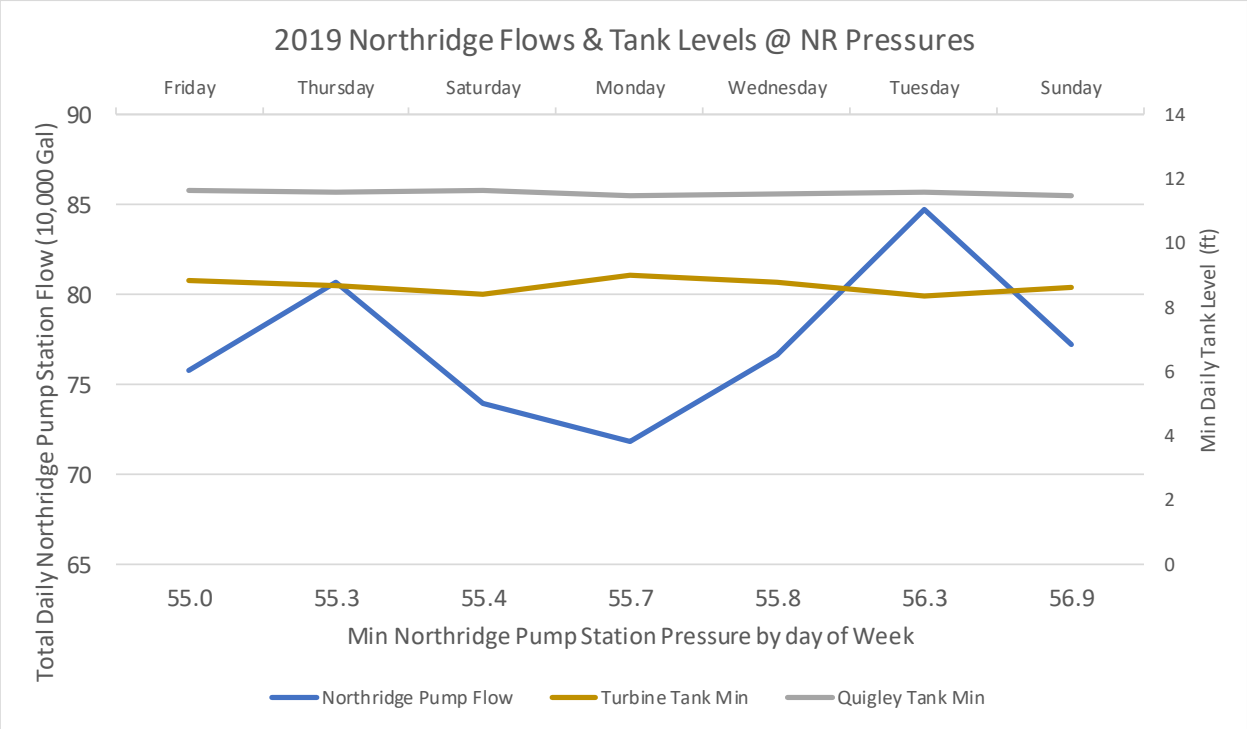


Figure 28. 2019 Northridge Pump Station Discharge Pressure vs Turbine Tank Level

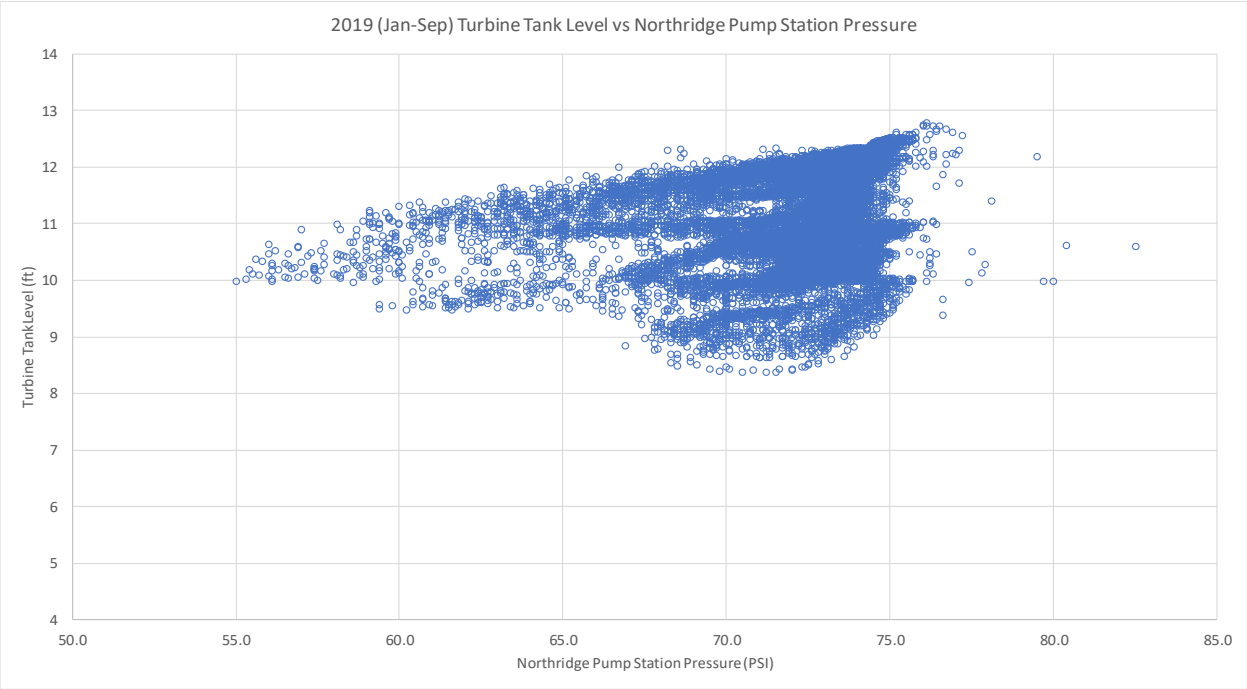


Figure 29. 2019 Northridge Pump Station Discharge Pressure vs Quigley Tank Level

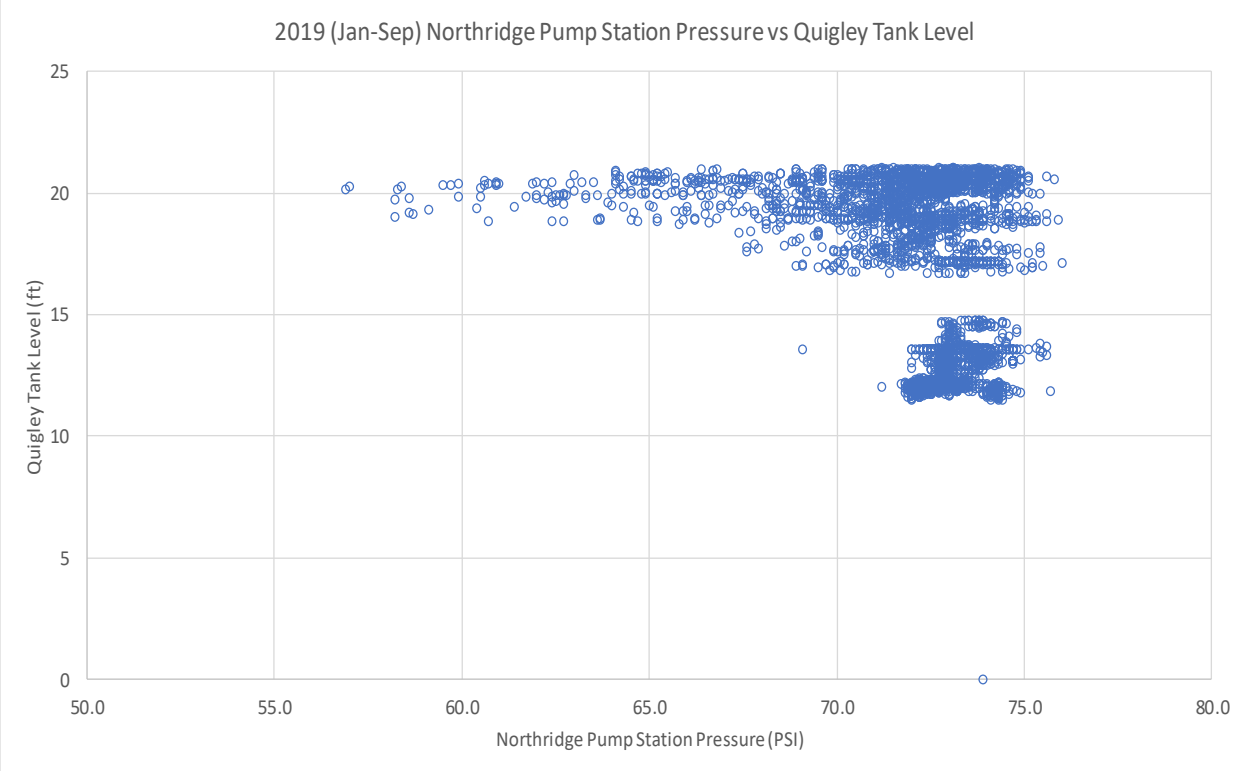


Figure 30. 2019 Northridge Pump Station Discharge Pressure vs Woodside Pump Station Discharge Pressure

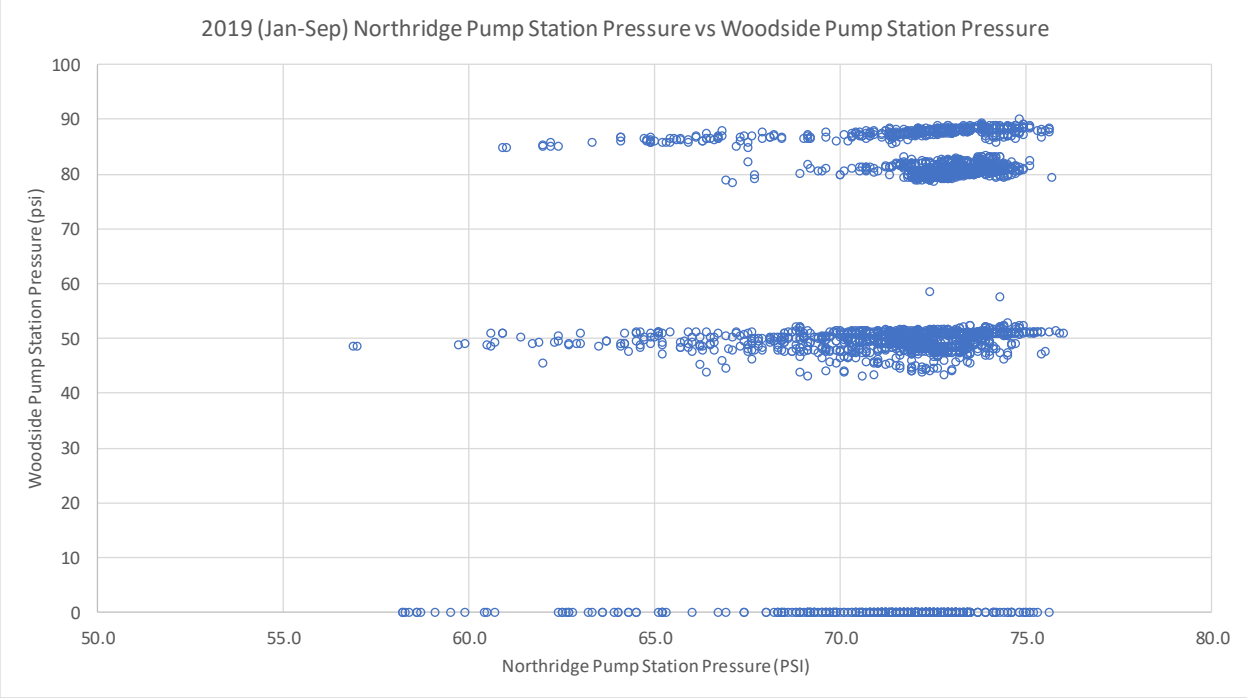


Figure 31. 2019 Northridge Pump Station Discharge Pressure vs 3rd Ave Pump Station Discharge Pressure

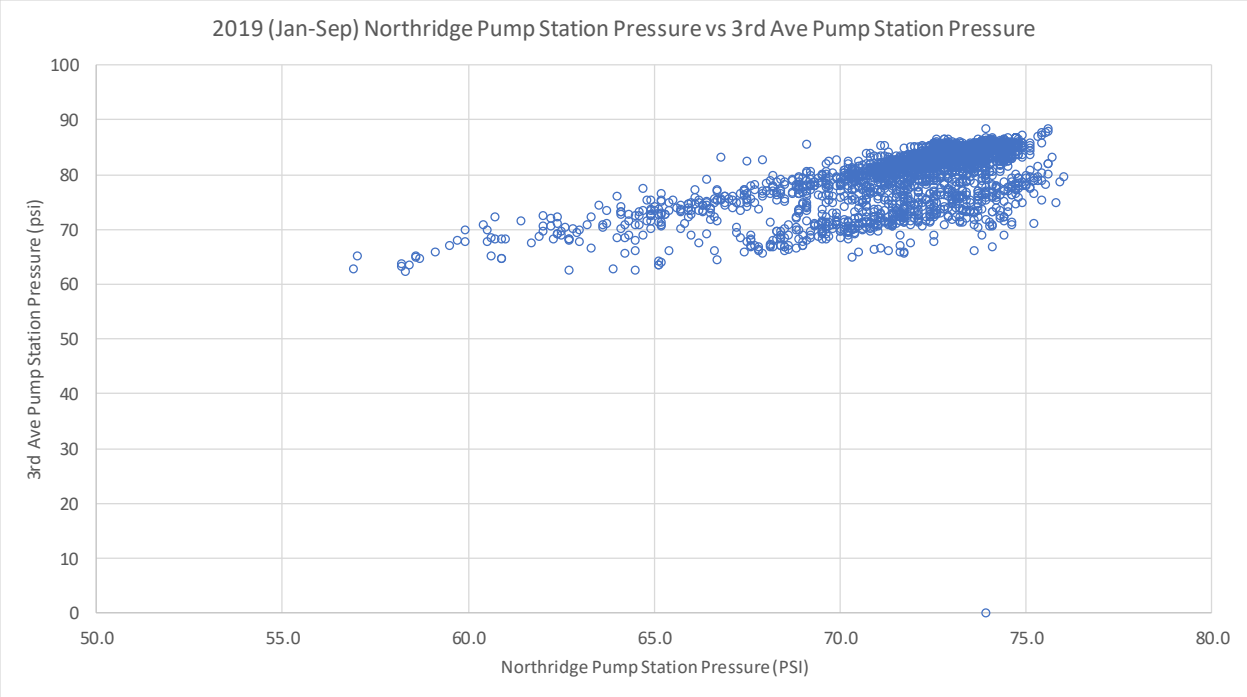


Figure 32. 2019 Northridge Pump Station Discharge Pressure vs River Street Pump Station Discharge Pressure

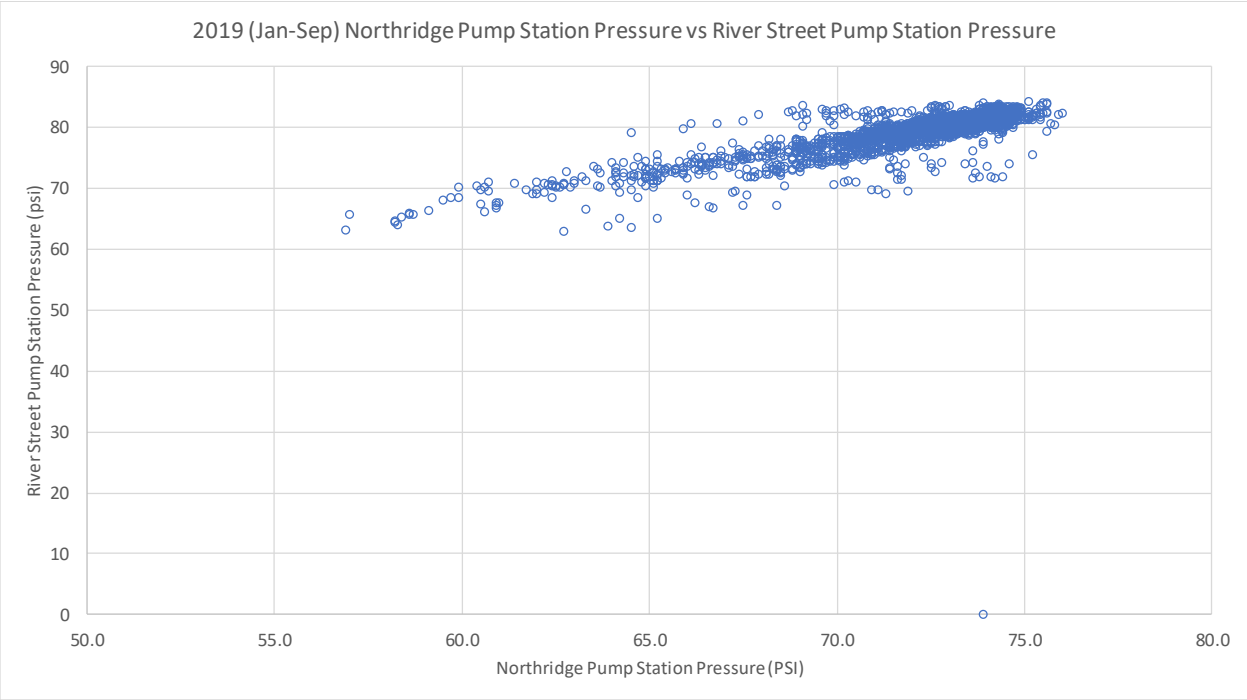


Figure 33. 2019 Northridge Pump Station Discharge Pressure vs Turbine Tank Outflow

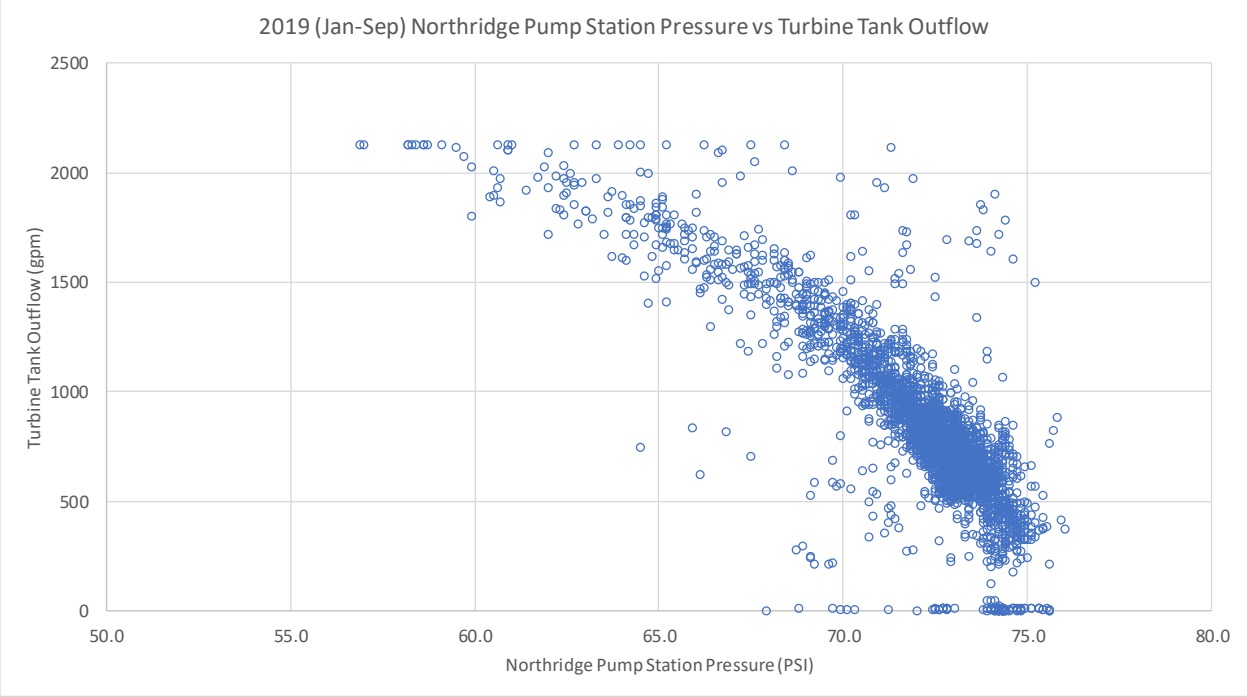


Figure 34. 2019 Northridge Pump Station Discharge Pressure vs Turbine Tank Inflow

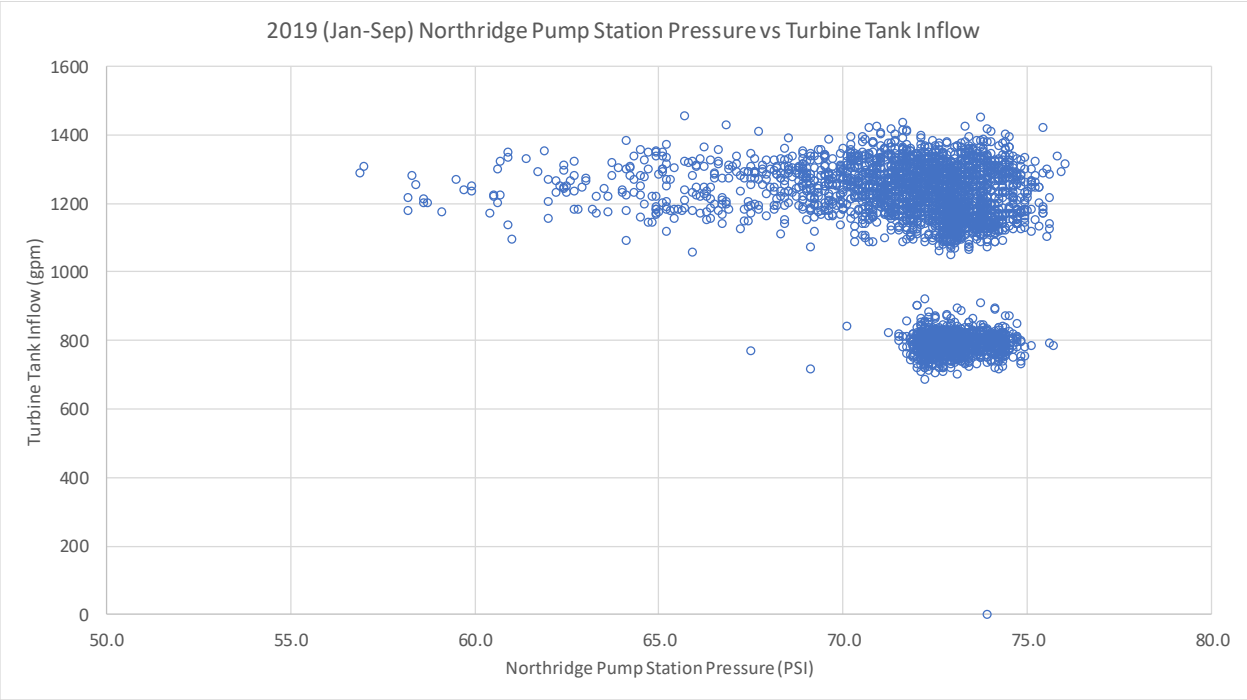


Figure 35. 2019 Northridge Pump Station Discharge Pressure vs Indian Springs Flow

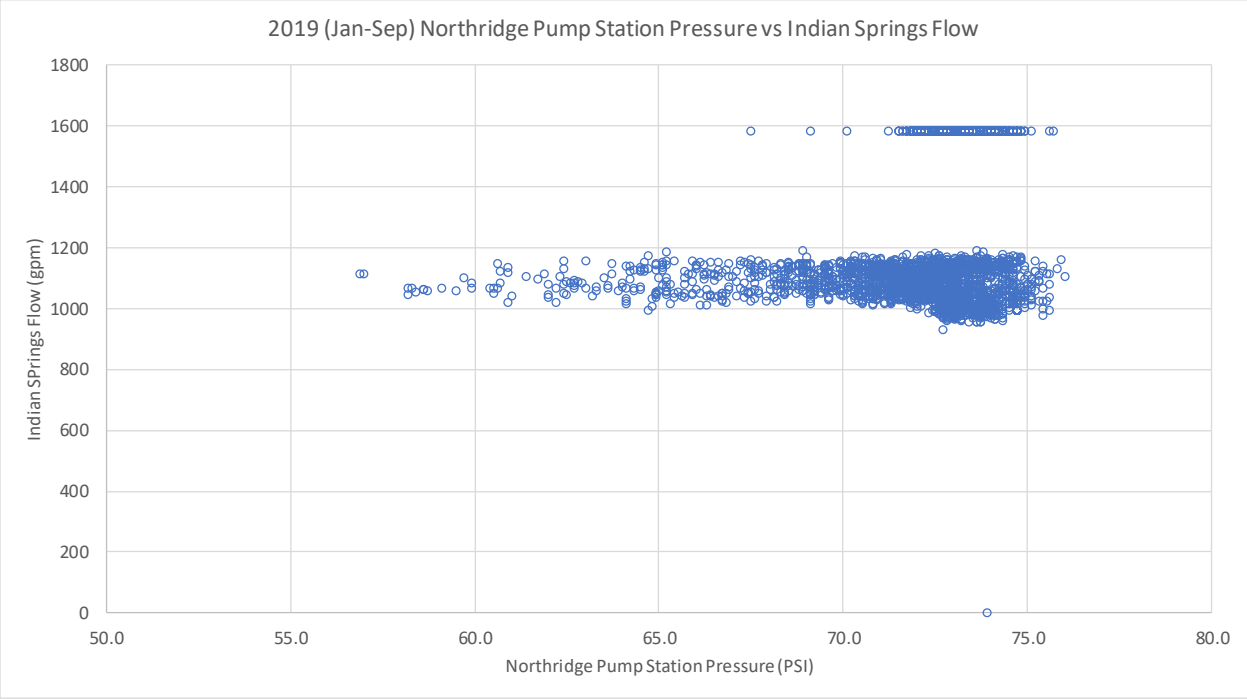


Figure 36. 2019 Northridge Pump Station Discharge Pressure vs Northridge Pump Station Flow

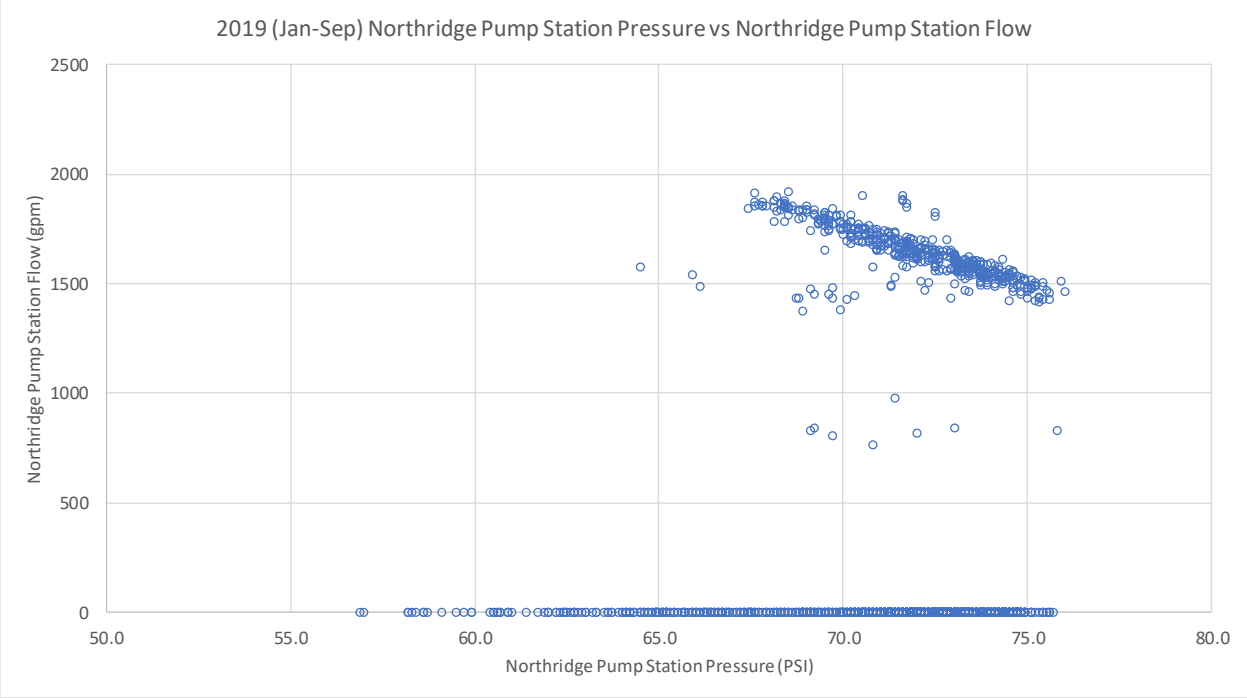


Figure 37. 2019 Northridge Pump Station Discharge Pressure vs River Street Pump Station Flow

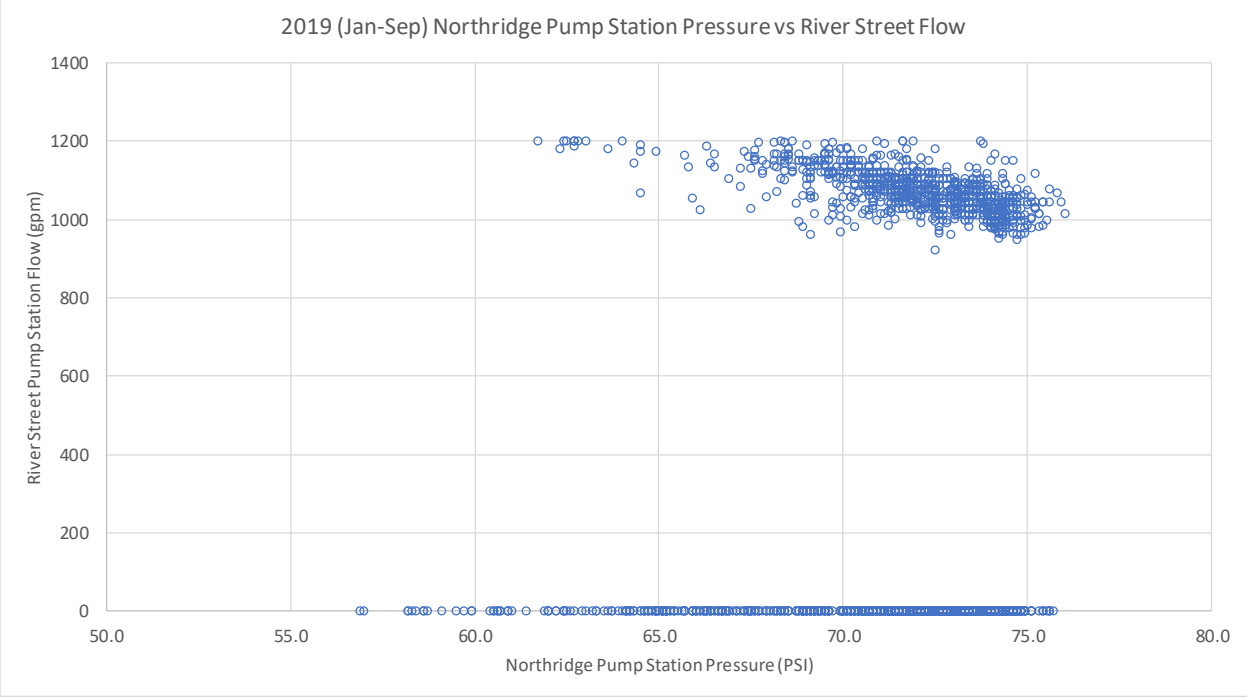


Figure 38. 2019 Northridge Pump Station Discharge Pressure vs 3rd Ave Pump Station Flow

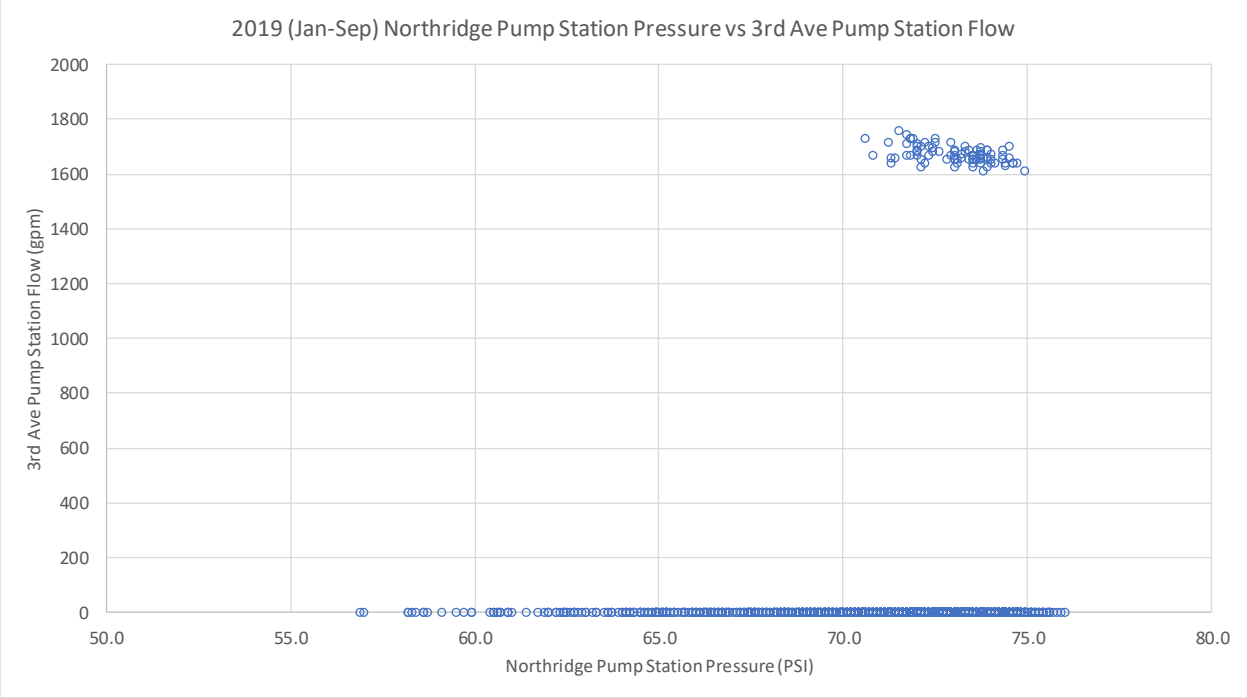


Figure 39. 2019 Northridge Pump Station Discharge Pressure vs Woodside Pump Station Flow

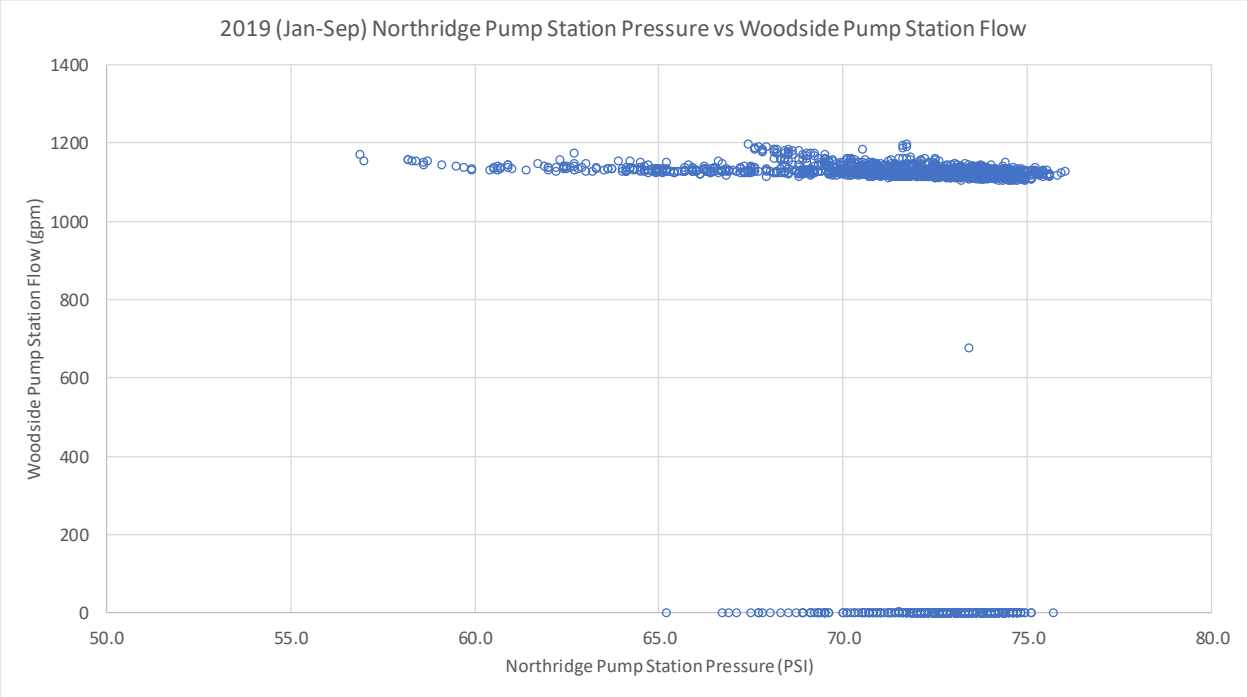


Figure 40. 2019 Northridge Pump Station Flow vs 1420 N 2nd Ave Pressure

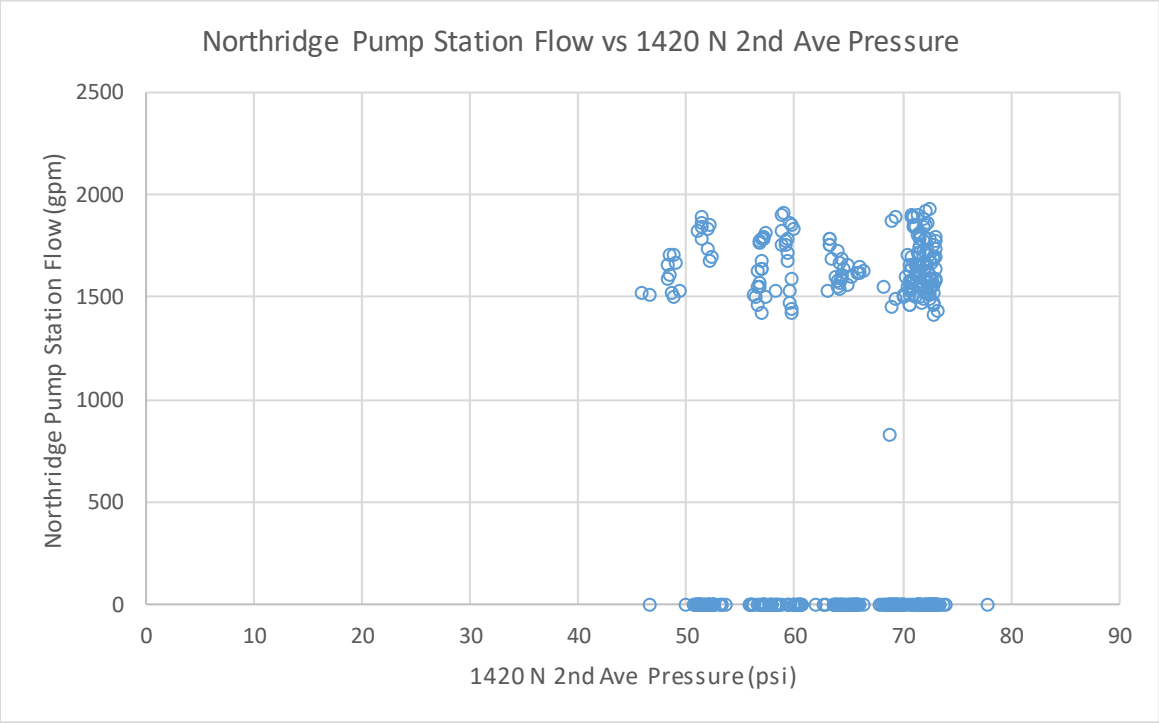


Figure 41. 2019 Northridge Pump Station Flow vs 1320 Heroic Ave Pressure

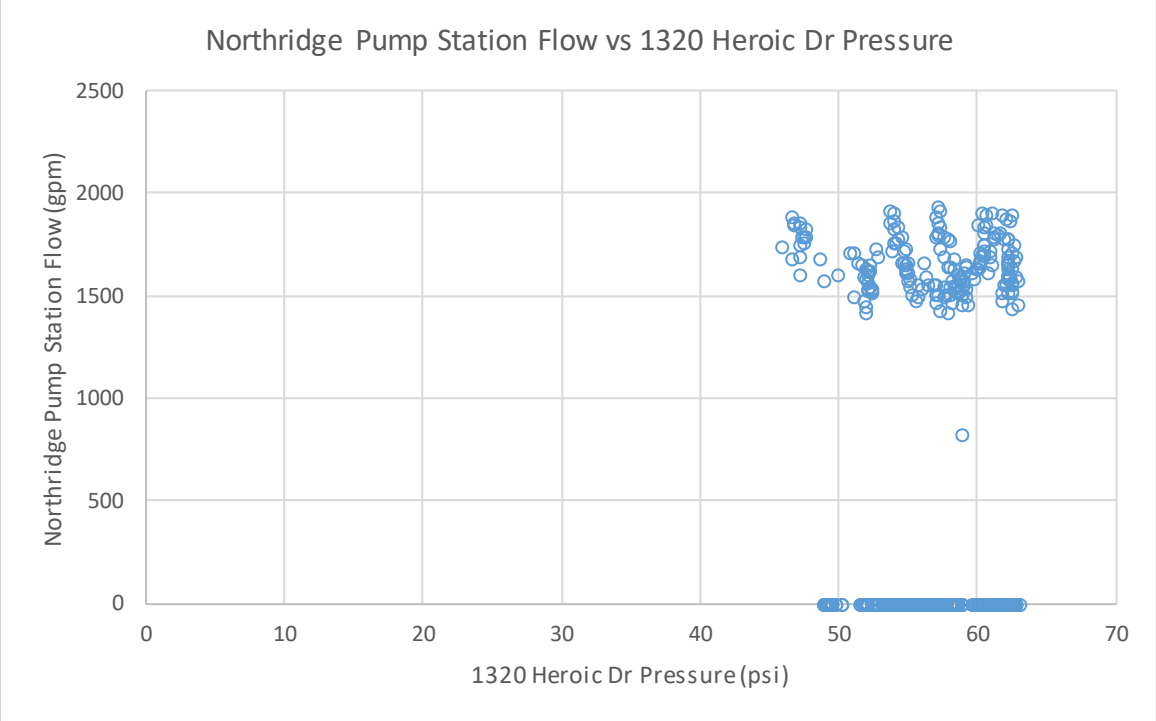


Figure 42. 2019 Northridge Pump Station Flow vs 710 Kintail Dr Pressure

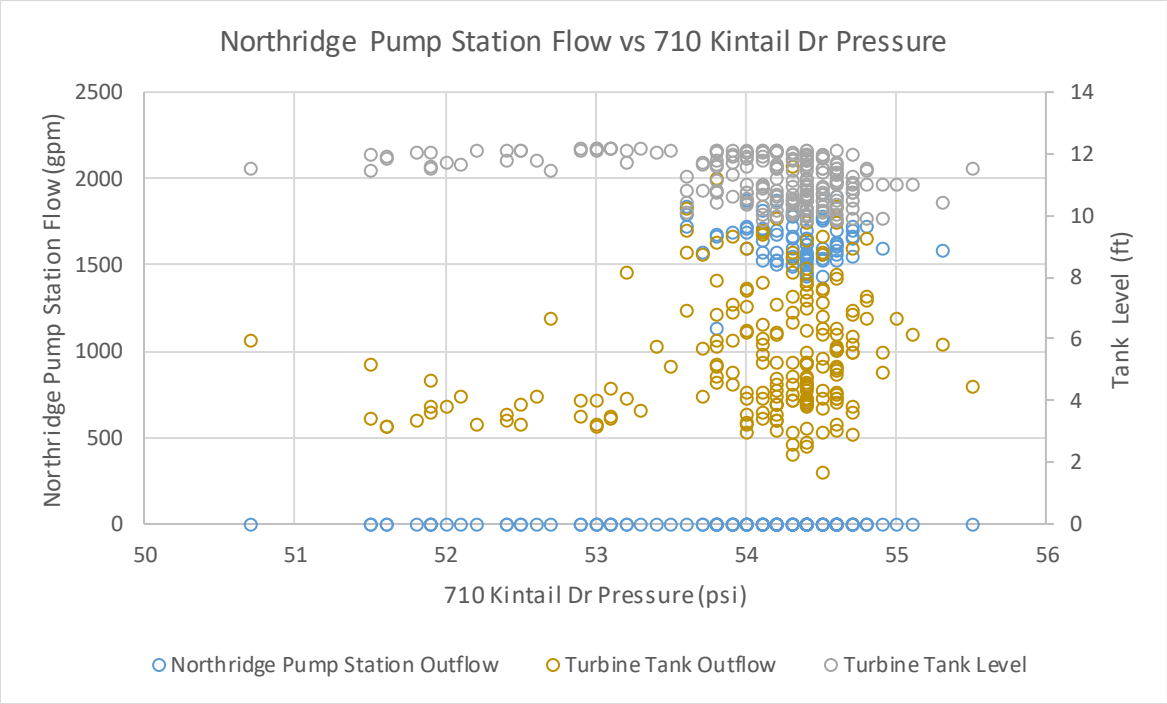
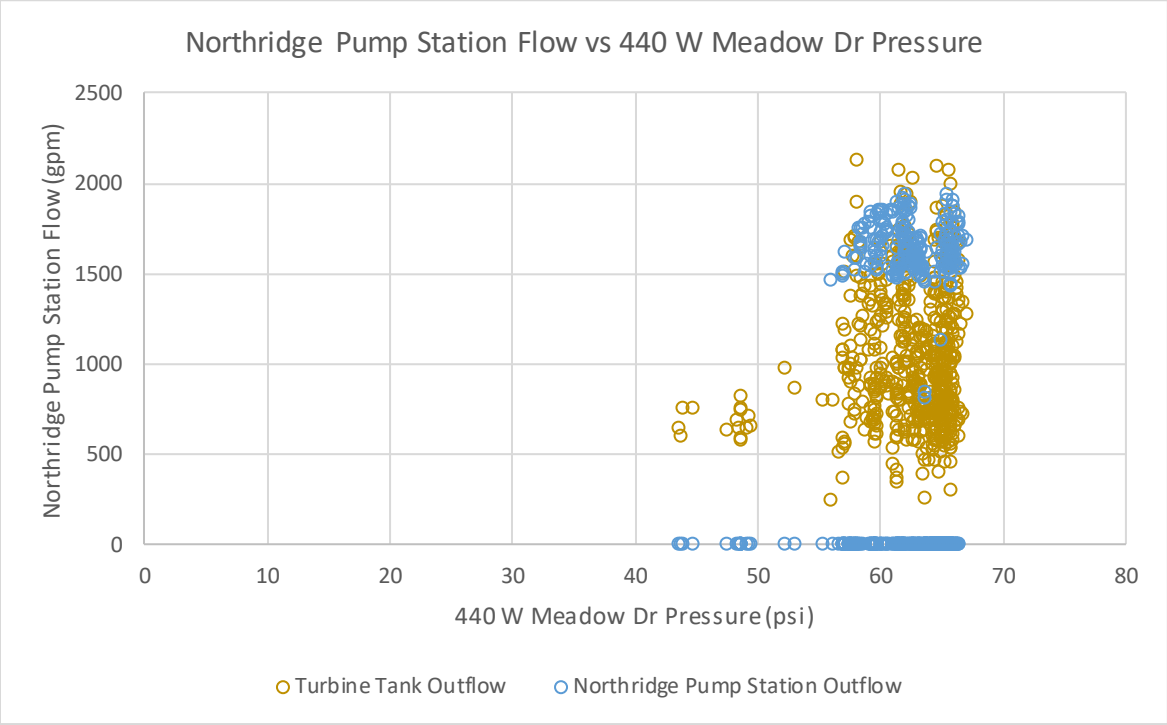


Figure 43. 2019 Northridge Pump Station Flow vs 440 W Meadow Dr Pressure



MEMORANDUM

DATE: November 25, 2019

TO: Brian Yeager, P.E., P.L.S., City of Hailey

FROM: Scott McGourty, P.E., SPF, Eric Landsberg, P.E., SPF

PROJECT NO: 330.0350

RE: Part 2: Northridge Area Pressure Study – Hydraulic Model Calibration

---

1.0 Introduction

The City of Hailey, Idaho (the City) has commissioned a study of water pressures in the City's public drinking water distribution system, with a specific geographic focus on the Northridge and Old Cutters Areas. The Study Area is approximately bounded by Highway 75 to the west, CD Olena Drive to the east, McKercher Boulevard and Myrtle Street to the South, and West Meadow Drive to the north.

This memorandum extends previous work (SPF, 2019) by using data gathered as part of the fall 2019 field study to calibrate the existing hydraulic model of the City's water distribution system (the calibrated model). The purpose of this memo is to; 1) document the results of the calibrated model (with focus on the Northridge area), specifically the accuracy of the model and the calibration effort, 2) project simulated worst-case conditions for water system pressure in the Northridge, and 3) provide preliminary alternatives for improving water system pressure in the Northridge Area.

This memorandum is the second of three anticipated parts of the overall study of water system pressure in the Northridge Area and is intended to support stakeholders, including water customers, City staff, and local public officials by providing data to determine appropriate performance goals for the Northridge Area water system, and identify preliminary options for increasing system pressure where desired.

The results of the calibration effort indicate that the City's hydraulic model of the Northridge Area can match field measured pressures with approximately 99.1% accuracy, or ± 1 psi primarily via structured adjustment of system demand (see Section 3). The calibrated model was used to project estimated worst case conditions in Northridge (lowest pressures at residential locations) based on an observed pressure of 55 psi at the Northridge booster pump station (a 4-year low seen on July 19, 2019 at 10:45 PM). Based on the calibrated model, pressures could reasonably be expected to drop as low as 28 psi in the Northridge Area on a 15-minute instantaneous basis (see Section 4.0).

Projected water system performance calculated by the model is believed to be a reasonable estimate of potential field conditions, however the results of the model are approximate, and rely on many variables including approximate pipe invert elevations throughout the City's water system which have the potential to introduce inaccuracy (likely to range from approximately 5-10 psi). Pipe inverts for the Northridge Area were checked versus approximates of ground surface elevation and updated in the hydraulic model, which is believed to have decreased inaccuracy related to pipe elevations within the Study Area. The success of the model in matching field measurement data at multiple locations simultaneously across several scenarios via adjustment of system demand generally indicates that the network components of the hydraulic model are accurate to a relatively high degree.

2.0 Method

The City of Hailey's water system hydraulic model has undergone previous limited calibration efforts, most recently in November 2018. The hydraulic model calibrated in November 2018 was the starting point for the calibration effort documented in this memorandum.

The November 2018 calibration effort also focused on the Northridge Area and included the following calibration steps:

- Use of the Bentley® WaterCAD CONNECT Edition (Version 10.00.18) Darwin Calibrator™ to incorporate the results of fire hydrant flow test data from hydrants in the Northridge Area to calibrate the Hazen-Williams "C" pipe roughness coefficients for the pipe network in the Northridge Area. The Darwin Calibrator employs genetic fitness algorithms to recursively change model variables in parent-child iterations.
- Updated pipe diameters and topographic data for the existing distribution piping in the model within the Northridge Area based on as-built and design drawings provided by the City.

Model Input

The calibration effort completed as part of this evaluation consisted of the use of field measurement data to reconstruct and simulate hydraulic conditions observed in the field. Input used as part of the calibration process were obtained for the locations presented in Table 1.

Table 1

Field Measurement Data Locations

Residential Locations	440 W Meadow Drive 710 Kintail Drive 1710 Northridge Drive 1740 2nd Ave North 1320 Heroic Drive 1420 2nd Ave N 154 S Hiawatha Dr 158 S Hiawatha Dr
Booster Pump Stations	Northridge 3rd Ave River St Woodside
Storage Tanks	Turbine Quigley

The following data were used as input for modeling each scenario:

1. Pressure data from field measurements
    - Pressure at the Northridge Booster Pump Station (from SCADA data)
    - Field study data from eight residential monitoring locations (from temporary pressure recorders installed by the City)
2. Hydraulic equipment status
    - Pump station status (from SCADA data)
    - Tank Levels (from SCADA data)
3. Approximate topographic elevation data from USGS Digital Elevation Models derived from the National Elevation Dataset (NED) provided by Google Earth
4. System demand (based on water meter data provided by the City)

The initial conditions data used during model calibration are presented in Table 2. The topographic elevations of residential pads were found to be higher than the elevation of the nearest pipe junction in the hydraulic model for the following addresses:

- 440 W Meadow Dr (revised to 5,388-ft from 5,381-ft)
- 1740 2nd Ave N (revised to 5,384-ft from 5,370-ft)
- 1320 Heroic Dr (revised to 5,373-ft from 5,351-ft)
- 154 and 158 S Hiawatha Dr (revised to 5,394-ft from 5,385-ft).

As shown in Table 2, the minimum pressures observed during the field study at the residential monitoring locations ranged from 41-46 psi, while the corresponding pressures at the nearest booster pump station (Northridge [NR] booster pump station) ranged from 66-73 psi at the time that minimum pressures were observed at the residential locations.

Table 2

Field Measurement & SCADA Data

Location Address	Field Min (psi)	Date/Time of Min.	NR Pressure (psi)	NR Flow (psi)	Turbine Tank (ft)	Quigley Tank (ft)	River St Flow (gpm)	3rd Ave Flow (gpm)	Woodside Flow (gpm)
440 W Meadow Dr	42	8/19/2019 1:46	73	0	12.1	18.5	0	0	1,121
710 Kintail Dr	41	8/14/2019 20:58	65	0	11.3	19.6	0	0	1,132
1710 Northridge Dr	45	8/21/2019 0:36	68	1,896	10.3	16.9	1,152	0	1,187
1740 2nd Ave N	45	8/20/2019 21:34	66	0	10.8	17.9	1,167	0	1,144
1320 Heroic Dr	46	8/23/2019 0:52	68	1,895	10.0	17.0	1,176	0	1,187
1420 2nd Ave N	44	8/25/2019 23:44	69	1,834	10.4	18.1	1,186	0	1,166
154 S Hiawatha Dr	41	8/28/2019 21:36	66	0	10.9	19.3	1,163	0	1,139
158 S Hiawatha Dr	45	9/3/2019 0:02	68	1,871	10.4	19.4	1,167	0	1,171

Calibration Process

The intent of the calibration process was to demonstrate the ability of the hydraulic model to reproduce conditions observed during the field study (conducted from August to September 2019 [SPF, 2019]) and to adjust model parameters where needed to increase the accuracy of the model. Eight scenarios were modeled as part of the calibration effort, each corresponding to one of the residential locations monitored during the field study. The purpose of each calibration scenario was to identify the adjustments to the model which were required to match; a) the hydraulic grade line at the Northridge booster pump station (as reported by SCADA data), and b) the hydraulic grade line at the residential location recorded at the same day and time. The initial conditions for each scenario were constructed by matching the conditions of various hydraulic elements including tank levels and pump status for all four of the City's large booster pump stations.

The general process for conducting calibration of the model was as follows:

1. Input the status of pumps and tanks from SCADA data into the model for each scenario

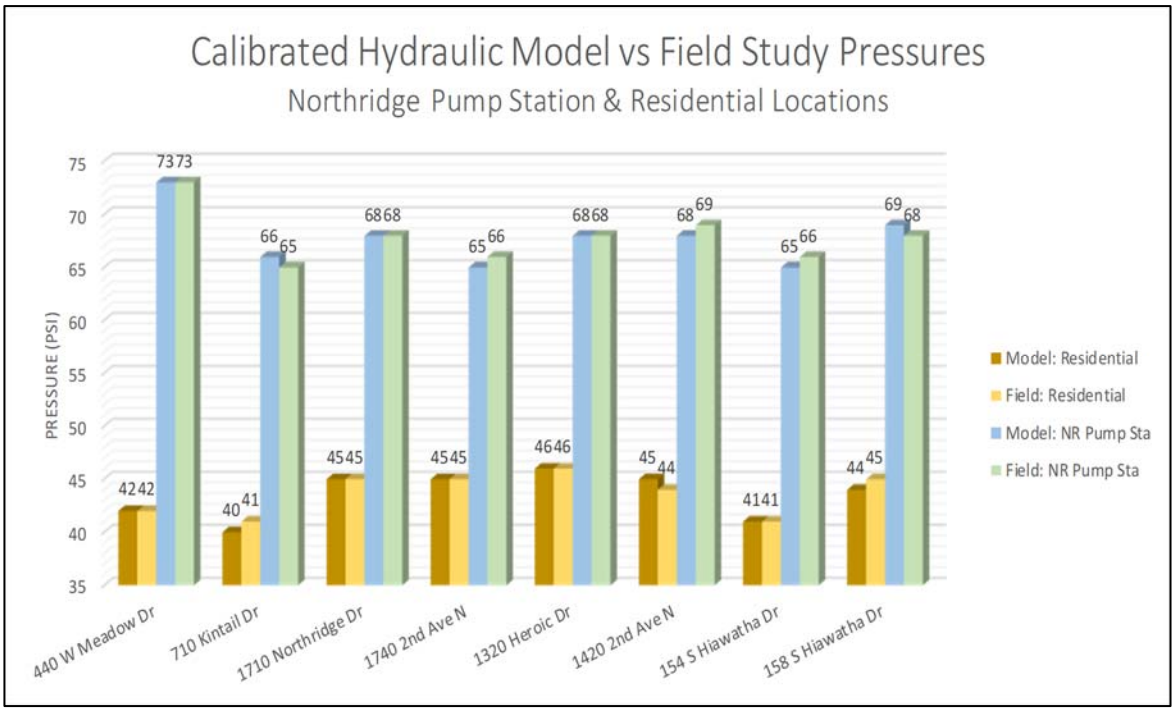
2. Compare approximate residential lot elevations as reported by the NED to topographic elevation of the nearest hydraulic model pipe junction and update the model as required
3. Update model demand based on water meter data provided by the City
4. Perform initial model run
5. Perform structured demand adjustment on an iterative basis to converge model results to the field study data for each scenario. The demand adjustment process consisted of progressively more narrow geographic adjustments to demand, scaling successively beginning city wide, then area wide, and finally on a junction specific basis.

3.0 Hydraulic Model Calibration Results

The results of the calibrated model across all eight scenarios are presented in Figure 1. As shown in Figure 1, the calculated model results match pressures observed in the field, both at the Northridge booster pump station and the residential monitoring locations. Output from the calibrated model is presented in Appendix A.

Figure 1

Calibration Results



Model Accuracy

Model accuracy is a measure of how closely the calculated results of the model match actual conditions observed in the field. The accuracy of the calibrated hydraulic model is evaluated on the basis of five metrics discussed below (results are presented in Table 4).

1. **Standard Deviation:** A measure of the deviation of the results of the calibrated hydraulic model versus the field study pressure data. The standard deviation was computed using Equation 1:

$$\sigma = \frac{1}{N}\sum_{n=1}^{N} |x_n - y_n| \qquad \text{(Equation 1)}$$

Where:

- x = the field study pressure measurement data
- y = the calibrated hydraulic model pressure results
- N = the total number of calibration points (eight residential locations and eight corresponding pressure readings from the SCADA data for the Northridge booster pump station)
- n = an individual calibration point
- σ = standard deviation

In the context of this analysis, standard deviation represents the average discrepancy between the model output and the field study measurements across the eight calibration scenarios, which included 16 calibration data points (eight residential pressures and eight pressures for the Northridge booster pump station were matched).

2. **Maximum Cumulative Difference**: A measure of the sum of the largest deviation of the hydraulic model versus the field data (Northridge booster pump station plus the corresponding residential location). A combined absolute difference of 2 psi was seen at 710 Kintail Dr and 1420 2nd Ave N (Table 3).

Table 3

Field Measurement Data Locations

Residential Location	Field Study (psi)		Calibrated Model (psi)		Difference (psi)	
	Res.	NRBPS	Res.	NRBPS	Res.	NRBPS
440 W Meadow Drive	42	73	42	73	0	0
710 Kintail Drive	41	65	40	66	1	-1
1710 Northridge Drive	45	68	45	68	0	0
1740 2nd Ave North	45	66	45	65	0	1
1320 Heroic Drive	46	68	46	68	0	0
1420 2nd Ave N	44	69	45	68	-1	1
154 S Hiawatha Dr	41	66	41	65	0	1
158 S Hiawatha Dr	45	68	44	69	1	-1

3. **Percent Accurate**: A measure of the average relative percent difference between pressures calculated by the model and observed pressures in the field for each of the eight residential locations and the Northridge booster pumps station as reported by the SCADA system at the same time and day. The results of this calculation were computed using Equation 2, with results presented in Table 4.

$$rpd = 1 - \left(\frac{1}{N}\sum \left|\frac{x_n - y_n}{x_n}\right|\right) \quad \text{(Equation 2)}$$

Where:

- x = the field study pressure measurement data
- y = the calibrated hydraulic model pressure results
- N = the total number of calibration points (eight residential locations and eight corresponding pressure readings from the SCADA data for the Northridge booster pump station)
- n = an individual calibration point
- rpd = average relative percent difference

4. **Accuracy Range**: A measure of the largest range of the minimum and maximum difference between the pressures calculated by the calibrated model and pressures observed in the field. 710 Kintail Dr and 1420 2nd Ave N showed a range of -1 to +1 (Table 3).

5. **Pearson's Correlation Coefficient**: A measure of the strength of the regression relationship between the pressures calculated by the calibrated model versus pressures observed in the field. The results of this calculation were computed using Equation 3, with results presented in Table 4.

$$\rho_{xy} = \frac{\sigma_{xy}}{\sigma_x \sigma_y} \quad \text{(Equation 3)}$$

Where:

- ρ_{xy} = Pearson's "r" correlation coefficient
- σ_{xy}= covariance between the modeled pressures and field measured pressures
- σ_x= the standard deviation of modeled pressures
- σ_x= the standard deviation of field measured pressures

Table 4

Model Accuracy Results

Standard Deviation	σ = 0.5	psi
Max. Abs. Diff.	2	psi
% Accuracy	99.1	%
Accuracy Range	±1	psi
Pearson's "r"	0.9	psi/psi

4.0 Northridge Area Worst-Case Simulation

The calibrated model was used to project estimated worst case conditions in Northridge (lowest pressures at residential locations) based on an observed pressure of 55 psi at the Northridge booster pump station (a 4-year low seen on July 19, 2019 at 10:45 PM). The initial conditions for the "worst-case" scenario are presented in Table 5.

Table 5

Worst-Case Model Initial Conditions

Location Address	Date/Time of Min.	NR Pressure (psi)	NR Flow (psi)	Turbine Tank (ft)	Quigley Tank (ft)	River Flow (gpm)	3rd Flow (gpm)	Woodside Flow (gpm)
Worst Case	7/19/2019 22:45	55.0	0	10.0	20.1	0.0	0	1200

Based on the calibrated model, pressures could reasonably be expected to drop as low as 28 psi in the Northridge Area in the vicinity of 710 Kintail Drive. The 28-psi minimum is the

result of simulating a pressure of 55-psi at the Northridge booster pump station, which is an instantaneous value reported by the SCADA system on 15-minute intervals.

5.0 Preliminary Conceptual Improvement Alternatives

Typical pressure analysis of municipal water systems evaluates peak hour demand (PHD) as the worst-case scenario, which is less conservative than the instantaneous minimum pressure evaluated in the worst-case scenario. Regulatory requirements for pressure include a minimum of 40 psi during PHD conditions. Beyond regulatory requirements, water pressure as experienced by customers is also an aesthetic matter with preferences varying by community.

Four preliminary conceptual alternatives for increasing the pressure in the study area are provided below. The conceptual alternatives are provided as a starting point for further evaluation based on community and City goals for the water system performance. The results of modeling conceptual improvement scenarios are presented in Table 6 and Appendix B.

A. New water supply well in the North Ridge Area and creation of a new pressure zone. This scenario entailed the addition of a new well and pump near 710 Kintail Drive. For the purpose of this analysis, the pump was assumed to be similar to the existing Northridge #1 Pump (design point of 950 gpm controlled by VFD set to maintain 60 psi). The results of preliminary modeling of this scenario indicate that pressures in the Northridge Area could be increased to a minimum of 59 psi. During modeling, check valves were added to isolate the Northridge Area, including the existing Northridge booster pump station. Removal of the Northridge booster pump station from the rest of the City system caused minimum pressures near Lena Drive to drop from 49 to 42 psi. In this scenario, a maximum pressure of 85 psi was observed near the existing Northridge booster pump station.

B. New water supply well in the North Ridge Area with no new pressure zone. For this scenario, check valves simulated under Scenario A isolating the Northridge area were removed. With a set point of 60 psi at the new well pump, the minimum pressure during estimated worst-case conditions increases to 57 psi.

C. Modifications to the existing North Ridge Well Pump House and creation of a new pressure zone. This scenario entailed replacement of the Northridge #1 pump (50 HP) with a large 100 HP pump and VFD controlled discharge pressure of 85 psi (versus 75 psi under existing conditions). The results of preliminary modeling of this scenario indicate that pressures in the Northridge Area could be increased to a minimum of 58 psi. Removal of the Northridge booster pump station from the rest of the City system caused minimum pressures near Lena Drive to drop from 49 to 42 psi. In this scenario, a maximum pressure of 85 psi was observed near the existing Northridge booster pump station.

D. Modifications to the existing North Ridge Well Pump House with no new pressure zone. For this scenario, check valves simulated under Scenario C isolating the Northridge area were removed. With a set point of 85 psi at the new Northridge #1 pump, the minimum pressure during estimated worst-case conditions increases to 45 psi.

Table 6

Conceptual Improvement Scenario Modeling Results

Conceptual Improvement Scenario	Min. NR Pressure (psi)	Max. NR Pressure (psi)
New NR Well, New PZ	59	85
New NR Well, No PZ	57	77
NRBPS Upgrade, New PZ	58	85
NRBPS Upgrade, No PZ	45	73

6.0 Conclusions and Recommendations

Based on analysis of data from the City of Hailey hydraulic model, SPF concludes the following:

- The City's hydraulic model is able to reproduce field conditions with a high degree of accuracy for the Northridge and Old Cutters Areas.
- Initial conditions for calibration scenarios for tank levels and pumps station operating status were taken from field logs and SCADA data recorded during the fall 2019 field study. Pipe junction elevations were updated at four locations as part of this calibration effort.
- Model results are highly sensitive to demand inputs, which were the primary parameter used to calibrate model results to field conditions.
- The field study was not conducted over the peak irrigation demand season, when pressures in the study area are typically the lowest. This modelling exercise included a simulated worst-case scenario intended to estimate the lowest pressures likely to occur within the study area during peak demand periods. Model results suggest that pressures may drop as low as 28 psi during peak irrigation periods.
- Four conceptual alternatives are presented for increasing pressure in the Northridge Area. The conceptual alternatives are provided as a starting point for further evaluation based on community and City goals for the water system performance.
- Fire flow analysis has not been assessed for the conceptual improvement scenarios, and should be evaluated before proceeding further with improvement planning.

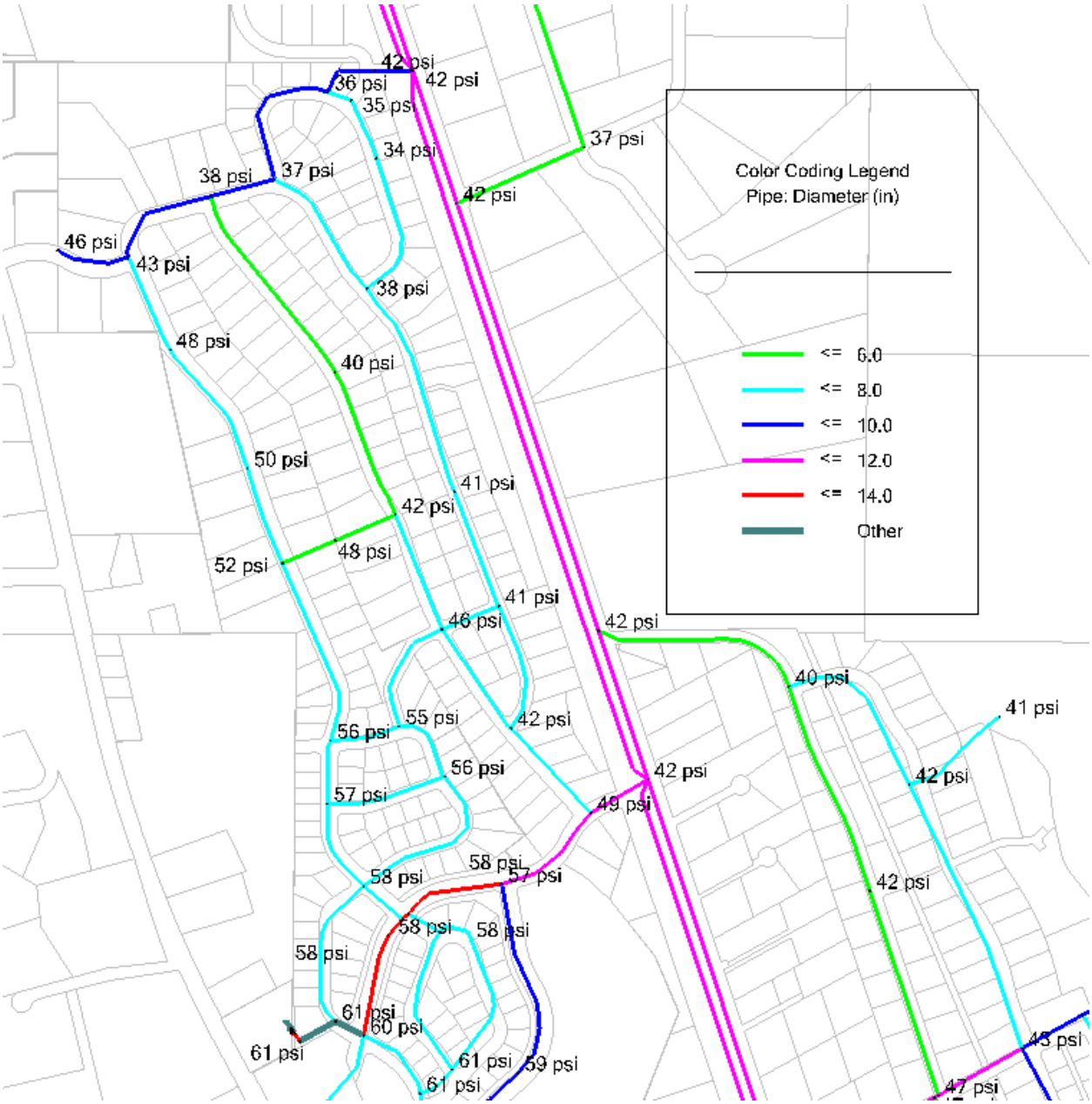
7.0 References

SPF, 2019. Draft Northridge Area Pressure Study – Field Data Review. Prepared for the City of Hailey, October 2019.

Appendix A

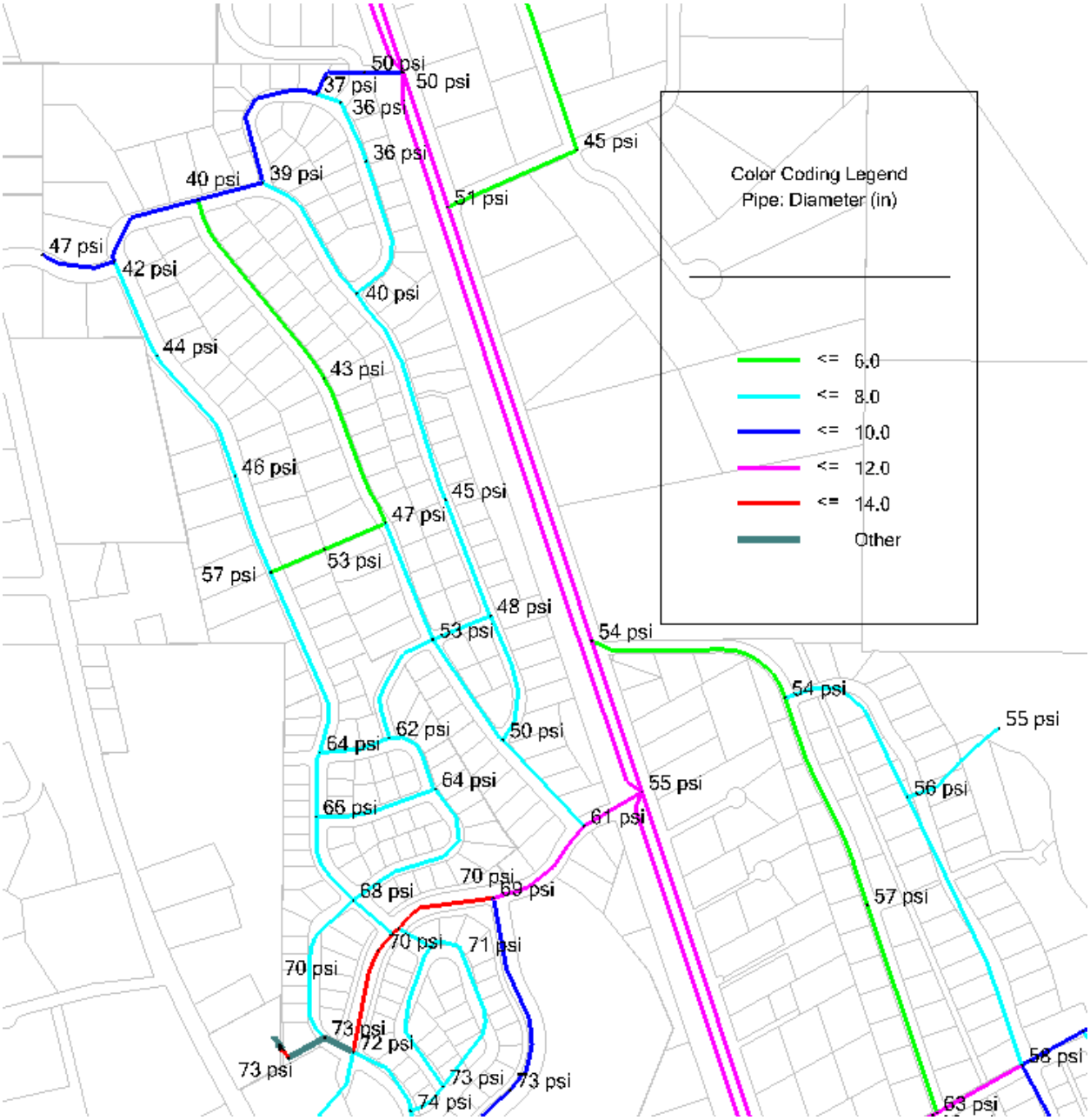
Model Output

Baseline Peak Hour Demand (Pre-Field Study Calibration)



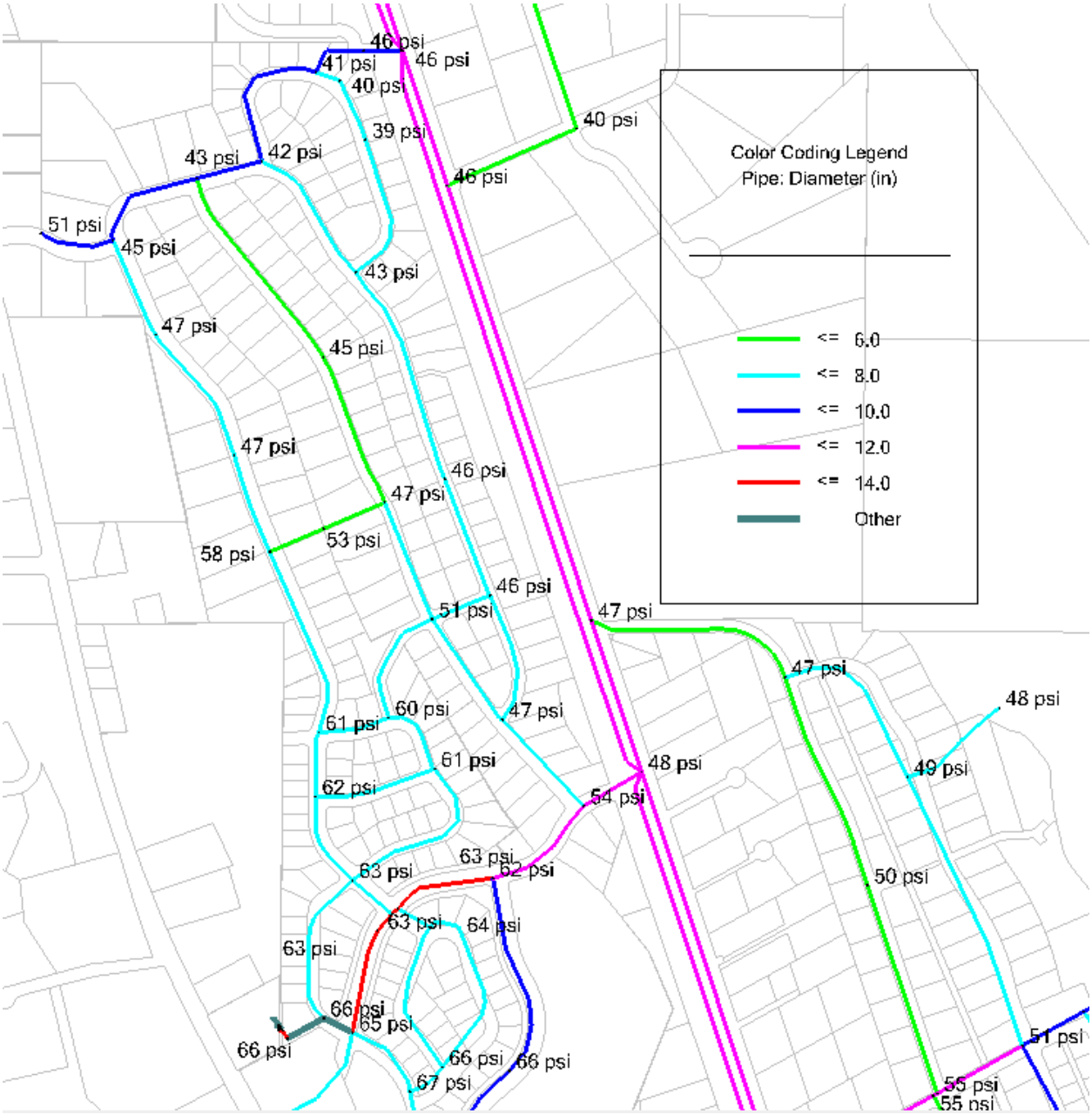
Scenario 1

440 W Meadow Drive Calibration Results



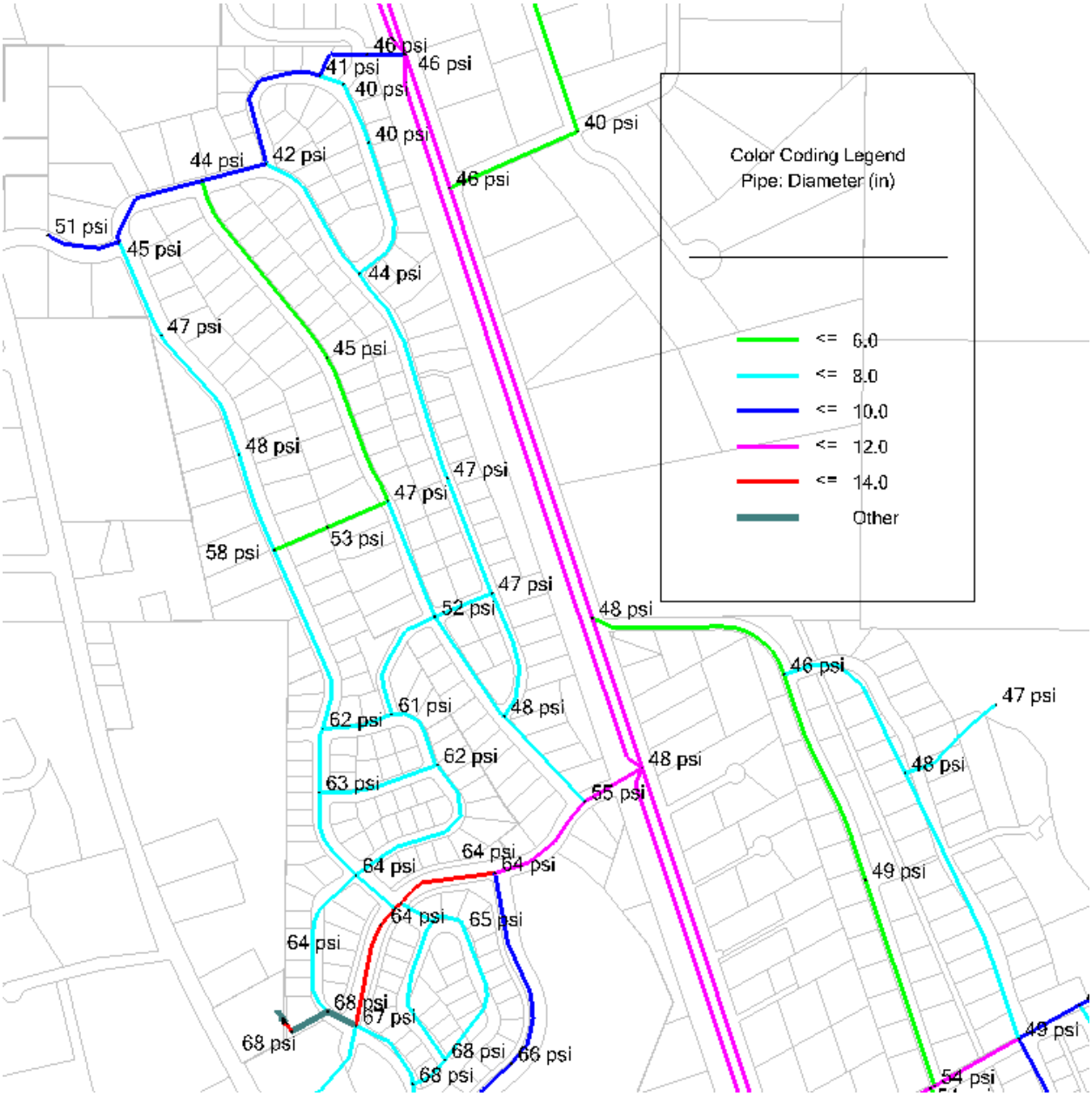
Scenario 2

710 Kintail Drive Calibration Results



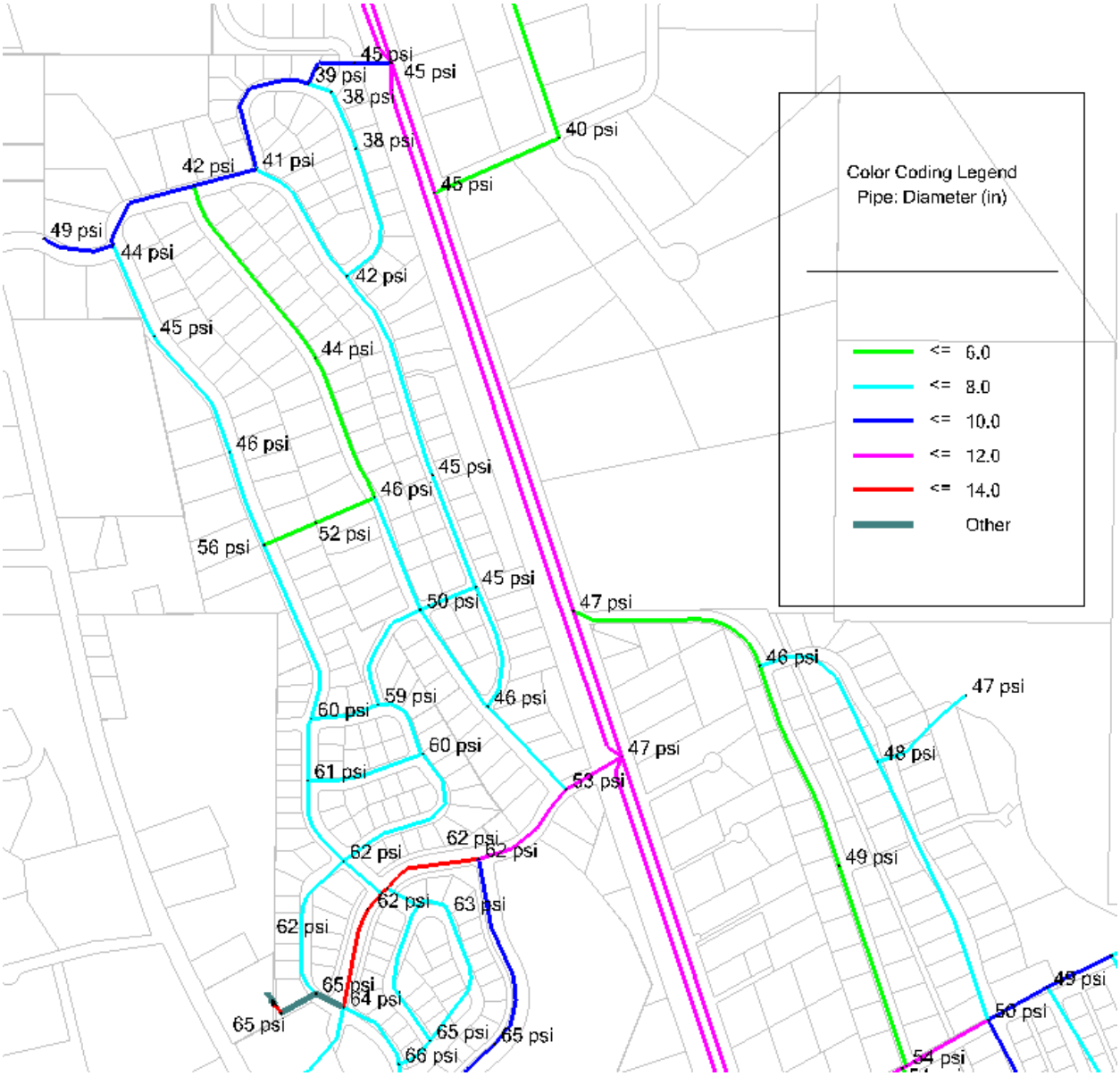
Scenario 3

1710 Northridge Drive Calibration Results



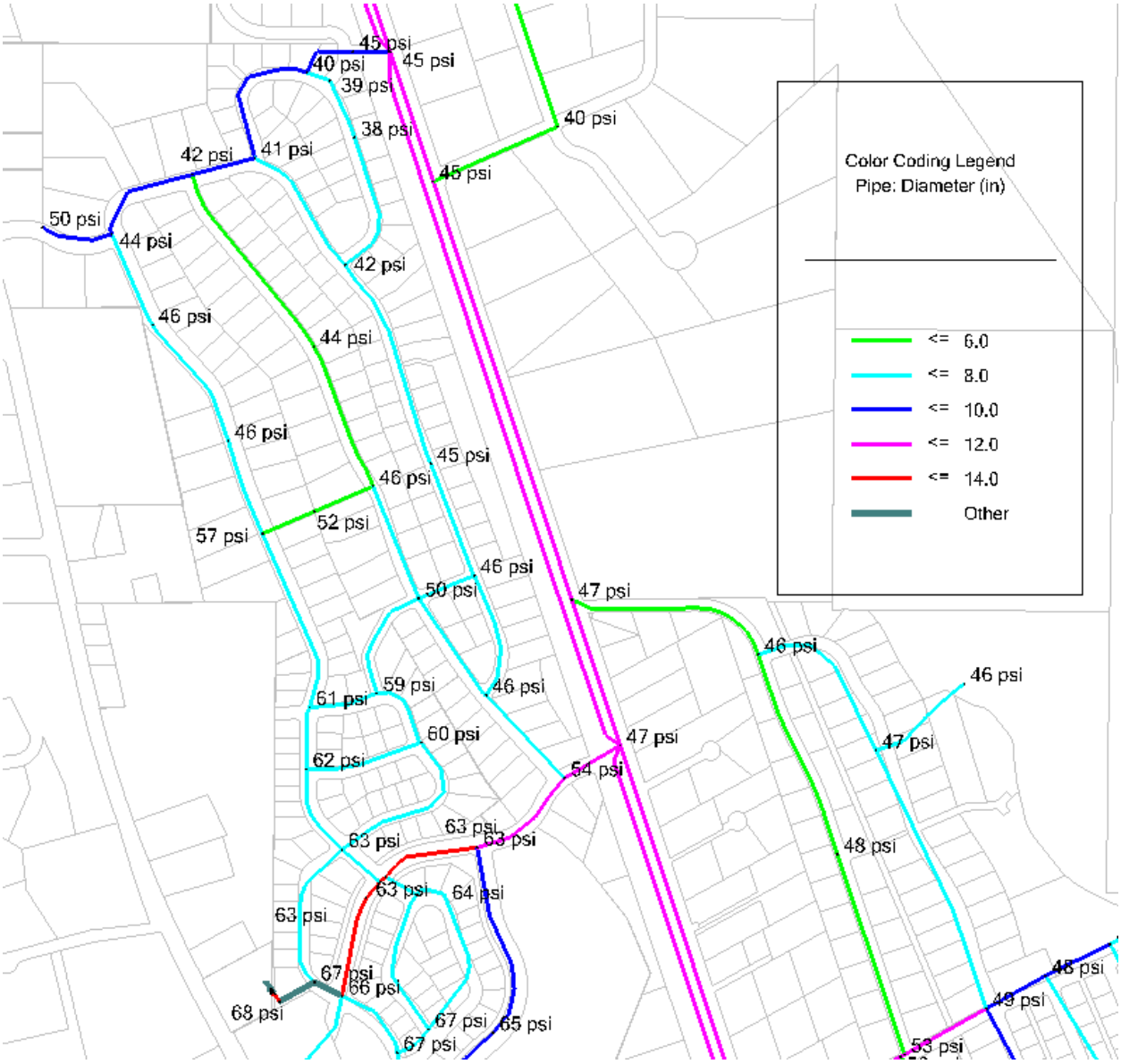
Scenario 4

1740 2nd Ave North Calibration Results



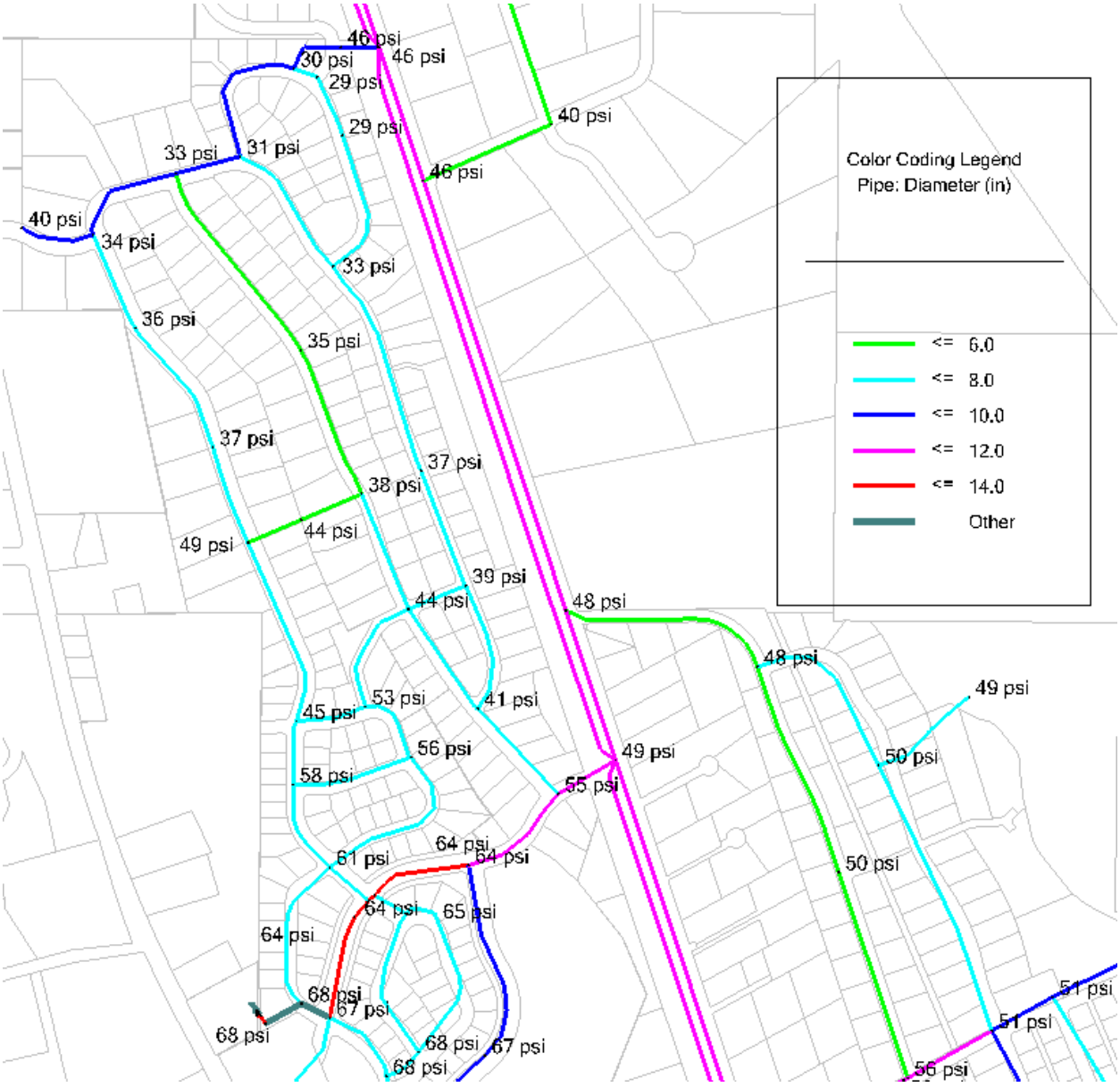
Scenario 5

1320 2nd Ave North Calibration Results



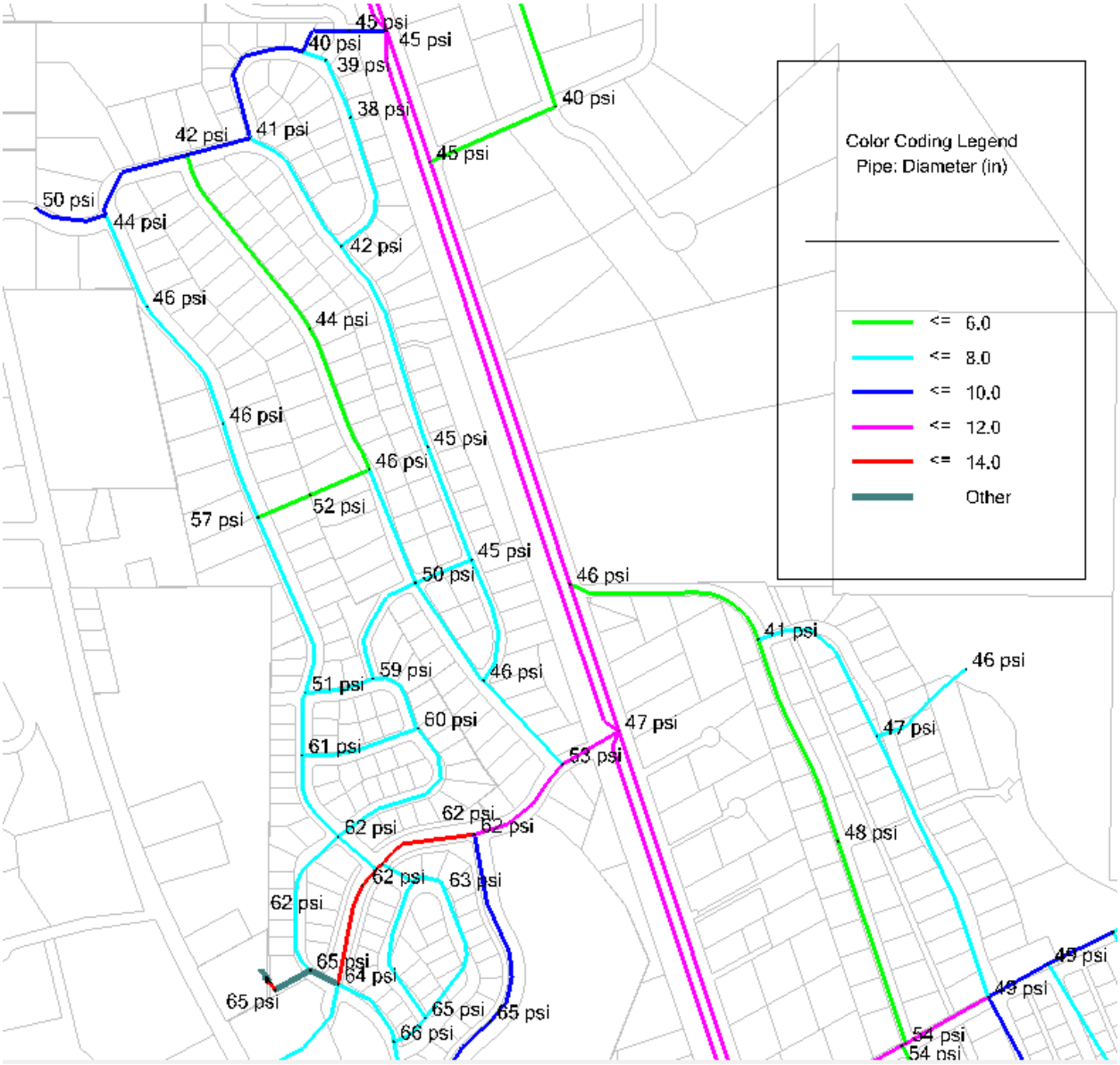
Scenario 6

1420 2nd Ave North Calibration Results



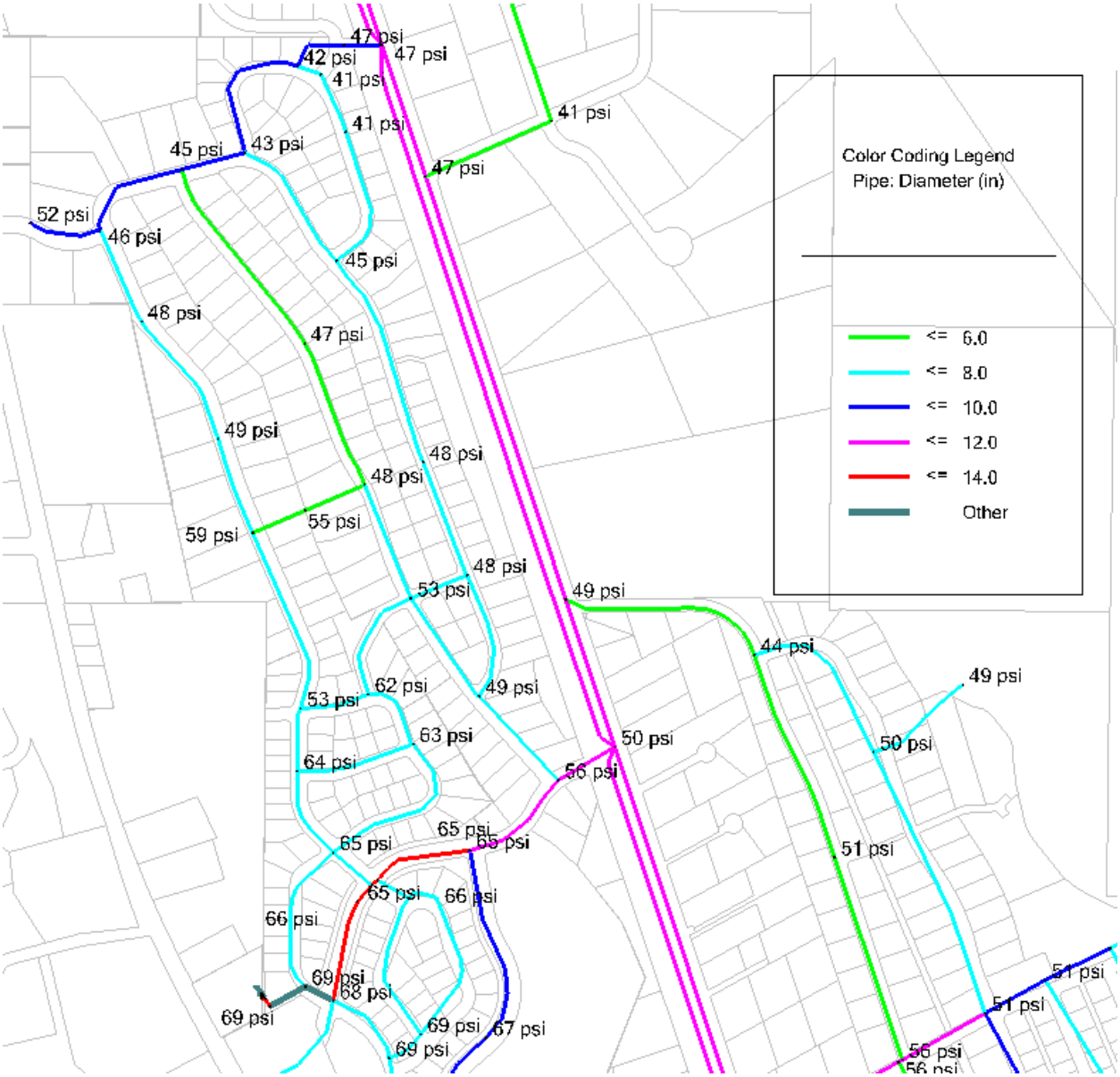
Scenario 7

154 S Hiawatha Drive Calibration Results



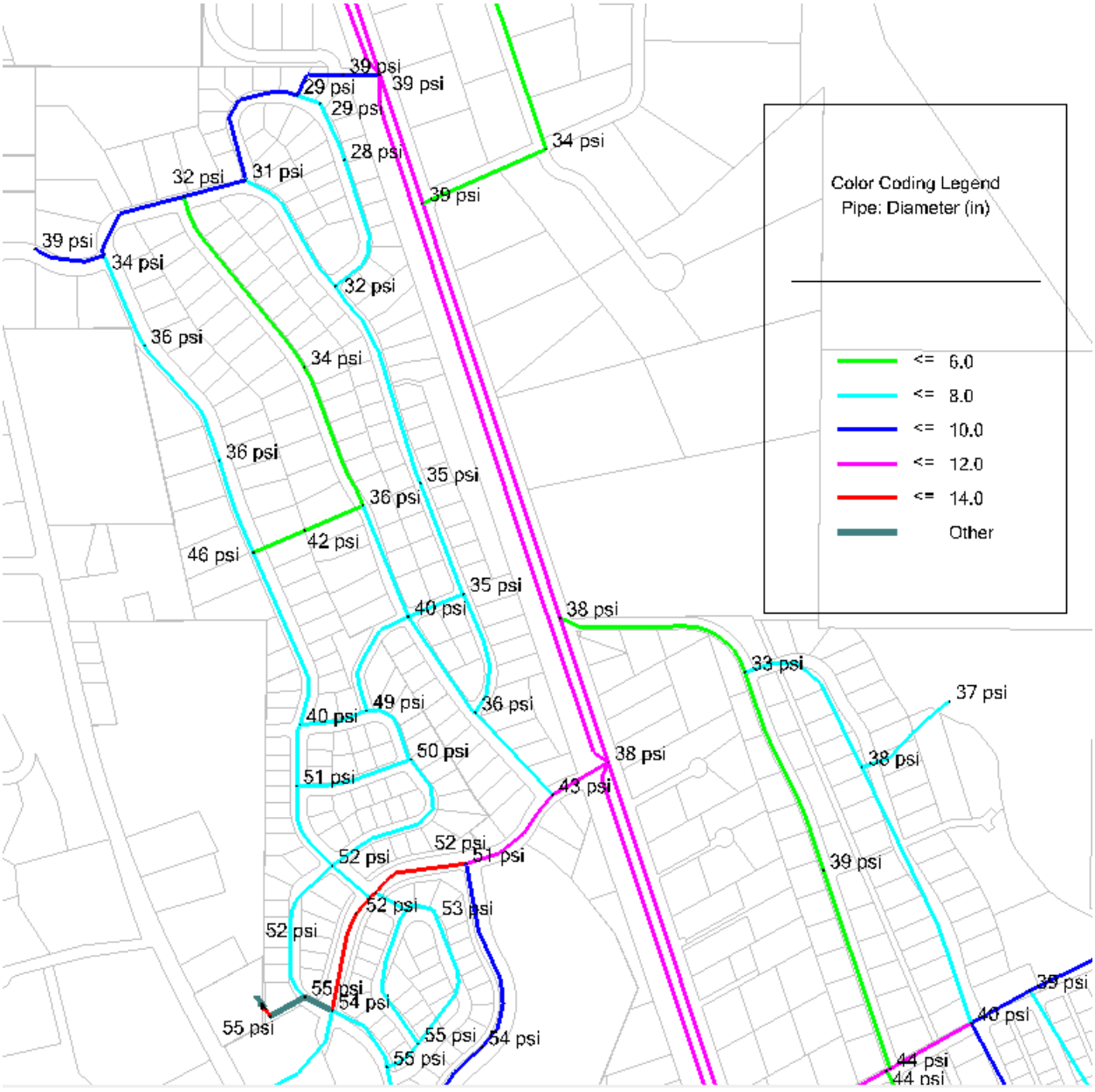
Scenario 8

158 S Hiawatha Drive Calibration Results



Scenario 9

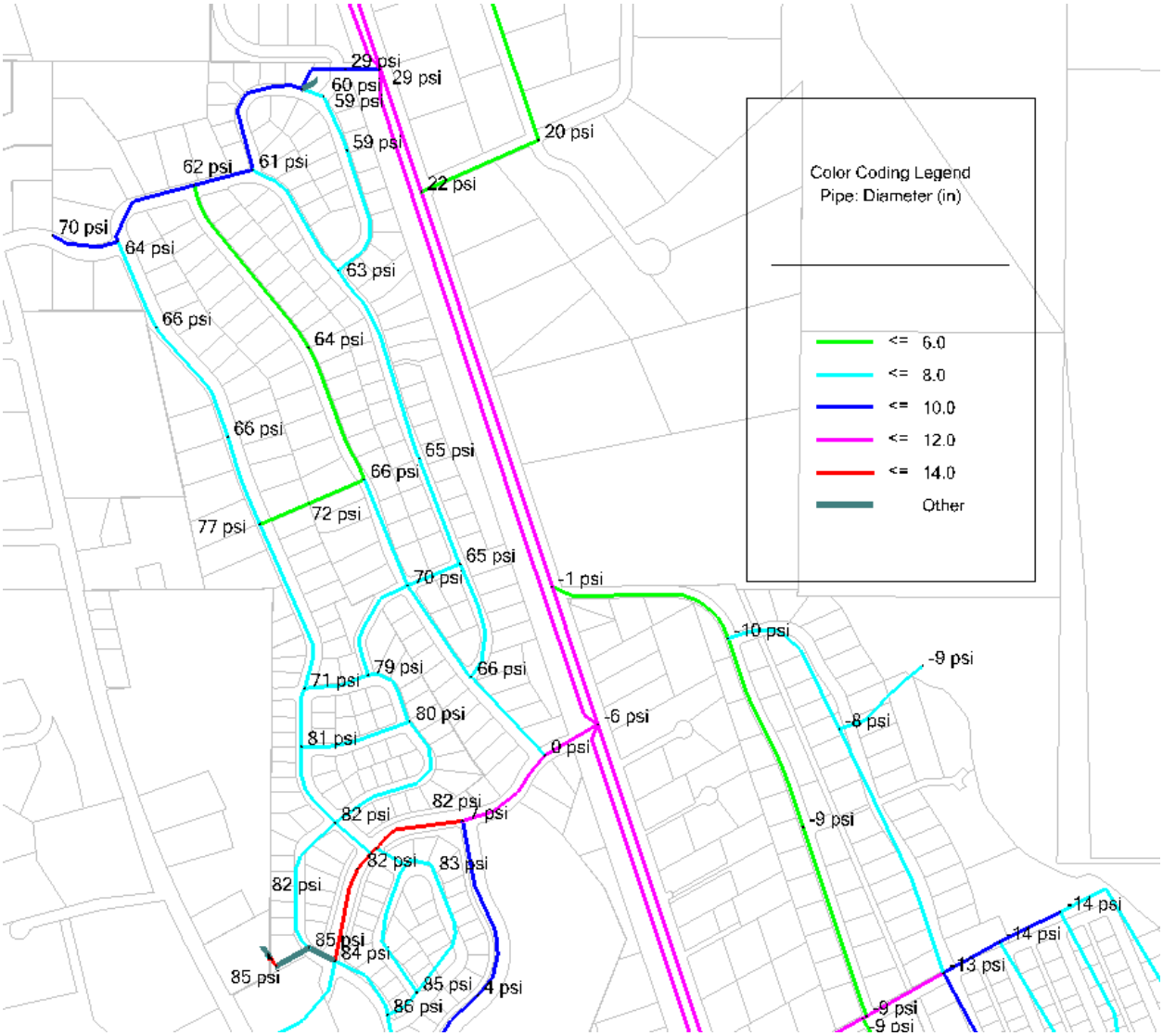
"Worst-Case" Simulated Pressures



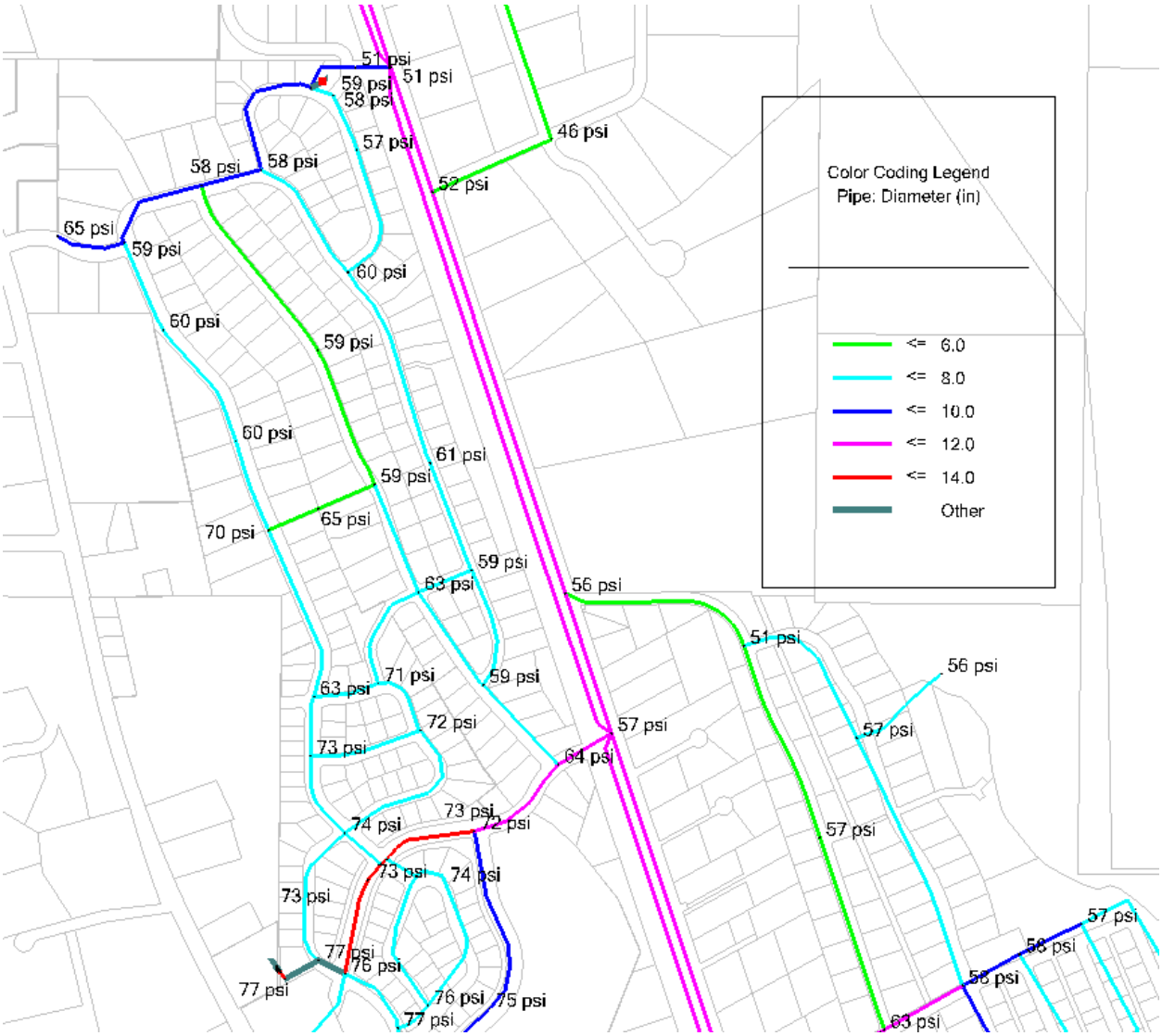
Appendix B

Conceptual Northridge Improvement Alternatives

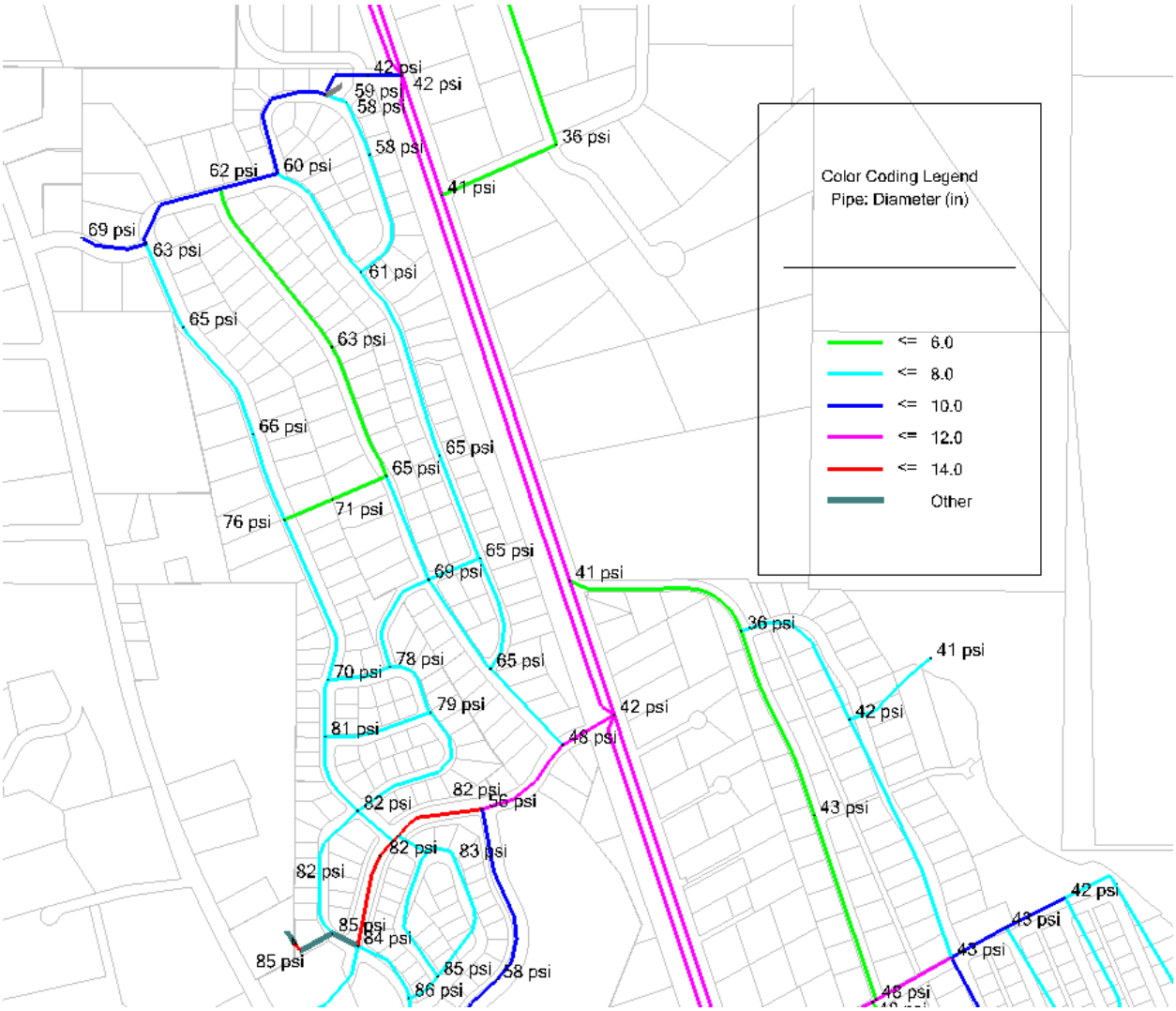
New Northridge Well with New Pressure Zone



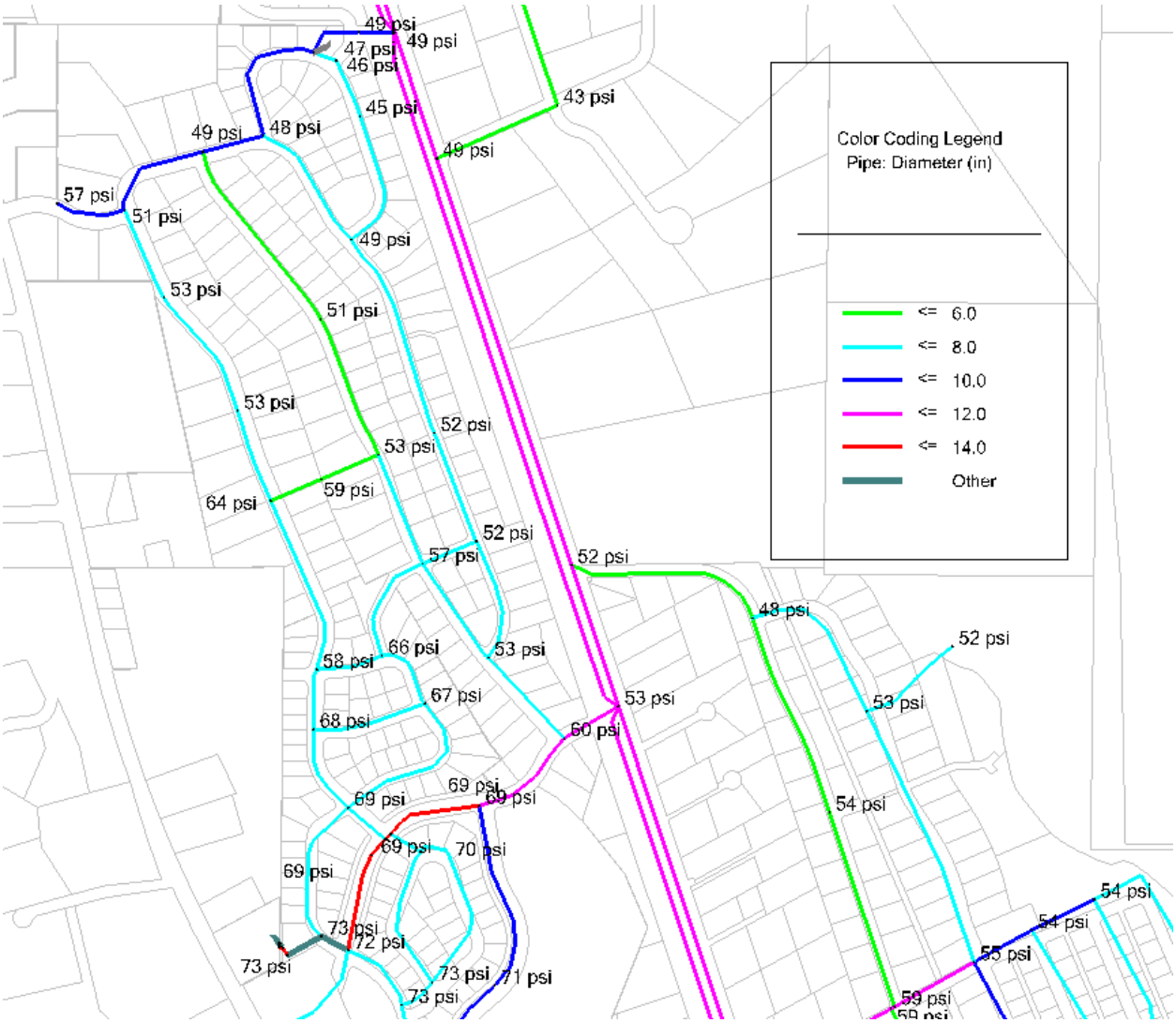
New Northridge Well with No New Pressure Zone



Northridge Booster Pump Station Upgrades with New Pressure Zone



Northridge Booster Pump Station Upgrades with No New Pressure Zone



SPF WATER ENGINEERING

TECHNICAL MEMORANDUM

DATE: December 30, 2019

TO: Brian Yeager, P.E., P.L.S., City of Hailey

FROM: Scott McGourty, P.E., SPF, Eric Landsberg, P.E., SPF

PROJECT NO: 330.0350

RE: Part 3: Northridge Area Pressure Study – Conceptual Improvement Alternatives

EXECUTIVE SUMMARY

The City of Hailey, Idaho (the City) has commissioned a study of water pressures in the City's public drinking water distribution system, with a specific geographic focus on the Northridge and Old Cutters Areas. The Study Area is approximately bounded by Highway 75 to the west, CD Olena Drive to the east, McKercher Boulevard and Myrtle Street to the South, and West Meadow Drive to the north (see Figure 3).

This memorandum presents the evaluation of candidate alternatives to improve minimum pressures at residential service locations throughout the Northridge and Old Cutters area. Twenty-seven alternatives (grouped within five general categories) have been developed and screened for simulated effectiveness in increasing pressures within the Study Area. Sixteen of the alternatives were selected for further evaluation which included development of conceptual cost estimates. Each water supply alternative is outlined in Section 2.0 and Appendix A including a description of the simulated improvements.

Cost estimates have been developed at a conceptual level, or Class 5 as defined by the Association for the Advancement of Cost Engineering International (AACEI). The estimates are based on actual costs of recently completed similar projects and capacity factored parametric models. Cost estimates at this level have an expected accuracy range of -30% to +50%. The cost estimates were prepared following standard industry practice to provide a defensible basis for planning decisions. Capital cost estimates include permitting, design, and construction costs. Cost of land acquisition is not included in the estimates but may be required for some alternatives. Capital cost per pressure increase (psi) are presented in Figure 1 and Table 1. Total capital costs are presented in Figure 2 and Table 1.

In general, alternatives that rely primarily on modification of the operating criteria for existing pumping facilities are the lowest cost. The highest increases in system pressure were seen by combining modification of the Northridge pump station operating criteria with at least one other approach such as creation of a new pressure zone, changes to the River Street pump operating criteria, and/or construction a new water supply source. SPF recommends Alternative 2C – modification of Northridge and River Street pump controls as the safest and most effective alternative for increasing pressures in the Study Area (see Sections 2.0 and 3.0). Alternative 2C could be implemented quickly and with relatively low capital cost, and on a trial basis. Other effective alternatives such as 4K and 4M could be implemented in a phased approach with Alternative 2C as a first step for additional pressure gains within the Study Area. It should be noted that a new source of supply (new well) is recommended in the near future because maximum day demand is approaching firm capacity of the system.

Figure 1

Comparison of Unit Capital Costs for Alternatives Considered

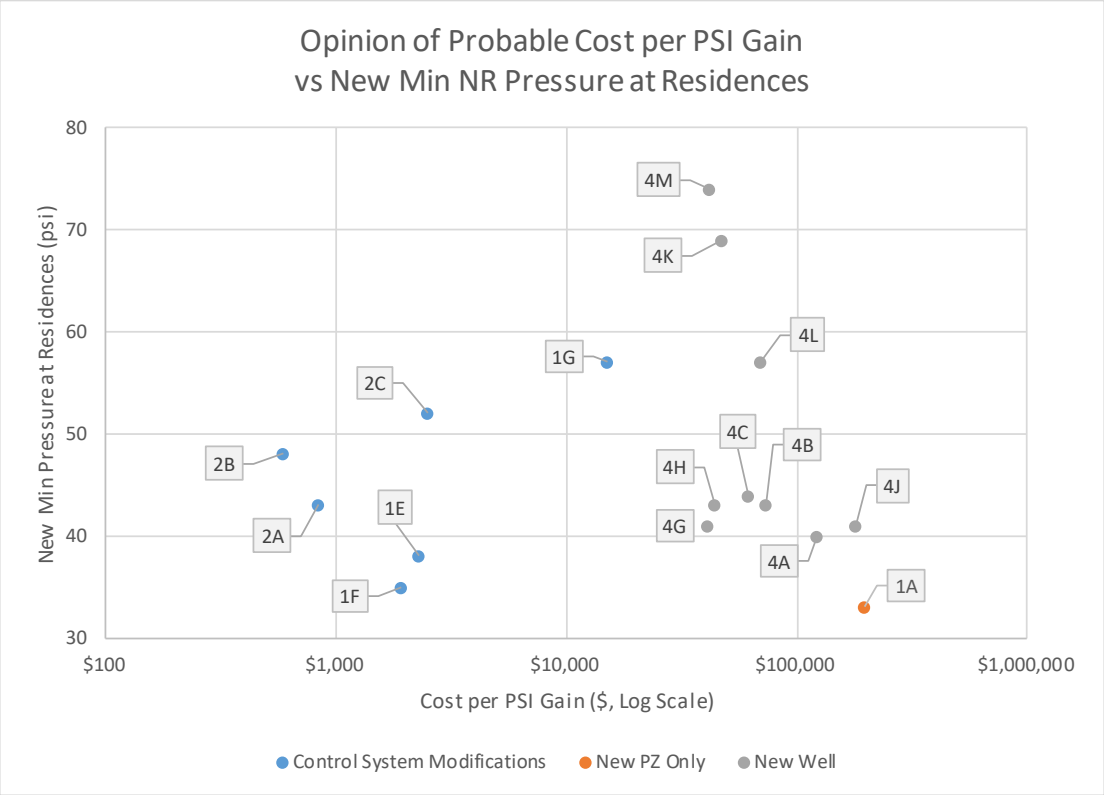


Figure 2

Comparison of Total Capital Costs for Alternatives Considered

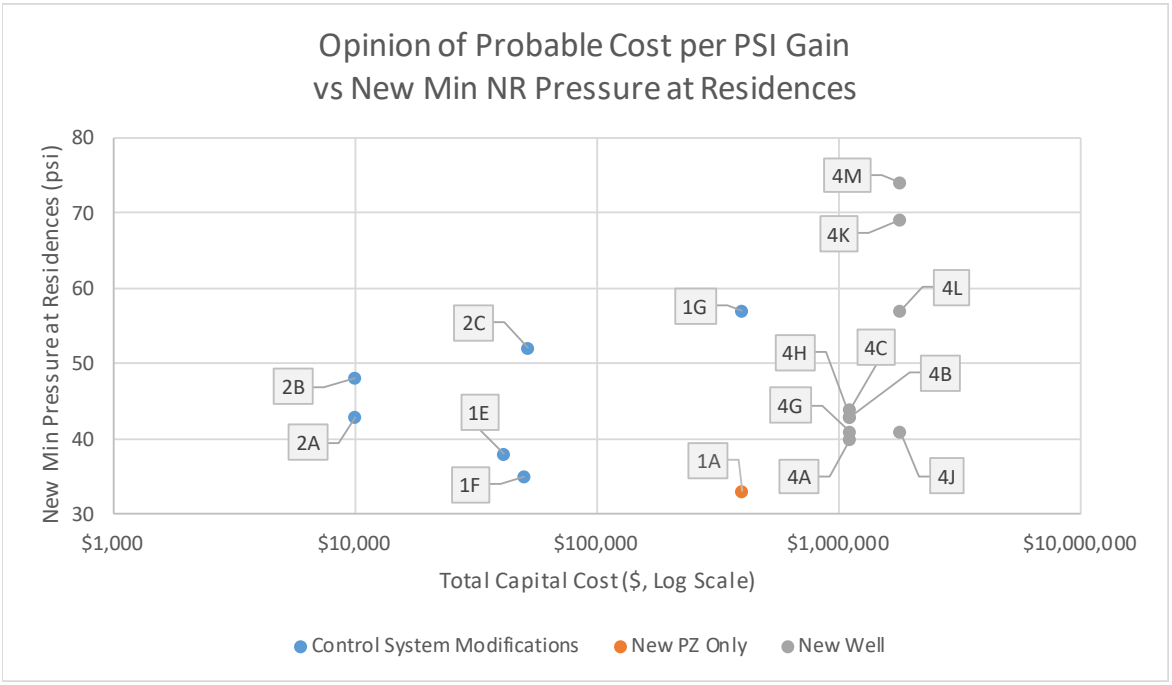


Table 1
Summary of Opinion of Probable Capital Costs for Selected Alternatives

Alternative No.	Description	Capital Cost	Increase in NR Pressure (psi)	$/psi	Min NR/OC Pressure (psi)
1A	NEW PRESSURE ZONE FOR NORTHRIDGE & CUTTERS, PUMP CTRL MODS TO NRBPS & RIVER ST	$394,000	2	$197,000	33
1E	PARTIAL HYDRAULIC ISOLATION OF THE NORTHRIDGE AREA	$41,000	18	$2,278	38
1F	PARTIAL HYDRAULIC ISOLATION OF NORTHRIDGE & NRBPS PUMP CONTROL MODIFICATION	$50,000	26	$1,923	35
1G	NEW PRESSURE ZONE FOR NORTHRIDGE & CUTTERS, PUMP CTRL MODS TO NRBPS & RIVER ST	$394,000	26	$15,154	57
2A	NRBPS CONTROL MODIFICATION	$10,000	12	$833	43
2B	NRBPS CONTROL MODIFICATION	$10,000	17	$588	48
2C	NRBPS & RIVER ST CONTROL MODIFICATION	$52,000	21	$2,476	52
4A	NEW WELL IN SUNBEAM DEVELOPMENT NEAR CARBONATE ST	$1,100,000	9	$122,222	40
4B	NEW WELL IN 2-IT RANCH DEVELOPMENT NEAR HIGHWAY 75	$1,100,000	15	$73,333	43
4C	NEW WELL IN NORTHRIDGE AREA NEAR W MEADOW DR.	$1,100,000	18	$61,111	44
4G	NEW PARTIAL PRESSURE ZONE & NEW WELL IN NORTHRIDGE AREA NEAR W MEADOW DR.	$1,100,000	27	$40,741	41
4H	NEW PRESSURE ZONE & NEW WELL IN NORTHRIDGE AREA NEAR W MEADOW DR.	$1,100,000	25	$44,000	43
4J	NEW PRESSURE ZONE & NEW WELL IN SUNBEAM NEAR CARBONATE ST	$1,800,000	10	$180,000	41
4K	NEW PRESSURE ZONE & NEW WELL IN 2-IT RANCH NEAR HIGHWAY 75	$1,800,000	38	$47,368	69
4L	NEW PRESSURE ZONE & NEW WELL IN SUNBEAM NEAR CARBONATE ST & NRBPS CTRL MOD	$1,800,000	26	$69,231	57
4M	NEW PRESSURE ZONE & NEW WELL IN 2-IT RANCH NEAR HWY 75 & NRBPS CTRL MOD	$1,800,000	43	$41,860	74

1.0 Existing Water System

The existing City system includes four well sites and one spring source (see Figure 3). The current operating conditions for booster pumps are controlled by tank level as shown in Table 2.

Table 2
Water Supply Facilities

Source	No. Wells	Capacity[1] (gpm)	Chlorine Contact Tank Design Time (min)	Pump "On" Control	Pump "On" Level (feet)	Pump "Off" Level (feet)
Indian Creek Springs	N/A	845	None	N/A	N/A	N/A
River St Well	1	1070	None	Turbine Tank	11.0	11.5
3rd Avenue Well	1	1730	None	Turbine Tank	10.0	11.5
Woodside Well	1	1270	30	Quigley Tank	Unk.	Unk.
Northridge Facility	3	1577 (2)	30	Turbine Tank	10.5	11.5

Notes:

1. Estimated 90th percentile production per Master Plan, SPF 2015.
2. Brockway, 2018.

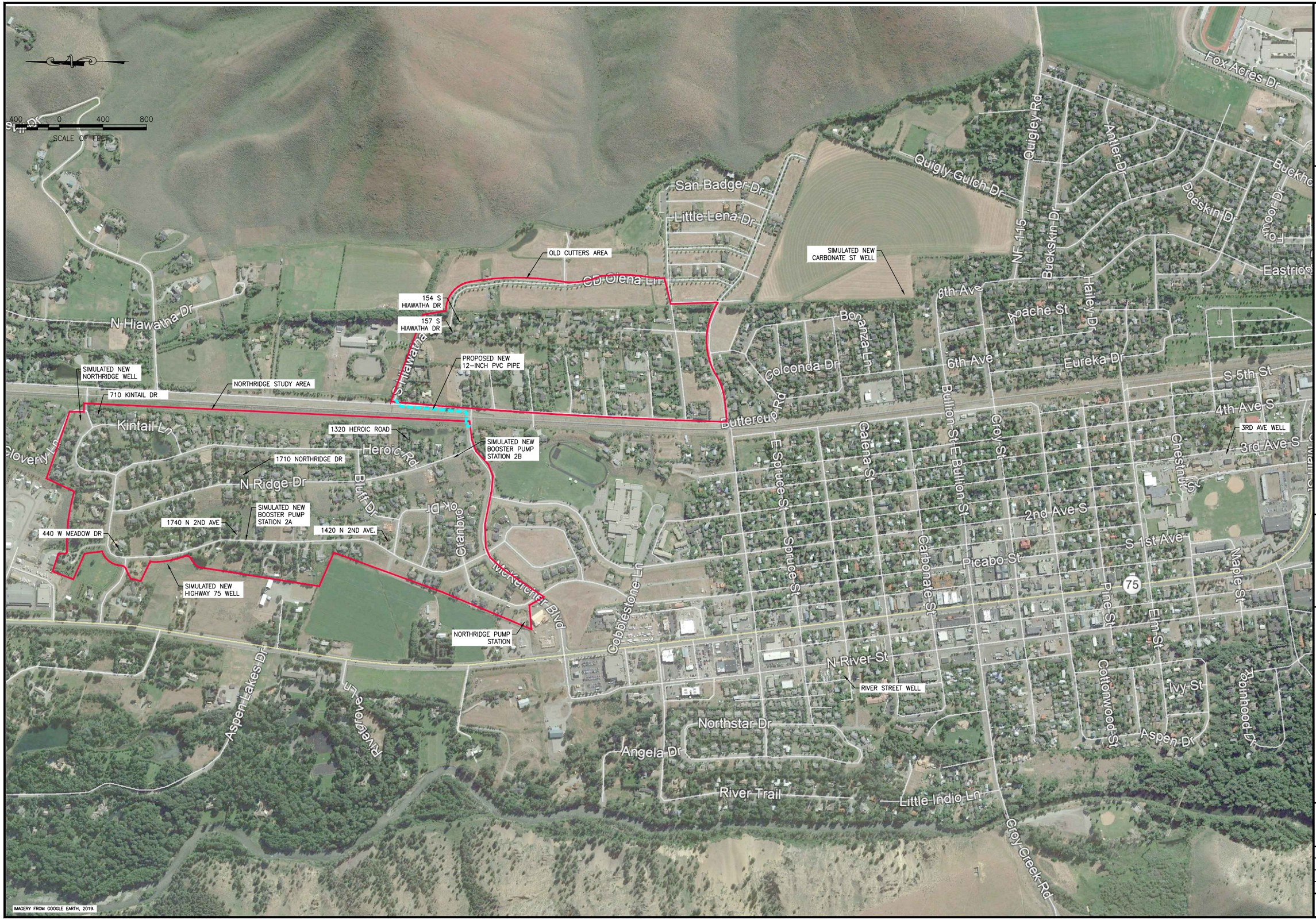
Table 3
Water Storage Facilities

Reservoir	Dimensions	Volume (MG)	Invert Elevation(2) (ft)	Overflow Elevation(3) (ft)	Maximum Water Height (ft)
Turbine Tank	120 ft dia.	0.98	5514.65	5526.25	11.6
Quigley Tank	116' x 136' (1)	2.2	5507.9	5530.3	22.4

Notes:

1. Rectangular shape. There are columns, steps, an overflow box and other various obstructions located inside the Quigley Tank. The total available volume is approximately 2.2 million gallons.
2. Invert elevations estimated from surveyed overflow elevations and plan sets.
3. Overflow elevations surveyed by Alpine Enterprises Inc., October 2008.

Per Section 13.08.010 of the City Hailey Municipal Code, municipal irrigation is prohibited between 10am and 6pm. In addition, irrigation is restricted to odd numbered street address on odd numbered calendar days, and even numbered street addresses on even numbered calendar days.



SPF WATER ENGINEERING
300 East Mallard Drive, Suite 350
Boise, Idaho 83706
Tel (208) 383-4140 Fax (208) 383-4156

NORTHRIDGE PRESSURE STUDY
CITY OF HAILEY

STUDY AREA

PRELIMINARY DRAFT NOT FOR CONSTRUCTION

REVISIONS			
ITEM	DESCRIPTION	DRAFT	DATE
0			12/30/19

VERIFY SCALE
0 1/2 1
BAR MEASURES ONE-INCH ON FULL SIZE DRAWING.

PROJECT:	330.0350
DESIGNED:	SM
DRAWN:	SM
CHECKED:	EL

FIG. 3

The City of Hailey collected field measurements of water system pressures in the Northridge Area from 8/13/19-9/4/19 (SPF, 2019a/b). Figure 4 presents typical system performance in the Northridge Area during the irrigation season (May through September).

Figure 4 depicts system pressure at two residential monitoring locations observed during the 2019 field study. Residential pressures drop daily around 6pm both at the Northridge Booster Pump Station (NRBPS) and at the residences. At the same time, outflow from Turbine tank increases from around 500 gpm to 1,500 gpm. Both booster pumps at the NRBPS are controlled by tank levels in Turbine Tank. As seen in Figure 4, the NRBPS pumps do not typically turn on until approximately 9:30pm each night, or about 3 hours after pressures in the system have begun to drop. Several alternatives are presented in Section 2 for modifying the operation of the NRBPS to compensate for the delayed reaction of the NRBPS pumps to decreased system pressures.

The existing baseline “worst-case” simulated conditions for the study area are shown in Figure 5 (based on work completed in SPF, 2019b).

Figure 4

Typical Water System Performance during Irrigation Season

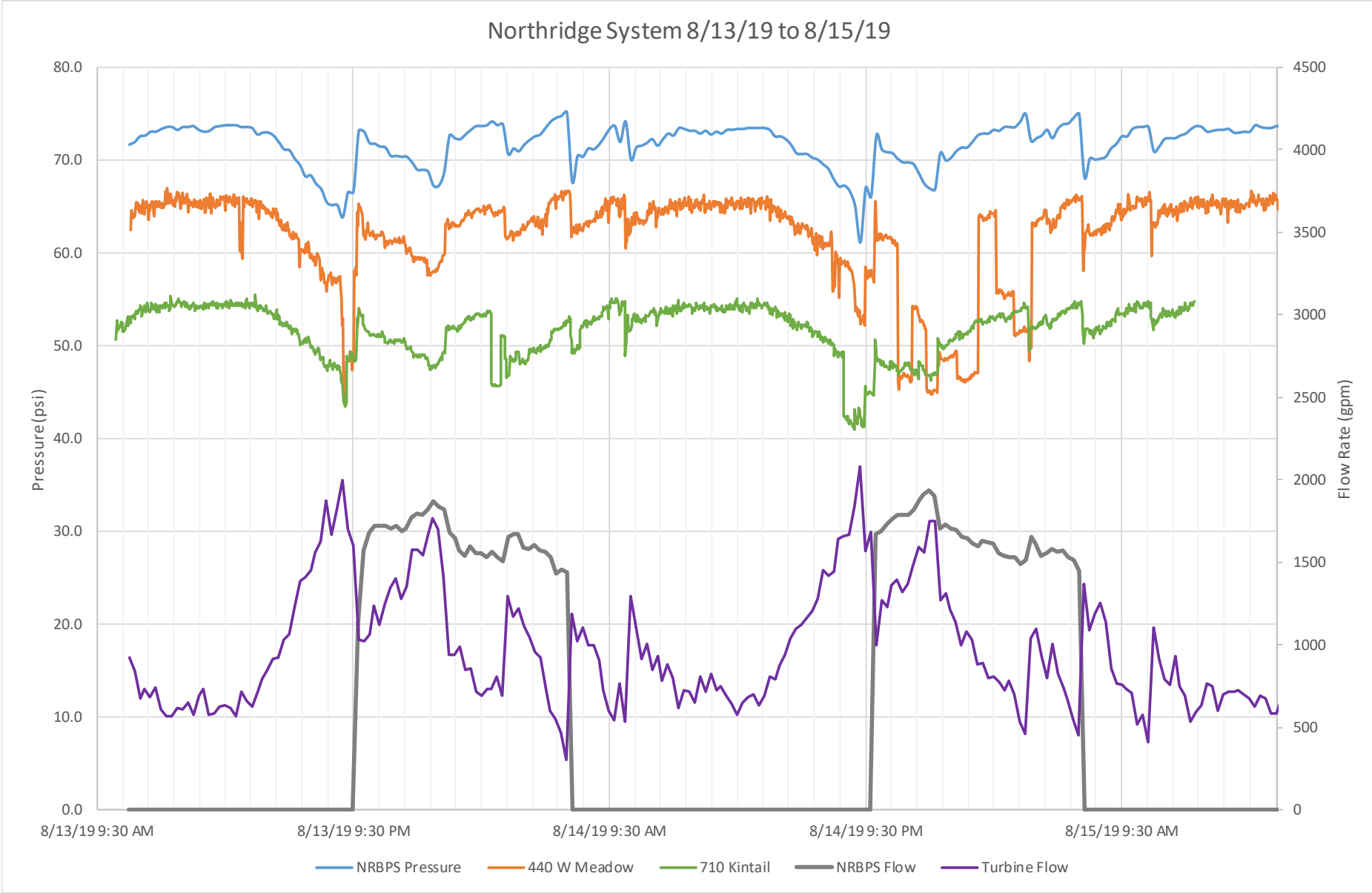
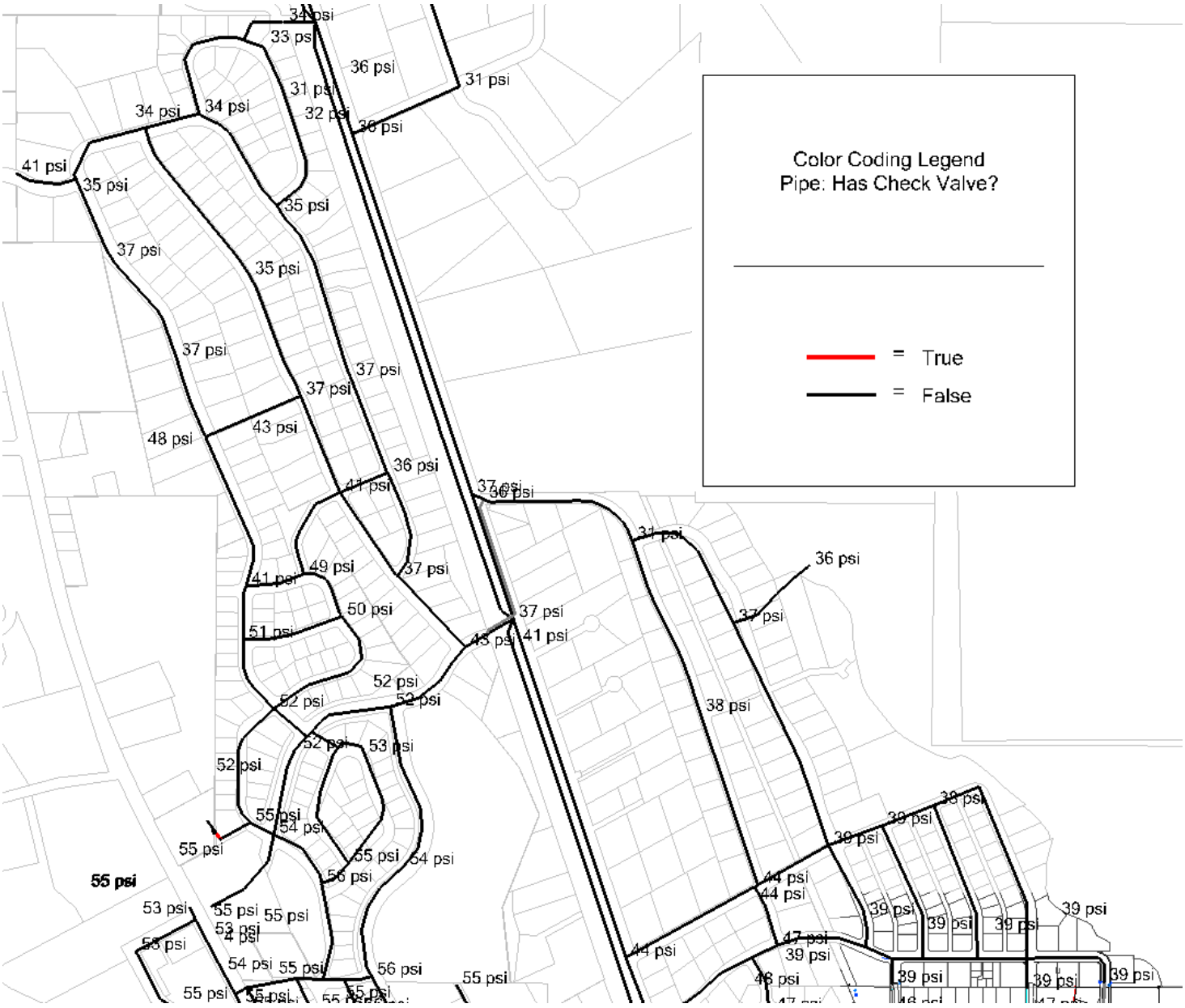


Figure 5

Baseline “Worst-Case”



2.0 Alternatives Analsyis

A total of twenty-seven alternatives have been developed and screened for simulated overall effectiveness in increasing pressures within the Study Area (see Appendix A).

Sixteen of the alternatives were selected for further evaluation which included development of conceptual cost estimates. Each group of water supply alternatives is outlined below including a description of the simulated changes to the City water system.

1. **Alternatives 1A-1H: Partial Hydraulic Isolation of Northridge and Old Cutters area**

   This alternative entails installation of 1-7 check valves, construction of approximately 900-LF of new 12-inch water main to connect existing mains in McKercher Blvd and S Hiawatha Dr, and reconfiguration of the operational settings at the Northridge and/or River Street pump stations to activate one booster pump based on pressures in the Northridge area.

2. **Alternative 2A-2C: Seasonal Operational Criteria for Northridge Pump Station**

   This alternative consists of changing the Northridge and/or River Street pump stations control scheme to operate the pumps based on pressure criteria (either at the booster pump discharge, or elsewhere in the Northridge area) during the irrigation season, and tank level criteria during the non-irrigation season, and partial isolation of the Northridge (NR) and/or Old Cutters (OC) areas by installation of check valves and additional transmission piping.

3. **Alternative 3A-3B: New Booster Pump Station in Northridge**

   This alternative entails the construction of a new booster pump station and associated yard piping in the Northridge area.

4. **Alternative 4A-4M: New Supply Source**

   This alternative evaluates the construction of a new supply source (new groundwater well) at three potential locations; 1) the Northridge Area, 2) along Highway 75, and 3) east of Carbonate St.

5. **Alternative 5: Improvements to the Turbine Tank supply**

   This alternative includes alterations to the operation of Indian Springs and/or construction of a new booster pump station on the discharge side of Turbine Tank.

The Alternative 1 and Alternative 2 groups of scenarios that involve simulated changes to the operating criteria of the Northridge and River Street pumps stations envision pump controls similar to the following:

- Pumps ON if ***both*** of the following conditions are met:
  - Pressure at the Northridge Booster Pump Station < 80 psi, and
  - Turbine Tank Level < 10.75-ft
- Pumps OFF if the Turbine Tank water level >11.5-ft

The alternatives analysis process consisted of the following steps:

1. Generation of a preliminary list of proposed system improvements based on evaluation of the pressure study data,

2. Simulating proposed improvements using Bentley WaterCAD Connect™ software to evaluate the City's hydraulic model with the proposed changes,
3. Refinement of alternatives based on preliminary model results, and generation of new alternatives,
4. Re-running updated and new scenarios in the City's hydraulic model.

Preliminary alternatives were screened versus the following criteria:

a) New simulated minimum pressure in the Northridge Area at residential locations
b) New simulated minimum pressure in the Old Cutters Area at residential locations
c) Simulated available fire flow in the Northridge and Old Cutters areas

Alternatives that performed relatively well versus the screening criteria were further evaluated based on opinions of probable construction cost developed by SPF (see Table 1 and the following discussion below).

Alternative 1A – New Pressure Zone for Northridge & Old Cutters, and NRBPS & River St Pump Control Modifications

Alternative 1A involves the construction of 7 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- S Hiawatha Drive near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road
- Myrtle Street between Mother Lode Drive and Buffalo Drive
- Hiawatha Drive between Buttercup Road and Buffalo Drive

This alternative also entails construction of approximately 900-linear feet (LF) of 12-inch PVC main in Buttercup Road from McKercher Blvd to S Hiawatha Dr.

For this alternative, both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $197,000 per psi increase in Northridge (the highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $394,000 (see Figure 7).

The current "worst case" pressure condition for customers in the Study Area occurs when both of the NRBPS pumps and the River Street pump are off. This alternative illustrates the simulated performance of the City's water system if the Northridge and Old Cutters Area are isolated without modifying the current pump operating criteria or adding a new water supply source.

Under this alternative, the hydraulic model provides the following results (see Figure 6):

- New minimum pressure for the Northridge Area: 33 psi (improvement of +2 psi)
- New minimum pressure for the Old Cutters Area: 33 psi (improvement of +2 psi)

Alternative 1A was the worst performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration.

Figure 6

Alternative 1A – Hydraulic Model Results

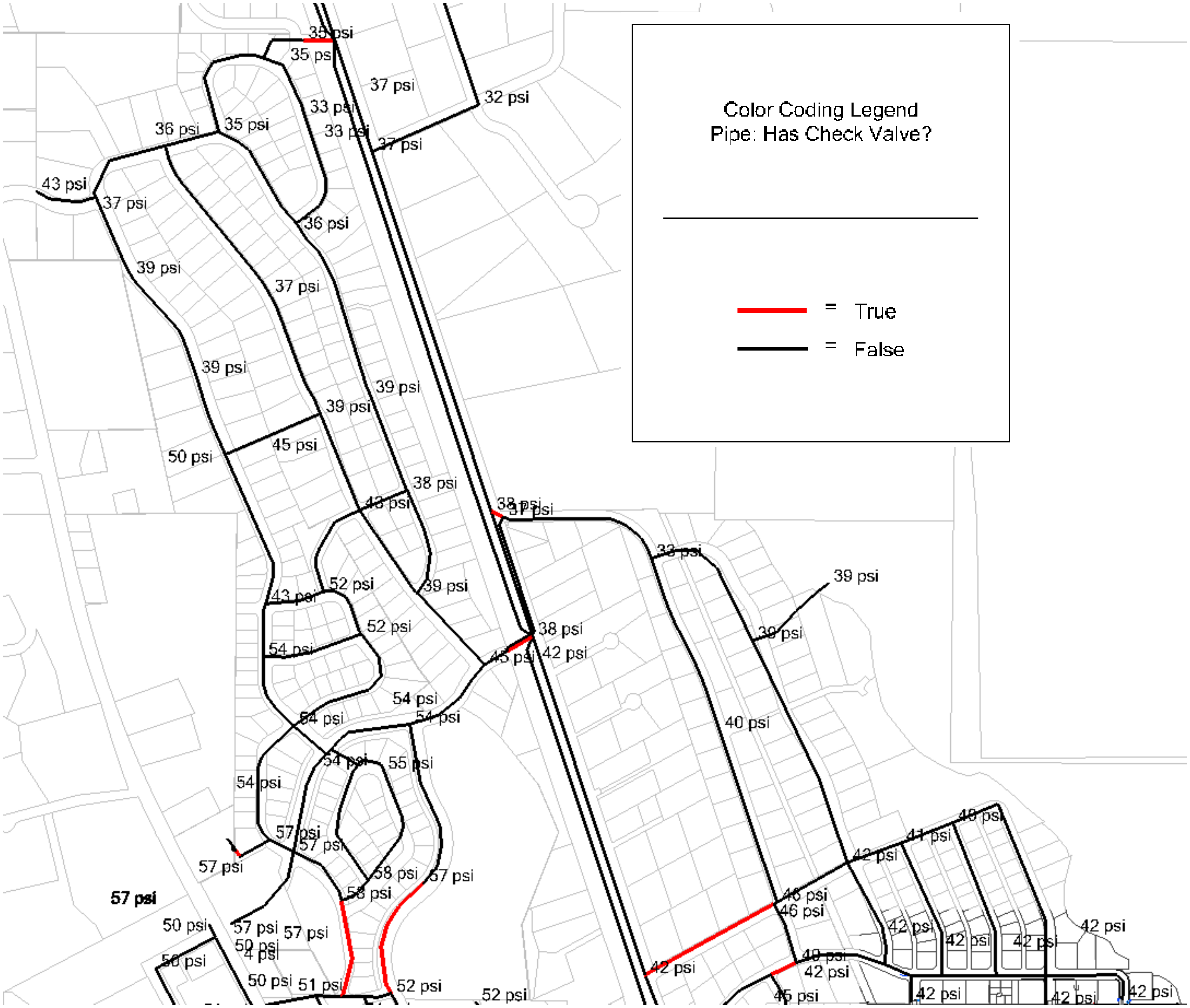


FIGURE 7

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 1A

NEW PRESSURE ZONE FOR NORTHRIDGE & CUTTERS

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	6-IN CHECK VALVES	6	EA	$3,310	$19,860
2	6-IN GATE VALVES	1	EA	$1,400	$1,400
3	8-IN CHECK VALVES	1	EA	$4,020	$4,020
4	10-IN CHECK VALVES	2	EA	$5,880	$11,760
5	12-IN CHECK VALVES	2	EA	$7,740	$15,480
6	12-IN GATE VALVES	4	EA	$1,800	$7,200
7	12-IN DIA C900 PVC PIPING	900	EA	$210	$189,000
8	CONTINGENCY			30%	$74,616
9	ENGINEERING			15%	$48,500
		ESTIMATED PROJECT COST			**$372,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 1E – Partial Hydraulic Isolation of the Northridge Area

Alternative 1E involves the construction of 3 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road

For this alternative, both of the existing NRBPS pumps were on while the River St pump was off.

The estimated capital cost for this alternative is $2,287 per psi increase in Northridge (the 12th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $41,000 (see Figure 9).

This alternative illustrates the simulated performance of the City's water system if the Northridge area is isolated to the south and east, and if the current pump operating criteria at NRBPS are modified as discussed in Section 2.0, but without adding a new water supply source.

Under this alternative, the hydraulic model provides the following results (see Figure 8):

- New minimum pressure for the Northridge Area: 49 psi (improvement of +18 psi)
- New minimum pressure for the Old Cutters Area: 38 psi (improvement of +7 psi)

Alternative 1E was the 9th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration.

Figure 8

Alternative 1E – Hydraulic Model Results

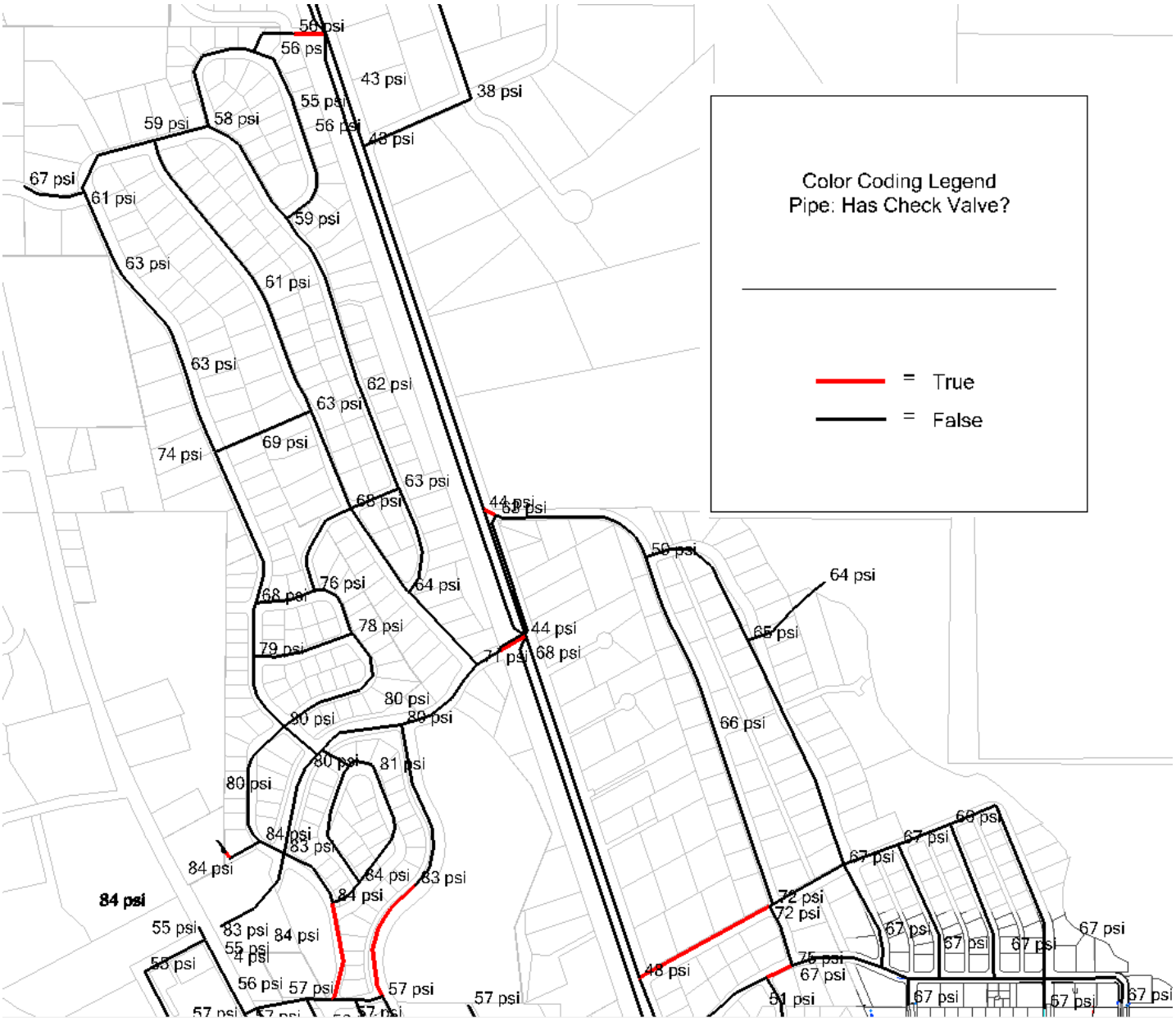


FIGURE 9

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 1E

PARTIAL HYDRAULIC ISOLATION OF THE NORTHRIDGE AREA

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	8-IN CHECK VALVES	1	EA	$4,020	$4,020
2	10-IN CHECK VALVES	1	EA	$5,880	$5,880
3	12-IN CHECK VALVES	1	EA	$7,740	$7,740
4	PUMP PROGRAMMING AND CONTROLS	1	LS	$10,000	$10,000
5	CONTINGENCY			30%	$8,292
6	ENGINEERING			15%	$5,390
		ESTIMATED PROJECT COST			**$41,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 1F –Partial Hydraulic Isolation of Northridge & NRBPS Pump Control Modification

Alternative 1F involves the construction of 4 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road

For this alternative, both of the existing NRBPS pumps were on while the River St pump was off.

The estimated capital cost for this alternative is $1,923 per psi increase in Northridge (the 13th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $50,000 (see Figure 10).

This alternative illustrates the simulated performance of the City's water system if the Northridge area is isolated to the north, south, and east, and if the current pump operating criteria at NRBPS is modified as discussed in Section 2.0, but without adding a new water supply source.

Under this alternative, the hydraulic model provides the following results (see Figure 11):

- New minimum pressure for the Northridge Area: 57 psi (improvement of +26 psi)
- New minimum pressure for the Old Cutters Area: 35 psi (improvement of +3 psi)

Alternative 1F was the 5th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration.

Figure 10

Alternative 1F – Hydraulic Model Results

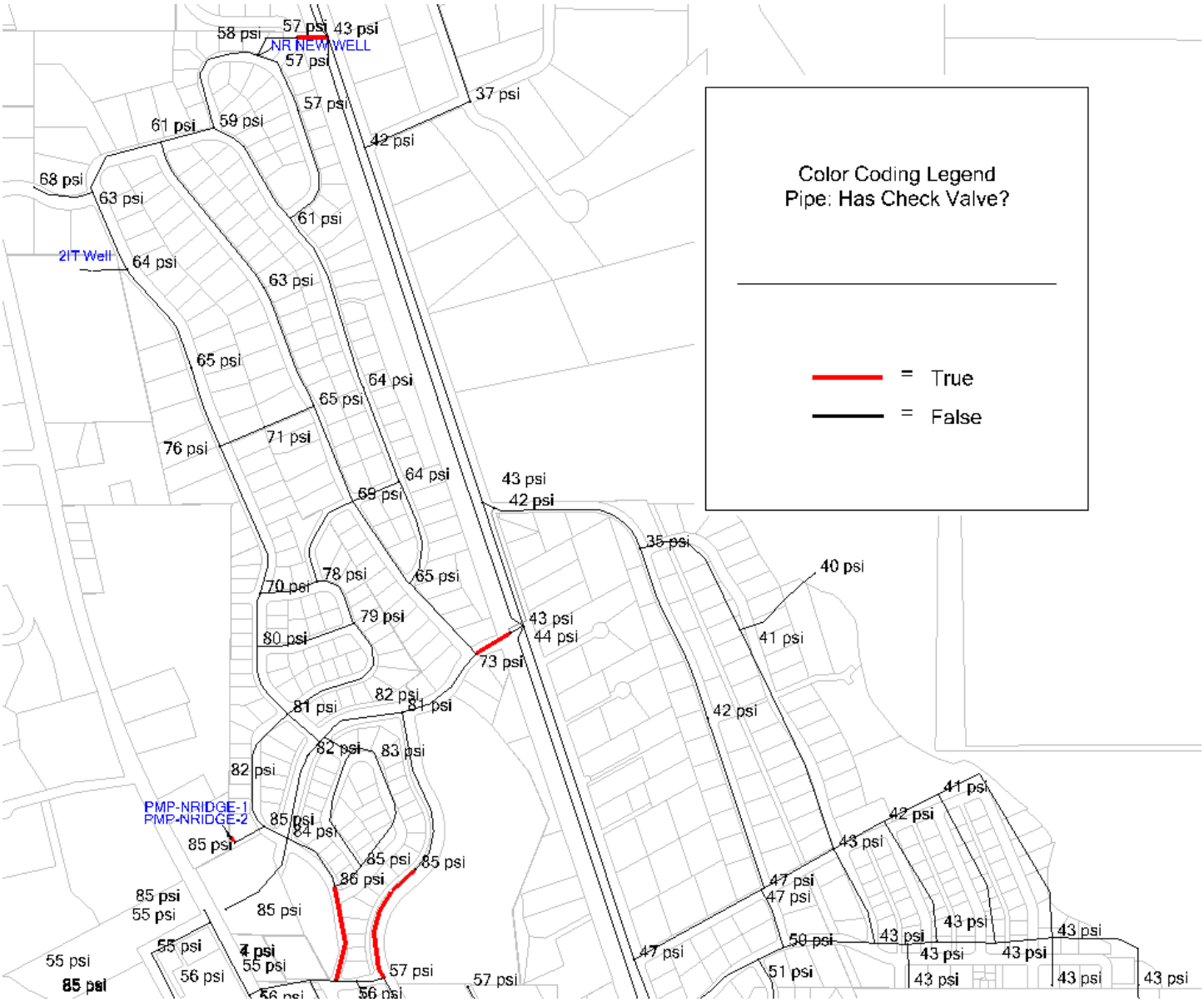


FIGURE 11

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 1F

PARTIAL HYDRAULIC ISOLATION OF NORTHRIDGE & NRBPS PUMP CONTROL MODIFICATION

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	8-IN CHECK VALVES	1	EA	$4,020	$4,020
2	10-IN CHECK VALVES	2	EA	$5,880	$11,760
3	12-IN CHECK VALVES	1	EA	$7,740	$7,740
4	PUMP PROGRAMMING AND CONTROLS	1	LS	$10,000	$10,000
5	CONTINGENCY			30%	$10,056
6	ENGINEERING			15%	$6,536
		ESTIMATED PROJECT COST			**$50,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 1G – New Pressure Zone for Northridge & Old Cutters, Pump Control Modificactions to NRBPS and River Street

Alternative 1G involves the construction of 7 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- S Hiawatha Drive near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road
- Myrtle Street between Mother Lode Drive and Buffalo Drive
- Hiawatha Drive between Buttercup Road and Buffalo Drive

For this alternative, both of the existing NRBPS pumps and the River St pump were on.

This alternative also entails construction of approximately 900-linear feet (LF) of 12-inch PVC pipe in Buttercup Road from McKercher Blvd to S Hiawatha Dr.

The estimated capital cost for this alternative is $15,154 per psi increase in Northridge (the 11th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $394,000 (see Figure 13).

This alternative illustrates the simulated performance of the City's water system if both the Northridge and Old Cutters areas are isolated, and if the current pump operating criteria at NRBPS is modified as discussed in Section 2.0, but without adding a new water supply source.

Under this alternative, the hydraulic model provides the following results (see Figure 12):

- New minimum pressure for the Northridge Area: 57 psi (improvement of +26 psi)
- New minimum pressure for the Old Cutters Area: 60 psi (improvement of +29 psi)

Alternative 1G was the 4th best performing alternative of all 16 in terms of pressure increase and is recommended for further consideration.

Figure 12

Alternative 1G – Hydraulic Model Results

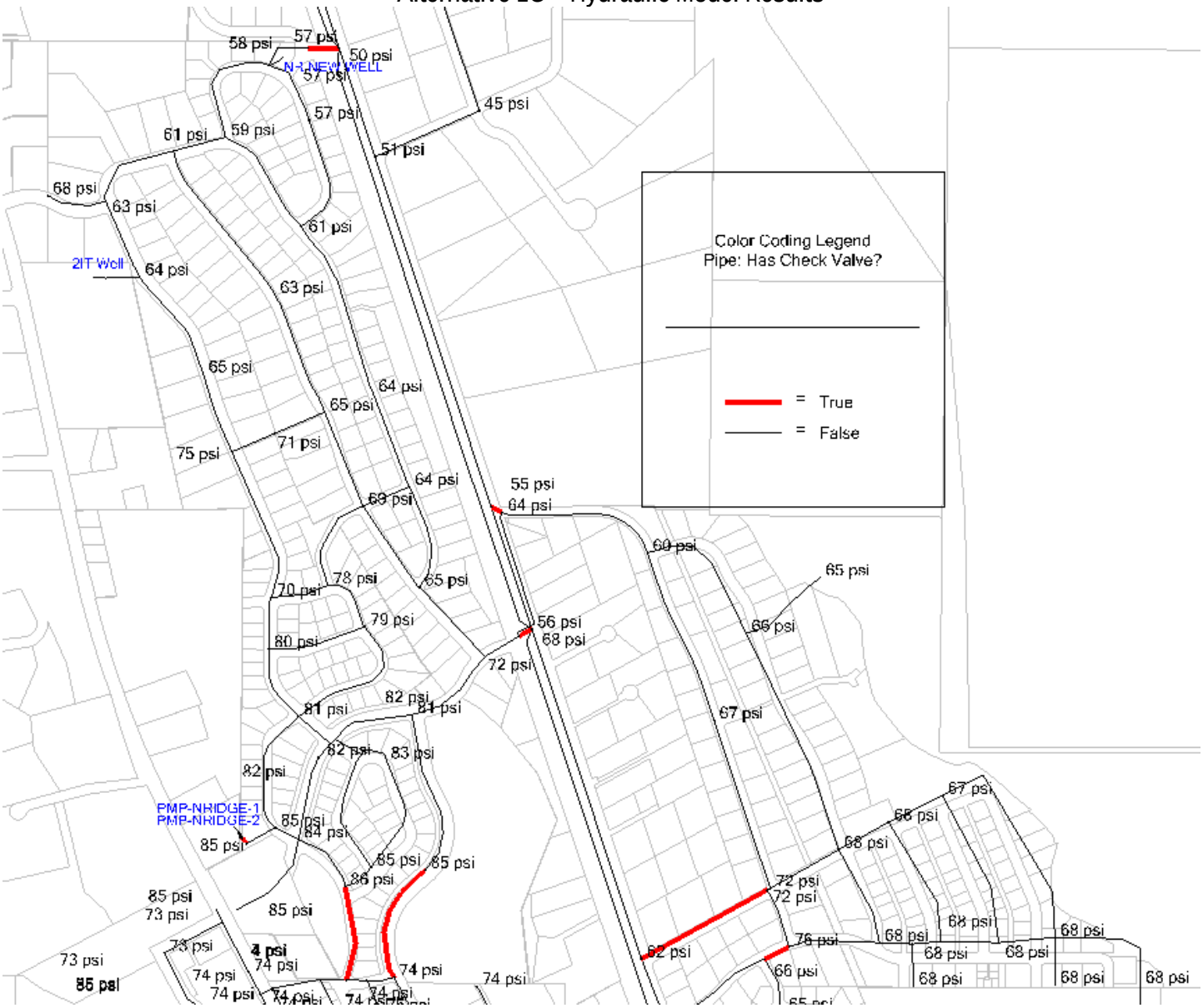


FIGURE 13

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 1G

NEW PRESSURE ZONE FOR NORTHRIDGE & CUTTERS, PUMP CTRL MODS TO NRBPS & RIVER ST

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	6-IN CHECK VALVES	6	EA	$3,310	$19,860
2	6-IN GATE VALVES	1	EA	$1,400	$1,400
3	8-IN CHECK VALVES	1	EA	$4,020	$4,020
4	10-IN CHECK VALVES	2	EA	$5,880	$11,760
5	12-IN CHECK VALVES	2	EA	$7,740	$15,480
6	12-IN GATE VALVES	4	EA	$1,800	$7,200
7	PUMP PROGRAMMING AND CONTROLS	1	LS	$15,000	$15,000
8	12-IN DIA C900 PVC PIPING	900	EA	$210	$189,000
9	CONTINGENCY			30%	$79,116
10	ENGINEERING			15%	$51,425
		ESTIMATED PROJECT COST			**$394,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternatives 2A/2B/2C – Northridge and River Street Pump Control Modification

The current "worst case" pressure condition for customers in the Study Area occurs when both of the NRBPS pumps and the River Street pump are off. The family of Alternative 2 scenarios evaluates hydraulic pressures in the City's water system if pump controls for one or both facilities are modified to turn on based on pressure control rather than water level in Turbine Tank, and without adding a new supply source.

As discussed in Section 2.0, the new pump control criteria are envisioned to take into account both pressure in the Northridge area and the water level in Turbine Tank to minimize overflow occurrences at the tank.

Detailed cost estimates were not prepared for the Alternative 2 scenarios. The engineer's opinion of probable cost for scenarios 2A and 2B is $10,000 to reprogram the NRBPS pump controls. For scenario 2C the engineer's opinion of probable cost is $52,000 which includes a VFD and harmonic filter. These costs assume that the existing pumps are equipped with VFD compatible (inverter duty) motors. If a new pump motor is required at River Street, capital cost for Alternative 2C will increase.

The results of hydraulic modeling for scenarios 2A, 2B, and 2C are summarized in Table 1 and Appendix A.

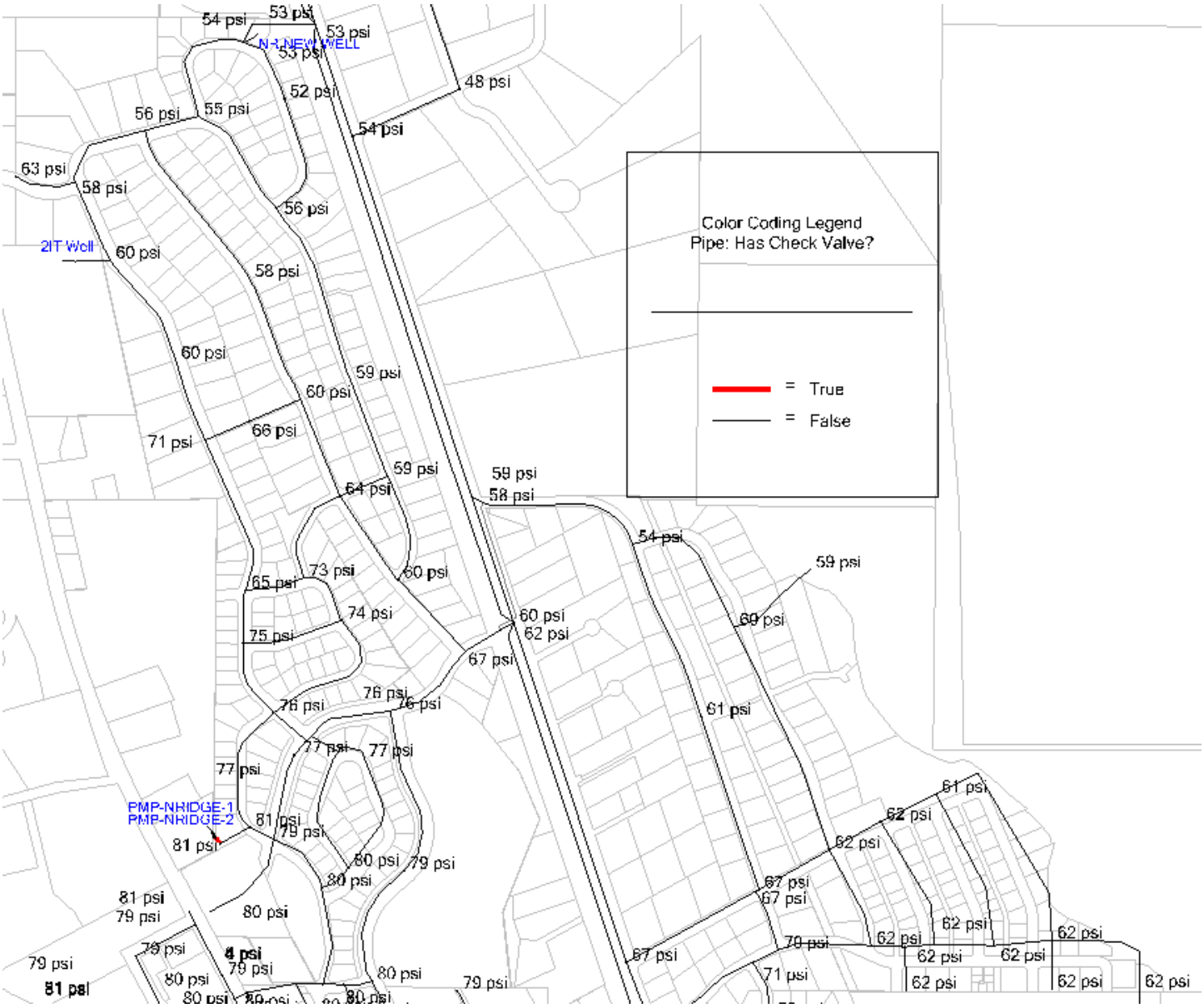
The best performing of the three Alternative 2 scenarios was Alternative 2C, which yielded the following results (see Figure 14):

- New minimum pressure for the Northridge Area: 52 psi (improvement of +21 psi)
- New minimum pressure for the Old Cutters Area: 54 psi (improvement of +23 psi)

Alternative 2C was the 8th best performing alternative of all 16 in terms of pressure increase and is recommended for further consideration due to potentially very low relative capital cost (3rd lowest; only 2A and 2B were lower) as discussed in Section 3.0.

Figure 14

Alternative 2C – Hydraulic Model Results



Alternative 4A – New Well in Sunbeam Development near Carbonate Street

Alternative 4A involves the construction of a new municipal water supply well east of Carbonate Street. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $122,222 per psi increase in Northridge (the 3rd highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,100,000 (see Figure 16). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the proposed Sunbeam development.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 15):

- New minimum pressure for the Northridge Area: 40 psi (improvement of +9 psi)
- New minimum pressure for the Old Cutters Area: 42 psi (improvement of +11 psi)

Alternative 4A was the 15th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration as the primary solution to Northridge low pressure issue.

Figure 15

Alternative 4A – Hydraulic Model Results

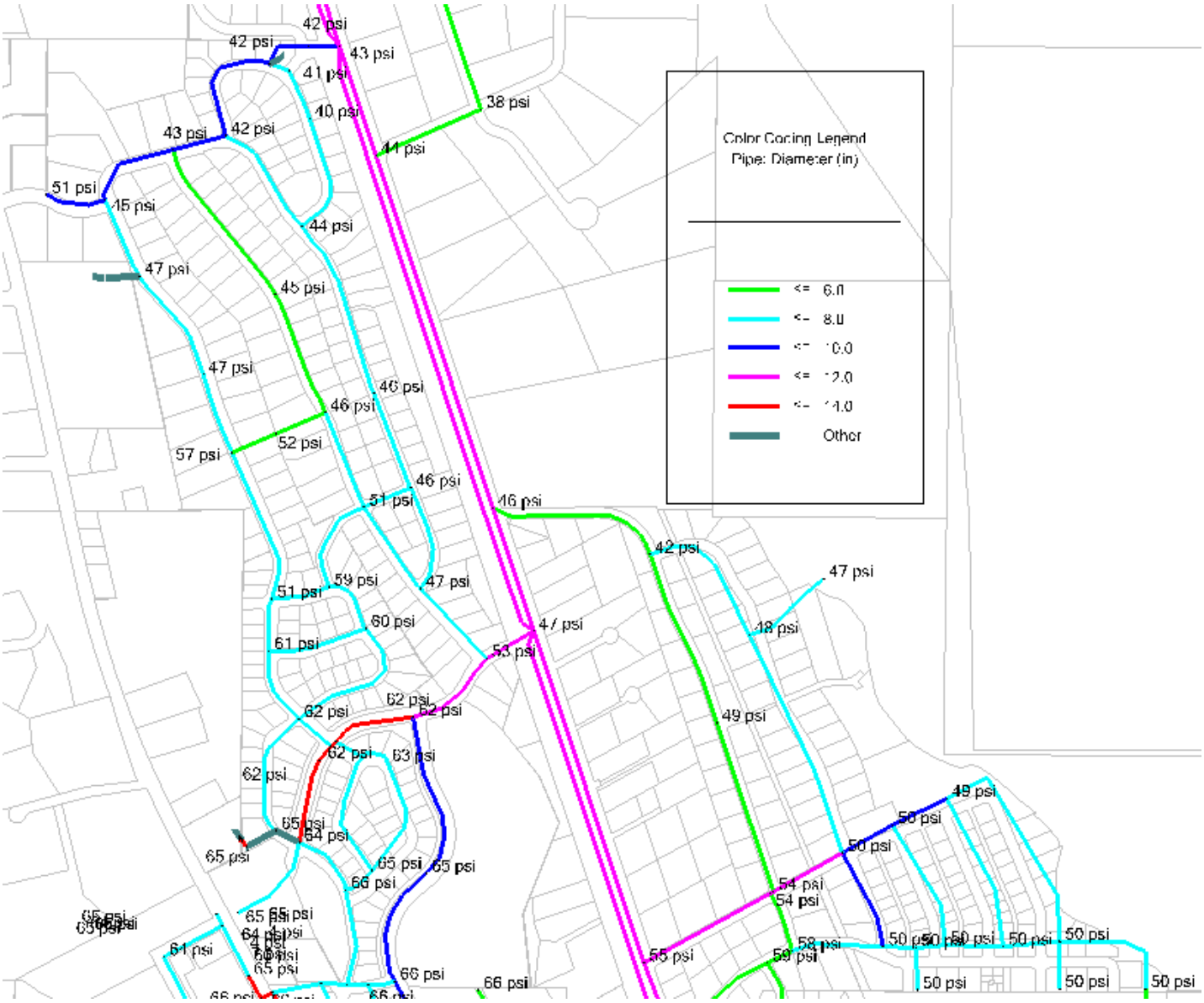


FIGURE 16

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4A

NEW WELL IN SUNBEAM DEVELOPMENT NEAR CARBONATE ST

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	WATER RIGHTS	1	LS	$50,000	$50,000
2	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
3	INSTALL WELL PUMP	1	LS	$125,000	$125,000
4	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
5	12-IN DIA C900 PVC PIPING	150	LF	$210	$31,500
6	CONTINGENCY	30%			$222,500
7	ENGINEERING AND PERMITTING	15%			$144,600
		TOTAL ESTIMATED PROJECT COST			**$1,100,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4B – New Well in 2-IT Ranch Development near Highway 75

Alternative 4B involves the construction of a new municipal water supply well east of Highway 75 in the proposed 2-IT Ranch development. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $73,333 per psi increase in Northridge (the 4th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,100,000 (see Figure 18). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the proposed 2-IT Ranch development.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed 2-IT Ranch development (see Figure 17):

- New minimum pressure for the Northridge Area: 46 psi (improvement of +15 psi)
- New minimum pressure for the Old Cutters Area: 43 psi (improvement of +12 psi)

Alternative 4B was the 12th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration as the primary solution to Northridge low pressure issue, but is an important option for developing adequate water supply to meet maximum day demand with continued population growth in the near term.

Figure 17

Alternative 4B – Hydraulic Model Results

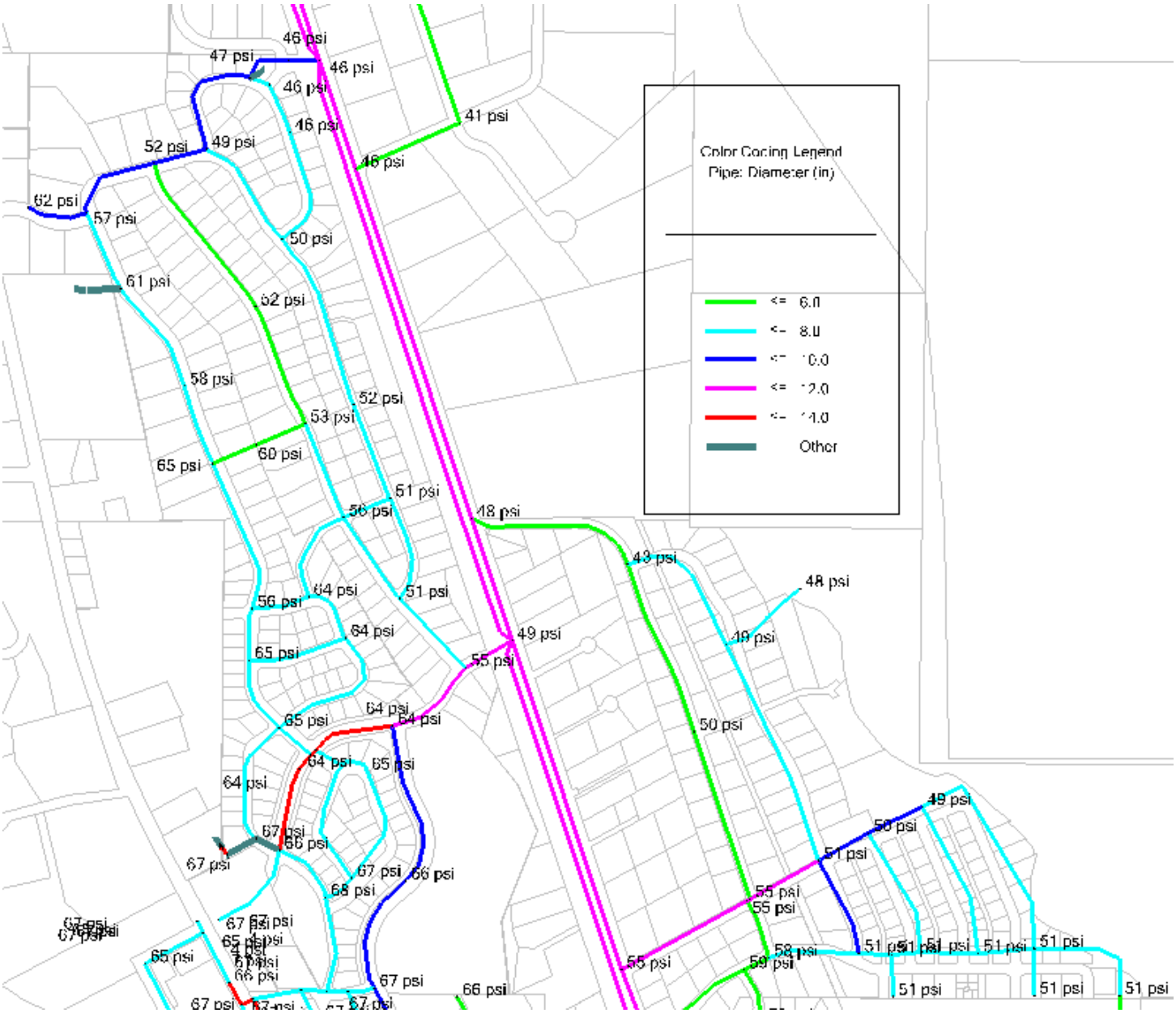


FIGURE 18

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4B

NEW WELL IN 2-IT RANCH DEVELOPMENT NEAR HIGHWAY 75

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	WATER RIGHTS	1	LS	$50,000	$50,000
2	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
3	INSTALL WELL PUMP	1	LS	$125,000	$125,000
4	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
5	12-IN DIA C900 PVC PIPING	150	LF	$210	$31,500
6	CONTINGENCY	30%			$222,500
7	ENGINEERING AND PERMITTING	15%			$144,600
		TOTAL ESTIMATED PROJECT COST			**$1,100,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4C – New Well in Northridge Area near W Meadows Dr.

Alternative 4C involves the construction of a new municipal water supply well in the northeast corner of the Northridge Area on W Meadows Dr. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $61,111 per psi increase in Northridge (the 6th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,100,000 (see Figure 20). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the Northwest Area.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam or 2-IT Ranch developments (see Figure 19):

- New minimum pressure for the Northridge Area: 49 psi (improvement of +18 psi)
- New minimum pressure for the Old Cutters Area: 44 psi (improvement of +13 psi)

Alternative 4C was the 9th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration as the primary solution to Northridge low pressure issue, but is an important option for developing adequate water supply to meet maximum day demand with continued population growth in the near term.

Figure 19

Alternative 4C – Hydraulic Model Results

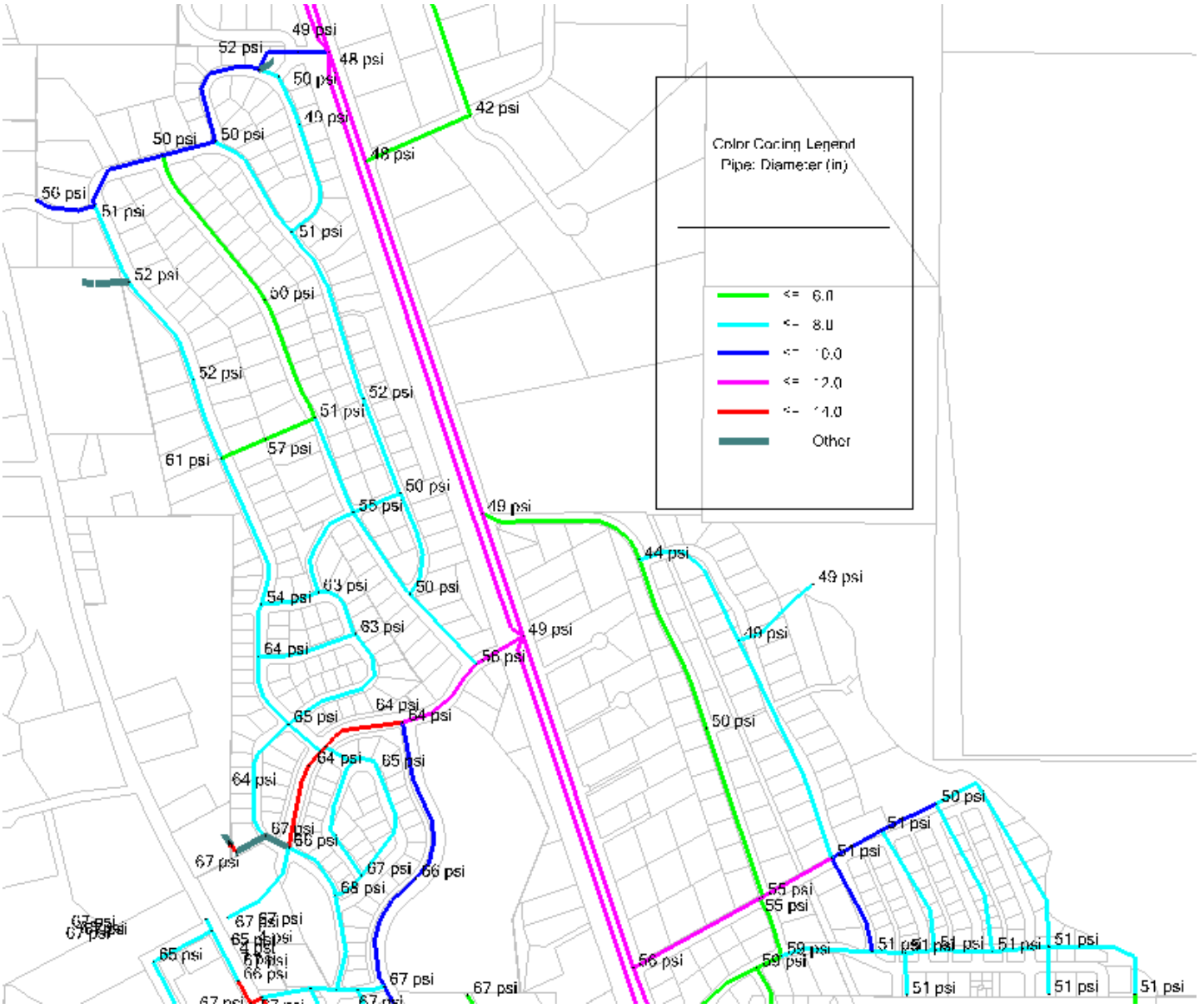


FIGURE 20

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4C

NEW WELL IN NORTHRIDGE AREA NEAR W MEADOW DR.

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	WATER RIGHTS	1	LS	$50,000	$50,000
2	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
3	INSTALL WELL PUMP	1	LS	$125,000	$125,000
4	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
5	12-IN DIA C900 PVC PIPING	150	LF	$210	$31,500
6	CONTINGENCY	30%			$222,500
7	ENGINEERING AND PERMITTING	15%			$144,600
		TOTAL ESTIMATED PROJECT COST			**$1,100,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4G –New Partial Pressure Zone & New Well in Northridge Area near W Meadows Dr.

Alternative 4G involves the construction of a new municipal water supply well in the northeast corner of the Northridge Area on W Meadows Dr. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

Alternative 4G involves the construction of 4 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $40,741 per psi increase in Northridge (the 10th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,100,000 (see Figure 22). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the Northwest Area and if the Northridge Area is hydraulically isolated.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 21):

- New minimum pressure for the Northridge Area: 58 psi (improvement of +27 psi)
- New minimum pressure for the Northridge Area: 41 psi (improvement of +10 psi)

Alternative 4G was the 3rd best performing alternative of all 16 in terms of pressure increase and is not recommended as the primary solution to Northridge pressure issues, but is an important option for developing adequate water supply to meet maximum day demand with continued population growth in the near term.

Figure 21

Alternative 4G – Hydraulic Model Results

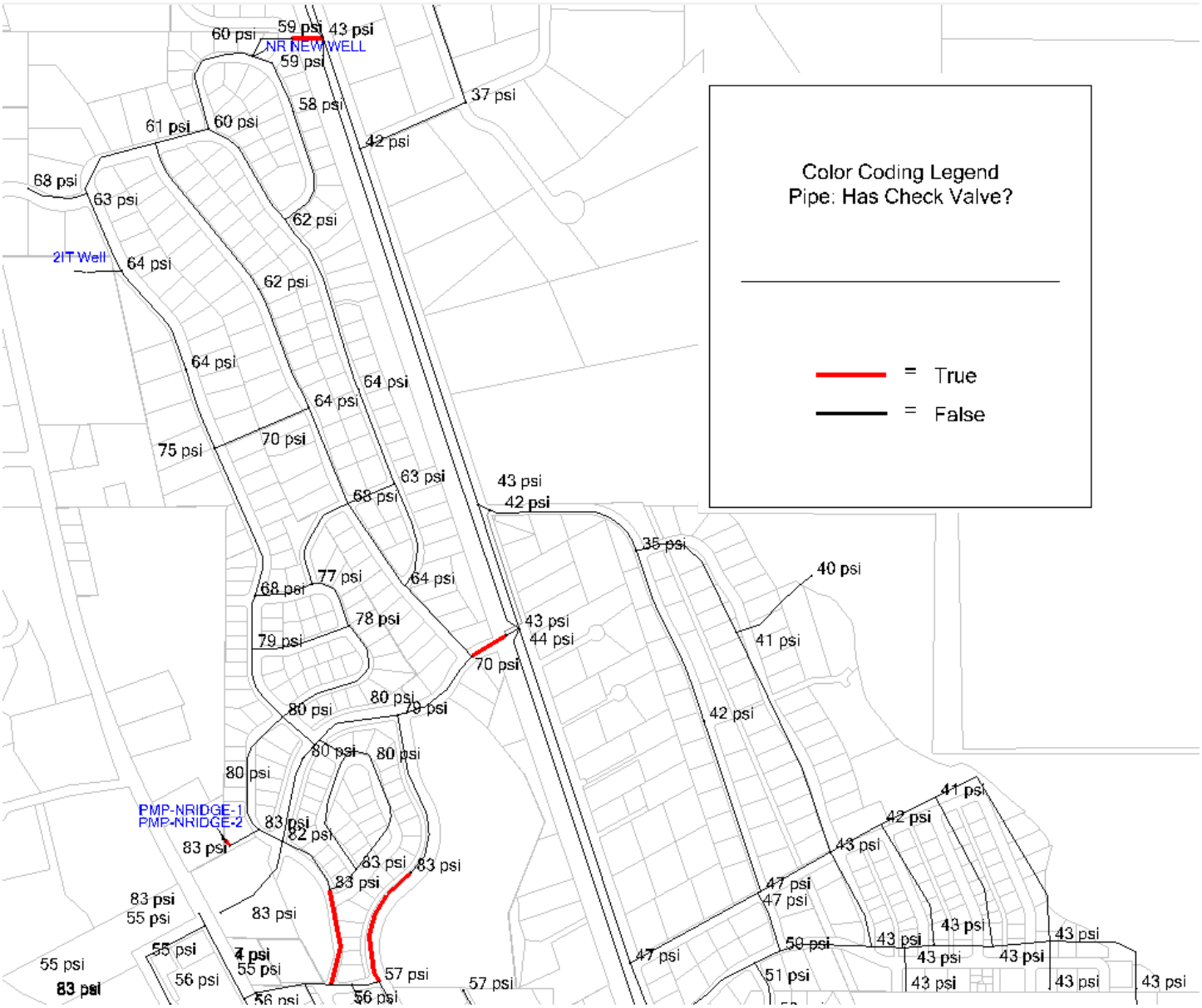


FIGURE 22

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4G

NEW PARTIAL PRESSURE ZONE & NEW WELL IN NORTHRIDGE AREA NEAR W MEADOW DR.

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	8-IN CHECK VALVES	1	EA	$4,020	$4,020
2	10-IN CHECK VALVES	2	EA	$5,880	$11,760
3	12-IN CHECK VALVES	1	EA	$7,740	$7,740
4	WATER RIGHTS	1	LS	$50,000	$50,000
5	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
6	INSTALL WELL PUMP	1	LS	$125,000	$125,000
7	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
8	12-IN DIA C900 PVC PIPING	150	LF	$210	$31,500
9	CONTINGENCY	30%			$229,500
10	ENGINEERING AND PERMITTING	15%			$149,200
	TOTAL ESTIMATED PROJECT COST				**$1,100,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4H – New Pressure Zone & New Well in Northride Area near W Meadow Dr

Alternative 4H involves the construction of a new municipal water supply well in the northeast corner of the Northridge Area on W Meadows Dr. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

Alternative 4H involves the construction of 1 new check valve at the following locations:

- W Meadows Drive near the intersection with Buttercup Road

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $4,000 per psi increase in Northridge (the 8th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,100,000 (see Figure 24). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the Northwest Area and if the Northridge Area is partially hydraulically isolated to the north.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 23):

- New minimum pressure for the Northridge Area: 56 psi (improvement of +25 psi)
- New minimum pressure for the Old Cutters Area: 42 psi (improvement of +11 psi)

Alternative 4H was the 7th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration as the primary solution to Northridge pressure issues, but is an important option for developing adequate water supply to meet maximum day demand with continued population growth in the near term.

Figure 23

Alternative 4H – Hydraulic Model Results

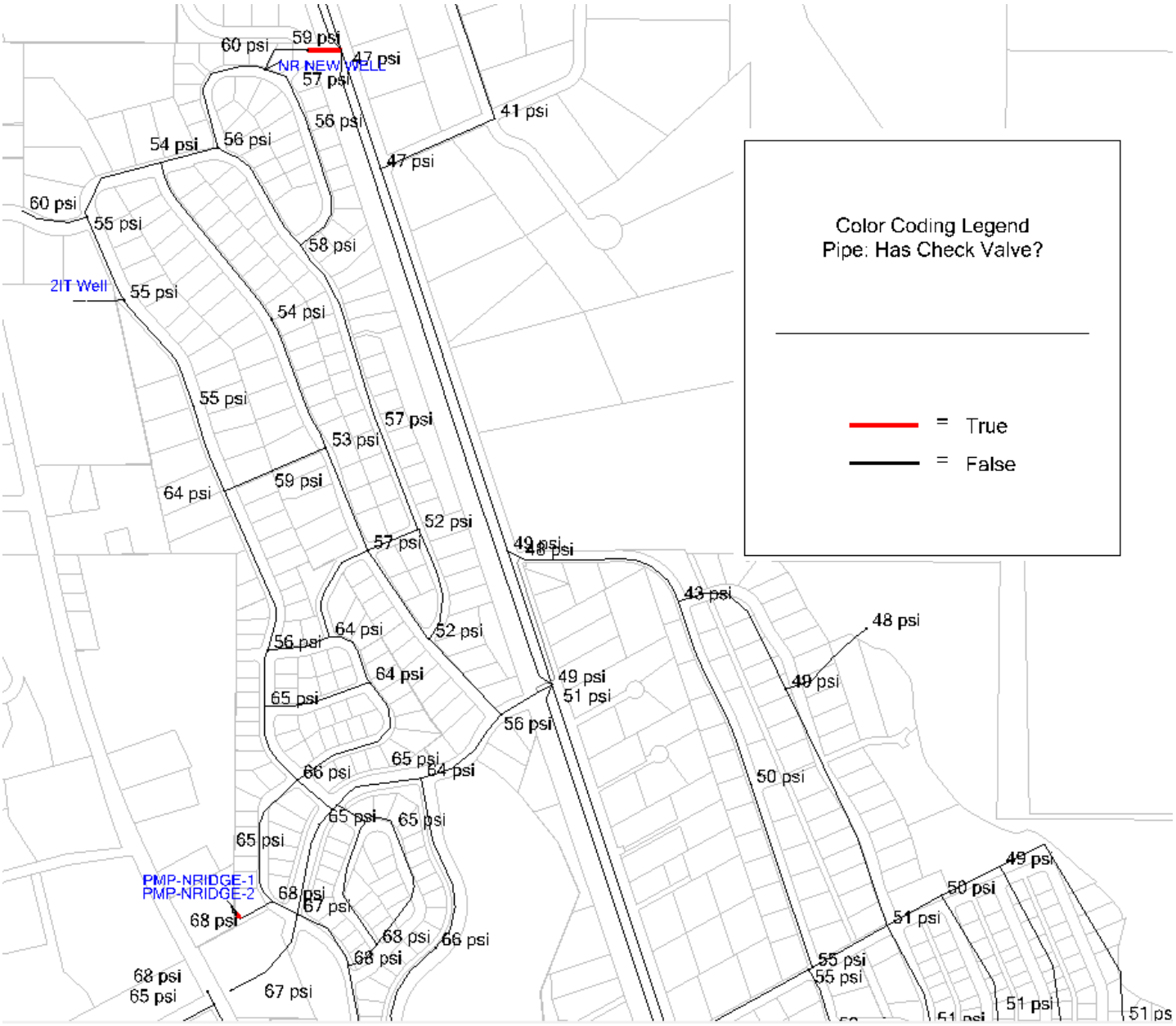


FIGURE 24

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4H

NEW PRESSURE ZONE & NEW WELL IN NORTHRIDGE AREA NEAR W MEADOW DR.

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	10-IN CHECK VALVES	2	EA	$5,880	$11,760
2	WATER RIGHTS	1	LS	$50,000	$50,000
3	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
4	INSTALL WELL PUMP	1	LS	$125,000	$125,000
5	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
6	12-IN DIA C900 PVC PIPING	150	LF	$210	$31,500
7	CONTINGENCY	30%			$226,000
8	ENGINEERING AND PERMITTING	15%			$146,900
		TOTAL ESTIMATED PROJECT COST			**$1,100,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4J – New Pressure Zone & New Well in Sunbeam Development near Carbonate St

Alternative 4J involves the construction of a new municipal water supply well east of Carbonate Street. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

Alternative 4J involves the construction of 7 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- S Hiawatha Drive near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road
- Myrtle Street between Mother Lode Drive and Buffalo Drive
- Hiawatha Drive between Buttercup Road and Buffalo Drive

This alternative also entails construction of approximately 900-linear feet (LF) of 12-inch PVC pipe in Buttercup Road from McKercher Blvd to S Hiawatha Dr.

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $180,000 per psi increase in Northridge (the 2nd highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,800,000 (see Figure 26). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the proposed Sunbeam development and if the Northridge Area and Old Cutters Area are a separate pressure zone.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 25):

- New minimum pressure for the Northridge Area: 41 psi (improvement of +10 psi)
- New minimum pressure for the Northridge Area: 43 psi (improvement of +12 psi)

Alternative 4J was the 14th best performing alternative of all 16 in terms of pressure increase and is not recommended for further consideration.

Figure 25

Alternative 4J – Hydraulic Model Results

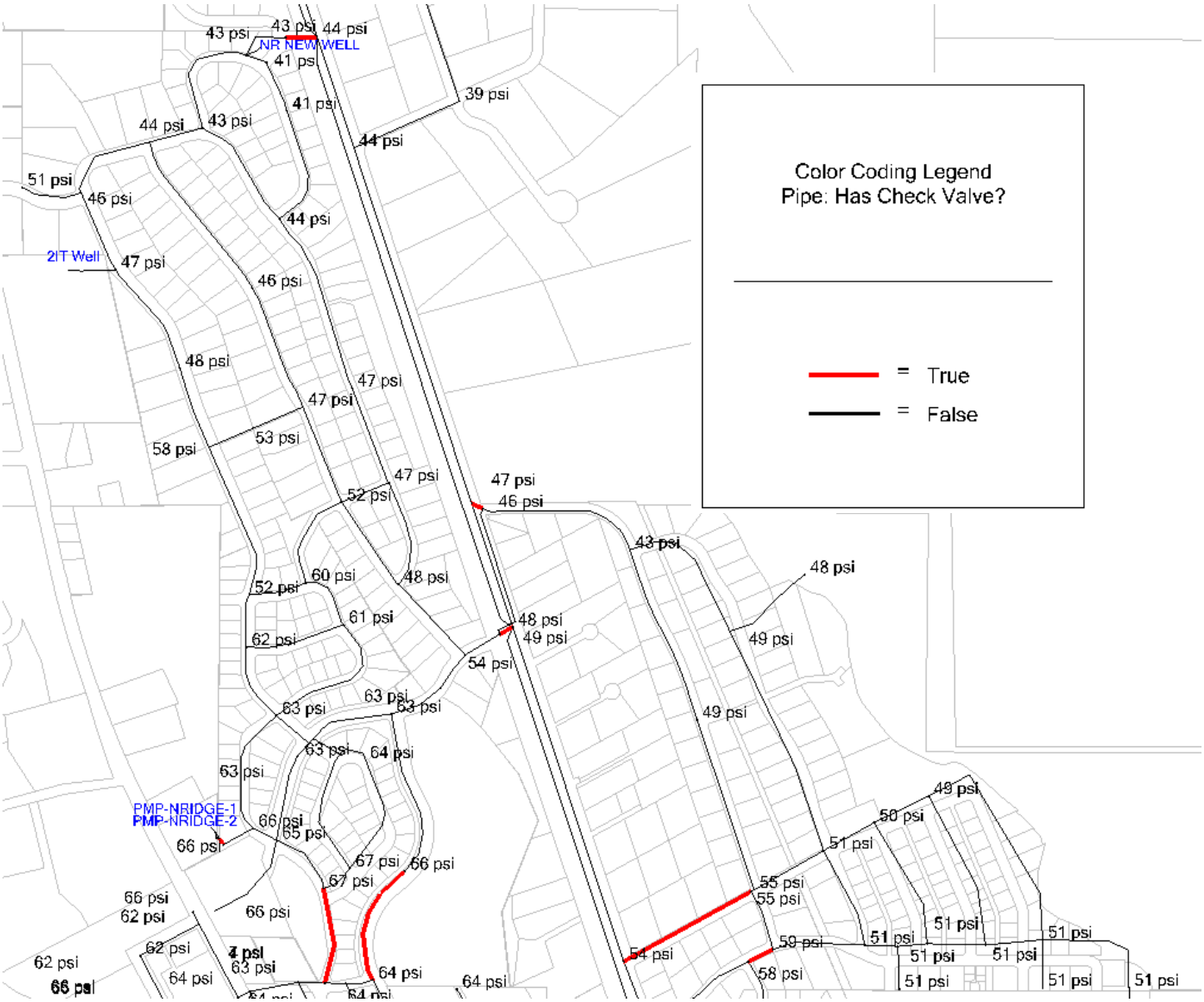


FIGURE 26

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4J

NEW PRESSURE ZONE & NEW WELL IN SUNBEAM NEAR CARBONATE ST

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	6-IN CHECK VALVES	6	EA	$3,310	$19,860
2	6-IN GATE VALVES	1	EA	$1,400	$1,400
3	8-IN CHECK VALVES	1	EA	$4,020	$4,020
4	10-IN CHECK VALVES	2	EA	$5,880	$11,760
5	12-IN CHECK VALVES	2	EA	$7,740	$15,480
6	12-IN GATE VALVES	4	EA	$1,800	$7,200
7	12-IN DIA C900 PVC PIPING	900	EA	$210	$189,000
8	WATER RIGHTS	1	LS	$50,000	$50,000
9	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
10	INSTALL WELL PUMP	1	LS	$125,000	$125,000
11	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
12	12-IN DIA C900 PVC PIPING	1,100	LF	$210	$231,000
13	CONTINGENCY	30%			$356,900
14	ENGINEERING AND PERMITTING	15%			$232,000
		TOTAL ESTIMATED PROJECT COST			**$1,800,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4K – New Pressure Zone & New Well in 2-IT Ranch near Highway 75

Alternative 4K involves the construction of a new municipal water supply well east of Highway 75 in the proposed 2-IT Ranch development. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

Alternative 4K involves the construction of 7 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- S Hiawatha Drive near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road
- Myrtle Street between Mother Lode Drive and Buffalo Drive
- Hiawatha Drive between Buttercup Road and Buffalo Drive

This alternative also entails construction of approximately 900-linear feet (LF) of 12-inch PVC pipe in Buttercup Road from McKercher Blvd to S Hiawatha Dr.

For this alternative both of the existing NRBPS pumps and the River St pump were off.

The estimated capital cost for this alternative is $47,368 per psi increase in Northridge (the 7th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,800,000 (see Figure 28). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the proposed 2-IT Ranch development and if the Northridge Area and Old Cutters Area are a separate pressure zone.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 27):

- New minimum pressure for the Northridge Area: 69 psi (improvement of +38 psi)
- New minimum pressure for the Old Cutters Area: 71 psi (improvement of +40 psi)

Alternative 4K was the 2nd best performing alternative of all 16 in terms of pressure increase and is recommended for further consideration as discussed in Section 3.0.

Figure 27

Alternative 4K – Hydraulic Model Results

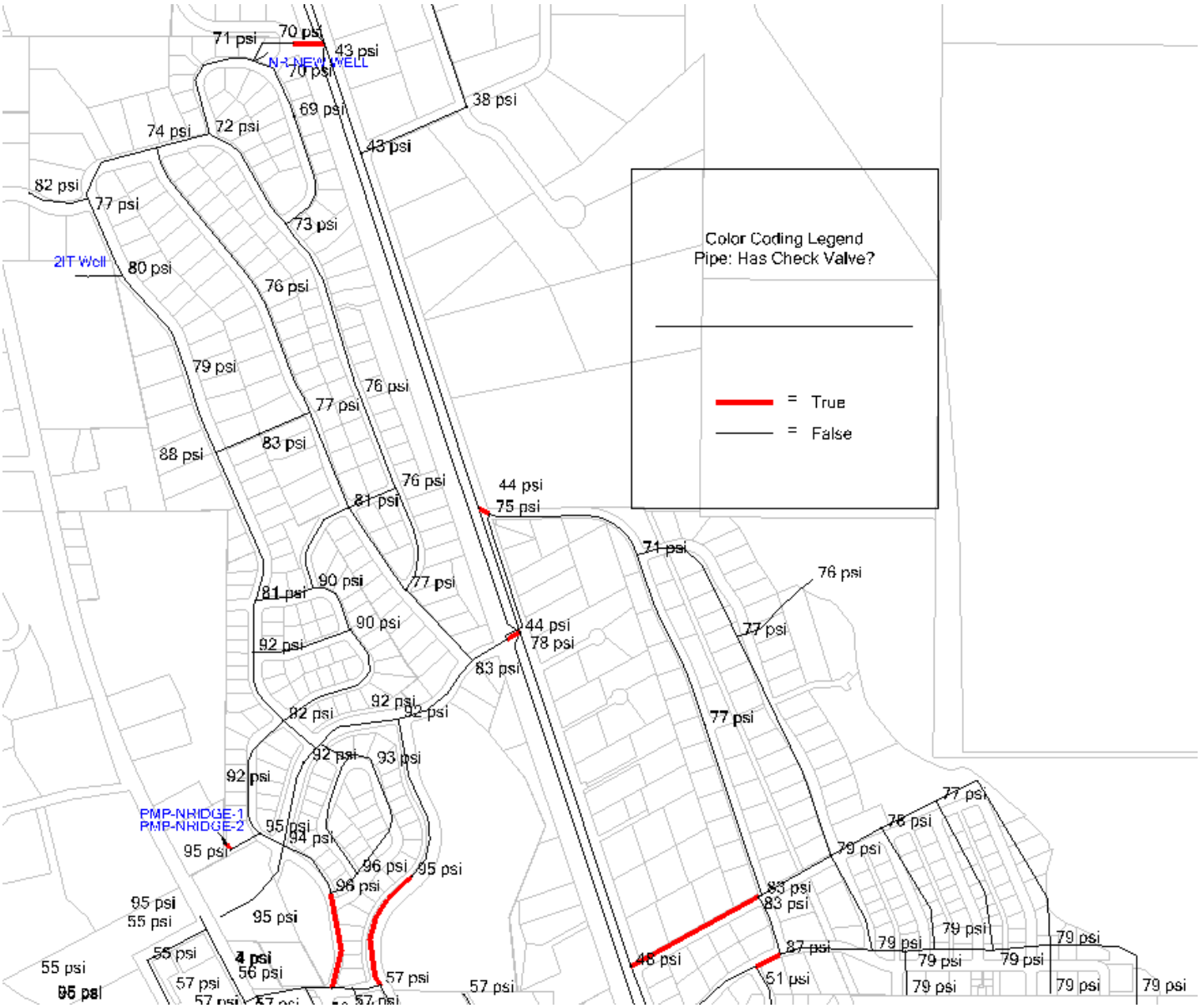


FIGURE 28

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4K

NEW PRESSURE ZONE & NEW WELL IN 2-IT RANCH NEAR HIGHWAY 75

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	6-IN CHECK VALVES	6	EA	$3,310	$19,860
2	6-IN GATE VALVES	1	EA	$1,400	$1,400
3	8-IN CHECK VALVES	1	EA	$4,020	$4,020
4	10-IN CHECK VALVES	2	EA	$5,880	$11,760
5	12-IN CHECK VALVES	2	EA	$7,740	$15,480
6	12-IN GATE VALVES	4	EA	$1,800	$7,200
7	12-IN DIA C900 PVC PIPING	900	EA	$210	$189,000
8	WATER RIGHTS	1	LS	$50,000	$50,000
9	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
10	INSTALL WELL PUMP	1	LS	$125,000	$125,000
11	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
12	12-IN DIA C900 PVC PIPING	1,100	LF	$210	$231,000
13	CONTINGENCY	30%			$356,900
14	ENGINEERING AND PERMITTING	15%			$232,000
		TOTAL ESTIMATED PROJECT COST			**$1,800,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4L – New Pressure Zone & New Well in Sunbeam near Carbonate St, and NRBPS Pump Control Modifications

Alternative 4L involves the construction of a new municipal water supply well east of Carbonate Street in the proposed Sunbeam development. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

Alternative 4L involves the construction of 7 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- S Hiawatha Drive near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road
- Myrtle Street between Mother Lode Drive and Buffalo Drive
- Hiawatha Drive between Buttercup Road and Buffalo Drive

This alternative also entails construction of approximately 900-linear feet (LF) of 12-inch PVC pipe in Buttercup Road from McKercher Blvd to S Hiawatha Dr.

For this alternative both of the existing NRBPS pumps and the River St pump were on.

The estimated capital cost for this alternative is $69,231 per psi increase in Northridge (the 5th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,800,000 (see Figure 30). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the proposed Sunbeam development, control modifications are made to NRBPS and River Street pumps, and if the Northridge Area and Old Cutters Area are a separate pressure zone.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 29):

- New minimum pressure for the Northridge Area: 57 psi (improvement of +26 psi)
- New minimum pressure for the Old Cutters Area: 60 psi (improvement of +29 psi)

Alternative 4L was the 4th best performing alternative of all 16 in terms of pressure increase and is recommended for further consideration as discussed in Section 3.0.

Figure 29

Alternative 4L – Hydraulic Model Results

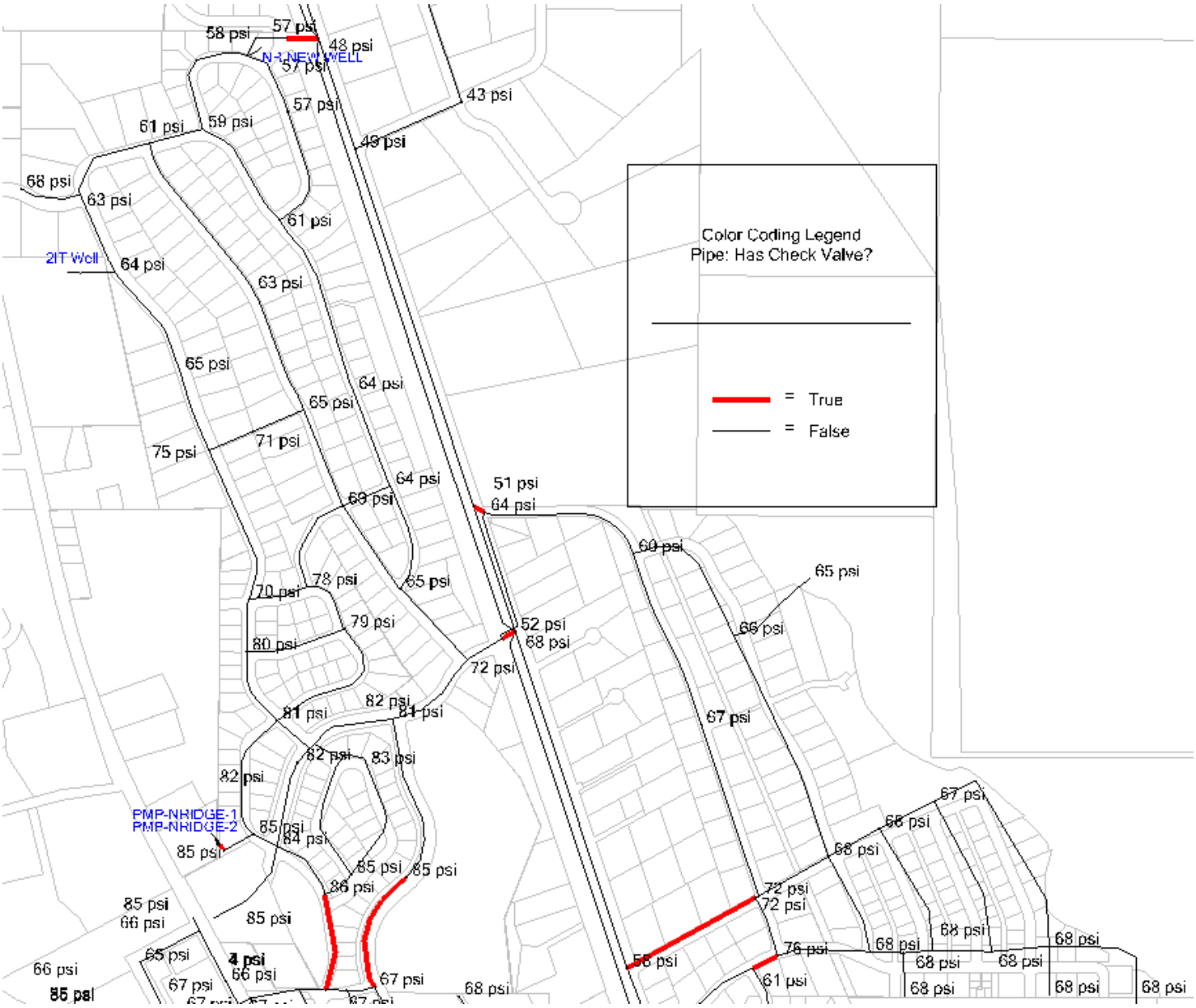


FIGURE 30

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4L

NEW PRESSURE ZONE & NEW WELL IN SUNBEAM NEAR CARBONATE ST & NRBPS CTRL MOD

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	6-IN CHECK VALVES	6	EA	$3,310	$19,860
2	6-IN GATE VALVES	1	EA	$1,400	$1,400
3	8-IN CHECK VALVES	1	EA	$4,020	$4,020
4	10-IN CHECK VALVES	2	EA	$5,880	$11,760
5	12-IN CHECK VALVES	2	EA	$7,740	$15,480
6	12-IN GATE VALVES	4	EA	$1,800	$7,200
7	12-IN DIA C900 PVC PIPING	900	EA	$210	$189,000
8	PUMP PROGRAMMING AND CONTROLS	1	LS	$10,000	$10,000
9	WATER RIGHTS	1	LS	$50,000	$50,000
10	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
11	INSTALL WELL PUMP	1	LS	$125,000	$125,000
12	WELL HOUSE AND MECHANICAL	1	LS	$400,000	$400,000
13	12-IN DIA C900 PVC PIPING	1,100	LF	$210	$231,000
14	CONTINGENCY	30%			$359,900
15	ENGINEERING AND PERMITTING	15%			$233,900
		TOTAL ESTIMATED PROJECT COST			**$1,800,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternative 4M – New Pressure Zone & New Well in 2-IT Ranch Development near Highway 75, and NRBPS Pump Control Modifications

Alternative 4M involves the construction of a new municipal water supply well east of Highway 75 in the proposed 2-IT Ranch development. The well is assumed to be 18-inch diameter, 300-ft deep, capable of producing at least 800 gpm.

Alternative 4M involves the construction of 7 new check valves at the following locations:

- 1st Avenue between Cobblestone Lane Winterberry Loop
- 2nd Avenue between Cobblestone Lane and McKercher Boulevard
- McKercher Boulevard near the intersection with Buttercup Road
- S Hiawatha Drive near the intersection with Buttercup Road
- W Meadows Drive near the intersection with Buttercup Road
- Myrtle Street between Mother Lode Drive and Buffalo Drive
- Hiawatha Drive between Buttercup Road and Buffalo Drive

This alternative also entails construction of approximately 900-linear feet (LF) of 12-inch PVC pipe in Buttercup Road from McKercher Blvd to S Hiawatha Dr.

For this alternative both of the existing NRBPS pumps and the River St pump were on.

The estimated capital cost for this alternative is $41,860 per psi increase in Northridge (the 9th highest cost of all 16 alternatives), shown in Table 1. The total estimated capital cost for this alternative is $1,800,000 (see Figure 32). These costs include construction of a new well house and associated mechanical equipment, installation of a well pump, and a placeholder for water rights permitting costs.

This alternative illustrates the simulated performance of the City's water system with a new water supply source in the proposed 2-IT Ranch development, control modifications are made to NRBPS and River Street pumps, and if the Northridge Area and Old Cutters Area are a separate pressure zone.

Under this alternative, the hydraulic model provides the following results, excluding demand from the proposed Sunbeam development (see Figure 31):

- New minimum pressure for the Northridge Area: 74 psi (improvement of +43 psi)
- New minimum pressure for the Old Cutters Area: 74 psi (improvement of +43 psi)

Alternative 4M was the best performing alternative of all 16 in terms of pressure increase and is recommended for further consideration as discussed in Section 3.0.

Figure 31

Alternative 4M – Hydraulic Model Results

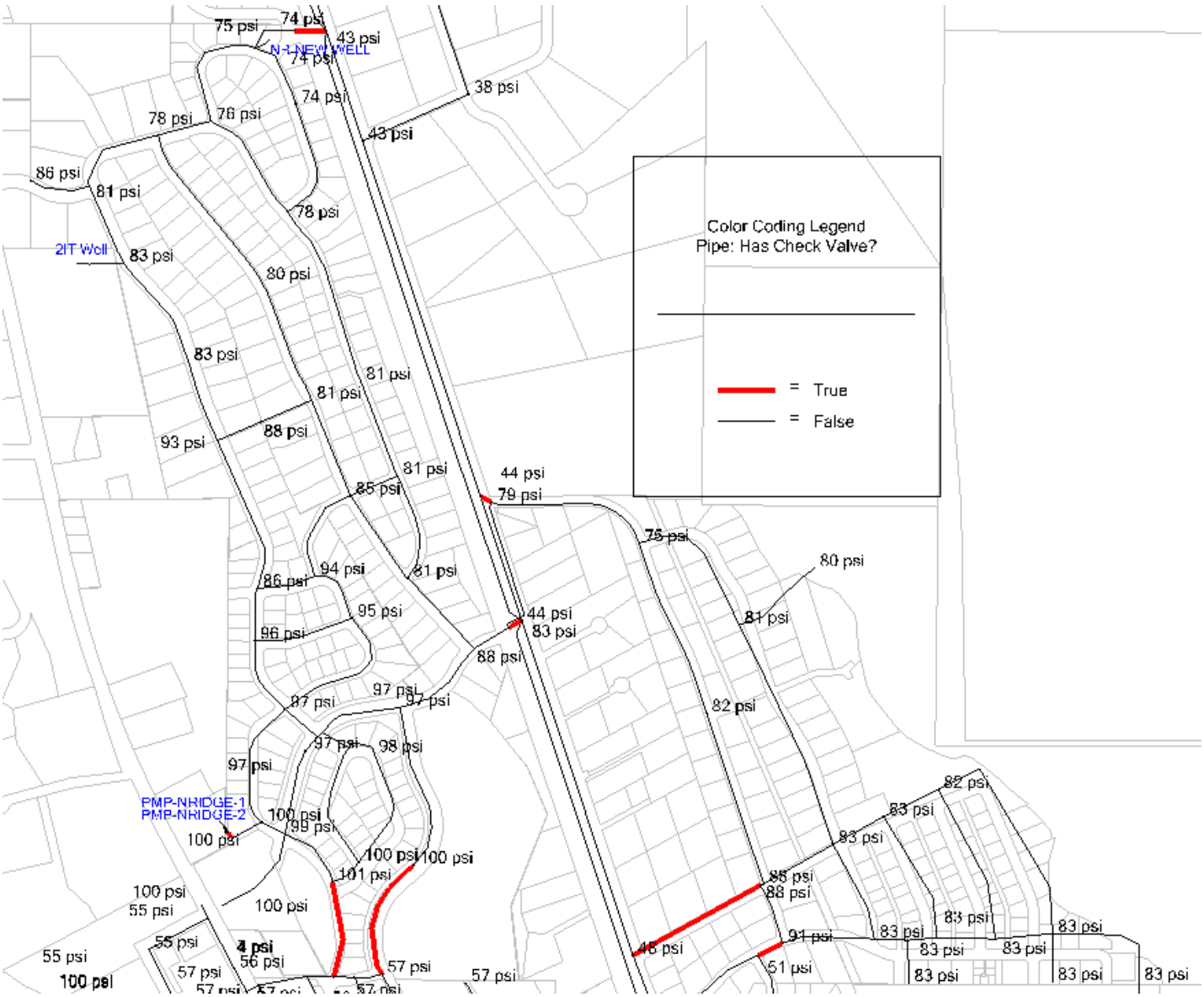


FIGURE 32

SPF WATER ENGINEERING

CONCEPTUAL COST ESTIMATE

ALTERNATIVE 4M

NEW PRESSURE ZONE & NEW WELL IN 2-IT RANCH NEAR HWY 75 & NRBPS CTRL MOD

PROJECT : Northridge Pressure Improvements
JOB # : 330.0100
LOCATION : Hailey, ID

ESTIMATE CLASS : 5
DATE : 12/30/2019
BY : SM
REVIEWED : EL

NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	COST
1	6-IN CHECK VALVES	6	EA	$3,310	$19,860
2	6-IN GATE VALVES	1	EA	$1,400	$1,400
3	8-IN CHECK VALVES	1	EA	$4,020	$4,020
4	10-IN CHECK VALVES	2	EA	$5,880	$11,760
5	12-IN CHECK VALVES	2	EA	$7,740	$15,480
6	12-IN GATE VALVES	4	EA	$1,800	$7,200
7	12-IN DIA C900 PVC PIPING	900	EA	$210	$189,000
8	PUMP PROGRAMMING AND CONTROLS	1	LS	$10,000	$10,000
9	WATER RIGHTS	1	LS	$100,000	$100,000
10	CONSTRUCT WELL (ASSUME 18" DIA BOREHOLE)	300	FT	$450	$135,000
11	INSTALL WELL PUMP	1	LS	$125,000	$125,000
12	WELL HOUSE AND MECHANICAL	1	LS	$350,000	$350,000
13	12-IN DIA C900 PVC PIPING	1,100	LF	$210	$231,000
14	CONTINGENCY	30%			$359,900
15	ENGINEERING AND PERMITTING	15%			$233,900
		TOTAL ESTIMATED PROJECT COST			**$1,800,000**

This cost estimate reflects our professional opinion of accurate costs at this time based on current conditions at the project location. This estimate is subject to change through the project planning and design process. Actual construction cost will depend on the cost of labor, materials, equipment, and services provided by others, contractor's methods of determining prices, competitive bidding and market conditions.

Alternatives that Failed Preliminary Screening

As discussed in Section 2.0, a total of 25 preliminary alternatives were recommended, while only 16 were advanced for further evaluation. The following is a brief commentary on the reasons the remaining 9 alternatives were not evaluated further:

- Alternatives 1B-1D: these alternatives were rejected for further analysis due to decreases in simulated minimum available fire flow to Old Cutters (1B/1C), or for relatively lower pressure gains in the Northridge Area (1D: new minimum pressure = 48 psi).
- Alternatives 3A-3B: these alternatives were rejected for further analysis due to decreases in simulated minimum available fire flow to the Northridge and Old Cutters areas below 1,000 gpm and relatively low pressure gains in Northridge and Old Cutters.
- Alternatives 4D-4F, 4I: these alternatives were rejected for further analysis due to relatively low pressure gains in Northridge and Old Cutters.
- Alternative 5: this alternative was rejected for further analysis due to relatively low pressure gains in Northridge and Old Cutters.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Twenty-seven preliminary alternatives were developed for increasing pressure in the Northridge and Old Cutters areas. Sixteen alternatives were advanced for further analysis including development of engineer's opinion of probable cost. Of the sixteen alternatives, the following five alternatives offer an effective improvement in minimum pressures in both the Northridge and Old Cutters areas:

- Alternative 1G: New Northridge & Old Cutters Pressure Zone created with installation of check valves, and control modifications to NRBPS and River Street pumps
- Alternative 2C: Control modifications to NRBPS and River Street pumps to turn on based on both; a) Turbine Tank level, and b) pressure at NRBPS as discussed in Section 2.0.
- Alternative 4L: New groundwater well in 2-IT Ranch and new pressure zone for Northridge and Old Cutters areas
- Alternative 4K: New groundwater well in Sunbeam, a new pressure zone for Northridge and Old Cutters areas, and control modifications to NRBPS pumps
- Alternative 4M: New groundwater well in 2-IT Ranch, a new pressure zone for Northridge and Old Cutters areas, and control modifications to NRBPS pumps

Additional alternatives were not analyzed but may also offer significant improvements include a new groundwater well in the northern portion of the Northridge Area near W Meadows Dr and Buttercup Road in conjunction with control modifications to NRBPS pumps.

Of the five alternatives recommended for additional consideration by the City, SPF recommends Alternative 2C for implementation due to the following reasons:

1) Alternative 2C offers the lowest impacts to available fire flow (see Appendices A and B). All alternatives that involve the creation of a new pressure zone or partial pressure zone negatively impact available fire flow. The simulated impacts to available fire flow are quantified in Appendix B for each alternative.

2) Alternative 2C is the lowest cost alternative of the five recommended alternatives.

Currently, all pumps in the hydraulic model except the Woodside pump station are off during fire flow analysis. The decreases to available fire flow due to alternatives that include the creation of a new pressure zone or partial pressure zone could potentially be mitigated if standby power were provided at additional well facilities. For example, if standby power is provided to other pump stations, fire flow fire flow is anticipated to improve for all alternatives. The results of simulated fire flow analysis are included in Appendix B.

SPF further recommends that the City evaluate implementing one of either Alternatives 4K or Alternative 4M (or similar); construction of a new groundwater supply well. Based on the maximum day demand data shown below in Table 4, the City is likely approaching the firm system-wide water supply capacity of 7.3 million gallons per day (MGD) (SPF, 2015). Given the anticipated long lead time in developing a new groundwater supply (potentially 2 years or more including water rights permitting), SPF recommends that the City consider beginning the process of siting and designing a new future source of supply.

Table 4
Maximum Day Demand 2013-2017

Year	Jan (MGD)	Feb (MGD)	Mar (MGD)	Apr (MGD)	May (MGD)	Jun (MGD)	Jul (MGD)	Aug (MGD)	Sep (MGD)	Oct (MGD)	Nov (MGD)	Dec (MGD)
2017	1.4	1.3	1.3	1.6	3.8	5.1	6.0	6.0	5.5	3.0	1.4	1.6
2016	1.0	1.7	1.0	2.0	3.5	6.0	6.6	6.3	5.6	2.5	1.2	1.2
2015	1.1	1.0	1.1	3.6	4.0	6.4	5.9	5.4	4.8	3.5	1.2	1.0
2014	2.1	1.2	2.2	2.1	5.0	5.8	7.2	5.7	4.7	3.3	1.1	1.1
2013	1.8	1.6	1.4	3.2	4.8	6.0	5.2	5.1	5.6	2.2	2.0	1.2

4.0 REFERENCES

Brockway Engineering, 2018. Northridge Pumping Station Performance Testing and Analysis. Prepared for the City of Hailey, June 25, 2018.

SPF, 2019a. Draft Northridge Area Pressure Study – Field Data Review. Prepared for the City of Hailey, October 2019.

SPF, 2019b. Draft Northridge Area Pressure Study – Hydraulic Model. Prepared for the City of Hailey, October 2019.

SPF, 2015. Water System Master Plan. Prepared for the City of Hailey, May 2015.

APPENDIX A
SUMMARY OF SCENARIOS

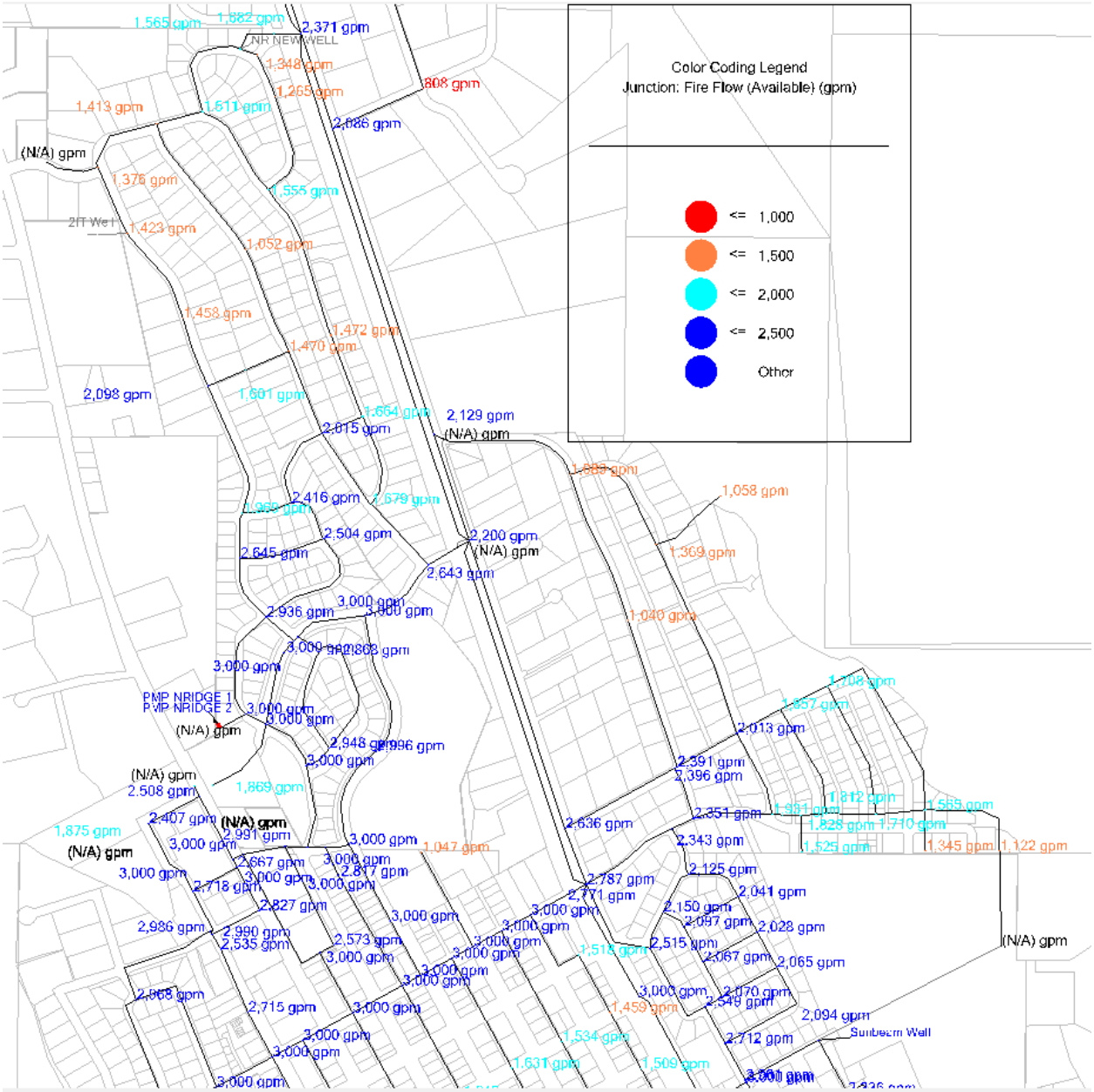
Alternative Title	Baseline	Partial NR Isolation of NR/OC								NRBPS Pressure Control			New NRBPS	
Alternative No.	0	1a	1b	1c	1d	1e	1f	1g	1h	2a	2b	2c	3a	3b
Description	Existing Conditions; "Worst-Case"	Check Valves in NR; both NR Pumps Off	Check Valves in NR; East NR Pump On	Check Valves in NR; Both NR Pumps On	Both NR Pumps On, w/1 Check Valve	Both NR Pumps On, w/3 Check Valves	Both NR Pumps On, w/4 Check Valves	New PZ, NRBPS & River Pressure Ctrl Mod	Both NR Pumps On, River On, 3 Check Valves	Existing Infra; East NR Pump Pressure Ctrl	Existing Infra; Both NR Pumps Pressure Ctrl	NRBPS & River Pressure Ctrl Mod	New BPS on Northridge Dr.	New BPS near 2-IT Ranch
NRBPS East Pmp	Off	Off	On	On	On	On	On	On	On	On	On	On	Off	Off
NRBPS West Pump	Off	Off	Off	On	On	On	On	On	On	Off	On	On	Off	Off
New Pmp?	No	No	No	No	No	No	No	No	No	No	No	No	2	2
New Source?	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Check Valves in NR/OC?	No	7	7	7	1	3	4	7	3	No	No	No	1	5
NRBPS Pressure (psi)	55	57	84	85	76	85	85	85	85	69	76	81	53	53
Min NR Res Pressure (psi)	31	33	55	57	48	49	57	57	52	43	48	52	36	35
Min Old Cutters Pressure (psi)	31	33	44	44	48	38	35	60	50	44	48	54	29	30
Change vs Baseline (Min NR psi)	0	2	24	26	17	18	26	26	21	12	17	21	5	4
Cost Estimate?	N	Y	N	N	N	Y	Y	Y	N	N	N	N	N	N
Min NR Fire Flow (gpm)	1052	1083	1083	1083	1052	1080	1083	1083	1080	N/A	N/A	1052	991	841
Min Old Cutters Fire Flow (gpm)	1040	995	995	995	1040	980	995	995	980	N/A	N/A	1040	990	914
No. >2000 gpm to <2000 gpm	0	17	17	17	0	16	16	17	16	0	0	0	Not Analyzed	Not Analyzed
No. >1500 gpm to <1500 gpm	0	5	5	5	0	5	5	5	5	0	0	0	-	-
No. >1000 gpm to <1000 gpm	0	3	3	3	0	4	4	3	4	0	0	0	-	-
No. >1500 gpm to <1000 gpm	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Avg. gpm Change	0	-61	-61	-61	0	-63	-63	-61	-63	0	0	0	-	-
Total FF Junctions Decreased	0	217	217	217	0	217	217	217	217	0	0	0	-	-
Max Decrease	0	-622	-622	-622	0	-633	-633	-622	-633	0	0	0	-	-
No. Decreased >500 gpm	0	11	11	11	0	10	10	11	10	0	0	0	-	-
No. Decreased 250-499 gpm	0	51	51	51	0	54	54	51	54	0	0	0	-	-
No. Decreased 100-249 gpm	0	80	80	80	0	83	83	80	83	0	0	0	-	-
No. Decreased 0-100 gpm	0	75	75	75	0	70	70	75	70	0	0	0	-	-

Alternative Title	New Source													Turbine Pump
Alternative No.	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	4k	4l	4m	5
Description	New Sunbeam Well near Carbonate St	New 2-IT Ranch Well	New Northridge Well near W Meadows Dr	New Sunbeam Well w/ 3 Check Valves	New 2-IT Ranch Well w/ 3 Check Valves	New NR Well w/3 Check Valves	New NR Well w/4 Check Valves	New NR Well w/1 Check Valve	New Sunbeam Well w/1 Check Valve	New Sunbeam Well + New PZ	New 2-IT Ranch Well + New PZ	New Sunbeam Well + New PZ + NRBPS Ctrl Mod	New 2-IT Ranch Well + New PZ + NRBPS Ctrl Mod	New BPS new Indian Creek & Buttercup
NRBPS East Pmp	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	On	On	Off
NRBPS West Pump	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	On	Off	Off
New Pmp?	1	1	1	1	1	1	1	1	1	1	1	1	1	2
New Source?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Check Valves in NR/OC?	No	No	No	3	3	3	4	1	1	7	7	7	7	No
NRBPS Pressure (psi)	65	67	67	65	66	67	65	68	65	66	95	85	100	53
Min NR Res Pressure (psi)	40	46	49	40	47	50	58	56	40	41	69	57	74	32
Min Old Cutters Pressure (psi)	42	43	44	42	41	42	41	43	42	43	71	60	74	33
Change vs Baseline (Min NR psi)	9	15	18	9	16	19	27	25	9	10	38	26	43	1
Cost Estimate?	Y	Y	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	N
Min NR Fire Flow (gpm)	1052	1052	1052	1080	1080	1080	1083	1052	1052	1083	1083	1083	1083	1052
Min Old Cutters Fire Flow (gpm)	1040	1040	1040	980	980	980	995	1040	1040	995	995	995	995	1040
No. >2000 gpm to <2000 gpm	0	0	0	16	16	16	16	0	0	17	17	17	17	0
No. >1500 gpm to <1500 gpm	0	0	0	5	5	5	5	0	0	5	5	5	5	0
No. >1000 gpm to <1000 gpm	0	0	0	4	4	4	4	0	0	3	3	3	3	0
No. >1500 gpm to <1000 gpm	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avg. gpm Change	0	0	0	-63	-63	-63	-63	0	0	-61	-61	-61	-61	0
Total FF Junctions Decreased	0	0	0	217	217	217	217	0	0	217	217	217	217	0
Max Decrease	0	0	0	-633	-633	-633	-633	0	0	-622	-622	-622	-622	0
No. Decreased >500 gpm	0	0	0	10	10	10	10	0	0	11	11	11	11	0
No. Decreased 250-499 gpm	0	0	0	54	54	54	54	0	0	51	51	51	51	0
No. Decreased 100-249 gpm	0	0	0	83	83	83	83	0	0	80	80	80	80	0
No. Decreased 0-100 gpm	0	0	0	70	70	70	70	0	0	75	75	75	75	0

APPENDIX B

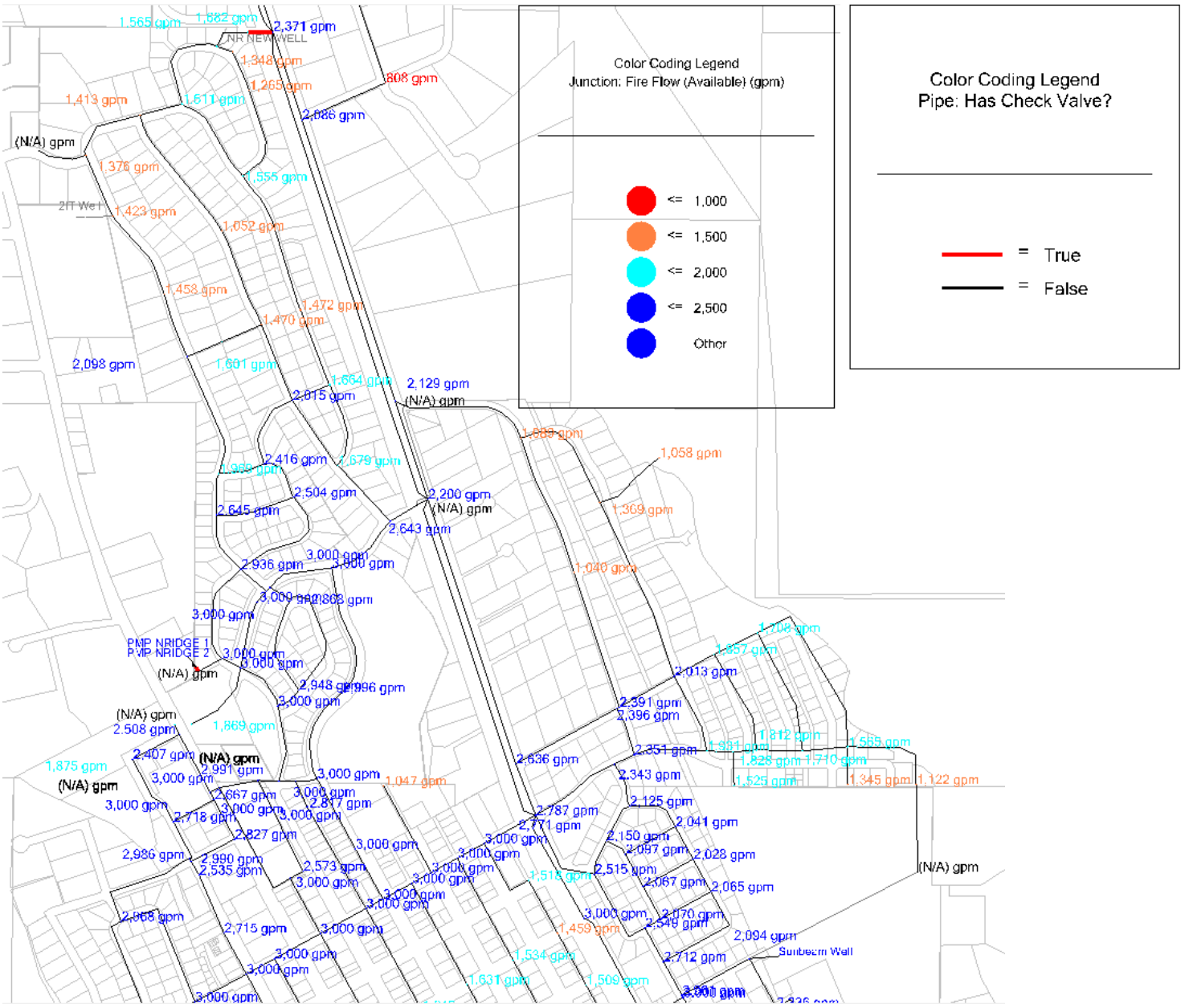
SIMULATED AVAILABLE FIRE FLOW MODELING RESULTS

BASELINE SIMULATED AVIALABLE FIRE FLOW



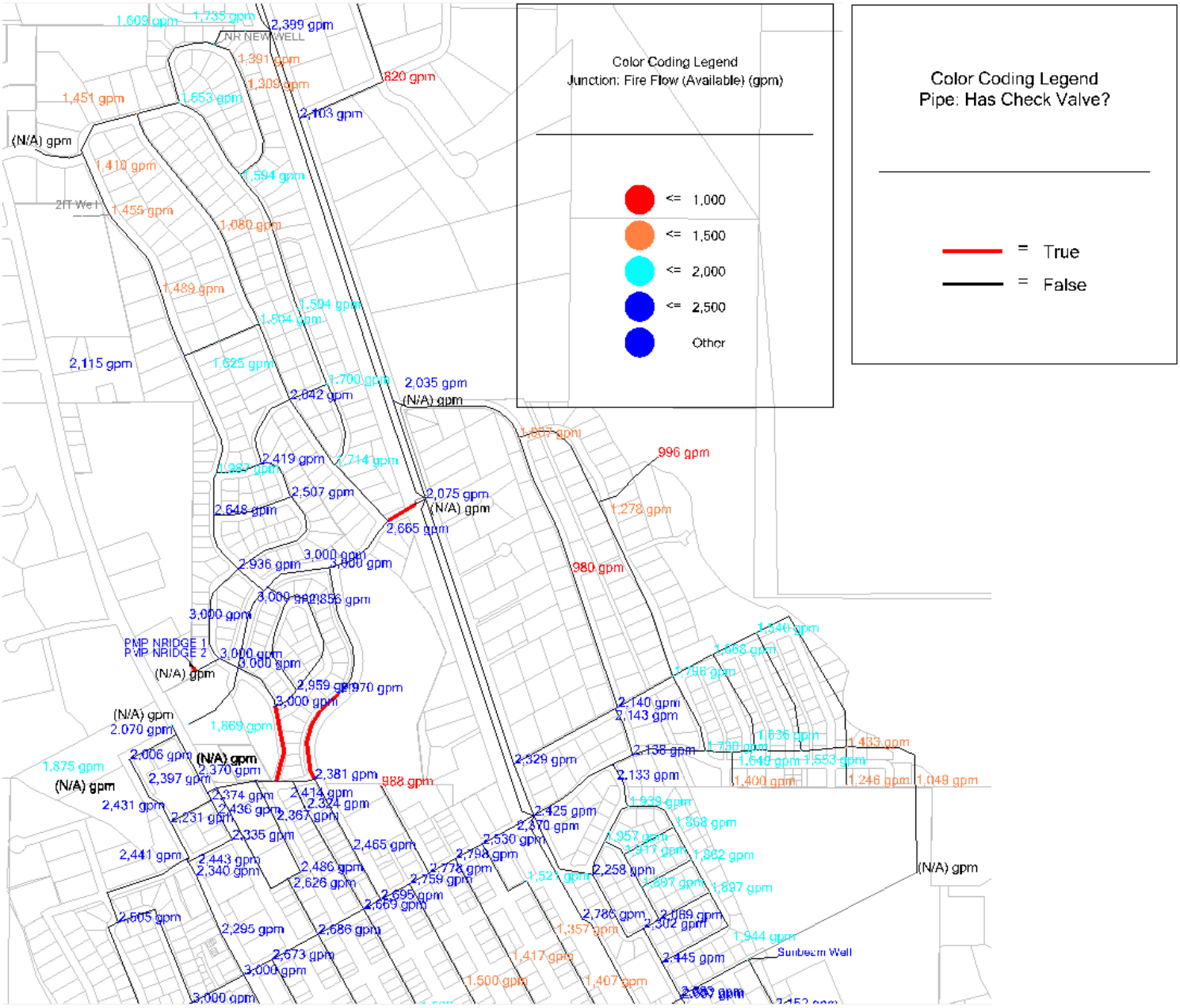
1 CHECK VALVE

SIMULATED AVIALABLE FIRE FLOW



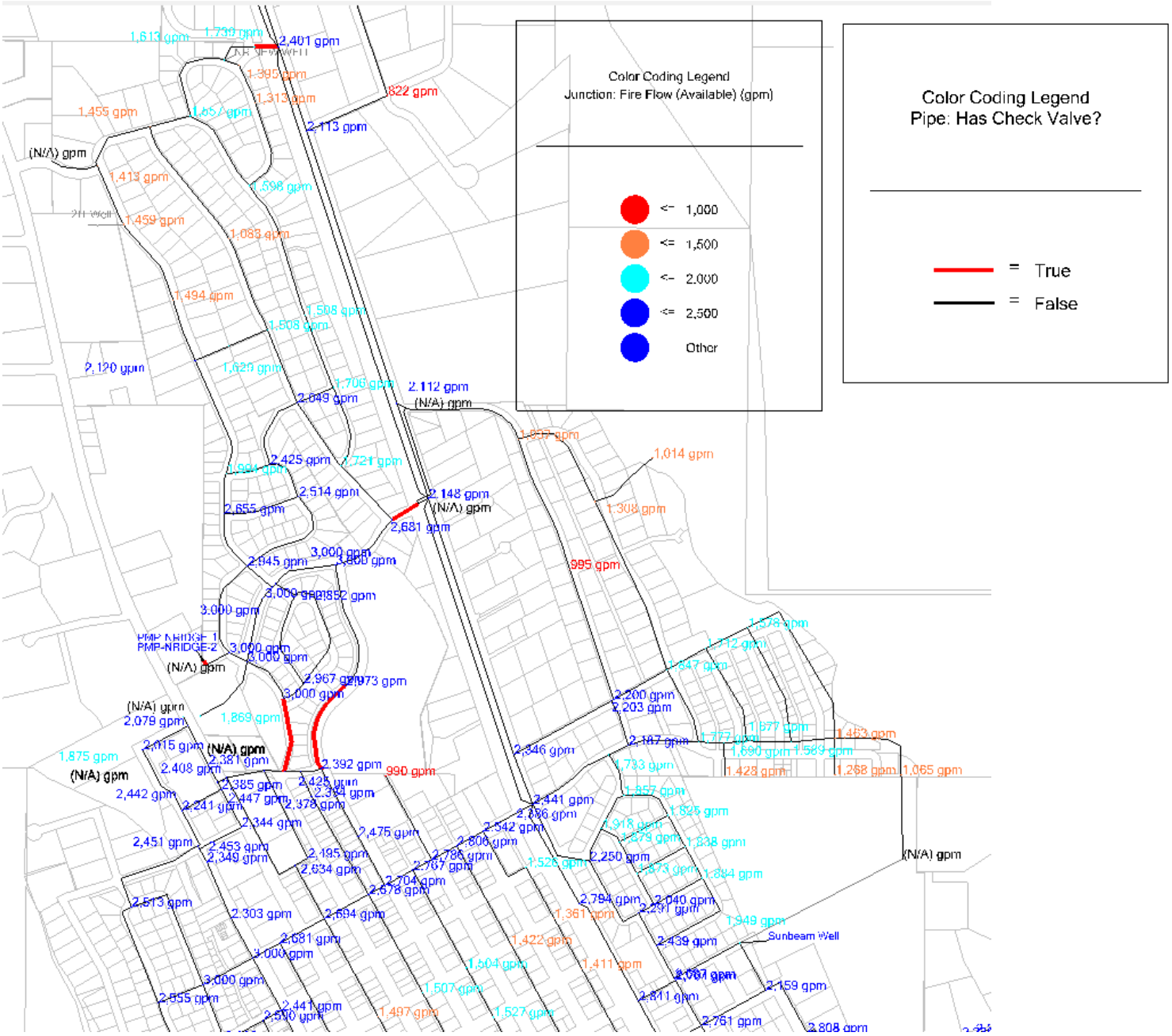
3 CHECK VALVES

SIMULATED AVIALABLE FIRE FLOW



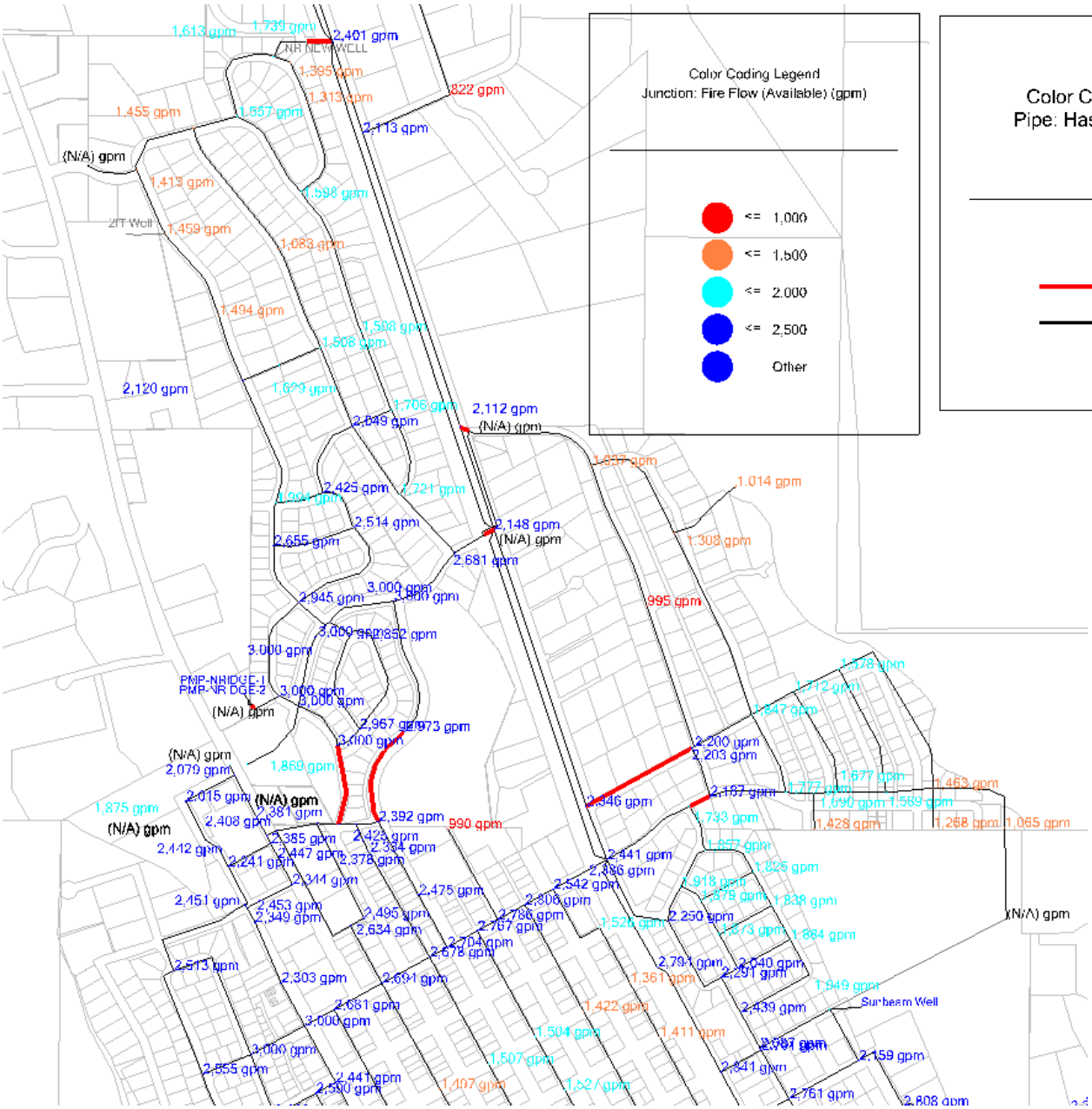
4 CHECK VALVES

SIMULATED AVIALABLE FIRE FLOW



7 CHECK VALVES

SIMULATED AVIALABLE FIRE FLOW



SPF WATER ENGINEERING

TECHNICAL MEMORANDUM

DATE: January 29, 2020

TO: Brian Yeager, P.E., P.L.S., City of Hailey

FROM: Scott McGourty, P.E., SPF,

CC: Mike Boeck, P.E., SPF

PROJECT NO: 330.0351

RE: Part 4: Northridge Area Pressure Study – Recommended Improvements

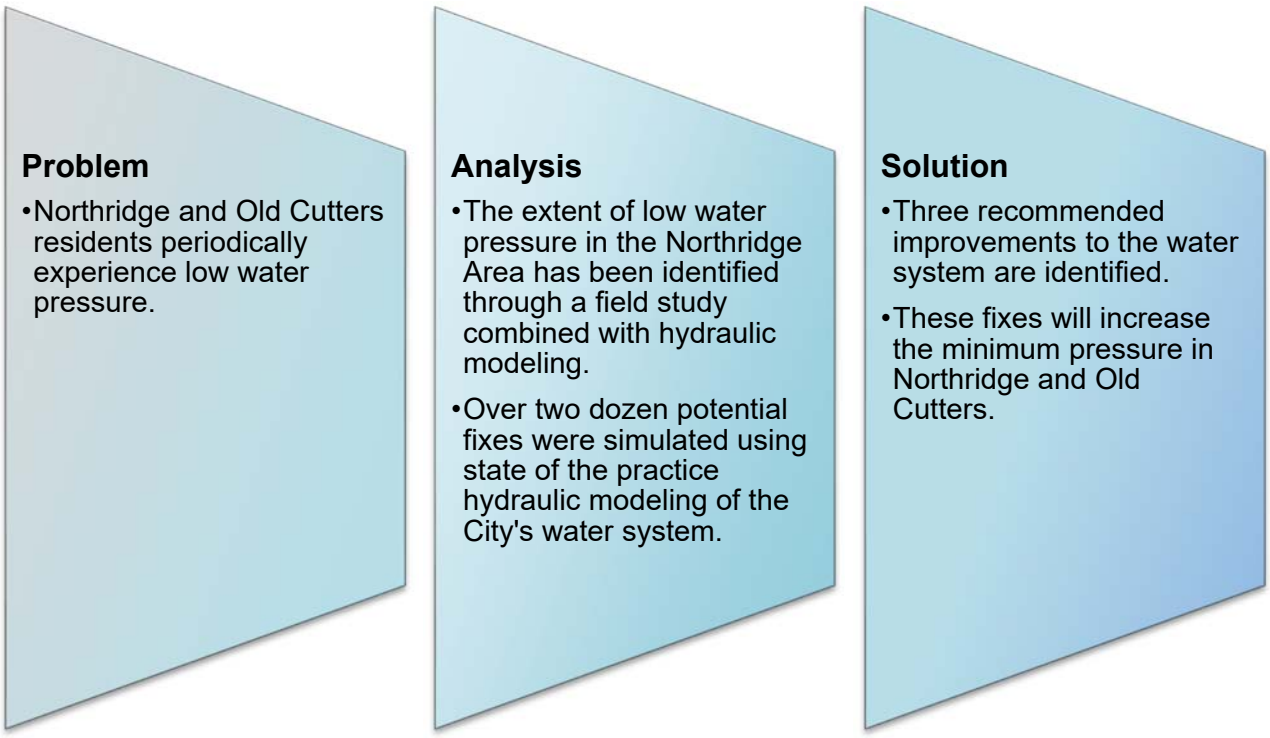
---

The City of Hailey, Idaho (the City) has commissioned a study of water pressures in the City's water distribution system, with a specific geographic focus on the Northridge and Old Cutters areas (the Study Area). The study process is summarized in Figure 1.

SPF Water Engineering (SPF) has identified three recommended modifications to the City's water system, which are designed to increase minimum water pressure in the Northridge and Old Cutters area. This memo presents four key findings resulting from the pressure study (SPF, 2019 a/b/c), which form the basis for recommended solutions. This memo summarizes the extent and causes of low pressure in the subject area, and provides recommendations for implementing solutions.

Figure 1

Summary of Northridge Area Water Pressure Study



What is the extent of the low-pressure issue in the Northridge Area?

The first goal of the Northridge pressure study was to identify the lowest pressure that residential customers are likely to experience, and the geographic extent of low-pressure problems within the Study Area.

The pressure study identified two worst-case conditions that periodically arise in the Study Area (Table 1). Hydraulic modeling of worst-case conditions indicates that pressures can fall as low as 32 psi at service locations at the highest elevation in Northridge (near Kintail Lane and W Meadows Dr). According to historic water system data, these minimum pressures are seasonal, with the lowest pressures occurring in the evening sporadically between June and August when residential irrigation water demand is at its highest. The minimum pressure required for public drinking water systems is 40 psi. The lowest pressures occur in the northeast corner of the Study Area, although pressures likely also have the potential to fall below 40 psi on 2nd Ave, Northridge Dr., and Heroic Rd., north of Bluff Dr., as well as along S Hiawatha Dr., and Olena Ln.

The steps involved in the study are summarized as follows:

- **Review of Historic City Water System Data:** Review of the City's water system performance from July 1, 2016 to October 2, 2019, including pressures at booster pumps near the Study Area, tank levels, and flow rates from production wells.
- **Field Monitoring of System Pressures**: Field monitoring at residential locations from August 13, 2019 to September 4, 2019 via pressure transducers temporarily installed in the water service lines at eight locations in the Study Area.
- **Hydraulic Model Calibration**: The City maintains a hydraulic model of the pipes, tanks, pumps, and other equipment that comprises the water distribution system. Updates were made to the computer model of the city-wide water system to match data from the field monitoring effort and historic water system data.
- **Simulation of "Worst-Case" Low Pressure**: The calibrated model was run to simulate the theoretical minimum pressure at residential locations. Two low-pressure scenarios were identified. These "worst-case" scenarios refer to minimum pressures that may occur during normal system operation. The worst-case pressure was estimated to be 55 psi at the Northridge Booster Pump Station (NRBPS) and 32 psi at the highest elevation locations in the Study Area.

Why has the Northridge Area experienced low water pressure?

The City's water system was evaluated using hydraulic modeling software to identify which water system conditions result in the lowest system pressures in the Study Area. Two scenarios were identified that result in low pressures in the study area:

- Condition #1– This occurs when both River St and Northridge Pump Stations are off, and the system demands are equal to 70-75% of peak hour demand (PHD). This condition was identified in the hydraulic model by reproducing the lowest pressure seen in the SCADA data at Northridge BPS as (55 psi on July 10th 2019) and observing how low the corresponding pressures at the service locations dropped (32 psi at the highest elevations in the Study Area). Condition #1 results from an increase in water demand

from irrigation systems that occur before tank levels drop and Northridge and River Street pumps turn on. As a compounding factor, the Northridge booster pump station is controlled by the water level in Turbine Tank. As a result, quick changes in demand can drop pressures in the Study Area while the Northridge pump station is off due to high water levels in Turbine Tank (Table 1).

- Condition #2 – This occurs after water levels in Turbine Tank have dropped low enough to activate the Northridge and River Street pumps, but demand continues to increase. This situation occurs during the very highest demand days in the peak of the irrigation season (>80% PHD). During these periods, pressures at Northridge pump station are moderately high, but pressures at the service locations diverge more from pressures at Northridge pump station (some service locations drop to as low as 36 psi).

Table 1

Conditions Resulting in Low Water Pressure in Northridge & Old Cutters

Water System Status	Condition 1	Condition 2
Turbine Tank Level (ft)	>11	<10.5
Northridge Pump Station	OFF	ON
River St Pump Station	OFF	ON
3rd Ave Pump Station	OFF	ON
Woodside Pump Station	ON	ON
Water Demand	<75% PHD	>80% PHD
Min. Pressure in Study Area	32 psi	36 psi
Min. NRBPS Pressure	55 psi	69 psi

The circumstances of Condition 2 are not directly visible in the system data due to two factors:

- During the field study period, the lowest pressures observed at the service locations occurred when the pumps were off (it may be the case that later in the irrigation season demands do not continue to extend higher after pumps are on).
- Historic system pressure data did not provide information on how pressures at the service locations behave when pressures at the pump station are high (they were recorded prior to installation of pressure loggers at the service locations); however, this is the only dataset gathered during the highest demand periods.

The lowest pressures that occur in the Study Area result from Condition 1, however Condition 2 occurs more frequently.

Key Finding #1: Under the current system configuration, high tank levels can occasionally prevent key pumps from turning on soon enough.

Key Finding #2: During the highest peak demand, pressures continue to drop in Northridge even with the Northridge and River Street pumps on.

What is the solution for increasing pressure in the Northridge Area?

SPF recommends three improvements; 1) change the pump controls at two nearby pump stations to activate sooner (Alternative 2C), 2) construct approximately 375-LF of new 16-inch pipeline in W Meadows Drive from Buttercup Road to Kintail Lane (Alternative 6A), and 3) construct a new water supply source (Alternative 4). SPF also understands that the City is currently upgrading the existing pump at the River Street wellhouse, which will improve pressures in the Study Area.

A total of twenty-eight potential alternatives were evaluated, broadly grouped into the following categories; creation of new pressure zones, changing pump operating criteria, new booster pump stations, new pipelines, and new water supply sources. Alternatives were evaluated based on effectiveness in increasing pressures in Northridge and Old Cutters, safety in providing fire flow, estimated capital cost, and estimated project timeline (SPF, 2019c).

Previous attempts to improve the controls at the Northridge pump station resulted in overflows at Turbine Tank, which is likely because the pump operating criterion was not able to account for whether system demand was high or low (see Key Findings 3 & 4). Additionally, previous system changes have not included changes to the River Street pump controls. SPF has identified a more complex controls adjustment (summarized below), which should significantly reduce overflow risk at Turbine Tank and includes two pump stations.

- Alternative 2C – Modify operating criteria of the Northridge and River Street booster pump stations to activate pumps based on two criteria:
    i. Pumps ON if Northridge pump station pressure is low, even if Turbine Tank levels are relatively high (but less than overflow level)
    ii. Pumps OFF if the Turbine Tank water level is near overflow level

The feasibility of using pressure criteria for the Northridge and River Street pump stations is explained by two factors:

- Key Finding #3: Pressure at the Northridge pump station is highly sensitive to system demand from the Northridge area due to its physical proximity, and thus a good proxy for when pumps should be turned on.
- Key Finding #4: The large topographic elevation difference between the Northridge and Old Cutters areas compared to the elevation of the Turbine Tank pad (50 psi of elevation head) means that pumps can be turned on during high demand conditions (low pressure in the Study Area) without overflowing Turbine Tank because the hydraulic grade line (HGL) in the Study Area with pumps on is still lower than the Turbine Tank overflow level. It is during low demand conditions (high HGL in the Study Area/high pressure at Northridge pump station) that turning pumps on can cause Turbine Tank to overflow.

In summary, the City can address low pressure Condition 1 by implementing new operating criteria that are more responsive to pressures at the residences in Northridge and Old Cutters without increasing the risk of overflow at Turbine Tank.

Hydraulic modeling indicates that a combination of the City's new pump at River Street and construction of a new 16-inch pipeline in W Meadows Drive (Alternative 6A) can increase the minimum pressures that occur in the Study Area as a result of Condition 2 from 36 psi to 45 psi. The engineer's opinion of probable cost for Alternative 6A is approximately $110,000.

As demands continue to increase due to future development, the City will also need a new water supply source to meet maximum day demands (Alternative 4).

Simulated results of changes to the Northridge and River Street pump controls, the upgrade to the River Street pump, and construction of the new pipeline are presented in Figure 2.

Implementation Recommendations

The pump control criteria (i) and (ii) may need to be fine-tuned based on observed results. Additionally, the lead-time for permitting and design of a new water supply well (Alternative 4) is approximately 2 years. SPF recommends the following schedule for implementing Alternatives 2C, 4, and 6A:

- Implement Alternative 2C during the winter or early spring 2020
- Construct the Alternative 6A pipeline during the summer 2020
- Monitor the results of Alternatives 2C and 6A during the 2020 irrigation season
- Evaluate the system data gathered over the 2020 irrigation season and update the Northridge Pressure Study Report in winter 2020
- Begin a siting study and permitting for the new Alternative 4 well in spring 2020 with a goal of completing construction by 2022. The Northridge Pressure Study evaluated several potential locations for a new supply well as iterations of Alternative 4, but does not make a final location recommendation. The location of the future well should be selected after consideration of which areas of the City are likely to experience greatest water supply and pressure deficits based on anticipated urban growth over the next several years, as well as the hydrogeologic areas indicative of acceptable quality groundwater.

Other Consderations

The water system improvements recommended as a result of this study if implemented by the City will increase pressures within the Study Area up to the point of service connection at the City's public water system. However, other factors on the private side of the service connection will also impact pressures experienced by customers at the point of use. If higher pressures at the point of use are desired by customers after the recommendations of the study are implemented, exploration of other factors on the private side of the service connection may also be required. These factors include:

- Construction of larger diameter private water service lines
- Installation of larger water service meter or higher capacity type
- Evaluation of lower headlosses irrigation sprinkler heads or potable water fixtures
- Optimization of sprinkler zone size and/or irrigation watering schedule, for example: reconfigure with smaller zones, or scheduling sprinklers outside of peak domestic use windows on scheduled watering days (avoid 6am-10am, and 6pm-1am).

Refereneces

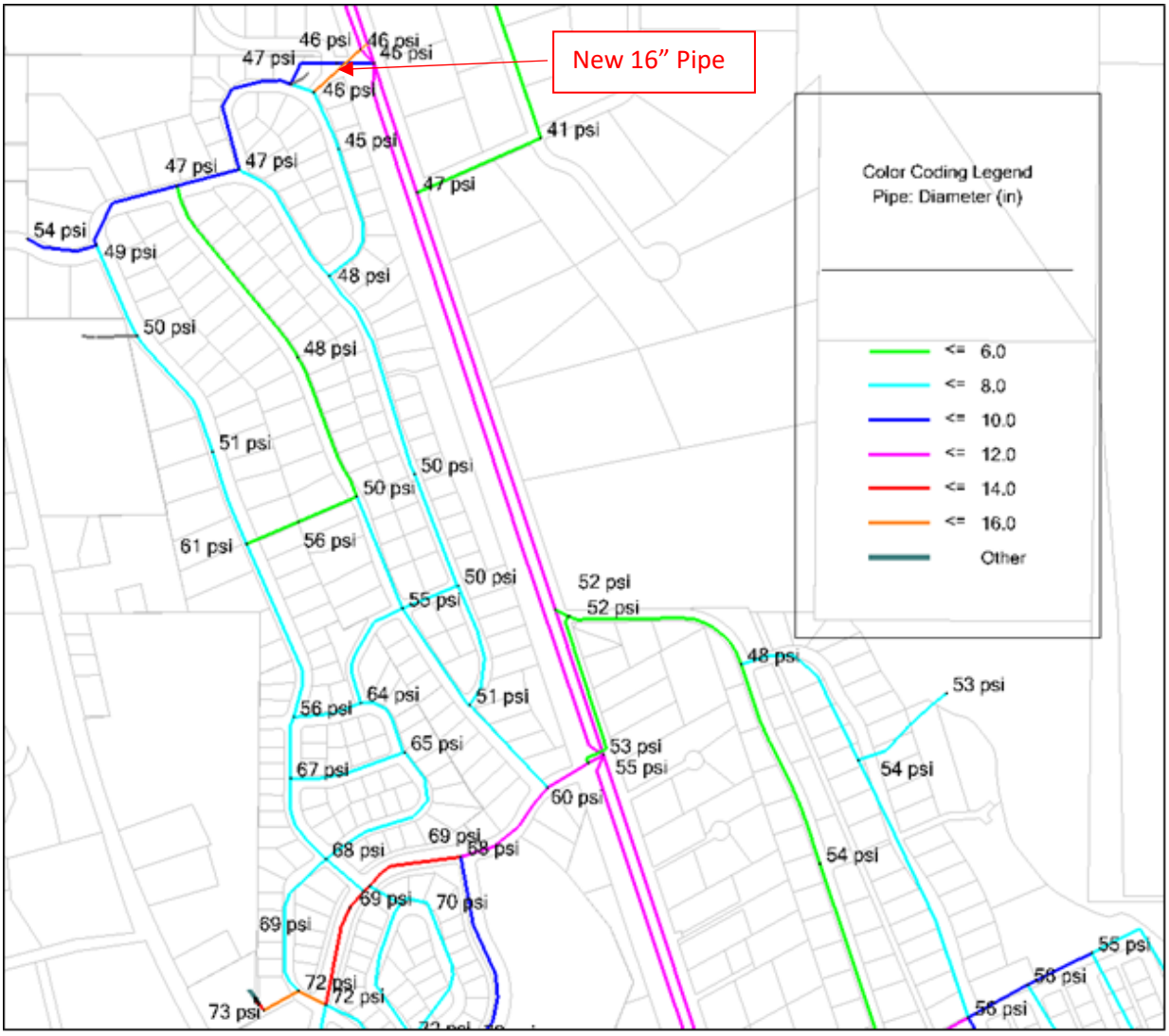
SPF, 2019a. Draft Northridge Area Pressure Study – Field Data Review. Prepared for the City of Hailey, October 2019.

SPF, 2019b. Draft Northridge Area Pressure Study – Hydraulic Model Calibration. Prepared for the City of Hailey, October 2019.

SPF, 2019c. Draft Northridge Area Pressure Study – Conceptual Improvement Alternatives. Prepared for the City of Hailey, December 2019.

Figure 2

Alternatives 2C/6A & River Street Upgrades - Hydraulic Modeling Results



Note: Figure 2 presents the results of modeling 100% of Peak Hour Demand with both Northridge pumps on, the new River Street pump on, and a new 16-inch pipe in W Meadows Dr.