FOR REVIEW

MINTURN NORTH PUD
WATER SYSTEM ANALYSIS

Prepared for:

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Minturn Crossing, LLC

Prepared by:

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Wright Water Engineers, Inc.

November 2022
Job No. 191-093.050

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1.0 INTRODUCTION

Wright Water Engineers, Inc. (WWE) has prepared this report to discuss the hydraulic model created to evaluate the proposed water system for the Minturn North Planned Unit Development (PUD) (Project) near Minturn, Colorado. The Minturn North PUD is located on the north side of Minturn between Taylor Street and Minturn Road and is planned to provide developable lots available for purchase by private entities. No construction of actual residential or multi-family units will be completed as part of the initial Project. WWE was retained by Rick Hermes of Minturn Crossing, LLC (Developer) to perform this hydraulic modeling water system analysis (Study).

Information developed in this report is based on information provided by Developer and civil engineer, Boundaries Unlimited (Civil Engineer). Civil design drawings are provided in the appendices for reference. This report was developed based on information supplied as of November 20, 2022.

2.0 PURPOSE

The purpose of this Study is to evaluate the proposed water system to serve the Minturn North PUD. The Study includes a review of portions of the existing water system which will supply the proposed system. A hydraulic model was created to evaluate the performance of both the existing and the proposed water systems during various demand scenarios including fire flow conditions. The scope of work for this Study included modeling the water system at the Minturn North PUD only, and not the entire Town of Minturn water system. A hydraulic model was created using EPANET, a software application developed by the United States Environmental Protection Agency's Water Supply and Water Resources Division for modeling water distribution systems.

3.0 STUDY AREA

The Study Area includes the existing 74 units along Taylor Street currently served by the Town of Minturn's water distribution system as well as the proposed 72 units included in the Minturn North PUD. Six of the existing units are part of mobile home park that will be removed as part of this Project. The Minturn North PUD is located on the north side of Minturn between Taylor

Street and Minturn Road. The proposed Project will develop 39 total lots requiring water service. There are two different categories of lots. A total of 33 lots will be standard single family home residential lots with 2 SFE per lot. These lots will be limited to 6,000 square feet homes. There are 6 deed restricted units which will only have one SFE per lot. These lots will be limited to 3,000 square feet homes. There is a total of 72 proposed residential SFE. The Project includes an additional 4 SFE to account for irrigation of up to 10,000 square feet of common area throughout the development. See Figure 1: Location and Vicinity Map, and Figure 2: Water System Map attached to the end of this report for additional information.

The Study Area is served by an existing pipeline along Taylor Street reported to be 8-inch diameter per the Water System Map published by the Town of Minturn. In an email to WWE on September 16, 2020, John Volk of Water Quality Control Professionals, LLC (WQCP) noted 12-inch water line was observed along Taylor Street during a repair at the intersection of 4th Avenue and Taylor Street. John Volk is the Operator in Responsible Charge (ORC) for the Town of Minturn water system. At this time, the extent of any existing 12-inch water line along Taylor Street is not known. The Town of Minturn did provide assumptions associated with various sections of the lines that might be a 12-inch, but due to uncertainty in this information and to be conservative in the modeling of fire flows, the existing water line in Taylor was assumed to be an 8-inch.

4.0 HYDRAULIC MODEL DEVELOPMENT

The hydraulic model was developed first by laying out the Taylor Street existing water system in the area of the Minturn North PUD and calibrating it based on field data provided by John Volk of WQCP. The existing pipe sizes and pipe alignment used in the hydraulic model are based on the Water System Map published by the Town of Minturn, see Figure 2 attached to this report. The scope of work for this Study included modeling the water system at the Minturn North PUD only, and not the entire Town of Minturn water system. The actual location, elevation, and dimensions of the existing Town of Minturn water storage tank were not incorporated into the model as the model is not intended to include the entire distribution system. Instead, the elevation of the water storage tank and the length of pipe from the water storage tank to the Minturn North

PUD were adjusted to calibrate the hydraulic model to the field measured fire hydrant flow and pressure data provided by WQCP.

Four existing fire hydrants at the Project site were tested by WQCP to determine static pressure, residual pressure at a given flow, and maximum flow capacity at a pressure of 20 pounds per square inch (psi). The Colorado Department of Public Health and Environment (CDPHE) *Design Criteria for Potable Water Systems* (2017) requires a minimum pressure of 20 psi at all points in the distribution system under all flow conditions to reduce potential contamination intrusion. The test data from the existing hydrants were used to calibrate the model for the Taylor Street existing water system. Following calibration, the model was expanded to include the proposed water system as designed by Civil Engineer to evaluate if fire flow demands could be provided by the proposed water system. Note, the hydraulic model was created using the information available at the time.

The hydraulic model was calibrated to the flow and pressure data available at the existing fire hydrants considering maximum daily demands at the existing units. According to the Town of Minturn Water System Capital Improvement Plan by SGM dated September 30, 2019 (2019 CIP), the maximum daily demand per single family equivalent (SFE) is 570 gallons per day (gpd). For efficiency, the existing 68 units were divided into 6 areas, with each area being a single demand point. The maximum daily demand for each area was calculated by multiplying the number of units in an area by the maximum daily demand per SFE. For the purposes of this evaluation and since more detailed development information is not available, each unit's water demand is assumed to be 1 SFE.

Once the existing water system hydraulic model was calibrated, the proposed water system for the Minturn North PUD was added to the model. The proposed pipe sizes and pipe alignment used in the hydraulic model are based on the design plans by Civil Engineer. Consistent with the existing system model, the proposed water system was divided into areas containing multiple units and assigned a single demand point. The total number of SFEs for the development is 144, which includes both existing and proposed SFEs. The demand for each proposed area was calculated by multiplying the number of SFE by the maximum daily demand per SFE of 570 gpd. See Figure 2: Water System Map attached to the end of this report for the location of each existing

and proposed areas. See below for a summary of the demands assigned to each area in the hydraulic model.

Table 1. Existing Areas – Maximum Daily Demand

Existing Area #	# of SFE	Unit Demand (gpd)	Total Demand (gpd)	Total Demand (gpm)
1	28	570	15,960	11.1
2	6	570	3,420	2.4
3	8	570	4,560	3.2
4	8	570	4,560	3.2
5	8	570	4,560	3.2
6	10	570	5,700	4.0

Table 2. Proposed Areas – Maximum Daily Demand

Proposed Area #	# of SFE	Unit Demand (gpd)	Total Demand (gpd)	Total Demand (gpm)
1	6	570	3,420	2.4
2	8	570	4,560	3.2
3	8	570	4,560	3.2
4	8	570	4,560	3.2
5	2	570	1,140	0.8
6	10	570	5,700	4.0
7	10	570	5,700	4.0
8	8	570	4,560	3.2
9	6	570	3,420	2.4
10	6	570	3,420	2.4
Common Area Irrigation	4	570	2,280	1.6

5.0 HYDRAULIC MODEL ASSUMPTIONS AND EXCLUSIONS

Exact elevations and sizes of existing pipelines are not known and developed based on best available information. Proposed grading and pipe alignments for the Minturn North PUD were

developed on designs by Civil Engineer. The condition of the existing pipes is not known in detail, therefore a C value of 130 for the pipe friction factor was used in the hydraulic model. The water storage tank included in the hydraulic model does not represent the actual elevation, dimensions, or location of the Town of Minturn Water Storage Tank. The parameters for the water storage tank included in the hydraulic model were adjusted to match the existing flow and pressure data reported by WQCP at the existing fire hydrants.

The hydraulic model does not provide any information on water availability or the Town's water rights, the hydraulic model is intended to provide an estimate on flow and pressure conditions only. Below is a list of the assumptions made to develop the hydraulic model.

- Existing fire hydrant elevations are based on the data provided by John Volk of Water Quality Control Professionals LLC.
- Fire hydrants are modeled with 6 feet of 6-inch diameter service line to the hydrant from the main line.
- Existing water piping elevations were set based on topographic survey data provided by Civil Engineer and an assumed pipe bury depth of 7 feet below grade.
- Proposed water piping elevations were set based on the proposed grading plan provided by Civil Engineer and an assumed pipe bury depth of 7 feet below grade.
- Pipe lengths for both the existing system and proposed system were set based on the plans by Civil Engineer.
- Both the "Existing Areas" and the "Proposed Areas" of units had maximum daily demands when analyzing fire flows. Maximum daily demands were calculated based on the maximum daily demand per single family equivalent (SFE) presented in the 2019 CIP.
- The elevations for the maximum daily demands at both "Existing Areas" and "Proposed Areas" were set to be the highest elevation adjacent to the given area based on the survey data provided by Civil Engineer.

5.1 Hydraulic Model Performance – Existing Conditions

Prior to expanding the Taylor Street existing water system model to include the proposed water system, WWE compared the model outputs to the field data available at existing fire hydrants #6, #11, #12, and #13. The field data was collected during fire hydrant testing performed on August 21, 2020 by WQCP. WQCP tested the static pressure at the fire hydrants at zero flow, the residual pressure at a flow of approximately 1,000 gallons per minute (gpm), and the maximum flow at a pressure of 20 psi. Below is a summary of the hydraulic model outputs compared to the field data at existing fire hydrants #6, #11, #12, and #13.

Table 3. Hydraulic Model Performance Summary – Existing Conditions

Existing Hydrant #6			
Parameter	Field Data	Calculated Model Value	% Difference
Static Pressure (psi)	86	88	1.9%
Residual Pressure (psi)	66	69	4.4%
Flow (gpm)	811	811	0.0%
Flow at 20 psi (gpm)	1,545	1,627	5.3%

Existing Hydrant #11			
Parameter	Field Data	Calculated Model Value	% Difference
Static Pressure (psi)	105	105	0.2%
Residual Pressure (psi)	89	94	5.9%
Flow (gpm)	936	936	0.0%
Flow at 20 psi (gpm)	2,306	2,490	8.0%

Existing Hydrant #12			
Parameter	Field Data	Calculated Model Value	% Difference
Static Pressure (psi)	113	112	0.6%
Residual Pressure (psi)	102	102	0.4%
Flow (gpm)	1,011	1,011	0.0%
Flow at 20 psi (gpm)	3,202	3,242	1.2%

Existing Hydrant #13			
Parameter	Field Data	Calculated Model Value	% Difference
Static Pressure (psi)	114	114	0.3%
Residual Pressure (psi)	103	104	0.7%
Flow (gpm)	1,023	1,023	0.0%
Flow at 20 psi (gpm)	3,258	3,340	2.5%

Based on the relatively low deviations between the Taylor Street existing water system hydraulic model and the available fire hydrant test data, WWE proceeded with further developing the model to include the proposed water system.

5.2 Fire Flow Evaluation

To determine the fire flow requirements for the Minturn North PUD, WWE reviewed and relied upon a combination of the existing documentation for fire flow requirements as presented in the Town of Minturn's Town Code (Minturn 2020) and the 2019 CIP. The following sections provide excerpts and relevant information used as the basis for WWE's determination of fire flow requirements for the hydraulic model.

5.3 International Fire Code

The 2018 version of the International Fire Code (IFC) was evaluated to determine fire flow required at fire hydrants based on construction type. It was determined based on International Building Code Building Type V-B, standard residential construction, for homes with a maximum square footage of 7,700 square feet, a minimum of 2,250 gallons per minute for 2 hours of fire flow must be met. Building Type V-B is the least restrictive building type. Design guidelines will need to be developed to meet these requirements of building type and size.

5.4 Town of Minturn's Town Code

The Town of Minturn's Town Code was used to understand the Town's requirements for fire hydrants:

"1.01 – Fire Protection: The number and location of fire hydrants in a given area must be approved by the Eagle River Fire Protection District…The Applicant shall perform all fire hydrant "flow tests." Results of flow tests shall be provided to the Town and to the Eagle River Fire Protection District." (Minturn 2020).

5.5 Town of Minturn Water System Capital Improvement Plan

The 2019 CIP provides information on the fire flow requirements for new developments on the Town's water system. The 2019 CIP references communication between SGM and Mick Woodworth of the ERFPD:

> "For this water system, SGM met with Mick Woodworth of the ERFPD on June 5, 2019. Mr. Woodworth indicated that fire flow needs for Minturn would follow the International Fire Code (IFC) – latest edition; Minturn's code matches the IFC. For fire storage requirements, target fire flows are multiplied by duration, estimated using Appendix B of the 2017 International Fire Code (IFC)."

Table 17 in the 2019 CIP lists the maximum fire flow required for the Town of Minturn at 2,250 gpm for a duration of 2 hours for an entire service area.

The hydraulic model for the combined existing and proposed water systems was run to test fire flow capability throughout the Project Area. Each hydrant in the model was evaluated with a fire flow demand of 2,250 gpm to determine if the minimum pressure requirement of 20 psi was met throughout the system. Maximum daily demands were assigned to each existing and proposed area as listed in Table 1 and Table 2. Each proposed fire hydrant was labeled with a letter to identify it when reviewing outputs from the hydraulic model. See Figure 2: Water System Map attached to the end of this report for the locations of the fire hydrants included in the tables below. Table 4 is a summary of the hydraulic model outputs with the proposed 8-inch diameter water main and an assumed existing 8-inch diameter water main along Taylor Street.

Table 4. Fire Flows at Hydrants, 8-inch Proposed Water Main

Fire Hydrant I.D.	Flow (gpm)	Pressure at Hydrant (psi)	Minimum System Pressure (psi)
Existing 6	2,250	15	15
Existing 7	2,250	34	19
Existing 8	2,250	36	28
Existing 9	2,250	45	32
Existing 11	2,250	52	35
Proposed A	2,250	22	18
Proposed B	2,250	26	18
Proposed C	2,250	32	19
Proposed D	2,250	39	22
Proposed E	2,250	37	24
Proposed F	2,250	36	29

You will see in Table 4 above that there were multiple conditions where the minimum pressure requirement of 20 psi was not met with a fire flow demand of 2,250 gpm at a given hydrant.

To increase system pressure during fire flow demands, the hydraulic model was modified to increase the proposed water main to be 10-inch diameter. Below is a summary of the hydraulic model outputs with a 10-inch diameter proposed water main and an assumed existing 8-inch diameter water main along Taylor Street.

Table 5. Fire Flows at Hydrants, 10-inch Proposed Water Main

Fire Hydrant I.D.	Flow (gpm)	Pressure at Hydrant (psi)	Minimum System Pressure (psi)
Existing 6	2,250	24	24
Existing 7	2,250	39	26
Existing 8	2,250	38	31
Existing 9	2,250	45	33
Existing 11	2,250	52	35
Proposed A	2,250	37	26
Proposed B	2,250	36	26
Proposed C	2,250	42	27
Proposed D	2,250	48	28
Proposed E	2,250	46	29
Proposed F	2,250	42	32

The model indicated increasing the size of the proposed water main to 10-inch diameter increases the system pressure available during fire flows. Considering the assumptions used when developing the hydraulic model, WWE cannot say for certain that increasing the proposed water main to 10-inch diameter will allow adequate fire flows due to the small margin between the hydraulic model output pressure (24 psi) and the minimum allowable pressure of 20 psi. Considering the hydraulic model data in Table 5, Existing Fire Hydrant #6 is the limiting factor in providing fire flows. Relying on a nearby hydrant to Existing Fire Hydrant #6 to provide a some of the required 2,250 gpm fire flow will increase the likelihood of the water system meeting the fire flow and pressure requirements.

5.6 Flow velocity analysis

High flow velocities in pipelines impact overall system performance and longevity of infrastructure. Flow velocities in excess of 10 feet per second (fps) increase the potential for damage caused by water hammer, increases the required energy to run the system due to higher head loss, and causes wear and tear on fittings and other appurtenances which increases the

potential for leaks and pipe breaks. The 2019 CIP recommends the following maximum flow velocities:

- Maximum day demand conditions: Velocity < 5 fps (ideal), 7 fps (maximum)
- Peak hour demand conditions: Velocity < 10 fps

The 2019 CIP states peak hour demand is calculated as two times the maximum daily demand. As previously discussed, the maximum daily demand per SFE for the Town of Minturn water system is 570 gpd. The peak hour demand for each area included in the hydraulic model was calculated by multiplying the number of SFE by two times the maximum daily demand per SFE, which results in a value of 1,140 gpd per SFE. Below is a summary of the peak hour demands at each area:

Table 6. Existing Areas – Peak Hour Demand

Existing Area #	# of SFE	Demand Per SFE (gpd)	Total Demand (gpd)	Total Demand (gpm)
1	28	1,140	31,920	22.2
2	6	1,140	6,840	4.8
3	8	1,140	9,120	6.3
4	8	1,140	9,120	6.3
5	8	1,140	9,120	6.3
6	10	1,140	11,400	7.9

Table 7. Proposed Areas – Peak Hour Demand

Proposed Area #	# of SFE	Demand Per SFE (gpd)	Total Demand (gpd)	Total Demand (gpm)
1	6	1,140	6,840	4.8
2	8	1,140	9,120	6.3
3	8	1,140	9,120	6.3
4	8	1,140	9,120	6.3
5	2	1,140	2,280	1.6
6	10	1,140	11,400	7.9
7	10	1,140	11,400	7.9
8	8	1,140	9,120	6.3
9	6	1,140	6,840	4.8
10	6	1,140	6,840	4.8
Common Area Irrigation	4	1,140	4,560	3.2

The hydraulic model which includes a 10-inch proposed water main was run with peak hour demands at each area to evaluate flow velocities. Refer to Figure 3 attached to this report for the hydraulic model output. In summary, flow velocities were all less than the 10 fps recommendation by SGM.

The hydraulic model which includes a 10-inch proposed water main was run with maximum daily demands at each area to evaluate flow velocities. Refer to Figure 4 attached to this report for the hydraulic model output. In summary, flow velocities were all less than the 5 fps recommendation by SGM.

In addition to the maximum flow velocity conditions recommend for the Town of Minturn water system by SGM, many municipalities require flow velocities remain less than 10 fps when fire flows are coupled with maximum daily demands. The hydraulic model was run assuming maximum daily demands at each area and fire flow at Existing Hydrant #6 as it is the limiting hydrant for the system. The hydraulic model was run at these conditions assuming a proposed 10-inch water main. Refer to Figure 5 attached to this report for the hydraulic model output

during these conditions. In summary, the model indicated a flow velocity of 15 fps at a pipe section along the existing Taylor Street water system.

6.0 CONCLUSIONS & RECOMMENDATIONS

Based on the hydraulic model analysis described above, a fire hydrant flow demand of 2,250 gpm and a minimum pressure of 20 gpm can be provided with a 10-inch proposed water main, however, fire flow and pressure cannot be provided with an 8-inch proposed water main. Flow velocities exceed 10 fps at the existing system along Taylor Street when fire flow demand is coupled with maximum day demands. The high velocity conditions at the Taylor Street existing system need to be reviewed with the Town.

This report is being developed as part of preliminary submittal for approval by the Town of Minturn. Therefore, information provided is not developed based on final design or as-built conditions. As the project progresses and additional information becomes available, WWE reserves the right to update the findings included in this report.

7.0 REFERENCES

Boundaries Unlimited – Minturn North PUD Preliminary Water System Design Drawing.

Colorado Department of Public Health and Environment (CDPHE). Design Criteria for Potable Water Systems. December 15, 2017.

Eagle River Water and Sanitation District (ERWSD). Rules and Regulations for Water and Wastewater Service. March 2019.

International Fire Code (IFC). 2018.

SGM. Town of Minturn Water System Capital Improvement Plan. September 30, 2019.

Town of Minturn. Town of Minturn's Town Code. August 26, 2020.

Town of Minturn Water System Map. Minturn, Colorado. Taylor St / Railroad Area.

Wright Water Engineers, Inc. Consumptive Use Analysis for the Minturn North PUD. January 23, 2020.

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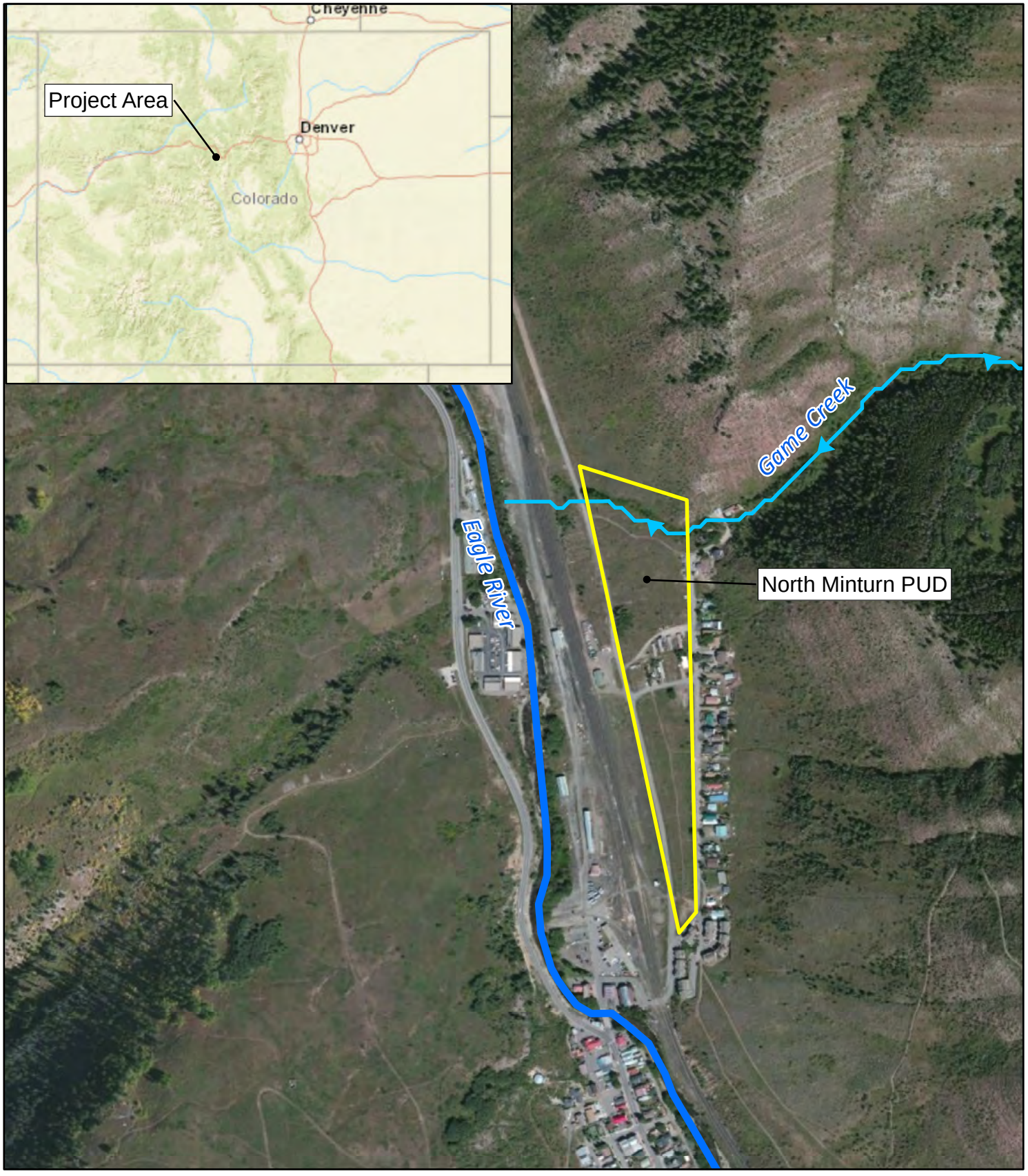
FIGURES

FIGURE 1

Location and Vicinity Map



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WRIGHT WATER ENGINEERS, INC.

MINTURN, CO

LOCATION AND VICINITY MAP

NORTH MINTURN PUD

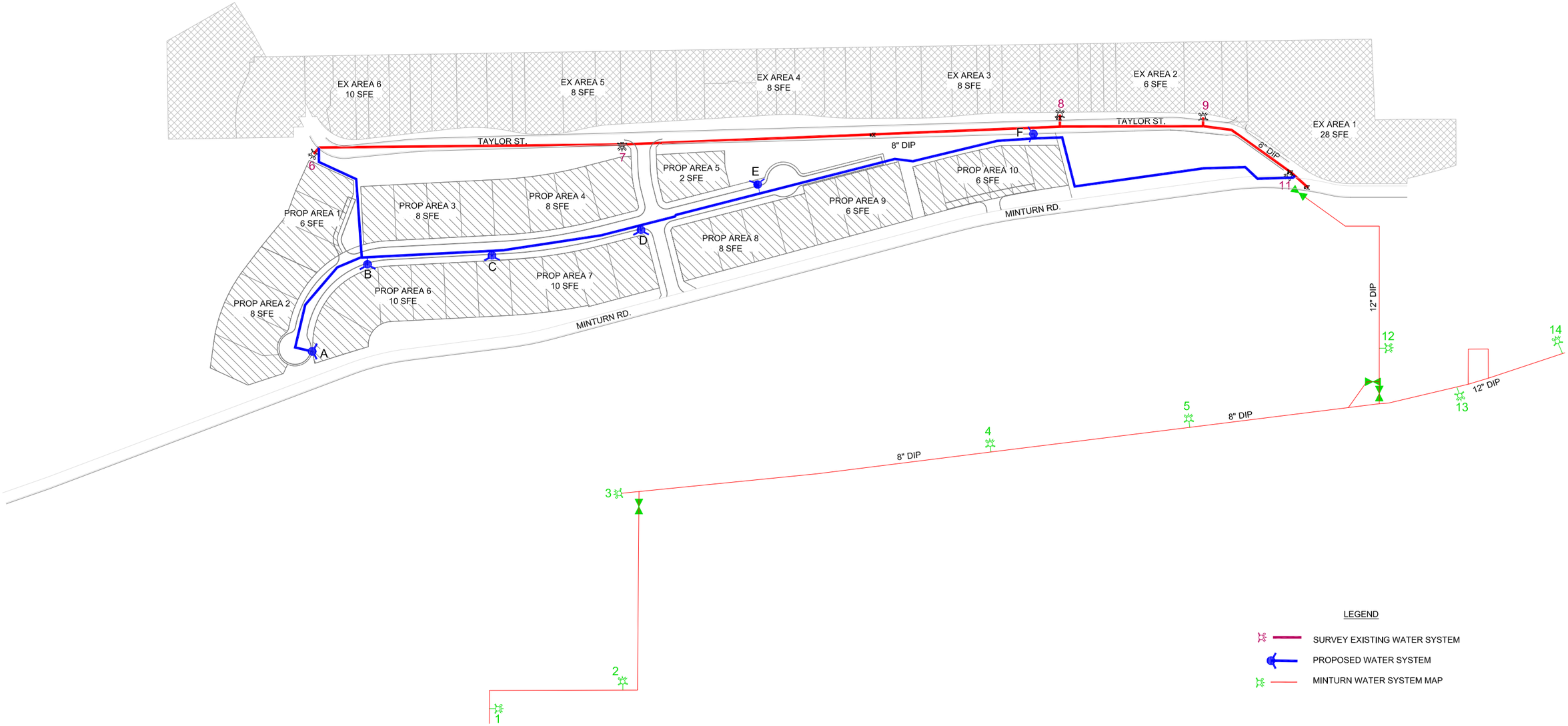
N W E S

0 330 Feet

FIGURE 1

FIGURE 2

Water System Map –Minturn North PUD



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WORK
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REVISIONS				COMMENTS
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DESIGN	ESB	XX/XX/22
DETAIL	ESB	XX/XX/22
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SCALE	SEE DRAWING	
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MINTURN NORTH PUD - WATER SYSTEM ANALYSIS

WATER SYSTEM MAP

JOB NO. 191-092.050
REVISION NO. 0
FIGURE NO. 2

Plot Date/Time: 11/22/2022, 02:39:49 PM: G:\WWE\191-092\050 - NEW PROJECT\CAD\01_DWGS\WWE-WATER SYSTEM 144 SFE.DWG-FIGURE 2

FIGURE 3

Peak Hour Demand – 10” Proposed Main

Figure 3: Peak Hour Demand - 10 inch Proposed Main

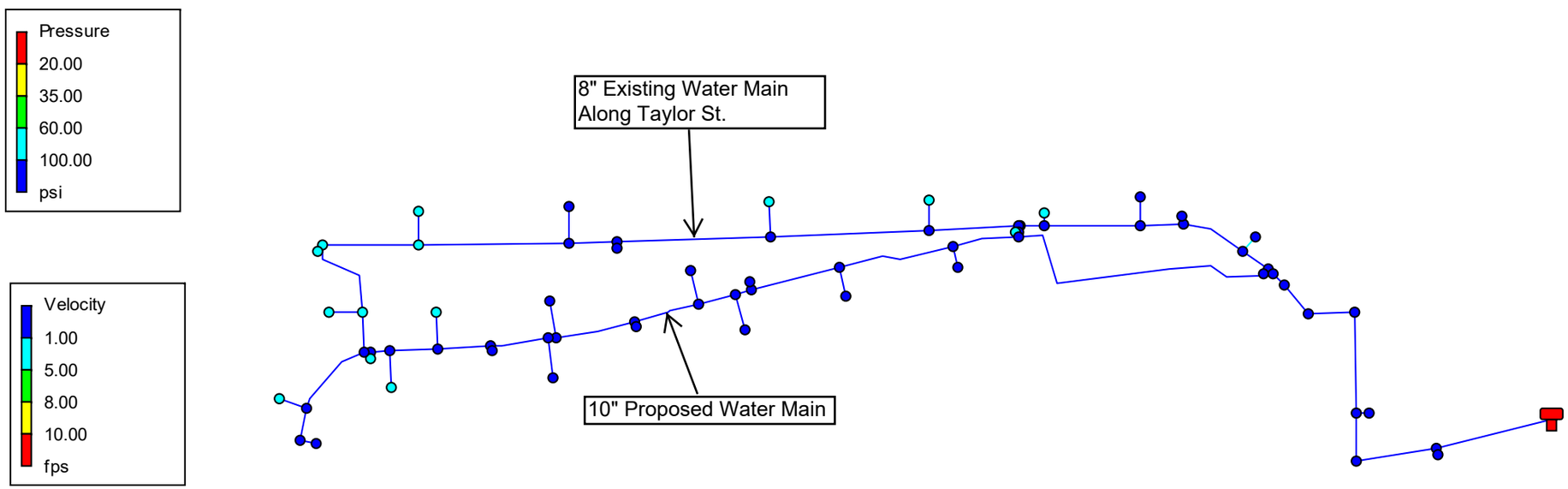


FIGURE 4

Max Day Demand – 10” Proposed Main

Figure 4: Maximum Daily Day Demand
10 inch Proposed Main

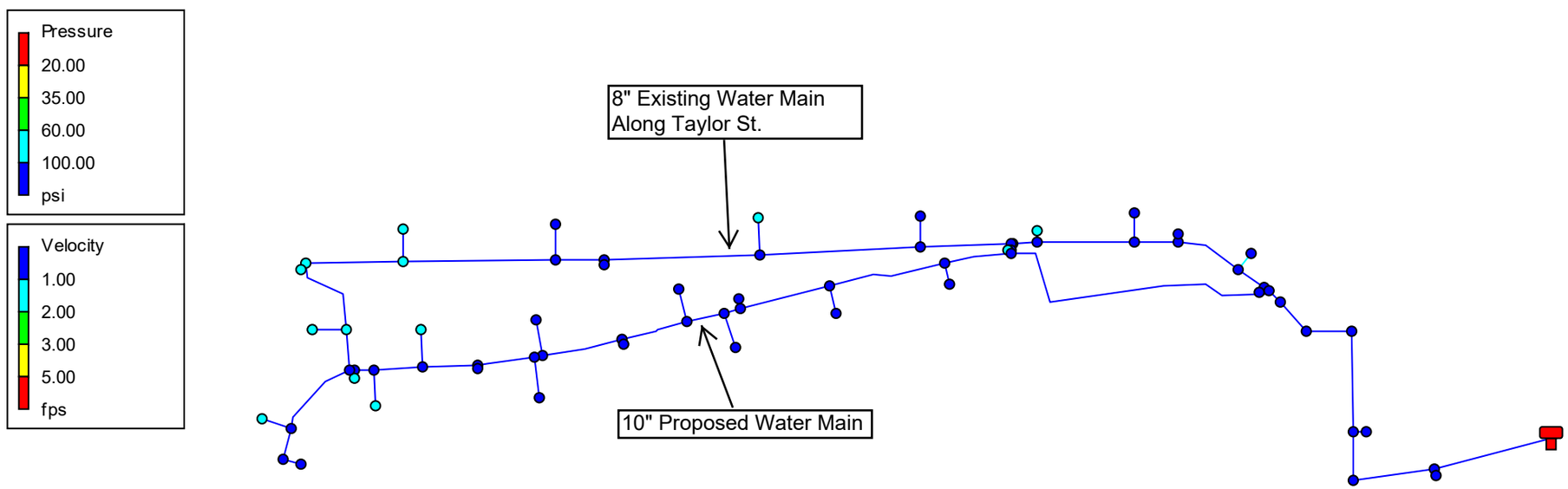
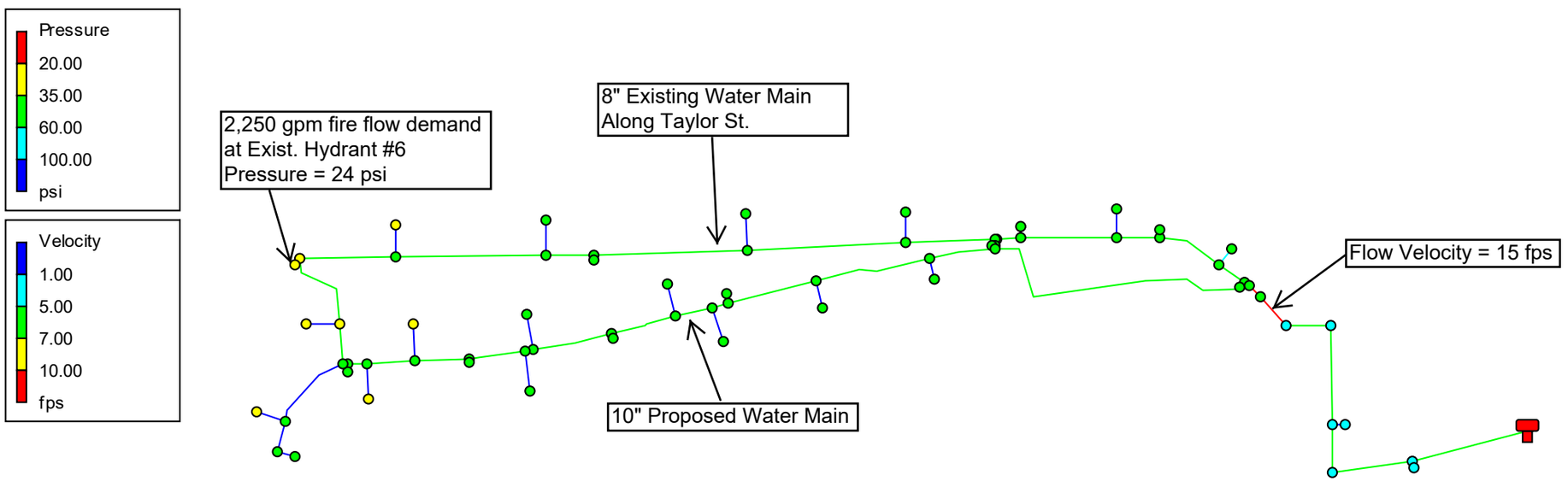


FIGURE 5

Max Day Demand & Fire Flow –

10” Proposed Main

Figure 5: Maximum Daily Day Demand +Fire Flow 10 inch Proposed Main



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