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# MEMORANDUM

**Date**: August 22, 2024

**To**: David E. Bennett, P.E., Public Works Director/City Engineer
Justin Wagner, Utilities Manager

**From**: Seth A. Peterson, P.E.

**Subject**: Northfield NW Area Hydraulic Analysis
Project No.: 0M2.128679

## 1. Background

This memorandum provides results and discussion for the City of Northfield's water distribution system model regarding developments in the north and northwest areas of the city. In addition to the previously analyzed potential industrial and residential mixed-use development areas, the city has identified an additional potential residential mixed-use development in the city's northern area. This memorandum should be read in conjunction with the Northfield NW Area Hydraulic Analysis Memorandum dated March 22, 2023 (Exhibit A), which summarizes previous modeling efforts for the northwest area.

The city's existing water distribution system model built by Bolton & Menk in 2021 using Innovyze's Infowater Pro Suite 2.0 was used for this analysis. The physical characteristics, demands and assumptions of the existing water distribution model were maintained except for the addition of the proposed north and northwest area infrastructure along with the demands from the potential development sites.

## 2. North/Northwest Area Hydraulic Analysis Development

The additional potential residential mixed-use development area is located east of Eveleth Avenue and consists of approximately 1,085 acres. Assuming 4 units per acre, 2.25 people per unit, and 116.7 gpcd, the estimated water demand for the residential mixed-use development area is 791 gpm. A peaking factor of 1.9 was used to create the residential mixed-use development maximum daily demand scenario.

In order to assess pressure and available fire flow conditions in the system with the addition of the potential development area, this analysis evaluated the required infrastructure to serve the ultimate service area, including the previously modeled industrial and residential mixed-use development areas, with a proposed water treatment plant. Figure 1 displays the layout of the distribution system with the proposed watermain diameter for the existing and ultimate service areas.

Northfield's existing water distribution system has two pressure zones: the central pressure zone that serves most of the city and a pressure zone to the northwest for the hospital. To accommodate the

additional potential residential mixed-use development area, the northwest pressure zone was extended east to near Dahomey Ave. The pressure zones were expanded even further as the ultimate service area expands to the west, northwest, east, and southeast.

The model was analyzed for average daily demand pressures, maximum daily demand pressures, and maximum daily demand available fire flows. The model scenarios were run with average daily demand simulations where HSPs at the water treatment plant are turned off, the storage tanks are nearly full, and a single jockey pump is active at booster stations to meet demand unless otherwise noted. Maximum daily demand simulations involve all HSPs actively pumping, storage tanks are half full, and the booster station jockey and fire pumps are active to represent a stressed system. The water system was examined for pressures, available fire flow, pipe flow velocities, and headloss in the distribution system.

### A. Recommended System Performance

Pressures at average daily demand should be maintained between 35 psi and 100 psi but are preferred to be maintained between 60 psi and 80 psi. Pressure should never fall below 20 psi during peak demand, as pressures below 15 psi risk collapsing the watermain as it falls below atmospheric pressure.

Recommended available fire flow is determined by the International Organization for Standardization (ISO) and varies based on building size and occupancy. The minimum recommended fire flow for residential areas is 1,000 gpm; however, dead-end watermains and small diameter watermains may not be able to achieve this flow rate. Generally, a fire flow of 3,500 gpm is considered adequate for commercial and industrial areas; however, the fire marshal and ISO should be consulted to verify the actual required fire flow for insurance purposes.

Pipe flow velocity is recommended to be maintained above 2.5 feet per second to allow adequate flushing of the watermain, but less than 10 feet per second. Headloss through watermains is recommended to be maintained below 10 feet per thousand feet of pipe; however, watermains near storage tanks and municipal wells may exceed these recommendations during peak demands.

## 3. Required Infrastructure to Serve Ultimate Service Area Model Results

The modeling scenario evaluated the required infrastructure to serve existing and ultimate service area with a proposed water treatment plant located by the existing Hall Avenue tower. The proposed infrastructure to meet the potential residential mixed-use development, in addition to previously modeled scenarios including the industrial site demand of 4,000 gpm and residential mixed-use development's maximum daily demand of 190 gpm, includes upsizing the existing booster station by the Northfield Hospital, adding a 1.0 MG water tower northwest of the Northfield Hospital, and adding a booster station southwest of the existing ground tanks.

The ultimate service area demand, including the proposed future developments modeled, exceeds the current water supply capacity available as well as proposed water treatment plant peak capacity. No new wells were modeled in this analysis, though the system would require additional supply to

meet future ultimate demand. Model results show that the proposed infrastructure is capable of, on average, supplying pressure and available fire flow to existing and ultimate service areas above recommended system performance with the proposed water treatment plant. Figure 2 provides the pressure during average daily demand conditions, and Figure 3 shows the available fire flow during maximum daily demand conditions.

The results for this modeling scenario are provided below in Table 1. Model results show that the pressure of the central zone ranged from 31 psi to 94 psi averaging 63 psi with average daily demands and ranged from 28 psi to 86 psi averaging 58 psi with maximum daily demands. Available fire flow ranged from 600 gpm to 5,000 gpm and averaged 3,400 gpm.

In the northwest zone, pressure ranged from 46 psi to 98 psi averaging 71 psi with average daily demands and ranged from 34 psi to 109 psi averaging 67 psi with maximum daily demands. Available fire flow ranged from 1,800 gpm to 5,000 gpm and averaged 4,500 gpm.

Lastly, in the southeast zone, pressure ranged from 55 psi to 111 psi averaging 89 psi with average daily demands and ranged from 67 psi to 123 psi averaging 101 psi with maximum daily demands. Available fire flow ranged from 2,200 gpm to 5,000 gpm and averaged 3,700 gpm.

**Table 1 – Overall Model Results**

| Alternative | Zone | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|---|
| **Proposed infrastructure serving existing and ultimate service area with a water treatment plant** | Central Zone | Range: 31 - 94[(1)] | Range: 28 - 86 | Range: 600 – 5,000+ |
| | | Average: 63 ± 10[(1)] | Average: 58 ± 10 | Average: 3,400 ± 1,200 |
| | Northwest Zone | Range: 46 - 98[(2)] | Range: 34 - 109 | Range: 1,800 – 5,000+ |
| | | Average: 71 ± 10[(2)] | Average: 67 ± 11 | Average: 4,500 ± 700 |
| | Southeast Zone | Range: 55 - 111[(3)] | Range: 67 - 123 | Range: 2,200 – 5,000+ |
| | | Average: 89 ± 15[(3)] | Average: 101 ± 15 | Average: 3,700 ± 800 |

[(1)] One HSP is active at the proposed water treatment plant
[(2)] Two jockey pumps are active at the proposed booster station southwest of the existing ground tanks
[(3)] One jockey pump is active at the proposed southeast booster station

Velocities and headloss throughout the distribution system pressure zones with the proposed upsized booster station, the addition of the 1 MG tower and the proposed booster station southwest of the existing ground tanks, were acceptable and mostly within the desired range. Some watermains exhibited elevated headloss during maximum daily demand simulations, but this is typical of watermains near storage tanks and pumps.

### A. Water Distribution Improvement Alternatives Capacity Summary

The following section provides a summary of the infrastructure required to provide the northwest zone with pressure and available fire flow at or above the recommended system performance under maximum day demand based on the modeled water demand. Table 2 below shows the water demand ranges and the corresponding infrastructure improvement

needs. Model results show that the existing booster station by the Northfield Hospital is capable of supplying pressure and available fire flow to the northwest zone up to a water demand of 630 gpm, as long as the two jockey pumps at the existing booster station are active.

When the northwest zone water demand exceeds 700 gpm, the existing jockey pumps at the hospital booster station need to be upsized to produce a combined flow of 1,000 gpm and fire pumps to produce a combined fire flow of 6,500 gpm. The proposed upsized booster station by Northfield Hospital can maintain pressure and available fire flow conditions up to a northwest zone water demand of 1,800 gpm.

When the northwest zone water demand exceeds 1,800 gpm, a new 1.0 MG water tower needs to be added to the system. The proposed upsized booster station by Northfield Hospital and 1.0 MG tower can maintain pressure and available fire flow conditions up to a northwest zone demand of 3,500 gpm.

Lastly, when the northwest zone water demand exceeds 3,500 gpm, a new booster station located southwest of the existing ground tanks, needs to be added to the system. The proposed booster station was modeled to produce a combined flow of 5,000 gpm, with fire pumps producing a combined fire flow of 7,000 gpm, and to fill the proposed 1.0 MG water tower. The proposed upsized booster station by Northfield Hospital, 1.0 MG tower, and the new booster station can maintain pressure and available fire flow conditions up to a northwest zone demand of 5,700 gpm.

The water demand of 5,700 gpm is the total maximum day demand modeled for the northwest zone, including existing, proposed, and ultimate service area demand and it does not represent the maximum capacity of the proposed water distribution improvements.

**Table 2 – Proposed Water Distribution Improvements Capacity Summary**

| Water Demand Range | Infrastructure Improvement Needs |
|---|---|
| 700 gpm – 1,800 gpm | Alternative 1 - Upsize jockey pumps at the existing booster station by the Northfield Hospital |
| 1,800 gpm – 3,500 gpm | Alternative 2 - Add 1.0 MG tower (In addition to Alternative 1) |
| 3,500 gpm – 5,700 gpm | Alternative 3 - Add proposed booster station located southwest of the existing ground tanks (In addition to Alternative 1 and 2) |

## 4. Proposed Improvements Cost Evaluation

The following section presents cost estimates for the water distribution improvement alternatives discussed in this memorandum. The cost opinions presented herein are meant to be used as a guideline in the decision-making process. For comparison purposes, the cost opinions consider construction and engineering services. The total estimated construction cost presented herein includes costs for mobilization, bonds and general conditions. The accuracy of these costs should be considered within +/- 20 percent of actual construction costs. Table 3 below shows the estimated costs for the water distribution improvement alternatives.

The water distribution improvement alternatives considered are:

- Alternative 1 - Upsize existing booster station by the Northfield Hospital: Upsize the existing jockey pumps to produce a combined flow of 1,000 gpm and fire pumps to produce a combined fire flow of 6,500 gpm.
- Alternative 2 - Add a 1.0 MG water tower (currently modeled northwest of the Northfield Hospital). Estimated high water level 170 ft. above ground level, 40 ft. head range.
- Alternative 3 - Add a booster station southwest of the existing ground tanks: The proposed booster station was designed to produce a combined flow of 5,000 gpm, fire pumps to produce a combined fire flow of 7,000 gpm and to be able to fill the proposed 1.0 MG water tower.

**Table 3 - Proposed Water Distribution Improvements Cost Estimate**

| Alternative | Item | Estimated Cost |
|---|---|---|
| Alternative 1 - Existing Booster Station Upgrade | Booster Station Building, Equipment, and Site Work | $600,000 |
| Alternative 2 - 1.0 MG Tank | Tower, Site Work and Utilities | $7,750,000 |
| Alternative 3 - New Booster Station | Booster Station Building, Equipment, and Site Work | $3,000,000 |

### A. Watermain Improvements Cost Evaluation

The watermain cost estimates considered DIP Class 52 for the pipe material and open cut as the installation method. The accuracy of these costs should be considered within +/- 20 percent of actual construction costs as estimated costs vary depending on conflicts with other utilities, watermain length being installed, soil conditions, traffic control measures, and other factors. Table 4 below shows the estimated costs for the proposed watermain improvements. No watermain improvements are required for Alternative 1 – Existing Booster Station Upgrade, except for the watermain extension from the Northfield Hospital to the proposed industrial site, which is included in the Alternative 2 cost estimate below.

**Table 4 - Proposed Water Distribution Improvements Cost Estimate - Watermain**

| Alternative | Route Description | Size | Estimated Length | Estimated Cost |
|---|---|---|---|---|
| Alternative 2 – 1.0 MG Tank | From Northfield Hospital to proposed water tower | 12" | 800 ft | $96,000 |
| | From Northfield Hospital to North Ave and Garret Ave intersection | 12" | 4,600 ft | $552,000 |
| | From North Ave and Garret Ave intersection to proposed industrial site | 16" | 2,800 ft | $476,000 |
| Alternative 3 – New Booster Station | From existing watermain along 5th St W to proposed booster station | 16" | 200 ft | $34,000 |
| | From proposed booster station to North Ave and Garret Ave intersection | 16" | 9,200 ft | $1,564,000 |

**LIST OF FIGURES**



**LIST OF APPENDICES**

City Of Northfield Minnesota

# NW Area Hydraulic Analysis

Northfield, Minnesota

## Figure 1 - Distribution System Layout

July 2024

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Northwest Zone

Central Zone

Southeast Zone

Mud Creek

Cannon River

Waterford

Northfield

Dundas

Prairie Creek

## Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Water Treatment Plant
- Proposed Valve

Proposed Diameter

- ≤ 2"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- 18"

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: daisy.ryan | Date Saved: 7/26/2024 10:07 AM

City Of Northfield Minnesota

# NW Area Hydraulic Analysis

Northfield, Minnesota

## Figure 2
## Average Daily Demand - Pressure

July 2024

BOLTON & MENK

Northwest Zone

Central Zone

Southeast Zone

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

WTP

### Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valve
- Watermain

Average Daily Demand - Pressure

- ≤ 30 psi
- ≤ 40 psi
- ≤ 50 psi
- ≤ 60 psi
- ≤ 70 psi
- ≤ 80 psi
- ≤ 90 psi
- ≤ 100 psi
- ≤ 110 psi

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: daisy.ryan | Date Saved: 7/26/2024 10:07 AM

Northwest Zone

Central Zone

Southeast Zone

Mud Creek

Cannon River

Waterford

Northfield

Dundas

Prairie Creek

## Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valve
- Watermain

Maximum Daily Demand - Fire Flow

- 0 - 500 gpm
- 500 - 1000 gpm
- 1000 - 1500 gpm
- 1500 - 2000 gpm
- 2000 - 2500 gpm
- 2500 - 3000 gpm
- 3000 - 3500 gpm
- 3500 + gpm

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

# Appendix A: Northfield NW Area Hydraulic Analysis Memorandum dated March 22, 2023

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# MEMORANDUM

**Date**: March 22, 2023

**To**: David E. Bennett, P.E., Public Works Director/City Engineer

Justin Wagner, Utilities Manager

**From**: Seth A. Peterson, P.E.

**Subject**: Northfield NW Area Hydraulic Analysis
Project No.: 0M2.128679

## 1. Background

This memorandum provides results and discussion for the City of Northfield's water distribution system model regarding developments in the northwest area. The city has identified a potential industrial site and a residential mixed-use development site both within the northwest area. The residential and industrial sites are located respectively at: 1) north of North Avenue and west of Eveleth Avenue; and 2) west of Garrett Avenue. The city's existing water distribution system model built by Bolton & Menk in 2021 using Innovyze's Infowater Pro Suite 2.0 was used for this analysis. The physical characteristics, demands and assumptions of the existing water distribution model were maintained except for the addition of the proposed northwest area infrastructure along with the demands from the potential development sites.

## 2. Northwest Area Hydraulic Analysis Development

In order to assess pressure and available fire flow conditions in the system with the addition of the potential development areas, this analysis evaluated four scenarios:

A. Required infrastructure to meet potential industrial site demand of 500 gpm
B. Required infrastructure to meet potential industrial site demand of 2,500 gpm
C. Required infrastructure to meet potential industrial site demand of 4,000 gpm
D. Proposed infrastructure adequacy to serve ultimate service area with a proposed water treatment plant

The infrastructure alternatives evaluated in scenarios A through C are described below. Figure 1 displays the layout of the distribution system for the three alternatives.

1. Upsize existing booster station by the Northfield Hospital
2. Add a 1 MG water tower northwest of the Northfield Hospital
3. Add a booster station southwest of the existing ground tanks

Alternative 3 consists of branching off from the existing 16-inch watermain along 5$^{th}$ Street West to a proposed booster pump station located southwest of the existing ground tanks then heading

northwest with a 16-inch line to the potential industrial site. Scenarios A through C were modeled using the city's existing supply infrastructure (wells) and Scenario D was modeled with a proposed water treatment plant located by the existing Hall Avenue tower. No new municipal wells were modeled in this analysis, though the system would require additional supply to meet future well capacity recommendation without the water treatment plant.

Correspondence with City's staff provided a general guideline to the expected demands from the potential industrial and residential mixed-use development sites within the northwest area. The industrial site demand is expected to be phased at 500 gpm, 2,500 gpm and 4,000 gpm whereas the residential mixed-use development is estimated to demand approximately 100 gpm. A peaking factor of 1.9 was used to create the residential mixed-use development maximum daily demand scenarios.

Northfield's existing water distribution system has two pressure zones: the central pressure zone that serves most of the city and a pressure zone to the northwest for the hospital. To accommodate the potential industrial development area, the northwest pressure zone was extended up to Garrett Avenue. The pressure zones were expanded even further as the ultimate service area expands to the west, northwest, east, and southeast.

The proposed expansion of the city to cover the ultimate service area requires the addition of the southeast zone, as this area has higher elevations than the current distribution system. The existing central zone cannot provide adequate pressure to the southeast zone without the installation of a booster station. The northwest, central and southeast pressure zone boundaries are included in Figure 1. The watermains leading to St. Olaf College were modeled and always show low pressure results, because St. Olaf College is a privately owned pressure zone.

The model was analyzed for average daily demand pressures, maximum daily demand pressures, and maximum daily demand available fire flows. The model scenarios were run with average daily demand simulations where all wells are turned off, the storage tanks are nearly full, and a single jockey pump is active at booster stations to meet demand unless otherwise noted. Maximum daily demand simulations involve all wells actively pumping, storage tanks are half full, and the booster station jockey and fire pumps are active to represent a stressed system. The water system was examined for pressures, available fire flow, pipe flow velocities, and headloss in the distribution system.

**A. Recommended System Performance**

Pressures at average daily demand should be maintained between 35 psi and 100 psi but are preferred to be maintained between 60 psi and 80 psi. Pressure should never fall below 20 psi during peak demand, as pressures below 15 psi risk collapsing the watermain as it falls below atmospheric pressure.

Recommended available fire flow is determined by the International Organization for Standardization (ISO) and varies based on building size and occupancy. The minimum recommended fire flow for residential areas is 1,000 gpm; however, dead-end watermains and small diameter watermains may not be able to achieve this flow rate. Generally, a fire flow of 3,500 gpm is considered adequate for commercial and industrial areas; however, the

fire marshal and ISO should be consulted to verify the actual required fire flow for insurance purposes.

Pipe flow velocity is recommended to be maintained above 2.5 feet per second to allow adequate flushing of the watermain, but less than 10 feet per second. Headloss through watermains is recommended to be maintained below 10 feet per thousand feet of pipe; however, watermains near storage tanks and municipal wells may exceed these recommendations during peak demands.

## 3. Existing System Results

City of Northfield existing system model results show that the pressure of the main central zone ranged from 37 psi to 97 psi and averaged 68 psi with average daily demands and ranged from 31 psi to 88 psi and averaged 61 psi with maximum daily demands. Available fire flow for the zone ranged from 600 gpm to 5,000+ gpm and averaged 3,400 gpm. Results are tabulated below in Table 1.

The northwest zone had pressures ranging from 74 psi to 100 psi and averaged 87 psi with average daily demand and pressures ranging from 69 psi to 95 psi and averaged 82 psi with maximum daily demands. Available fire flow ranged from 1,500 gpm to 3,300 gpm and averaged 2,200 gpm in the northwest zone. Results are included in Table 1.

**Table 1 – Existing system results**

| Zone | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|
| Central Zone | Range: 37 - 97<br>Average: 68 ±9 | Range: 31 - 88<br>Average: 61 ±10 | Range: 600 - 5,000+<br>Average: 3,400 ±1,300 |
| Northwest Zone | Range: 74 - 100<br>Average: 87 ±7 | Range: 69 - 95<br>Average: 82 ±8 | Range: 1,500 - 3,300<br>Average: 2,200 ±500 |

Velocities and headloss throughout the distribution system were acceptable and mostly within the desired range. Some watermains exhibited elevated headloss during maximum daily demand simulations, but this is typical of watermains near storage tanks and municipal wells.

## 4. Northwest Area Model Results

### A. Scenario A – Required infrastructure to meet potential industrial site demand of 500 gpm

Model results show that the existing system infrastructure is capable of supplying pressure and available fire flow to both potential development sites, as well as remaining northwest zone, above the recommended system performance, as long as the two jockey pumps are active at the existing booster station by the Northfield Hospital under average day demand.

Upsizing the existing jockey pumps by the hospital booster station to produce a combined flow of 1,000 gpm and fire pumps to produce a combined fire flow of 6,500 gpm would allow

only one jockey pump to be active while supplying pressure and available fire flow above the recommended system performance under average day demand. Figure 2 provides the pressure during average daily demand conditions, and Figure 3 shows the available fire flow during maximum daily demand conditions. Specific pressure and available fire flow results for both potential development sites are tabulated below in Table 2.

The results for Scenario A are provided below in Table 3. Model results show that the pressure of the northwest zone with existing infrastructure ranged from 46 psi to 79 psi averaging 60 psi with average daily demands and ranged from 61 psi to 89 psi averaging 75 psi with maximum daily demands. Available fire flow ranged from 1,200 gpm to 2,800 gpm and averaged 1,800 gpm in the northwest zone.

With larger pumps at the existing booster station, model results show that the pressure of the northwest zone ranged from 49 psi to 76 psi averaging 63 psi with average daily demands and ranged from 63 psi to 91 psi averaging 76 psi with maximum daily demands. Available fire flow ranged from 1,200 gpm to 3,000 gpm and averaged 1,900 gpm in the northwest zone. Results are included in Table 3.

**Table 2 – Scenario A results for potential development sites**

| Alternatives | Potential Development Site | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|---|
| **Existing system infrastructure** | Industrial | 57 | 72 | 2,000 |
| | Mixed-use Residential | 70 | 86 | 2,500 |
| **Upsize existing booster station** | Industrial | 61 | 74 | 2,100 |
| | Mixed-use Residential | 74 | 88 | 2,700 |

**Table 3 – Scenario A overall results**

| Alternatives | Zone | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|---|
| **Existing system infrastructure** | Central Zone | Range: 37 - 97 | Range: 32 - 89 | Range: 600 – 5,000+ |
| | | Average: 68 ± 10 | Average: 62 ± 11 | Average: 3,300 ± 1,300 |
| | Northwest Zone | Range: 46 – 79[(1)] | Range: 61 - 89 | Range: 1,200 - 2,800 |
| | | Average: 60 ± 8[(1)] | Average: 75 ± 9 | Average: 1,800 ± 400 |
| **Upsize existing booster station** | Central Zone | Range: 37 – 97 | Range: 32 - 89 | Range: 600 – 5,000+ |
| | | Average: 68 ± 10 | Average: 62 ± 11 | Average: 3,300 ± 1,300 |
| | Northwest Zone | Range: 49 - 76[(2)] | Range: 63 - 91 | Range: 1,200 – 3,000 |
| | | Average: 63 ± 8[(2)] | Average: 76 ± 9 | Average: 1,900 ± 500 |

[(1)] Two jockey pumps are active at the existing booster station by the Northfield Hospital
[(2)] One jockey pump is active at the upsized booster station by the Northfield Hospital

Velocities and headloss throughout the central and northwest zone distribution system with the upsized booster station were acceptable and mostly within the desired range. Some watermains exhibited elevated headloss during maximum daily demand simulations, but this is typical of watermains near storage tanks and municipal wells.

**B. Scenario B – Required infrastructure to meet potential industrial site demand of 2,500 gpm**

Model results show that the proposed upsized booster station by the Northfield Hospital is not capable of supplying pressure and available fire flow to both potential development sites above the recommended system performance, unless the proposed 1 MG tower located northwest of the Northfield Hospital is added to the system. Figure 4 provides the pressure during average daily demand conditions, and Figure 5 shows the available fire flow during maximum daily demand conditions. Specific pressure and available fire flow results for both potential development sites are tabulated below in Table 4.

The proposed upsized booster station by the Northfield Hospital can maintain pressure and available fire flow conditions above recommended system performance up to potential industrial site demand of 1,600 gpm.

The results for Scenario B are provided below in Table 5. Model results show that the pressure of the northwest zone with the proposed upsized booster station was negative with average daily demands and ranged from 2 psi to 55 psi averaging 21 psi with maximum daily demands. Available fire flow ranged from 0 gpm to 2,500 gpm and averaged 200 gpm in the northwest zone.

With the addition of the proposed 1 MG tower, in conjunction with the upsized booster station, model results show that the pressure of the northwest zone ranged from 55 psi to 86 psi averaging 73 psi with average daily demands and ranged from 52 psi to 87 psi averaging 59 psi with maximum daily demands. Available fire flow ranged from 1,800 gpm to 5,000 gpm and averaged 4,100 gpm in the northwest zone. Results are included in Table 5.

**Table 4 – Scenario B results for potential development sites**

| Alternatives | Potential Development Site | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|---|
| **Upsized existing booster station** | Industrial | Negative pressure | 2 | 2,500 |
| | Mixed-use Residential | Negative pressure | 46 | 950 |
| **Add a 1 MG water tower** | Industrial | 52 | 55 | 4,300 |
| | Mixed-use Residential | 76 | 83 | 4,600 |

| Table 5 – Scenario B overall results | | | | |
|---|---|---|---|---|
| **Alternatives** | **Zone** | **Average Daily Demand - Pressure (psi)** | **Maximum Daily Demand - Pressure (psi)** | **Maximum Daily Demand - Available Fire Flow (gpm)** |
| **Upsized existing booster station** | Central Zone | Range: 26 - 93 | Range: 13 - 87 | Range: 0 – 5,000+ |
| | | Average: 64 ± 12 | Average: 58 ± 14 | Average: 3,000 ± 1,500 |
| | Northwest Zone | Negative pressures | Range: 2 - 55 | Range: 0 - 2,500 |
| | | Negative pressures | Average: 21 ± 18 | Average: 200 ± 400 |
| **Add a 1 MG water tower** | Central Zone | Range: 37 - 98 | Range: 29 - 87 | Range: 600 – 5,000+ |
| | | Average: 69 ± 10 | Average: 61 ± 11 | Average: 3,300 ± 1,300 |
| | Northwest Zone | Range: 49 - 78 | Range: 52 - 87 | Range: 1,800 - 5,000 |
| | | Average: 67 ± 7 | Average: 59 ± 10 | Average: 4,100 ± 900 |

Velocities and headloss throughout the central and northwest zone distribution system with the proposed upsized booster station and the addition of the 1 MG tower were acceptable and mostly within the desired range. Some watermains exhibited elevated headloss during maximum daily demand simulations, but this is typical of watermains near storage tanks and municipal wells.

**C. Scenario C – Required infrastructure to meet potential industrial site demand of 4,000 gpm**

Model results show that the proposed upsized booster station by the Northfield Hospital and the proposed 1 MG tower are not capable of supplying pressure and available fire flow to the potential industrial site above the recommended system performance, unless the proposed booster station located southwest of the existing ground tanks is added to the system. The proposed booster station was designed to produce a combined flow of 5,000 gpm, fire pumps to produce a combined fire flow of 7,000 gpm and to be able to fill the proposed 1 MG water tower. Figure 6 provides the pressure during average daily demand conditions, and Figure 7 shows the available fire flow during maximum daily demand conditions. Specific pressure and available fire flow results for both potential development sites are tabulated below in Table 6.

The proposed upsized booster station by the Northfield Hospital and the proposed 1 MG tower can maintain pressure and available fire flow conditions above recommended system performance up to potential industrial site demand of 3,300 gpm.

The results for Scenario C are provided below in Table 7. Model results show that the pressure of the northwest zone with the proposed upsized booster station and proposed 1 MG tower ranged from 25 psi to 72 psi averaging 56 psi with average daily demands and ranged from 26 psi to 81 psi averaging 56 psi with maximum daily demands. Available fire flow ranged from 300 gpm to 5,000 gpm and averaged 3,400 gpm in the northwest zone.

With the addition of the proposed booster station southwest of the existing ground tanks, in conjunction with the upsized booster station and the 1 MG tower, model results show that the pressure of the northwest zone ranged from 60 psi to 100 psi averaging 77 psi with

average daily demands and ranged from 62 psi to 103 psi averaging 77 psi with maximum daily demands. Available fire flow ranged from 2,200 gpm to 5,000 gpm and averaged 4,700 gpm in the northwest zone.

Pressures above 100 psi are experienced in the low elevation area of the proposed northwest zone expansion's southern limit. It is recommended that homes and businesses within a close perimeter of the proposed booster station be built with in-home pressure reducing valves (PRVs). No new municipals wells were modeled in this scenario, though the system would require additional supply to meet future well capacity recommendation.

**Table 6 – Scenario C results for potential development sites**

| Alternatives | Potential Development Site | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|---|
| **Upsized existing booster station and 1 MG water tower** | Industrial | 25 | 27 | 4,300 |
| | Mixed-use Residential | 69 | 76 | 3,900 |
| **Add a booster station southwest of the existing ground tanks** | Industrial | 60 | 64 | 5,000+ |
| | Mixed-use Residential | 86 | 87 | 5,000+ |

**Table 7 – Scenario C overall results**

| Alternatives | Zone | Average Daily Demand - Pressure (psi) | Maximum Daily Demand - Pressure (psi) | Maximum Daily Demand - Available Fire Flow (gpm) |
|---|---|---|---|---|
| **Upsized existing booster station and 1 MG water tower** | Central Zone | Range: 37 - 97 | Range: 26 - 88 | Range: 600 – 5,000+ |
| | | Average: 68 ± 10 | Average: 61 ± 12 | Average: 3,300 ± 1,300 |
| | Northwest Zone | Range: 25 - 72 | Range: 26 - 81 | Range: 300 – 5,000 |
| | | Average: 56 ± 8 | Average: 56 ± 9 | Average: 3,400 ± 1,100 |
| **Add a booster station southwest of the existing ground tanks** | Central Zone | Range: 36 - 97 | Range: 31 - 88 | Range: 600 – 5,000+ |
| | | Average: 68 ± 10 | Average: 61 ± 11 | Average: 3,300 ± 1,300 |
| | Northwest Zone | Range: 60 – 100[(1)] | Range: 62 - 103 | Range: 2,200 - 5,000+ |
| | | Average: 77 ± 8[(1)] | Average: 77 ± 11 | Average: 4,700 ± 500 |

[(1)] Two jockey pumps are active at the proposed booster station southwest of the existing ground tanks

Velocities and headloss throughout the central and northwest zone distribution system with the proposed upsized booster station, the addition of the 1 MG tower and the proposed booster station southwest of the existing ground tanks, were acceptable and mostly within the desired range. Some watermains exhibited elevated headloss during maximum daily demand simulations, but this is typical of watermains near storage tanks and municipal wells.

## 5. Scenario D - Proposed Infrastructure Adequacy to Serve Ultimate Service Area

As previously mentioned, the ultimate service area expands to the west, northwest, east, and southeast. Commercial areas are expected to develop to the west and part of the northwest, and the remaining areas are expected to develop as residential areas. The southeast zone serves an area with a wide elevation range, and a booster station was designed to provide the high elevation areas with pressures close to the preferred pressure of 60 psi. However, this results in a low elevation area with pressures in excess of 100 psi. This low elevation area is at the very southern extent of the proposed expansion, and therefore, was not connected to the central zone. It is recommended that these homes be built with in-home PRVs.

Scenario D evaluated the proposed infrastructure adequacy to serve existing and ultimate service area with a proposed water treatment plant located by the existing Hall Avenue tower. The proposed infrastructure to meet potential industrial site demand of 4,000 gpm includes upsizing the existing booster station by the Northfield Hospital, adding a 1 MG water tower northwest of the Northfield Hospital and adding a booster station southwest of the existing ground tanks.

### A. Scenario D - Proposed Infrastructure Adequacy Model Results Scenario

Model results show that the proposed infrastructure is capable of supplying pressure and available fire flow to existing and ultimate service area above recommended system performance with the proposed water treatment plant. Figure 8 provides the pressure during average daily demand conditions, and Figure 9 shows the available fire flow during maximum daily demand conditions. Figure 10 displays the proposed watermain diameter for the existing and ultimate service areas.

The results for Scenario D are provided below in Table 8. Model results show that the pressure of the central zone ranged from 30 psi to 90 psi averaging 59 psi with average daily demands and ranged from 30 psi to 84 psi averaging 56 psi with maximum daily demands. Available fire flow ranged from 600 gpm to 5,000 gpm and averaged 3,300 gpm.

In the northwest zone, pressure ranged from 60 psi to 100 psi averaging 79 psi with average daily demands and ranged from 61 psi to 112 psi averaging 82 psi with maximum daily demands. Available fire flow ranged from 2,100 gpm to 5,000 gpm and averaged 4,700 gpm.

Lastly, in the southeast zone, pressure ranged from 51 psi to 107 psi averaging 86 psi with average daily demands and ranged from 64 psi to 120 psi averaging 98 psi with maximum daily demands. Available fire flow ranged from 2,000 gpm to 5,000 gpm and averaged 3,400 gpm.

| Table 8 – Scenario D overall results | | | | |
|---|---|---|---|---|
| **Alternatives** | **Zone** | **Average Daily Demand - Pressure (psi)** | **Maximum Daily Demand - Pressure (psi)** | **Maximum Daily Demand - Available Fire Flow (gpm)** |
| **Proposed infrastructure serving existing and ultimate service area with a water treatment plant** | Central Zone | Range: 30 - 90 | Range: 30 - 84 | Range: 600 – 5,000+ |
| | | Average: 59 ± 10 | Average: 56 ± 10 | Average: 3,300 ± 1,200 |
| | Northwest Zone | Range: 60 - 100[(1)] | Range: 61 - 112 | Range: 2,100 – 5,000+ |
| | | Average: 79 ± 9[(1)] | Average: 82 ± 12 | Average: 4,700 ± 600 |
| | Southeast Zone | Range: 51 - 107[(2)] | Range: 64 - 120 | Range: 2,000 – 5,000+ |
| | | Average: 86 ± 15[(2)] | Average: 98 ± 15 | Average: 3,400 ± 800 |

[(1)] Two jockey pumps are active at the proposed booster station southwest of the existing ground tanks
[(2)] One jockey pump is active at the proposed southeast booster station

**LIST OF FIGURES**

City Of Northfield Minnesota

# NW Area Hydraulic Analysis

Northfield, Minnesota

## Figure 1 – Distribution System Layout

March 2023

BOLTON & MENK

Northwest Zone

Central Zone

Southeast Zone

Alternative 1

Alternative 2

Alternative 3

T

B

B

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

### Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Existing Watermain
- Proposed Watermain

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: ryan.dugger | Date Saved: 3/21/2023 4:20 PM

City Of Northfield Minnesota

# NW Area Hydraulic Analysis

Northfield, Minnesota

## Figure 2 – Scenario A
## Average Daily Demand Pressure

March 2023

BOLTON & MENK

Central Zone

Northwest Zone

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

### Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valves
- Watermain
- Proposed Watermain

Average Daily Demand - Pressure

- ≤ 30 psi
- ≤ 40 psi
- ≤ 50 psi
- ≤ 60 psi
- ≤ 70 psi
- ≤ 80 psi
- ≤ 90 psi
- ≤ 100 psi

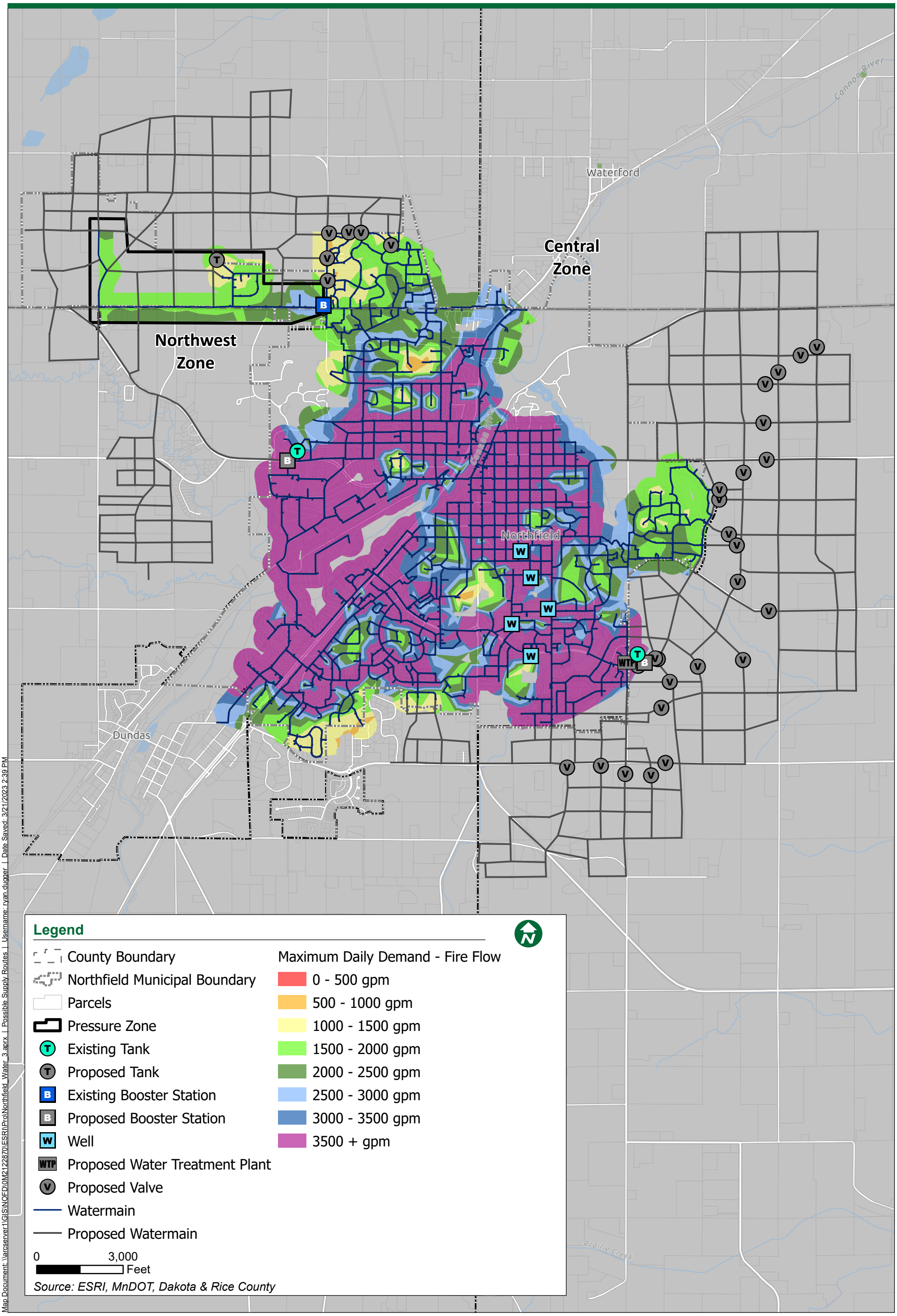
0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: ryan.dugger | Date Saved: 3/21/2023 2:39 PM

# Figure 3 – Scenario A
## Maximum Daily Demand - Available Fire Flow





Central Zone

Northwest Zone

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

## Legend

- County Boundary
- Northfield Municipal Boundary
- Pressure Zone
- Parcels
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valve
- Watermain
- Proposed Watermain

Average Daily Demand - Pressure (psi)

- ≤ 30 psi
- ≤ 40 psi
- ≤ 50 psi
- ≤ 60 psi
- ≤ 70 psi
- ≤ 80 psi
- ≤ 90 psi
- ≤ 100 psi

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Central Zone

Northwest Zone

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

## Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valve
- Watermain
- Proposed Watermain

Maximum Daily Demand - Fire Flow (gpm)

- 0 - 500 gpm
- 500 - 1000 gpm
- 1000 - 1500 gpm
- 1500 - 2000 gpm
- 2000 - 2500 gpm
- 2500 - 3000 gpm
- 3000 - 3500 gpm
- 3500 + gpm

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: ryan.dugger | Date Saved: 3/21/2023 2:39 PM

# Figure 6 – Scenario C
## Average Daily Demand - Pressure



Central Zone

Northwest Zone

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

**Legend**

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Proposed Valve
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Watermain
- Proposed Watermain

Average Daily Demand - Pressure

- ≤ 30 psi
- ≤ 40 psi
- ≤ 50 psi
- ≤ 60 psi
- ≤ 70 psi
- ≤ 80 psi
- ≤ 90 psi
- ≤ 100 psi

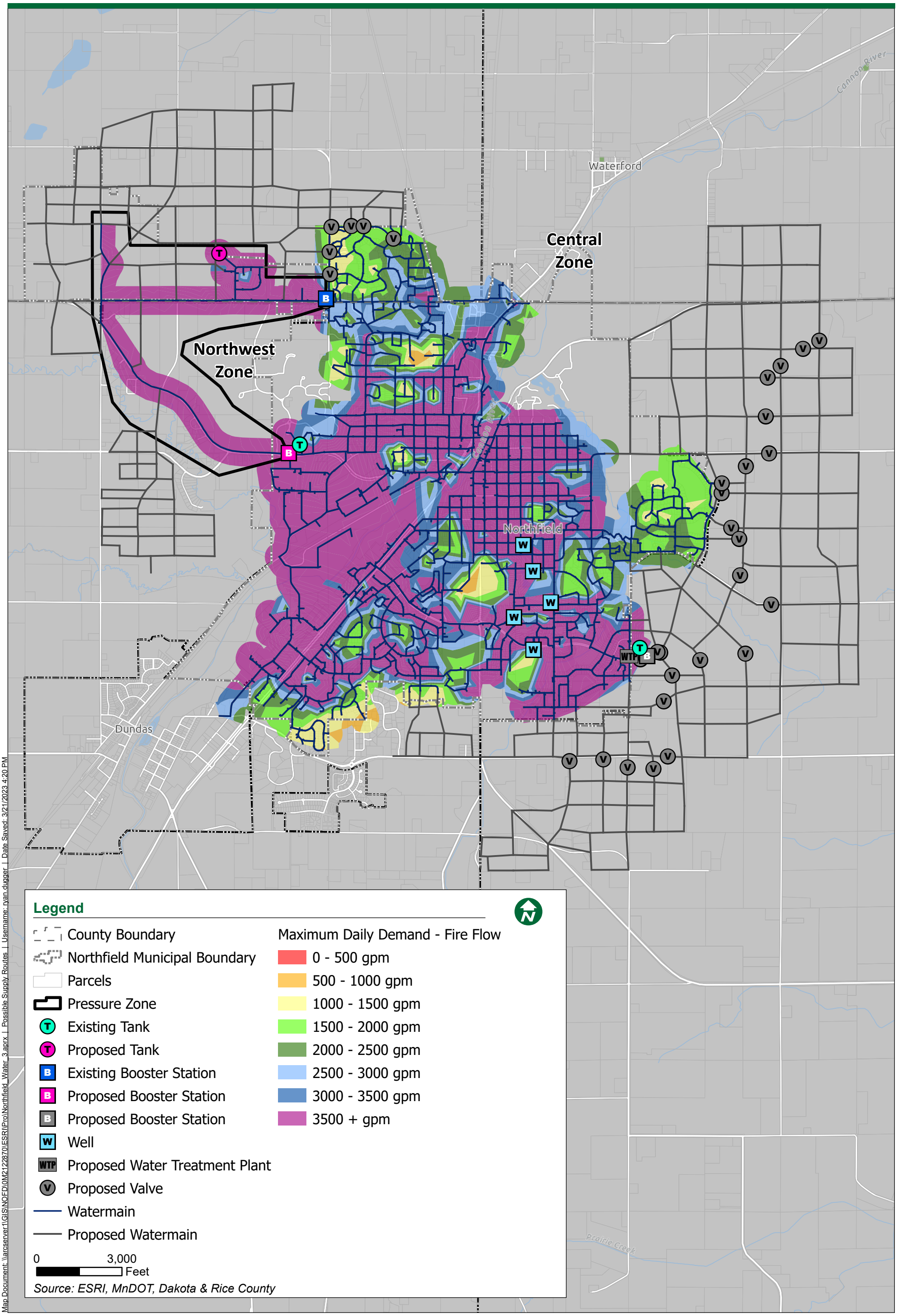
0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: ryan.dugger | Date Saved: 3/21/2023 5:56 PM

# Figure 7 – Scenario C
## Maximum Daily Demand - Available Fire Flow





Northwest Zone
Central Zone
Southeast Zone
Waterford
Northfield
Dundas
Cannon River
Prairie Creek
WTP

## Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valve
- Watermain

Average Daily Demand - Pressure

- ≤ 30 psi
- ≤ 40 psi
- ≤ 50 psi
- ≤ 60 psi
- ≤ 70 psi
- ≤ 80 psi
- ≤ 90 psi
- ≤ 100 psi
- ≤ 110 psi

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: ryan.dugger | Date Saved: 3/21/2023 5:56 PM

Northwest Zone
Central Zone
Southeast Zone
Waterford
Northfield
Dundas
Cannon River
Prairie Creek

## Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Proposed Water Treatment Plant
- Proposed Valve
- Watermain

Maximum Daily Demand - Fire Flow

- 0 - 500 gpm
- 500 - 1000 gpm
- 1000 - 1500 gpm
- 1500 - 2000 gpm
- 2000 - 2500 gpm
- 2500 - 3000 gpm
- 3000 - 3500 gpm
- 3500 + gpm

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

City Of Northfield Minnesota

NW Area Hydraulic Analysis
Northfield, Minnesota

Figure 10 – Scenario D
Proposed Watermain Diameter for Service Areas
March 2023

BOLTON & MENK

Northwest Zone

Central Zone

Southeast Zone

Waterford

Northfield

Dundas

Cannon River

Prairie Creek

## Legend

- County Boundary
- Northfield Municipal Boundary
- Parcels
- Pressure Zone
- Existing Tank
- Proposed Tank
- Existing Booster Station
- Proposed Booster Station
- Well
- Water Treatment Plant
- Proposed Valve

Proposed Diameter

- ≤ 2"
- 4"
- 6"
- 8"
- 10"
- 12"
- 16"
- 18"

0 3,000 Feet

*Source: ESRI, MnDOT, Dakota & Rice County*

Map Document: \\arcserver1\GIS\NOFD\0M2122870\ESRI\Pro\Northfield_Water_3.aprx | Possible Supply Routes | Username: ryan.dugger | Date Saved: 3/21/2023 5:04 PM