

# **Water System Simulation Report**

This report summarizes the system conditions, equipment utilized, and simulation results for the provided water distribution model. It is based on the latest uploaded simulation script and technical appendix.

## 1. System Conditions & Equipment

- Number of Connection Nodes (CNs): 80
- Pressure tank total volume: 1,280 gallons
- Storage tank total volume: 5,800 gallons
- Booster Pump #1 cut-in: 45 psi
- Booster Pump #2 cut-in: 40 psi
- Booster pumps cut-out: 55 psi
- Each booster pump capacity: 20 GPM
- Initial system pressure: 60 psi
- Failure threshold: 20 psi
- Simulation interval: 3 minutes
- Flow rates tested: 1.25, 1.0, 0.75, 0.5, 0.125 GPM per CN
- Darcy-Weisbach head loss modeled via simplified decay rate: -1.1 psi per timestep under deficit
- Elevation: datum at plant, +10 ft per 1000 ft from west to east

## 2. Hydraulic Model Overview

The simulation applies the mass continuity equation, Darcy-Weisbach head loss model, and operational control logic for booster pumps to predict system pressure and tank volumes over time.

Key equations include:

- Mass Continuity:  $Q_{in} - Q_{out} = dV/dt$
- Darcy-Weisbach:  $h_f = f \cdot (L/D) \cdot (v^2/2g)$ , pressure equivalent  $P = \rho \cdot g \cdot h_f$
- Drawdown equation for pressure tanks:  $Drawdown = V \cdot (P_{cutout} - P_{cutin}) / P_{cutout}$

### 3. Simulation Results

#### Results for Sample Views of Uploaded Simulation Scenarios

Unnamed: 0	Time (min)	Pressure (psi)	Flow Rate (GPM)	Scenario
0	0.0	60.00	40.0	0.500_GPM
1	2.5	50.62	40.0	0.500_GPM
2	5.0	41.25	40.0	0.500_GPM
0	0.0	60.00	40.0	0.500_GPM_Base
1	2.5	50.62	40.0	0.500_GPM_Base

#### Results for Simulation\_0.125\_GPM\_per\_CN

Time (min)	System Pressure (psi)	Booster Mode	Pressure Tank Volume (gal)	Storage Tank Volume (gal)
0	60.0	Off	1250.0	5800.0
3	58.9	Off	1220.0	5800.0
6	57.8	Off	1190.0	5800.0
9	56.7	Off	1160.0	5800.0
12	55.6	Off	1130.0	5800.0

#### Results for Simulation\_0.750\_GPM\_per\_CN

Time (min)	System Pressure (psi)	Booster Mode	Pressure Tank Volume (gal)	Storage Tank Volume (gal)
0	60.0	Off	1100.0	5800.0
3	58.9	Off	920.0	5800.0
6	57.8	Off	740.0	5800.0
9	56.7	Off	560.0	5800.0
12	55.6	Off	380.0	5800.0

#### Results for Simulation\_0.500\_GPM\_per\_CN

Time (min)	System Pressure (psi)	Booster Mode	Pressure Tank Volume (gal)	Storage Tank Volume (gal)
0	60.0	Off	1160.0	5800.0
3	58.9	Off	1040.0	5800.0
6	57.8	Off	920.0	5800.0
9	56.7	Off	800.0	5800.0
12	55.6	Off	680.0	5800.0

#### Results for Simulation\_1.000\_GPM\_per\_CN

Time (min)	System Pressure (psi)	Booster Mode	Pressure Tank Volume (gal)	Storage Tank Volume (gal)
0	60.0	Off	1040.0	5800.0
3	58.9	Off	800.0	5800.0
6	57.8	Off	560.0	5800.0
9	56.7	Off	320.0	5800.0
12	55.6	Off	80.0	5800.0

#### Results for Simulation\_1.250\_GPM\_per\_CN

Time (min)	System Pressure (psi)	Booster Mode	Pressure Tank Volume (gal)	Storage Tank Volume (gal)
0	60.0	Off	980.0	5800.0
3	58.9	Off	680.0	5800.0
6	57.8	Off	380.0	5800.0
9	56.7	Off	80.0	5800.0
12	55.6	Off	0.0	5580.0

## 4. Technical Appendix: Key Derivations

Refer to Technical\_Appendix\_Hydraulic\_Derivation.pdf for the full detailed derivations of hydraulic equations used in the simulation. Summary:

1. Mass continuity governs tank volume changes.
2. Booster pump logic is modeled with cut-in/cut-out thresholds and additive capacities.
3. Friction losses approximated with fixed psi decay per timestep under deficit.
4. Elevation incorporated as static head change in total pressure balance.