

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: $h_f = f^*(L/D)^*(v^2/2g)$, pressure equivalent $P = \rho * g * h_f$
- Drawdown equation for pressure tanks: $\text{Drawdown} = V * (P_{cutout} - P_{cutin}) / P_{cutout}$

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.