Hydraulic Engineering: Nederland, Colorado

“Redacted Author Names for Privacy”

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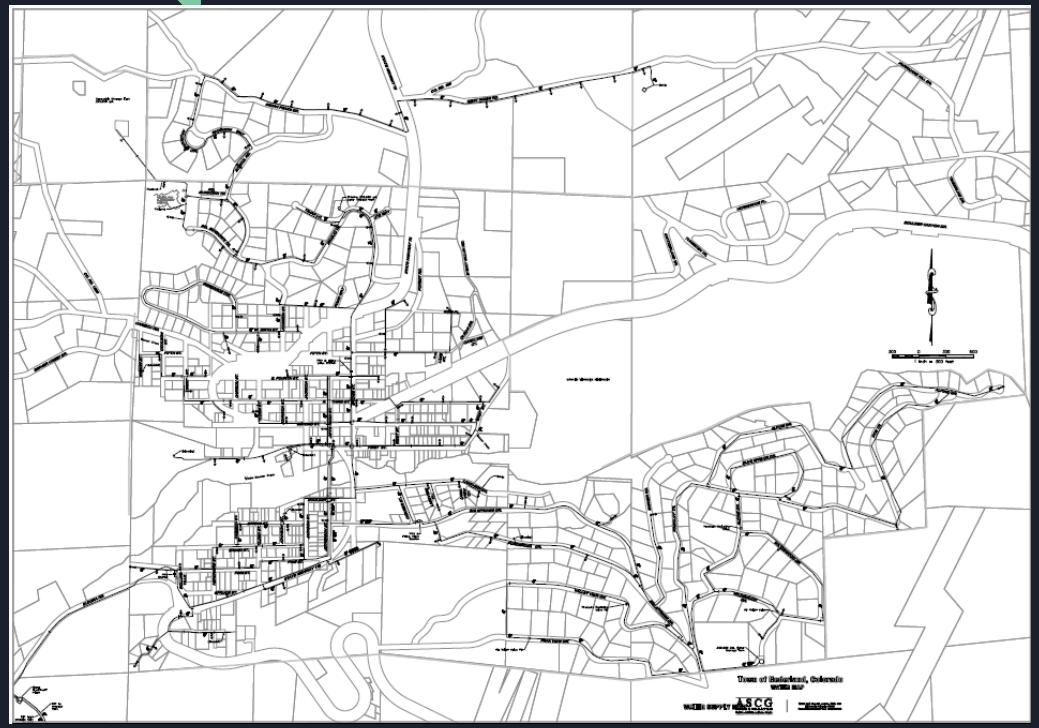
Nederland,Colorado



- Current water infrastructure: Ductile iron
- Proposed material: Steel
- Population: 1,336
- Located: Boulder county, Colorado
- Analysis: Main Piping of the city

EPAnet 2.2

- Software used for analysis the water infrastructure
- EPANET is a software application used throughout the world to model water distribution systems. It was developed as a tool for understanding the movement and fate of drinking water constituents within distribution systems, and can be used for many different types of applications in distribution systems analysis.
- Based on Hardy cross and Bernoulli's modified equation.

Assumptions

- Steady state flow
- Elevations
- Number of junctions
- Number of tanks
- Gravity fed pumps

Methodology

- Transferred map to autocad and fitted to scale
- Then transferred to EPAnet
- Estimated base demand 65 GPM
- Changed infrastructure using Hazen Williams coefficient
- 17 junctions, 19 Pipes, 2 tanks and added minor losses using bends, exits and entrances

Table 3.2 Roughness Coefficients for New Pipe

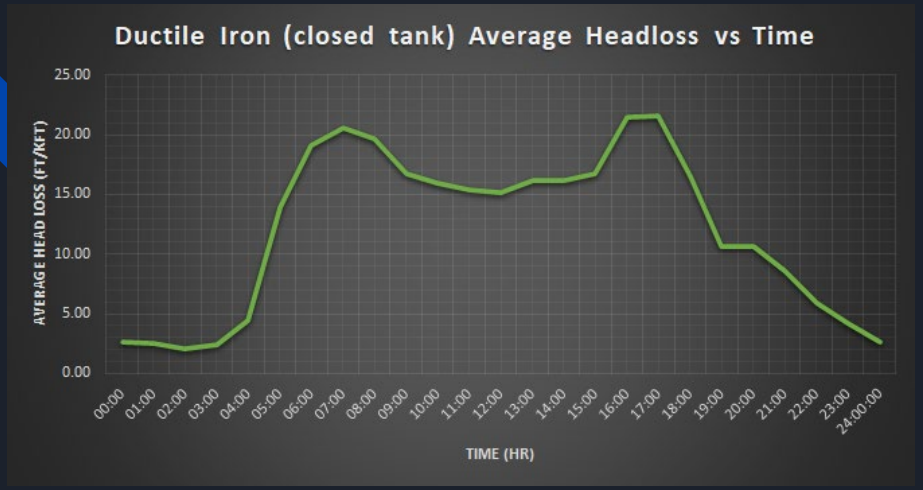
Material	*Hazen-Williams C (unitless)*	*Darcy-Weisbach ε (feet x 10^{-3})*	*Manning's n (unitless)*
Cast Iron	130 – 140	0.85	0.012 - 0.015
Concrete or Concrete Lined	120 – 140	1.0 - 10	0.012 - 0.017
Galvanized Iron	120	0.5	0.015 - 0.017
Plastic	140 – 150	0.005	0.011 - 0.015
Steel	140 – 150	0.15	0.015 - 0.017
Vitrified Clay	110		0.013 - 0.015

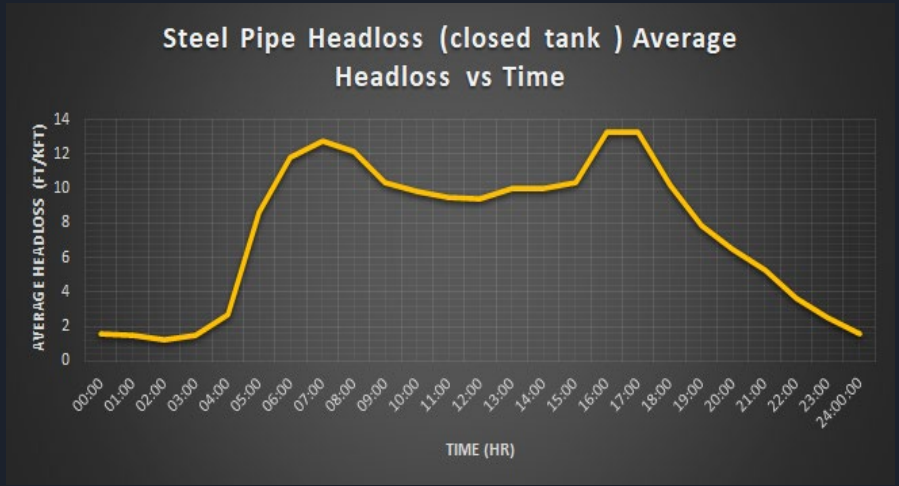
- Values used for calculations of head loss

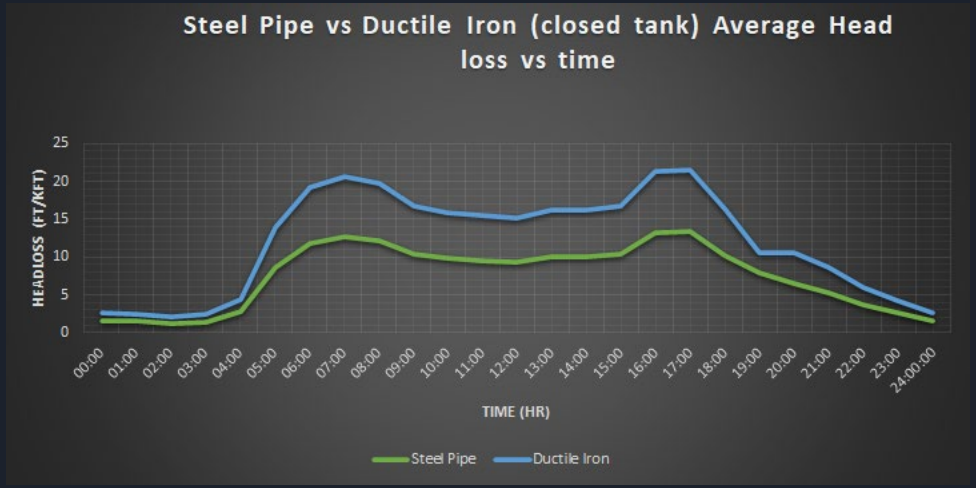
FITTING	*LOSS COEFFICIENT*
Globe valve, fully open	10.0
Angle valve, fully open	5.0
Swing check valve, fully open	2.5
Gate valve, fully open	0.2
Short-radius elbow	0.9
Medium-radius elbow	0.8
Long-radius elbow	0.6
45 degree elbow	0.4
Closed return bend	2.2
Standard tee - flow through run	0.6
Standard tee - flow through branch	1.8
Square entrance	0.5
Exit	1.0

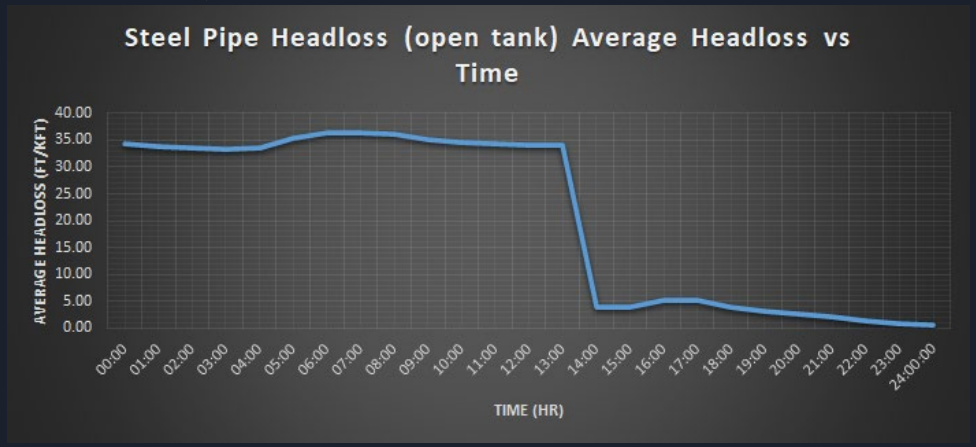
Results

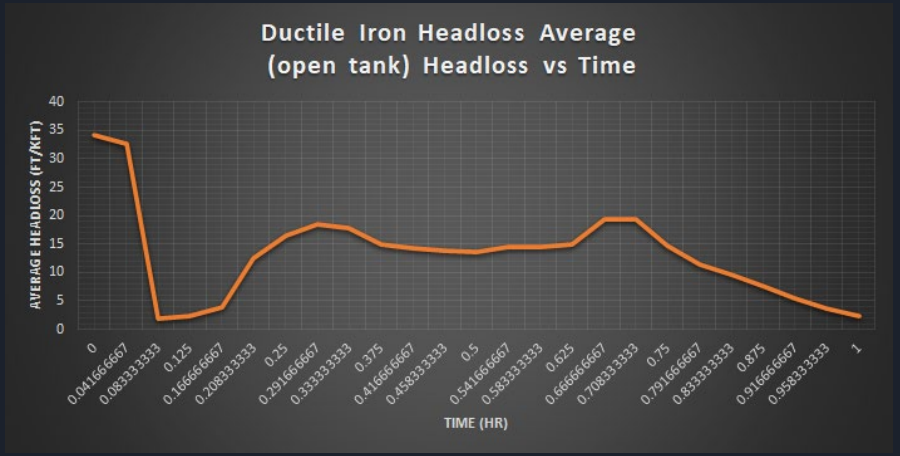
- Results as expected with closed tank
- Significant reduction of head loss using proposed material (steel)
- Inconsistencies: Open tank


Ductile Iron (closed tank) Average Headloss vs Time
AVERAGE HEAD LOSS (FT/KFT)
25.00
20.00
15.00
10.00
5.00
0.00
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 24:00:00
TIME (HR)

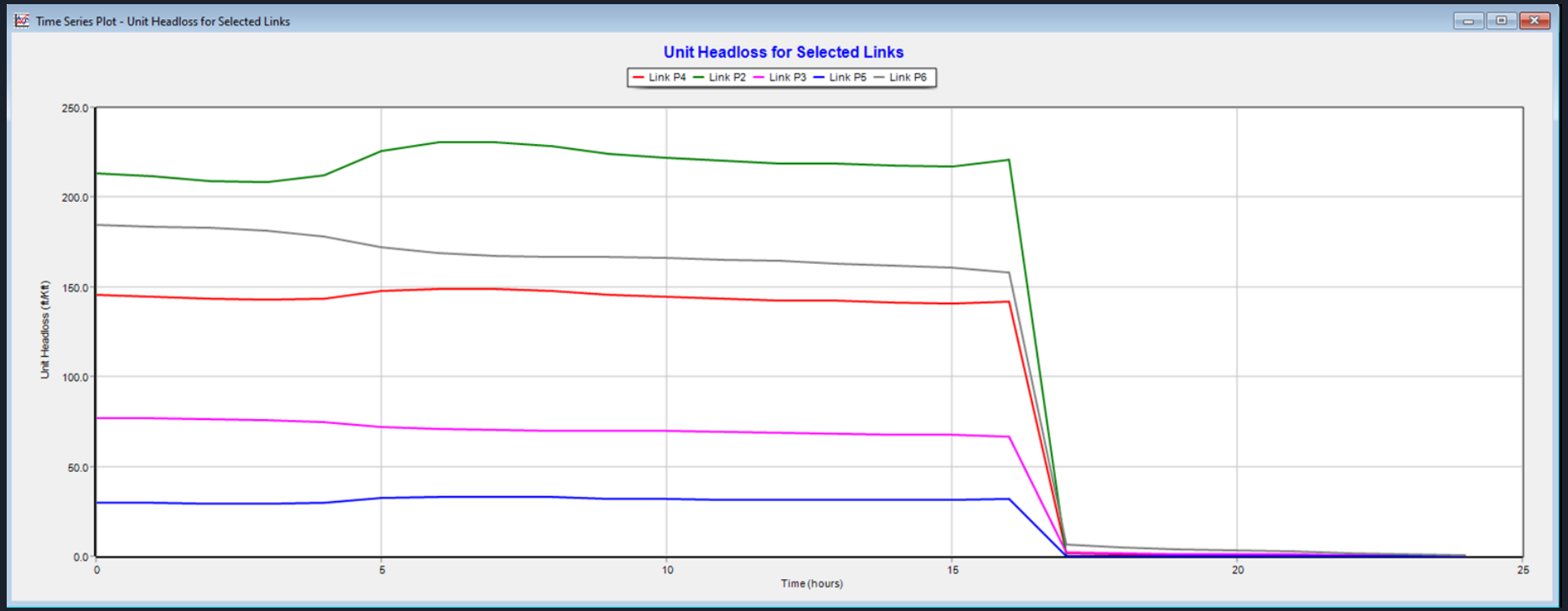

Steel Pipe Headloss (closed tank) Average Headloss vs Time
AVERAGE HEADLOSS (FT/KFT)
14
12
10
8
6
4
2
0
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 24:00:00
TIME (HR)


Steel Pipe vs Ductile Iron (closed tank) Average Head loss vs time
HEADLOSS (FT/KFT)
25
20
15
10
5
0
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 24:00:00
TIME (HR)
Steel Pipe
Ductile Iron


Steel Pipe Headloss (open tank) Average Headloss vs Time
AVERAGE HEADLOSS (FT/KFT)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00:00
TIME (HR)


Ductile Iron Headloss Average (open tank) Headloss vs Time
AVERAGE HEADLOSS (FT/KFT)
40
35
30
25
20
15
10
5
0
0
0.041666667
0.083333333
0.125
0.166666667
0.208333333
0.25
0.291666667
0.333333333
0.375
0.416666667
0.458333333
0.5
0.541666667
0.583333333
0.625
0.666666667
0.708333333
0.75
0.791666667
0.833333333
0.875
0.916666667
0.958333333
1
TIME (HR)

Ductile iron (Open tank 24 hour period)



Head loss (Ductile Iron)

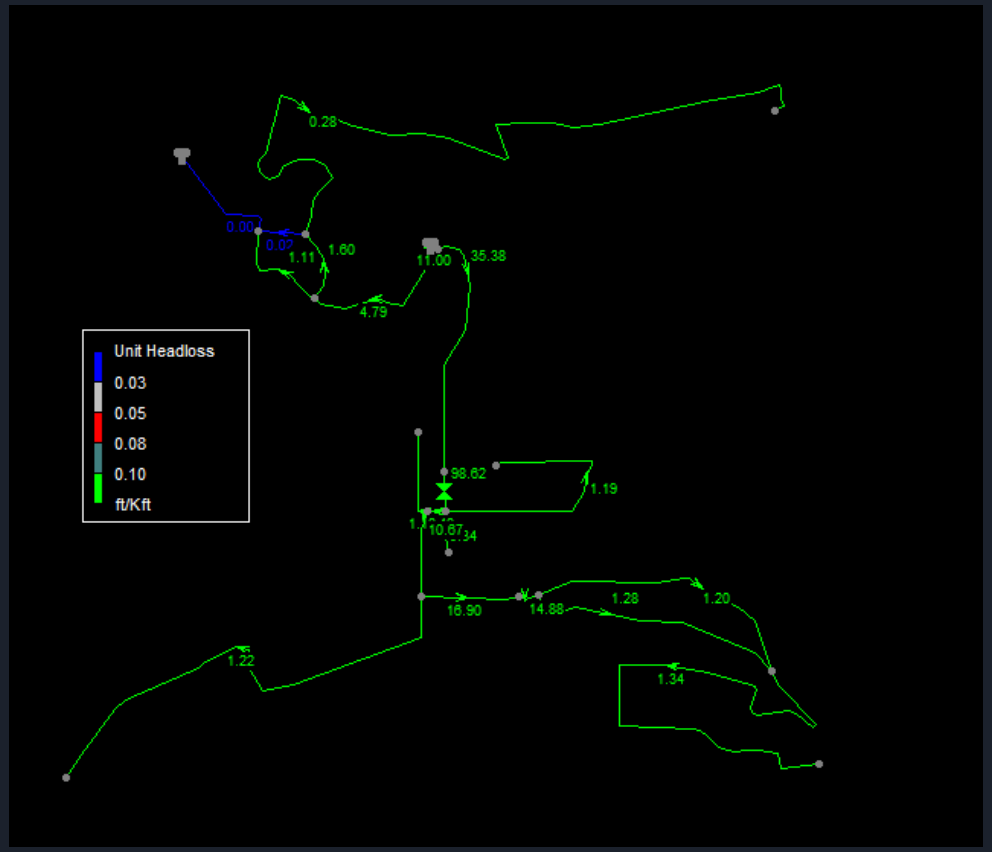
Link Results at 18:00 Hrs:

Link ID	Flow GPM	VelocityUnit fps	Headloss ft/Kft	Status
P1	-78.00	0.50	0.28	Open
P2	9.13	0.10	0.02	Open
P3	-165.13	1.05	1.60	Open
P4	-68.86	0.78	1.11	Open
P5	0.00	0.00	0.00	Closed
P6	-312.00	1.99	4.79	Open
P7	936.00	5.97	35.38	Open
P8	78.00	0.89	1.19	Open
P9	78.00	0.50	0.34	Open
P10	624.00	3.98	14.48	Open
P11	78.00	0.89	1.18	Open
P12	468.00	2.99	10.67	Open
P13	312.00	3.54	16.90	Open
P14	78.00	0.89	1.22	Open
P15	79.76	0.91	1.28	Open
P16	-76.24	0.87	1.20	Open
P17	78.00	0.89	1.34	Open
P18	234.00	2.66	14.88	Open
P19	1326.00	3.76	11.00	Open

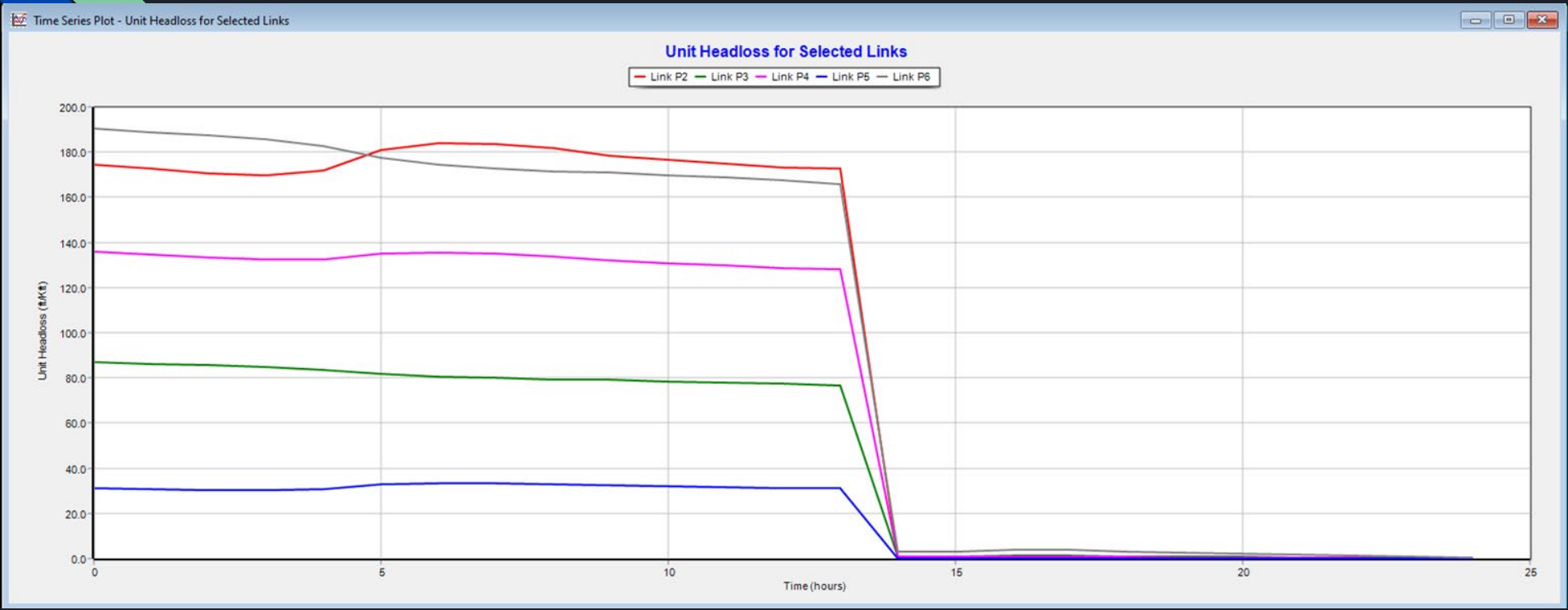
Link Results at 0:00 Hrs:

Link ID	Flow GPM	VelocityUnit fps	Headloss ft/Kft	Status
P1	-29.25	0.19	0.05	Open
P2	-1319.87	14.98	213.02	Open
P3	1261.37	8.05	77.08	Open
P4	904.40	10.26	145.70	Open
P5	2253.52	6.39	29.96	Open
P6	2136.52	13.64	184.73	Open
P7	351.00	2.24	5.55	Open
P8	29.25	0.33	0.19	Open
P9	29.25	0.19	0.05	Open
P10	234.00	1.49	2.31	Open
P11	29.25	0.33	0.19	Open
P12	175.50	1.12	1.66	Open
P13	117.00	1.33	2.68	Open
P14	29.25	0.33	0.20	Open
P15	29.90	0.34	0.20	Open
P16	-28.60	0.32	0.19	Open
P17	29.25	0.33	0.21	Open
P18	87.75	1.00	2.27	Open
P19	-1756.27	4.98	18.79	Open

Ductile iron (open tank 18:00 hours)



Steel pipe (head loss 24 hour period)



Head loss comparison (Steel pipe)

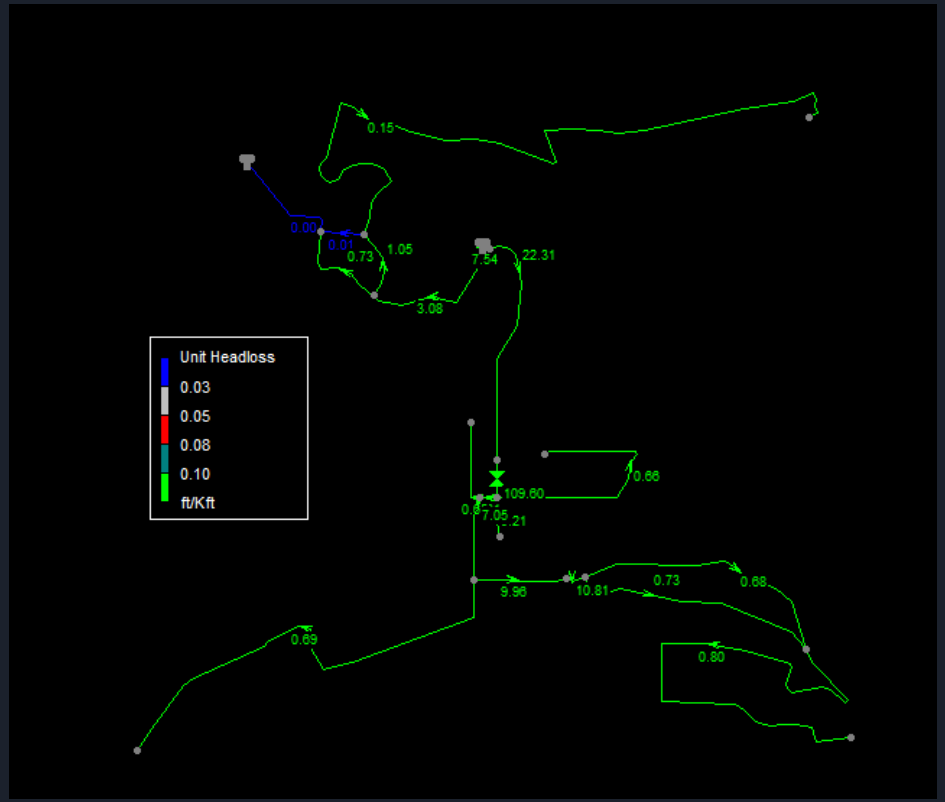
Link Results at 0:00 Hrs:

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
P1	-29.25	0.19	0.02	Open
P2	-1666.87	18.91	174.32	Open
P3	1608.37	10.27	87.08	Open
P4	1083.95	12.30	135.85	Open
P5	2780.08	7.89	31.12	Open
P6	2663.08	17.00	190.34	Open
P7	351.00	2.24	3.43	Open
P8	29.25	0.33	0.10	Open
P9	29.25	0.19	0.03	Open
P10	234.00	1.49	1.31	Open
P11	29.25	0.33	0.10	Open
P12	175.50	1.12	1.07	Open
P13	117.00	1.33	1.55	Open
P14	29.25	0.33	0.11	Open
P15	29.97	0.34	0.12	Open
P16	-28.53	0.32	0.11	Open
P17	29.25	0.33	0.12	Open
P18	87.75	1.00	1.61	Open
P19	-2282.83	6.48	21.55	Open

Link Results at 18:00 Hrs:

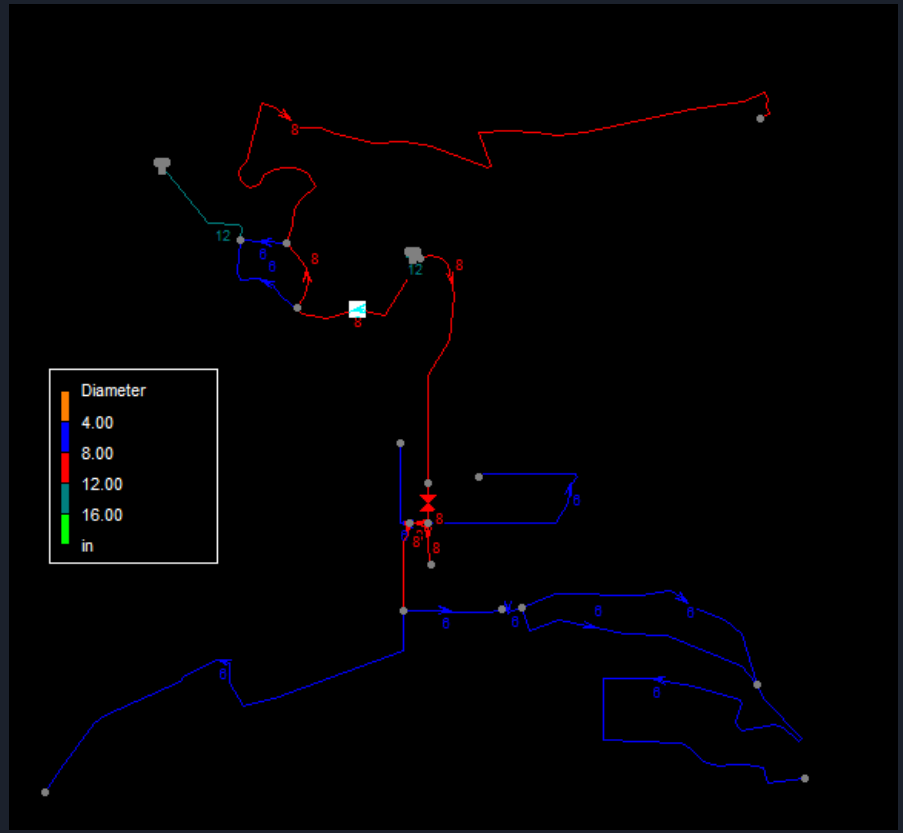
Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
P1	-78.00	0.50	0.15	Open
P2	7.26	0.08	0.01	Open
P3	-163.26	1.04	1.05	Open
P4	-70.74	0.80	0.73	Open
P5	0.00	0.00	0.00	Closed
P6	-312.00	1.99	3.08	Open
P7	936.00	5.97	22.31	Open
P8	78.00	0.89	0.66	Open
P9	78.00	0.50	0.21	Open
P10	624.00	3.98	8.31	Open
P11	78.00	0.89	0.65	Open
P12	468.00	2.99	7.05	Open
P13	312.00	3.54	9.96	Open
P14	78.00	0.89	0.69	Open
P15	79.97	0.91	0.73	Open
P16	-76.03	0.86	0.68	Open
P17	78.00	0.89	0.80	Open
P18	234.00	2.66	10.81	Open
P19	1326.00	3.76	7.54	Open

Steel pipe (Open tank 18:00 hours)

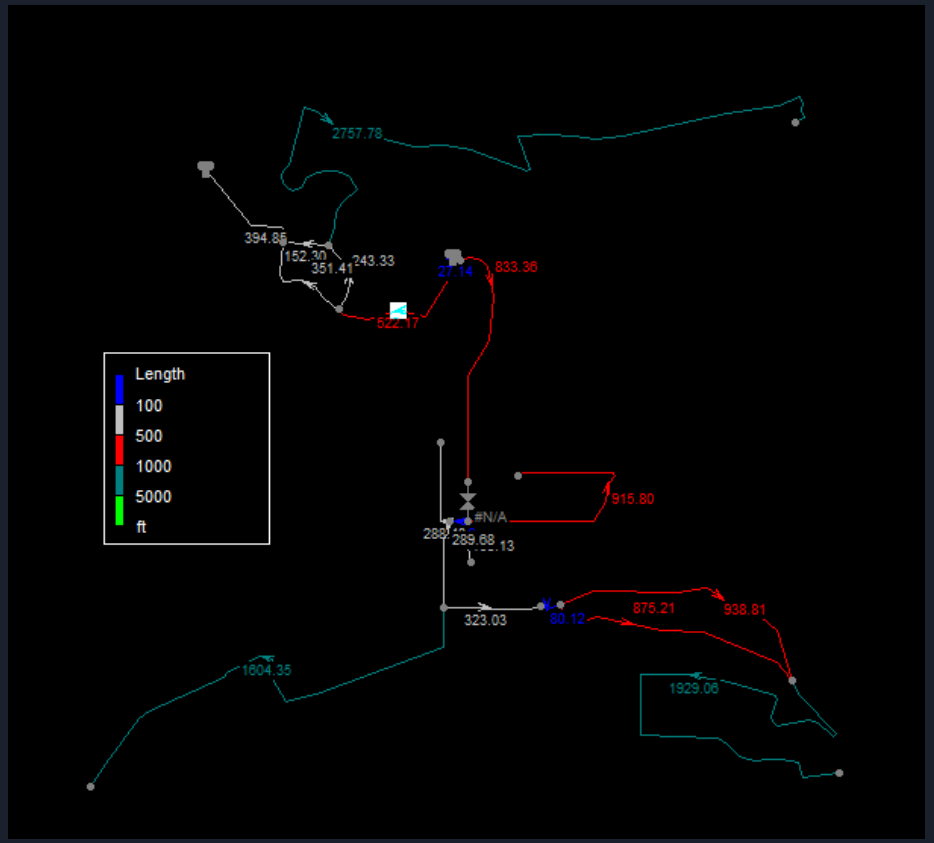


Models/figures

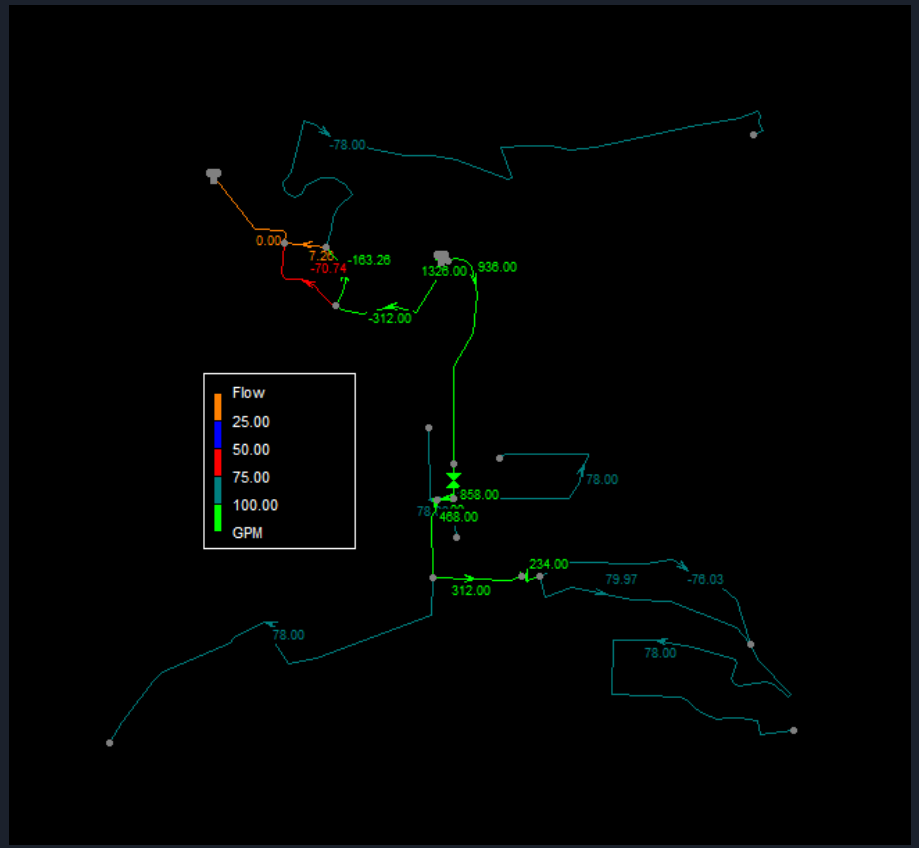
Diameter



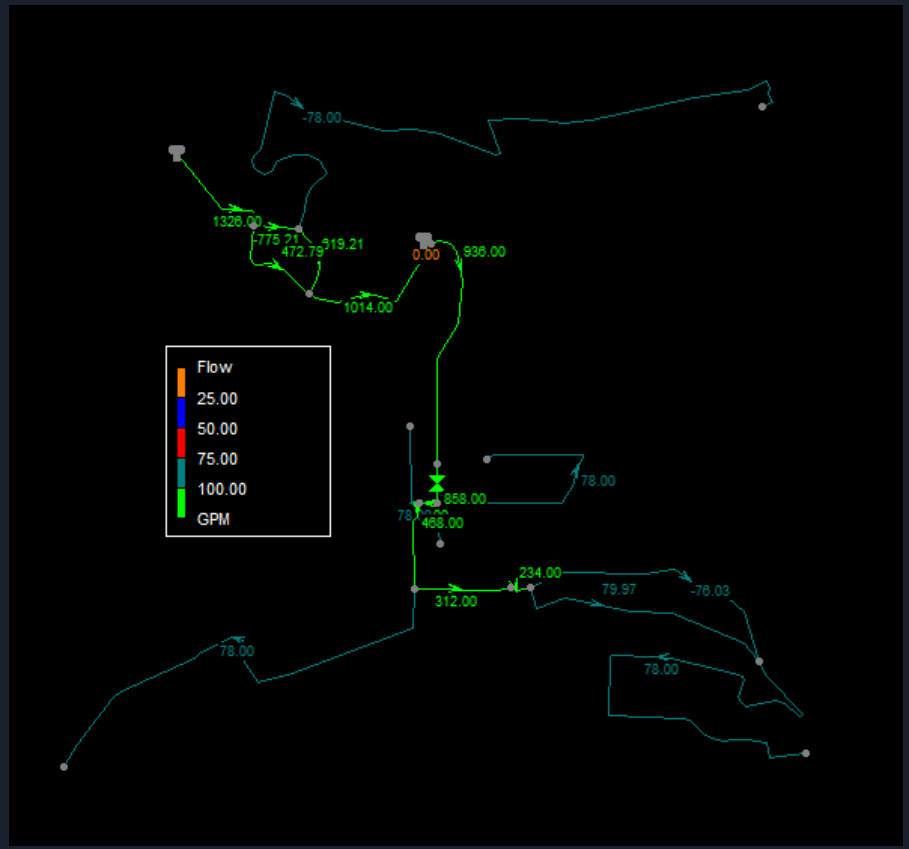
Length


Length
100
500
1000
5000
ft
2757.78
394.85
152.30
351.41
243.33
27.14
833.36
522.17
915.80
#N/A
289.68
323.03
80.12
875.21
938.81
1804.35
1929.06

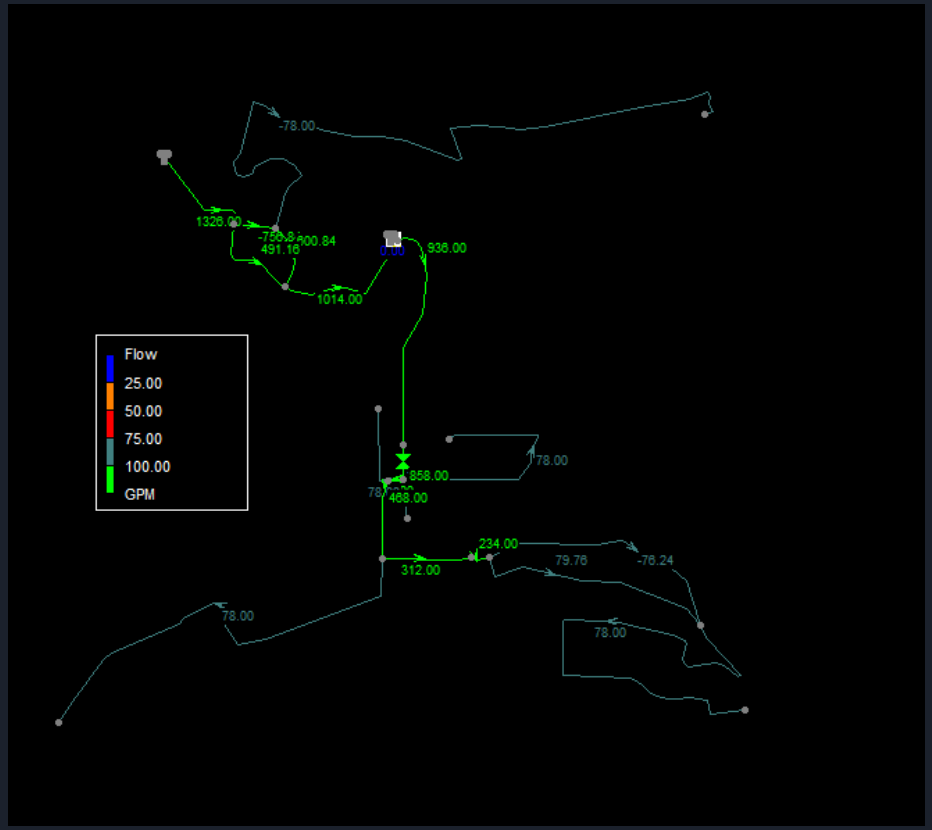
Flow (Steel pipe open tank 18:00 hours)



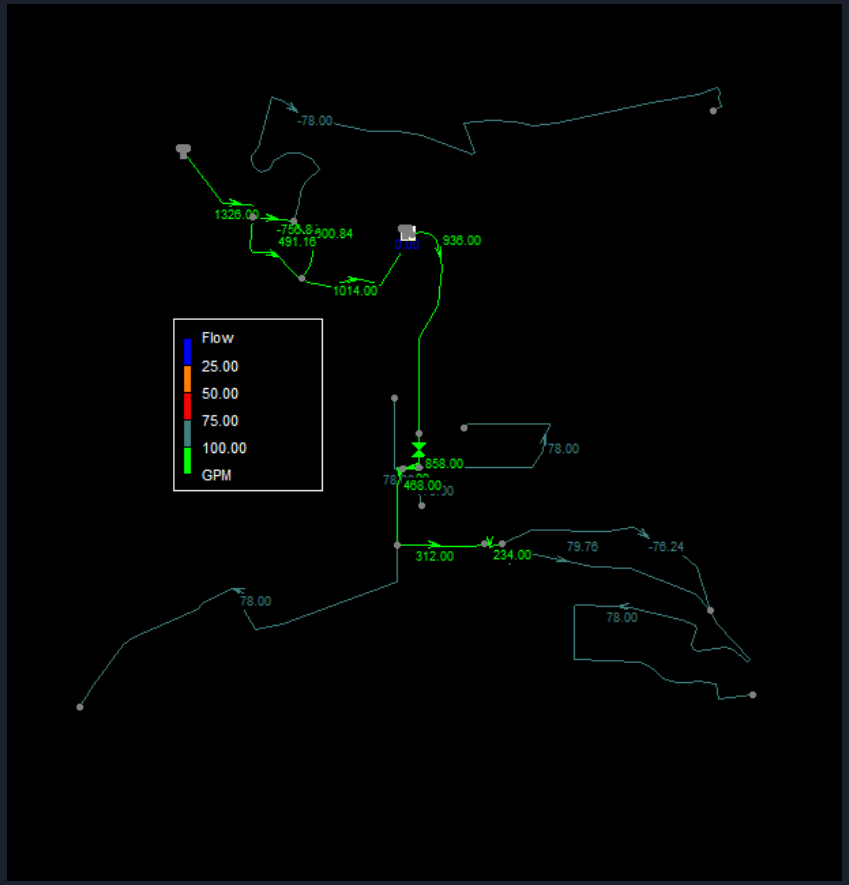
Flow (Steel pipe closed tank 18:00 hours)



Flow (Ductile iron Open tank 18:00 hours)



Flow (Ductile iron closed tank 18:00 hours)



Conclusions

- The result of the proposed material came out to be as expected
- Head loss was significantly lower for steel piping

Recommendations

- Further analysis of closing of tank two

- Economic feasibility of changing infrastructure to proposed material (steel)

References

1. EPANET. (2020, August 31). US EPA. https://www.epa.gov/water-research/epanet

2. Water Resources Engineering. (2013). Water Resources Engineering, David Chin 3rd Edition Page.76.

3. Wurbs, Ralph A., and Wurbs & James. “Water Resources Engineering.” Pearson, 2002, www.pearson.com/us/higher-education/program/Wurbs-Water-Resources-Engineering/PGM104797.html.

4. USGS. “U.S Department Interior U.S Geological Survey.” Nederland Quadrangle Colorado, USGS, 2016, pubs.er.usgs.gov/publication/gq833.

5. Town of Nederland. “Utility Maps –.” Town of Nederland, Colorado, nederlandco.org/government/town-departments/public-works/utility-maps. Accessed 7 Apr. 2021