Pumping and Material Cost Analysis

The cost analysis was performed in order to find the best qualifying material; in this case a pumping cost analysis and a material cost analysis were performed. As shown in Table 14, the head loss was calculated for different material in order to find the pumping energy required for the specified flow demand. Table 15 shows the cost of energy of all materials in addition to the extra annual cost of each material compare to ductile iron pipe, and the present worth of those costs considering a fifty-year life expectancy.

Table 14 – Unit Head Loss Calculation for All Materials

Material	Q (GPM)	Diameter, (in)	Velocity, (ft/sec)	Roughness Coefficient, C	Unit Head Loss, (ft/kft)
DIP	5190.18	24.95	3.41	140	1.32
PVC	5190.18	22.76	4.09	150	1.82
PCCP	5190.18	24.00	3.68	140	1.59
HDPE	5190.18	20.83	4.89	155	2.63
STEEL	5190.18	24.00	3.68	140	1.59

Table 15 – Present Worth Calculation for Annual Cost

Material	Pumping Cost $/yr/kft	Pumping Cost $/yr/pipeline	Additional Cost $	interest %	Present Worth $
DIP	$741.12	$7,248.13	$0.00	0.04	$0.0
PVC	$1,020.31	$9,978.58	$2,730.46	0.04	$58,656.16
PCCP	$895.38	$8,756.76	$1,508.63	0.04	$32,408.76
HDPE	$1,478.43	$14,458.96	$7,210.83	0.04	$154,904.38
SP	$895.38	$8,756.76	$1,508.63	0.04	$32,408.72

As shown in Table 16, DIP has the most expensive unit cost. However, as mentioned previously in the report PVC and HDPE cannot be used because they do not meet requirements and specifications provided by EPWU. Moreover, PCCP and SP need additional treatment for maintenance, corrosion control and cathodic protection, which will increase the total cost of the project. Therefore DIP is the best option.

Table 16 – Summary Table with Total Initial Cost

Material	Pipe Length, ft	Unit Cost, $/lf	Total Material Installation Cost, $	Present Worth, $	Total Initial Cost, $
DIP	9779.96	$140.00	$1,369,194.40	$0.00	$1,369,194.40
PVC	9779.96	$99.00	$968,216.04	$58,656.16	$1,026,872.20
PCCP	9779.96	$110.00	$1,075,795.60	$32,408.76	$1,108,204.36
HDPE	9779.96	$110.00	$1,075,795.60	$154,904.38	$1,230,699.98
STEEL	9779.96	$120.00	$1,173,595.20	$32,408.72	$1,206,003.92

Conclusions

Based on this report analysis and after meeting all the objectives for the project, it was concluded that DIP was the most cost efficient and durable material. Not only does it meet all the requirements provided by EPWU and TCEQ, but also it is the material that requires the least amount of maintenance. Although the initial cost is not the most economical, ductile iron pipe has lower energy and pumping cost, which has proven to be the best option for the project.

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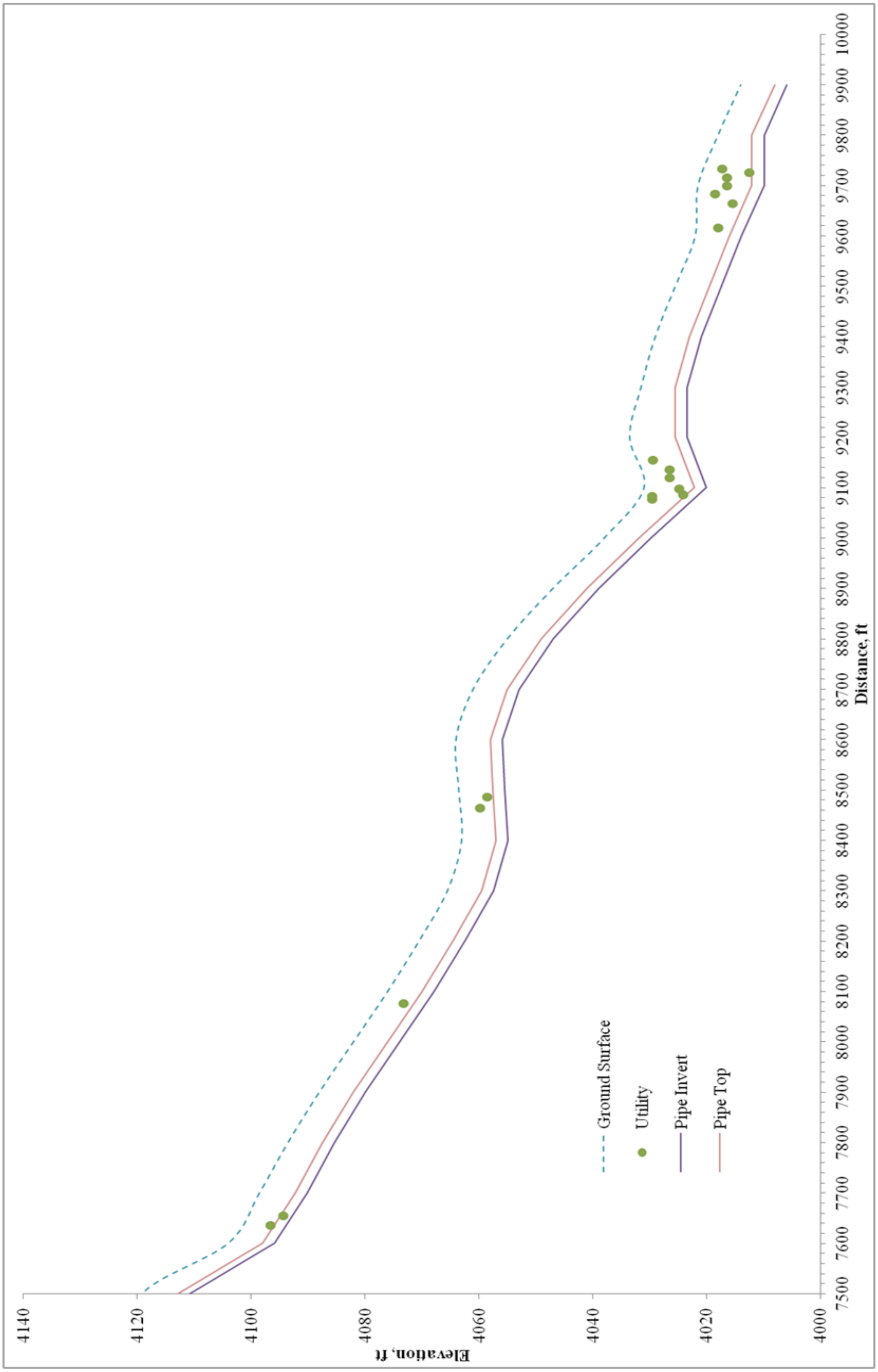
Appendix



Elevation, ft
Distance, ft
Ground Surface
Utility
Pipe Invert
Pipe Top
4000
4020
4040
4060
4080
4100
4120
4140
7500
7600
7700
7800
7900
8000
8100
8200
8300
8400
8500
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9700
9800
9900
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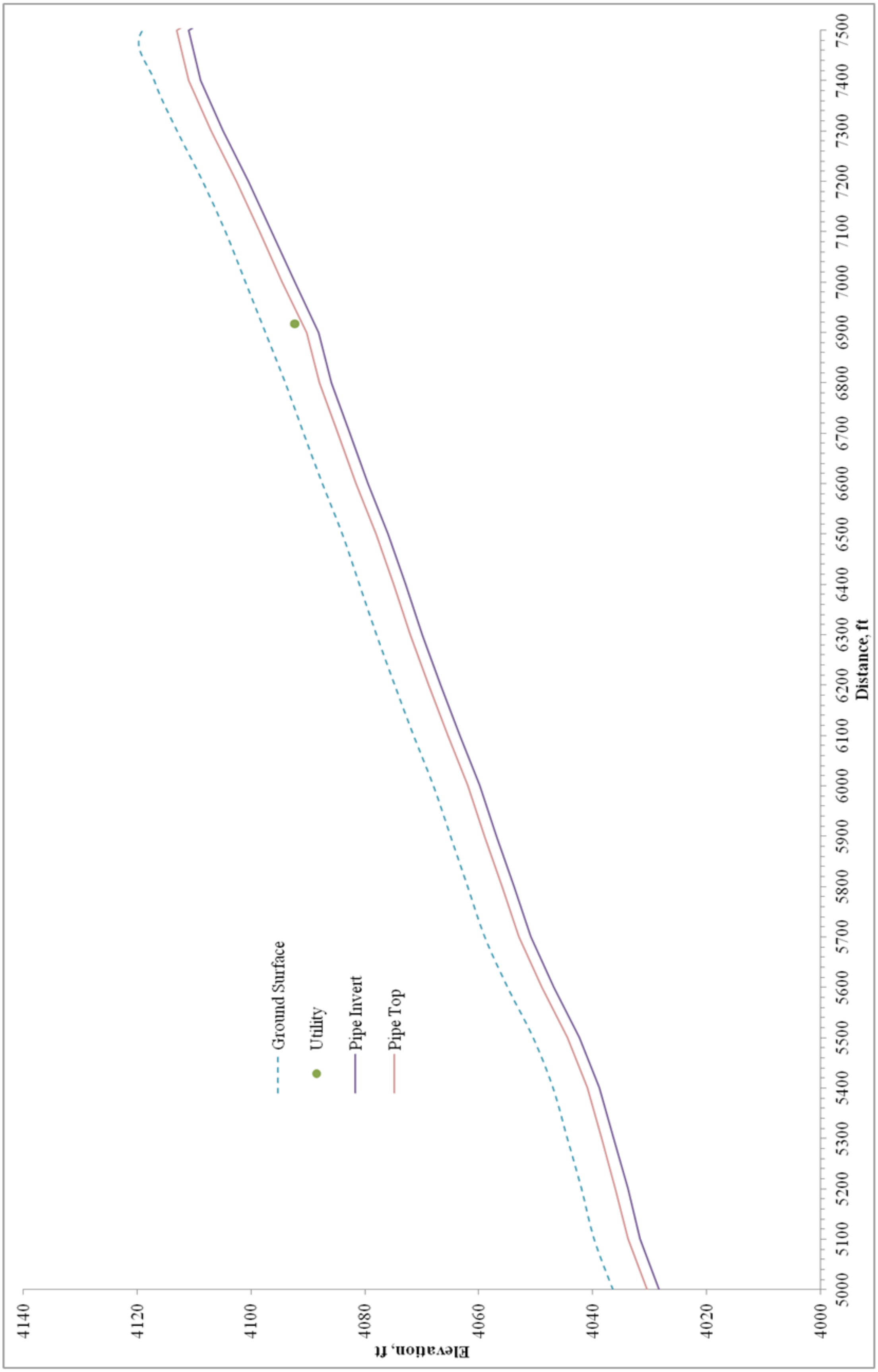
Ground Surface
Utility
Pipe Invert
Pipe Top
Elevation, ft
4000
4020
4040
4060
4080
4100
4120
4140
Distance, ft
5000
5100
5200
5300
5400
5500
5600
5700
5800
5900
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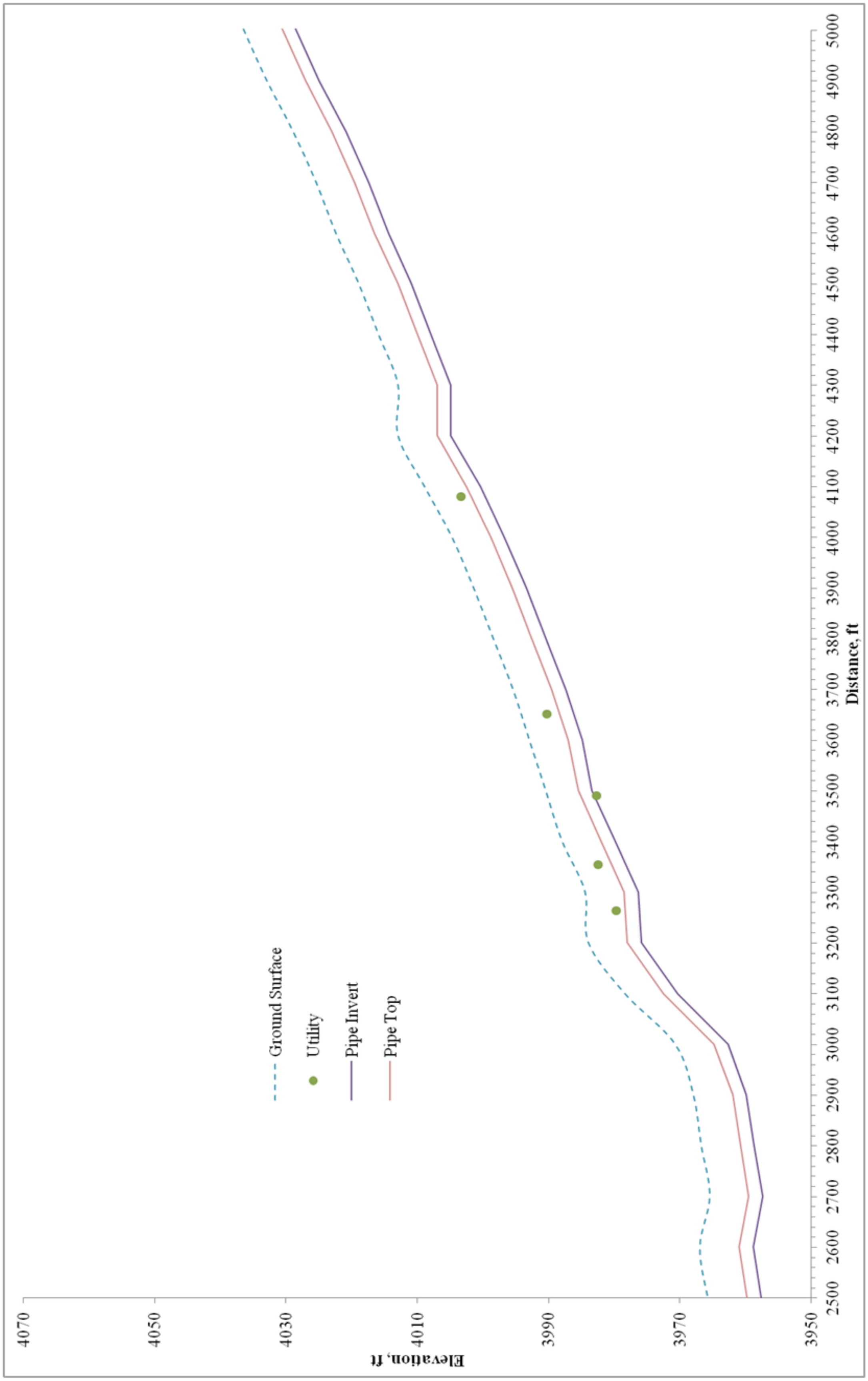
7200
7300
7400
7500


Ground Surface
Utility
Pipe Invert
Pipe Top
Elevation, ft
3950
3970
3990
4010
4030
4050
4070
Distance, ft
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
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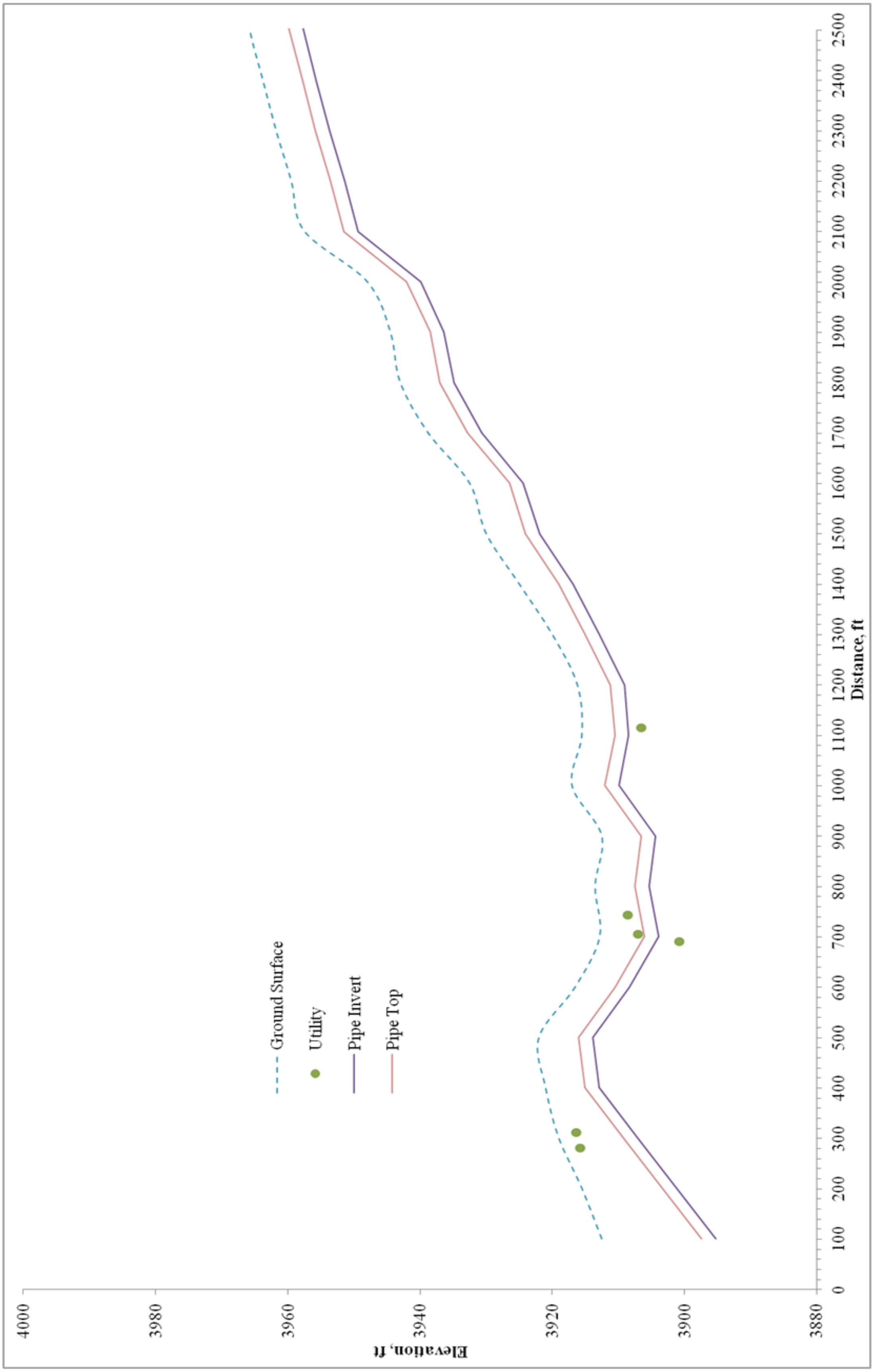
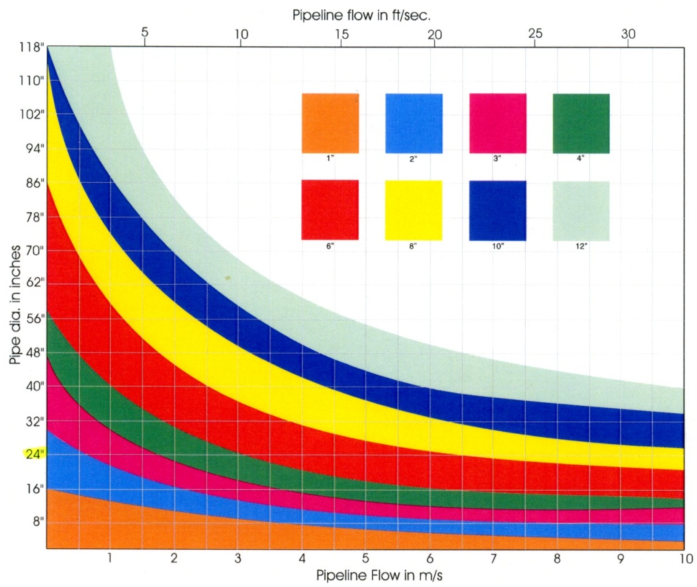
4700
4800
4900
5000


Ground Surface
Utility
Pipe Invert
Pipe Top
Distance, ft
Elevation, ft
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500
3880 3900 3920 3940 3960 3980 4000

The selection for air release and vacuum relief valves was made in accordance to the graph below. This figure expresses the relationship between pipeline flow and pipe diameter yielding the required diameter for the valve.



Selection Graph for Diameter of Valves In Relationship with Pipeline Flow and Pipe Diameter

- Unit Bearing Resistance

R_S = D'*K_n*P_p

P_p = Passive Soil Pressure
D = Nominal Diameter
K_n = Laying Condition

- Frictional Force

F_f = 0.7F_s → Polyethylene pipe

F_s = Unit Frictional Force

- Unit Frictional Force

F_s= A_p*C + W*tan (δ)

A_p = Surface Area of Pipe Bearing on Soil
C = Soil Cohesion
W = Unit Nominal Force

- Surface Area of Pipe Bearing on Soil

$A_p = \frac{D*\pi}{2}$ (For bends assumed half the pipe circumference bears against the soil)

D = Diameter

- Soil Cohesion

C = F_c*F_s

F_s = Unit Frictional Force
F_c = Frictional Resistance Force

- Earth Load

$W_e = \Upsilon_s(H + .11B_o) * B_o$

γs = Unit Weight of Soil
H = Height
Bo = Nominal Diameter