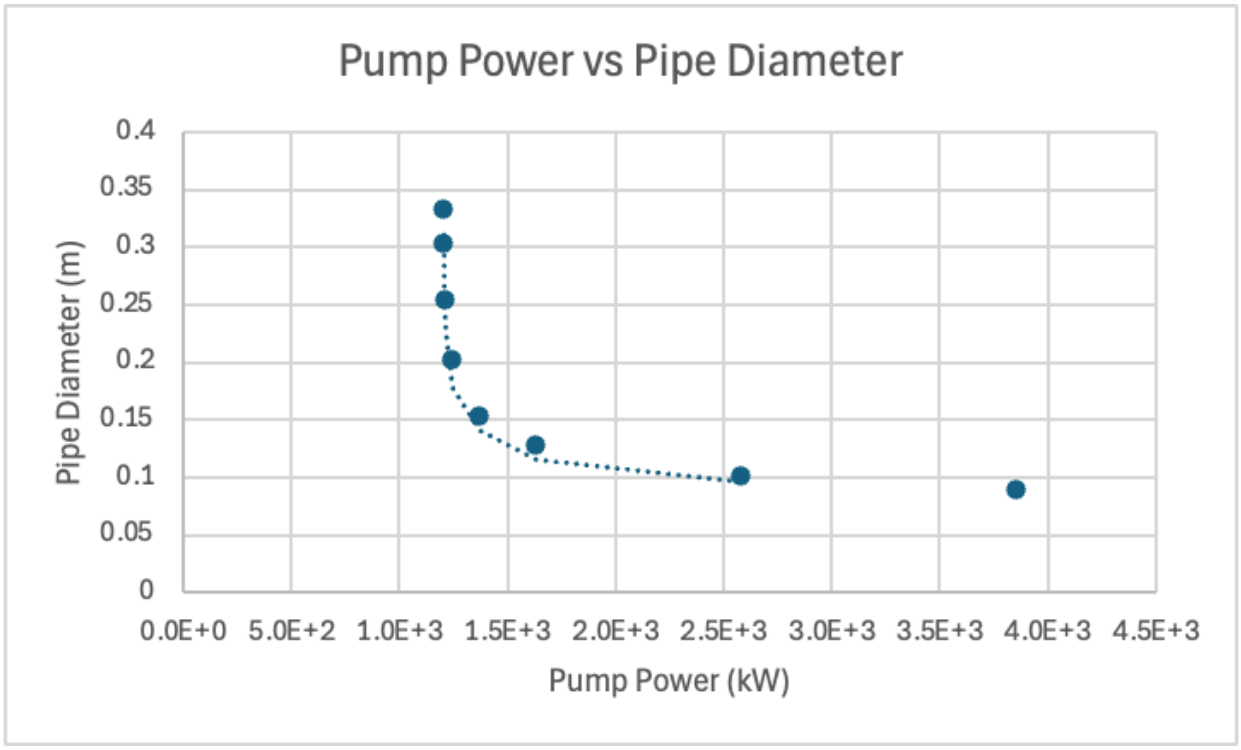


Figure 1

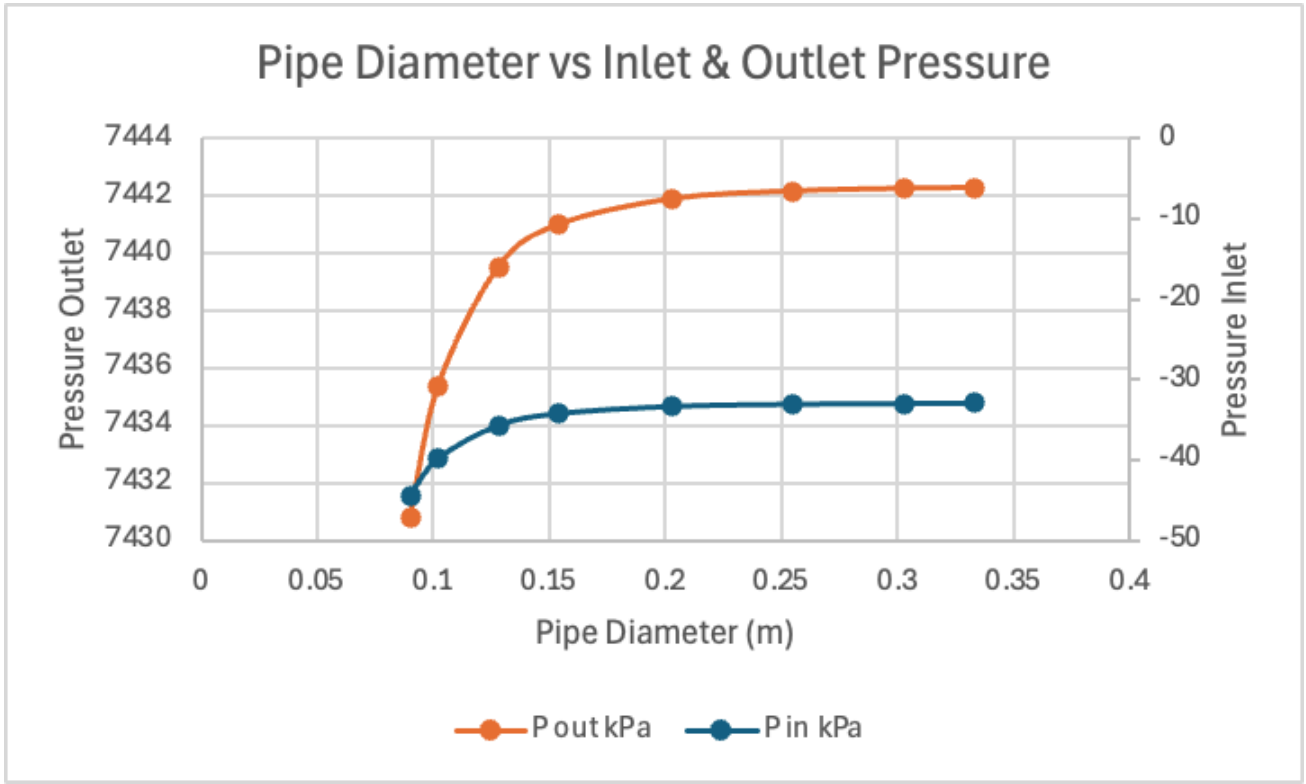
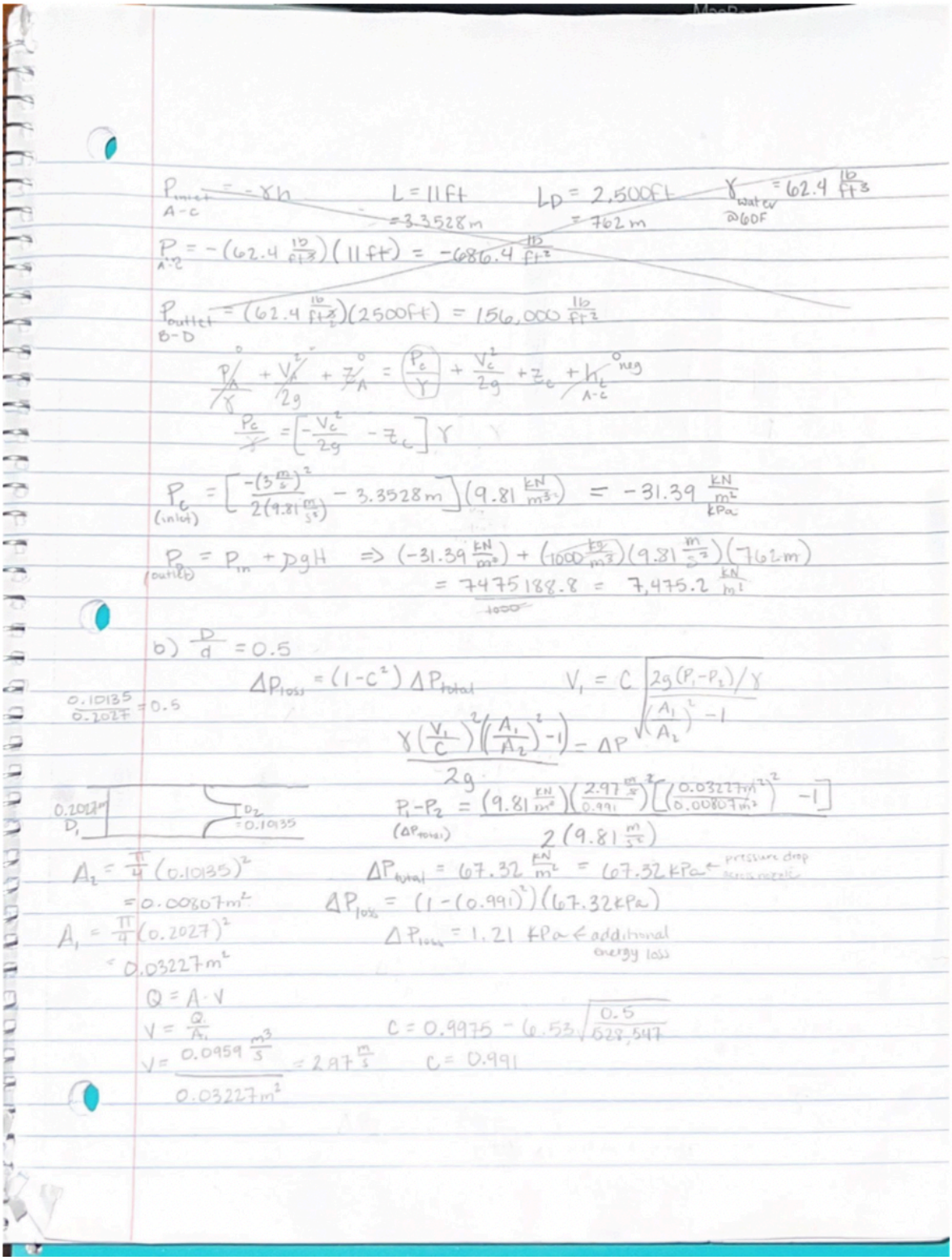


Figure 2

b)


P_{inlet} A-C $= -\gamma h$ $L = 11\,ft = 3.3528\,m$ $L_D = 2{,}500\,ft = 762\,m$ $\gamma_{water\ @60F} = 62.4\ \frac{lb}{ft^3}$
$P_{A-2} = -(62.4\ \frac{lb}{ft^3})(11\,ft) = -686.4\ \frac{lb}{ft^2}$
P_{outlet} B-D $= (62.4\ \frac{lb}{ft^3})(2500\,ft) = 156{,}000\ \frac{lb}{ft^2}$
$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_c}{\gamma} + \frac{V_c^2}{2g} + z_c + h_{L\ A-c}$ (neg)
$\frac{P_c}{\gamma} = \left[-\frac{V_c^2}{2g} - z_c\right]\gamma$
$P_{c\ (inlet)} = \left[\frac{-(5\ \frac{m}{s})^2}{2(9.81\ \frac{m}{s^2})} - 3.3528\,m\right](9.81\ \frac{kN}{m^3}) = -31.39\ \frac{kN}{m^2}\ kPa$
$P_{(outlet)} = P_{in} + \rho g H \Rightarrow (-31.39\ \frac{kN}{m^2}) + (1000\ \frac{kg}{m^3})(9.81\ \frac{m}{s^2})(762\,m)$
$= 7475188.8 = 7{,}475.2\ \frac{kN}{m^2}$ (÷1000)
b) $\frac{D}{d} = 0.5$
$\frac{0.10135}{0.2027} = 0.5$
$\Delta P_{loss} = (1-C^2)\,\Delta P_{total}$
$V_1 = C\sqrt{\frac{2g(P_1-P_2)/\gamma}{(\frac{A_1}{A_2})^2 - 1}}$
$\frac{\gamma(\frac{V_1}{C})^2((\frac{A_1}{A_2})^2 - 1)}{2g} = \Delta P$
$P_1 - P_2\ (\Delta P_{total}) = \frac{(9.81\ \frac{kN}{m^3})(\frac{2.97\ \frac{m}{s}}{0.991})^2\left[(\frac{0.03227\,m^2}{0.00807\,m^2})^2 - 1\right]}{2(9.81\ \frac{m}{s^2})}$
$D_1 = 0.2027\,m$ $D_2 = 0.10135$
$A_2 = \frac{\pi}{4}(0.10135)^2 = 0.00807\,m^2$
$\Delta P_{total} = 67.32\ \frac{kN}{m^2} = 67.32\,kPa$ ← pressure drop across nozzle
$A_1 = \frac{\pi}{4}(0.2027)^2 = 0.03227\,m^2$
$\Delta P_{loss} = (1-(0.991)^2)(67.32\,kPa)$
$\Delta P_{loss} = 1.21\,kPa$ ← additional energy loss
$Q = A \cdot V$
$V = \frac{Q}{A_1}$
$V = \frac{0.0959\ \frac{m^3}{s}}{0.03227\,m^2} = 2.97\ \frac{m}{s}$
$C = 0.9975 - 6.53\sqrt{\frac{0.5}{528{,}547}}$
$C = 0.991$