1) $\bar{V}_1 = \frac{Q}{A_1} = \frac{57/3600}{\pi(0.045)^2} = 2.49\ m/s$

$\bar{V}_2 = \frac{Q}{A_2} = \frac{57/3600}{\pi(0.015)^2} = 22.4\ m/s$

$\frac{P_1}{\rho g} + \frac{\alpha \bar{V}_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{\alpha \bar{V}_2^2}{2g} + z_2 + h_L - h_P$

$h_L = 7.5 \frac{V_1^2}{2g} = 7.5 \frac{2.49^2}{2 \times 9.81} = 2.37$

$h_P = \frac{400\,000}{9810} + \frac{1.06(22.4)^2}{2 \times 9.81} + 2.37$

$- \frac{120000}{9810} - \frac{1.06(2.49)^2}{2(9.81)}$

$= 57.69\ m$

$\therefore$ The Pump Power $P_P = \gamma Q h_P$

$= 9810 \left(\frac{57}{3600}\right)(57.69)$

$= 8960.7\ W = 8.96\ kW$

$\therefore$ The Pump Power is 8.96 kW

$Q = A_e V_e$

$V_e = \frac{Q}{A_e} = \frac{0.0611}{\pi \frac{(0.05)^2}{4}}$

$= 31.12\ m/s$

$\frac{P_1}{\rho g} + \frac{\alpha_1 V_1^2}{2g} + z_1$

$= \frac{P_2}{\rho g} + \frac{\alpha_2 V_2^2}{2g} + z_2$

$+ h_{turbine} - h_{pump} + h_{friction}$

$h_{pump} = \frac{\alpha_e V_e^2}{2g} + (z_2 - z_1) + h_{friction}$

$= \frac{(1.11)(31.12)^2}{2(9.81)} + 2 + 5 = 61.79\ m$

$P_{Pump} = \rho g Q h_{pump}$

$= (998)(9.81)(0.0611)(61.79)$

$= 36962.3\ W = 36.96\ kW$

$\therefore$ The Pump Power is 36.96 kW

2) $Q = 220 \frac{m^3}{h} \times \frac{1h}{3600s}$

$= 0.0611 \frac{m^3}{s}$

3) $V_1 = \frac{Q}{A_1} = \frac{2.3}{(\pi/4)(3/12)^2} = 46.984 \, ft/s$

$V_2 = \frac{1}{4} V_1 = 11.7 \, ft/s$

$P_2 - P_1 = (\gamma_m - \gamma_k)h - \gamma_k \Delta z$

$= (846 - 50.2)h - (50.2)(5)$

$= 796h - 251$

$\frac{P_1}{\gamma_k} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma_k} + \frac{V_2^2}{2g} + z_2$

$+ h_s - h_p$

$h_p = \frac{P}{\gamma_k Q} = \frac{8(550)}{(50.2)(2.3)}$

$= 38.1 \, ft$

$\frac{P_1}{50.2} + \frac{46.9^2}{2 \times 32.2} = \frac{P_2}{50.2} + \frac{11.7^2}{2 \times 32.2}$

$+ 5 + 8 - 38.1$

$\therefore P_2 - P_1 = 2866 \, \frac{lbf}{ft^2}$

$h = \frac{2866 + 251}{796} = 3.92 \, ft$

∴ The manometer reading is 3.92 ft

4) $Q = V_{out} A_{out}$

$V_{out} = \frac{Q}{A_{out}} = \frac{0.3}{\pi \times 0.3^2}$

$= 1.061 \, m/s$

$\frac{P_{in}}{\gamma} + \frac{V_{in}^2}{2g} + z_{in} + h_p = \frac{P_{out}}{\gamma} + \frac{V_{out}^2}{2g} + z_{out} + h_t + h_L$

$\therefore h_t = 1.5 - 0.3 - 0.2 - \frac{1.061^2}{2 \times 9.81} = 0.9426 \, m$

$P = Q \gamma_{sw} h_t$

$= 0.3 (1050 \times 9.81)(0.9426)$

$= 2912.83 \, W$

$= 2.91 \, KW$

∴ The power that can be produced is 2.91 KW